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Postmodal Art

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by

Josh Corey Simmons

Dissertation Committee:
Associate Professor Kojiro Umezaki, Chair
Professor Christopher Dobrian
Professor Nicole Mitchell
Professor Vincent Olivieri

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Dissertation Body

Introduction

Virtual reality is currently experiencing a massive resurgence in popularity. Dominant competitors in the market offer hardware at consumer attainable price points that continue a downward trend. The descent of hardware pricing and rapid innovation on the part of VR hardware manufacturers suggest that head-mounted VR has finally poised itself for mass adoption — something it failed to do during previous waves of VR popularity throughout the last few decades.

Along with these hardware developments, there have been commensurate advancements in the software tools that VR developers use to create artistic experiences for the head-mounted VR platform. For my own research I have used the Unity game engine to develop my VR simulation. Code libraries such as the one I used to integrate VR into my own gaming software, SteamVR, increase the ease of use even for those without traditional coding backgrounds. The competition between code library developers has driven the technological “barrier to entry” down significantly.

In recent decades there's been a specific technology where the barriers to entry have been lowered significantly. Artists are partially attracted to this new technology because of the sheer tactical concern of being able to spend more time creating than learning a new programming language from the ground up, or any other related inconveniences that may come as a result of integrating new digital technologies into one's work. The result of this phenomenon has been an increased number of computer musicians exploring the connection between music and VR.

This phenomenon is not isolated to music and VR, and I theorize that it is part of a larger movement in creative work that incorporate a wide variety of mediums that I have dubbed the Postmodal Era. Although this dissertation focuses mainly on the music-VR connection, it is important to understand the context into which this phenomenon fits, and the implications it will have for future artistic work in the community at large. As with the lowering of technological barriers to entry within the sphere of VR development, similar phenomena have occurred¹, and are currently occurring in almost every other artistic discipline. One such example is the recent lowering of barriers to entry in 3D animation. I first became aware of this around 2013 when I began to explore 3D animation. There were two key discoveries that I made around this time that suggested a larger phenomenon was occurring. Firstly, it would have been very difficult for me to incorporate 3D animation into my work even five years prior. Briefly put, reasons for this likely included the rapid increase of CPU/GPU speed in consumer-level computers, and the simplification of tools being used for animation. Secondly, after attending most of the major national and international conferences in computer music, I noticed that there was an increased representation of works integrating non-musical mediums, most eminently, 3D animation. It was clear that this evolution towards postmodality was happening not only in my own work, but internationally. Put simply, the Postmodal Era is an era of artistic work that releases the compulsory fealty of the artist to any set medium.

¹ Wagner illustrated this through his concept of gesamtkunstwerk where one auteur oversaw the production and integration of all artistic elements around a core story. In modern times, this concept is still present, yet different, due to the ability for the auteur to not only have creative control, but to also have an increasing ability to use the tools for production without the aid of others.

Within the realm of the postmodal music-VR connection, scholars, such as Hamilton, Serafin, and many others have created a number of interesting case studies exploring this link. The first section of this dissertation summarizes their research that can be considered useful for further inquiries into this connection. This review of the literature serves to uncover potential “best practices” for development in this area, and to begin to establish a lineage of research on this topic. As part of this section, theoretical principles are presented which serve not as an exhaustive literature review, as the VR field is far too amoebic to rigidly pin down, but as a demonstration for the music-VR artist beginning their own research.

The second section of this work explores the deeper implications of existing information on the connection between music and VR, and integrates more tangentially related disciplines that contain useful information. The symbolism of dreams, the psychedelic experience, myth, and artistic involvement in multimedia are examined in this section and contextualized under a framework derived from research on mythology. Examples of myth as a governing principle in historical postmodal work are considered in one of VR’s parent disciplines, opera, as well as one of my own works for fixed media audio and 3D graphics. To accomplish this, I borrow primarily from the work of Joseph Campbell’s monomyth model. I apply the model constructed in the previous section in the development of my own VR case study *Spektra*. After an initial public testing session of *Spektra*, I analyzed feedback from participants and developed a modified version of the music-VR instrument for another testing session. I conclude with ending remarks on this iterative development of *Spektra* and resultant findings. The iterative nature of the creation of *Spektra* will serve to illustrate one potential framework that I have found useful for creating a work that utilizes the music-VR connection. It is my hope that this work is helpful for computer musicians wishing to integrate VR into their own work.

The Postmodal Era

The field of computer music is mutating rapidly. The current rate of change, and dissolution of boundaries suggests that it, along with other related disciplines, will cease to exist solidly as individual entities, and instead integrate into a seamless, nonlinear continuum. In the relatively short time that I have been composing computer music I have observed a massive

increase in the acceptance of multimedia works into national and international conferences. As an artist working in multiple mediums I have reflected on this phenomenon for a long time. What does this increase in multimedia works in festival programming mean? Why are entire concerts at festivals such as the International Computer Music Conference, dedicated solely to multimedia art where animation or visuals dominate the sensory experience?

The most plausible explanation is an art-world version of a linguistic concept explained by Steven Pinker in his work *The Blank Slate*.

Linguists are familiar with the phenomenon, which may be called the euphemism treadmill. People invent new words for emotionally charged referents, but soon the euphemism becomes tainted by association, and a new word must be found, which soon acquires its own connotations, and so on. Water closet becomes toilet (originally a term for any kind of body care, as in toilet kit and toilet water), which becomes bathroom, which becomes restroom, which becomes lavatory. Undertaker changes to mortician, which changes to funeral director. Garbage collection turns into sanitation, which turns into environmental services. Gym (from gymnasium, originally “high school”) becomes physical education, which becomes (at Berkeley) human biodynamics [...]

The euphemism treadmill shows that concepts, not words, are primary in people's minds. Give a concept a new name, and the name becomes colored by the concept; the concept does not become freshened by the name, at least not for long. Names for minorities will continue to change as long as people have negative attitudes toward them. We will know that we have achieved mutual respect when the names stay put. (Pinker 2002, 212–13)

What struck me about Pinker's euphemism treadmill was the use of this concept as a tool to see past language. Seeing past the simple meaning of terms in this way, one can more fully comprehend the values of a culture. Applying this concept to the field of academic computer music can illuminate the values of groups functioning as a part of that culture. An interesting example of this is the evolution of the term tape music within the culture of academic computer music. The term tape music evolved into acousmatic music which was replaced by computer music.² This evolution allows us to see past the terms used. This three-stage metamorphosis focuses correspondingly on three types of technology: tape, quasi-digital tech, and computer. A focus on magnetic tape, and computer in the terms tape music and computer music, respectively, is implicit in the terminology used. Understanding the technical substrate utilized by acousmatic

² An argument can be made that these various terms are all still usable, but the overall eminence in casual and professional parlance of each term across the chronological listing I have proposed among groups of computer musicians is indisputable.

music is not implicitly obvious. Eminent figures in the field of acousmatic music have written extensively about the term and its meaning. A French acousmatic composer, Francis Dhomont provides a glimpse into the world of acousmatic music:

Today the act of hearing a sound without seeing the object from which it originates is a daily occurrence. This happens when we listen to a CD, a radio programme, or when we communicate by phone, etc. In fact, we are unsuspecting acousmatic practitioners. Yet, in these examples it is not the message that is acousmatic but rather the listening conditions for the communication of that message. Mozart, as he wrote the symphonies which we now hear in our living rooms, was not thinking of the CD but rather of live performances by an orchestra; on radio or disk, ‘. . . the announcer and the orchestra are absent, and yet they exist or, at least, existed during the recording, and that’s the only thing that counts’ (Bayle 1993, 51). In order to be designated as acousmatic, a composition should be conceived for an acousmatic listening environment, giving priority to the ears. This fundamental distinction is not always clearly understood by neophyte listeners. (Dhomont 1996, 24)

Dhomont outlines two main tenets of the acousmatic music genre in this passage. Firstly, the music is heard but not seen. At the core of this concept is a consideration of the recording as the work, as opposed to an acoustic performance by human musicians. Secondly, Dhomont explains that this listening experience must employ quasi-digital technology such as that found in a CD player. If we are to look at this through the Pinker-lens of the euphemism treadmill, that is, looking past the in-vogue terminology to more intimately understand the values of a culture, we can see that acousmatic music places a high value on quasi-digital technology.

The unifying element between the terms tape music, acousmatic music, and computer music are their eminent concern with the technological medium being used in the production of work in the genre. One can derive two deeper values at the core of artists working in this genre. First, there is such a preclusion with the employed technology that it sometimes seems unfitting to name them genres. I am using the term for simplicity here, but several issues arise because of its use, not the least of which is its inverting descriptive and prescriptive terminology. Genres such as punk and country each imply a style and a culture which create the music. Genres such as grime, and cool jazz imply something close to the mood, or environment that the music invokes. Some genre terms explicitly describe the sounds that one hears while listening to music in that given genre. These genres include those such as mumble rap, and djent. Mumble rap, although typically used as a pejorative, is an understood genre title by those working in hip-hop. The genre implies that the rapper’s delivery style will be mumbled as opposed to being

composed of intelligible, clear speech. The mumbled delivery and the culture surrounding this genre imply the use of sedative and painkiller medication during recording sessions. This is further verifiable by examining the death of eminent mumble rap artist Lil Peep who died as the result of an accidental painkiller and sedative overdose, as well as consulting album titles of artists associated with the genre, such as Kodak Black's *Codeine Dreaming*.

Djent is one of the most clearly descriptive genre monikers. The term djent is an onomatopoeia for the low, palm muted, distorted sound that is characteristic of the genre.

[...] the interesting thing about djent is that this scene doesn't exist in a traditional geographic sense. Although inspired by bands such as Sweden's tech-metal pioneers Meshuggah – who coined the term "djent" a decade ago – and the British band Sikth, the genre and its distinctive sound has been driven forward by bedroom guitarists using virtual amp setups and computer recording programmes, then trading songs, riffs and tips on online forums – a kind of Second Life for guitar geeks. (Thompson 2011)

Despite the extreme reliance of djent on a technical substrate for its creation and proliferation among a community, it is notable that the genre title resists the same prescriptive impetus such as that found in the genres tape music, acousmatic music, and computer music. Perhaps this is due to the rooting of most musicians working in these genres in the tradition of composed music. Composed music employing Western notation insists upon the primacy of prescriptivism. Sheet music put together by the composer is essentially a set of prescriptive actions for a performer to execute in an agreed upon manner. It is possible that the outgrowth of this tradition into the electronic realm is inclined towards prescriptivism as opposed to descriptivism. The importance of the technology used for production of computer music genres is highlighted by its inclusion in the taxonomy of the genre.

Secondly, one can derive that the community of artists working in the tape music, acousmatic music, and computer music genres are concerned not only with the prescriptive notion of the compositional process, but also with an overwhelming adherence to modern technology. This specificity and consistent change of genre monikers suggest that an importance is placed on technological "progress". In an interview conducted by Dick Witts for "The Wire", composer Karlheinz Stockhausen illustrates this point:

[DW] Have things got easier for you?

[KS] No. really not. The last three weeks I just spent every day in the studio, eight hours, working with a new digital technique with a Capricorn mixing console, the newest one, from Siemens, or the English Nieve Nicam, from Cambridge, and two 24 channel Sony tape recorders, one being the leader and one

running in slave, in order to make very special movements in space... And I must tell you that out of eight hours per day I waited seven hours without any result, because the technicians, sound engineers, didn't know how to deal with these instruments, and had never encountered problems which I had imposed. So it is becoming more difficult for me. (Witts 1995)

Not only does Stockhausen mention a significant number of music technology apparatuses, he does so without being asked about these details, and in the context of an interview that apart from this response does not delve significantly into technical description. There is also a clear emphasis on the innovative and laborious aspects of the technique mentioned by Stockhausen, as if the composer is straining to wrangle these tools into artistic harmony, "...I just spent every day in the studio, eight hours, working with a new digital technique..." (Witts 1995). This focus on technological progress is somewhat unique to the genres associated with, or in the lineage of tape music, acousmatic music, and computer music.

This unnatural preclusion with modernizing terminology surrounding production technology is not visible in many other closely related mediums. Most obviously this contrast appears when considering mainstream electronic dance music.³ The term DJ is still widely used in mainstream electronic dance music. The term was conceived as technologically relevant during its first uses as it referred to the use of sound systems driven by vinyl records. Some modern DJs still use vinyl records in their live performance setup (Boiler Room 2014), while others use a modern digital adaptation known as CDJs (Boiler Room 2018). Despite being digital, CDJs still mimic precisely the form factor and control scheme of their vinyl counterparts. This is significant to note because it directly contrasts the drive to reinvent completely found in the genre-lineage of computer music. Despite the developments in DJ technology, the musical instrument design of the genre looks backwards as much as forwards.

Summary

The genre-lineage of computer music is fluid, technologically reinventing itself, and highly concerned with the prescriptivism set about by the creation tools used by the artist. Faced with a plethora of new post-computer tools, the computer music community is now seeking a new direction for development, but this path is not as clear of a next step as it has been in the

³ Use of this term is to include any electronically created music disseminated with the primary intent of providing music that an audience can dance to. Whether or not this pursuit is successful is irrelevant to the term as I'm choosing to use it here.

past. Kim Cascone, in his paper The Aesthetics of Failure: "Post-Digital" Tendencies in Contemporary Computer Music writes a call to action for researchers to continue this innovation:

... new tools must be built with an educational bent in mind. That is, a tool should possess multiple layers of abstraction that allow novices to work at a simple level, stripping away those layers as they gain mastery. In order to help better understand current trends in electronic music, the researchers in academic centers must keep abreast of these trends [...] In this way, the gap can be bridged, and new ideas can flow more openly between commercial and academic sectors. (Cascone 2004, 398)

Cascone highlights the need for researchers to seek new technologies. He also suggests making the boundary between commercial and academic sectors more permeable, possibly to vet new technologies for academic research. Cascone is not the only artist working in this sphere that proposes questions about what is to come after computer music without offering foresight into this future. An entire academic community and conference has formed around this question. The annual NIME Conference is described as follows:

The International Conference on New Interfaces for Musical Expression gathers researchers and musicians from all over the world to share their knowledge and late-breaking work on new musical interface design. The conference started out as a workshop at the Conference on Human Factors in Computing Systems (CHI) in 2001. Since then, an annual series of international conferences have been held around the world, hosted by research groups dedicated to interface design, human-computer interaction, and computer music. ("International Conference on New Interfaces for Musical Expression" 2012)

The far-reaching possibilities of what can be included under the NIME umbrella suggests that again the question of what's next is posed but not answered. This year there will be a small VR workshop at NIME 2018. The description of this workshop highlights Cascone's urging to bridge the gap between academic and commercial sectors,

Leading technology companies today are growingly becoming invested in VR audio with new products, such as Facebook's Spatial Workstation and Google's Resonance Audio, that facilitate the use of Ambisonics and binaural audio with popular VR platforms. ("NIME Workshop on Audio-First VR" n.d.)

Importance for Artists

In addition to outlining the influence of the commercial sector on modern research in this field, the workshop description highlights the fundamental challenge facing artists working in VR coming from computer music fields:

However, most modern VR systems impart an ancillary role to audio, where sounds serve to amplify visual immersion. It is up to sound and music researchers to elaborate ways in which we can think natively about VR audio, and define the role of sound in the ultimate displays of the future. This workshop aims to

investigate the concept of an “audio-first VR” as a medium for musical expression, and identify multimodal experiences that focus on the auditory aspects of immersion rather than those that are ocular. (“NIME Workshop on Audio-First VR” n.d.)

A subtle but identifiable shift is taking place in the lineage of computer music. More artists are beginning to realize that a severely diminishing point of return has been reached in audio-only discoveries. For research in this field to continue to innovate, and discover new ground, it must redraw, or possibly eliminate the boundaries between audio and other mediums.

As of this writing, it is a rare practice for a consumer of entertainment to single out one sensory mode of experience for their entertainment. What is much more common and accepted in society is to enjoy multimedia experiences that use multiple sensory modes at once, such as a film or a live concert. In addition to this, most contemporary people’s lives are dominated by a multimedia rich Internet accessible on personal devices at any time. Therefore, the audience is primed to experience multi-media as opposed to single-medium.

Audio production is now one of the easiest⁴ artistic mediums to produce content in. Video streaming sites such as YouTube are filled with tutorials by young high school age gurus teaching advanced concepts in music production, concepts that until 10 or so years ago would have been limited to study at the academy. There are a bevy of smartphone apps available that can produce musical results of a high quality (or at least of high enough quality to entertain the general audience). Video production and 3D animation will follow this same trajectory, but the limiting factor is available processing power. For such applications to become simplified and deployable on mobile devices, these devices must have sufficient processing power. Once becoming available on consumer level devices, the tools will be available to and usable by a wider range of creators.

Many electronic musicians will argue that the research they are doing and the audio they are creating is pushing the boundary of what is possible with currently available software. However, most general listeners will never be able to hear the minute nuances that they are taking pains to create in the audio. One could perhaps argue that the listening capability of the average user will evolve to accommodate listening techniques necessary to perceive these small changes. However, this is not typically what happens in the domain of computer music. For

⁴ i.e. requiring the least computational power and having a large set of automated tools.

example, when the synthesizer was invented, its audio quality was easily perceivable as different than any other acoustic instrument previously heard. This research into new sonic territories is relevant and important, but it is not suitable for communicating with a general audience. If the crusade of the composer is to more effectively communicate their ideas with a general audience, they must begin to look beyond sound as I believe many composers are already doing.

As more composers continue to look beyond audio as the sole medium for artistic creation and as these audio production techniques become more available and more simplified for a general audience to use, the barrier to entry for using these techniques, and thus their value, is lowered significantly. If the composer is to continue creating art, requiring a high level of skill to create that also communicates their ideas effectively, the composer will have to think about how to thoughtfully integrate ideas from different mediums. There is a lot of stumbling going on with this at present. These are the early growing pains of this new discipline and way of understanding art. The divisions between mediums are murky or even nonexistent. These early missteps are positive. Criticism cannot be leveled against nothing it must be leveled against something. Beginning to foray into this new undivided terrain are the avant-garde composers and artists.

The existing solution for composers looking beyond the medium is to branch out into exploration with multimedia, i.e. adding more mediums to accompany audio. This is typically accomplished through their own creation or through collaboration with an artist in another medium. This is a technique that has sufficed throughout the past few decades but is no longer viable because of how rapidly technology and new mediums are being invented. Ray Kurzweil details this phenomenon in his work *The Singularity is Near*. Kurzweil theorizes that as processing power grows exponentially, technological development will also grow exponentially. This is Kurzweil's adaptation of Moore's Law (Kurzweil 2005, 59–74). Kurzweil's proposed end of this phenomenon is something he has dubbed the singularity. The singularity is the point at which technological development will happen at such a fast rate that humans will not be able to perceive it. Although the validity of this theory's future implications is up for debate, Kurzweil's formulation of Moore's Law can be applied to technological development over the last century or so with reasonable accuracy. The implications of this are far-reaching and affect not only technology but also the artists that work with that technology.

It is due to this exponential growth paradigm and Kurzweil's formulation of Moore's Law, that artists must prepare to abandon strict adherence to a set of mediums. Multimedia art is the first step in this liberation of medium. Soon, the artist will have to go further than this. The artist will have to learn how to take techniques and principles from their own discipline and rapidly apply it to new mediums, sometimes working with these mediums for the first time (and possibly the last time).

Defining Postmodal

Postmodal is the term that contextualizes my larger body of research. It is necessary to sufficiently define this term to discuss my specific work in integrating audio and virtual reality. Before defining postmodality, one must define what it is not. Postmodality is not the same term as multimedia, although multimedia art can be under the umbrella of postmodality. Multimedia art is, by its most simple definition, artwork that employs the use of two or more mediums. The term multimedia says nothing about who creates the different component parts of the work. Multimedia work can be created by a single artist working in multiple mediums, or by multiple artists contributing to the work in various capacities across various mediums. Multimedia art is often compartmentalized. This compartmentalization is most evident in the division of mediums in the work. Whether the work is created by multiple artists, or a single artist each singular medium employed in the work is typically conscious of meeting specific concerns such as best practices, established techniques, etc. For example, in a multimedia work involving video, the video artist will be aware of one of the most basic best practices of video art, aspect ratio. Most commonly, the video artist will select an aspect ratio that has been long established in the medium. If the artist chooses to use a different aspect ratio then they are consciously going against an established tradition and are likely aware of this.

Postmodality questions the division between mediums and posits the long-term superiority of portable aesthetic over technical knowledge. My first experience with this was when I created the work INDRA//NET for 3D animation and digital audio. In the period before the creation of INDRA//NET, I classify myself as a computer music musician who had some experience with 3D animation. My multimedia works before INDRA//NET followed the typical workflow pipeline of someone creating an animation. This pipeline involved the creation of the 3D animation and then sound tracking this animation after its completion. Before beginning

work on INDRA//NET I had a very clear image of what sounds I wanted in the work. After meditating on the sounds for some time I began to have a clear image of what the visuals should look like. This unfolding process of ideas made it clear to me that the audio must be developed first in the creation of that work. After finishing the audio for the piece, I began work on the 3D animation component. During this process the audio inspired me to create elements in the animation that I believe I would not have otherwise come up with had I created the visuals before the audio.

In this mutable process of multimedia creation, the very choice of mediums, how to employ them, in what order, etc. become as much a conscious part of the work as the sonic material. An artist cannot simply begin their journey working in postmodality. An artist must begin working in a single school in a single medium with a clear sense of desirable and undesirable elements. Conforming and rebelling against this established system will allow the artist to discover their own aesthetic. My aesthetic was forged within the framework of European modernist composers. Once I learned the “rules” of the game of European modernist composition I was able to begin questioning the rules that did not make sense to me and accepting the rules that made sense to my aesthetic.

Once the artist has developed an aesthetic in a given medium, they may begin experimenting with other mediums in conventional and unconventional ways. As the artist tries to port their aesthetic from their original medium into new mediums, they will begin to form a sense of portable aesthetic.

It is necessary to foster a sense of portable aesthetic to create work that is truly postmodal, instead of merely multimedia and compartmentalized. Having a unique portable aesthetic allows the artist to permeate each of the mediums employed in a work with their own unique style. Without this portable aesthetic, each of the components of the work are clearly divisible from the other components of the work.

A clear example of portable aesthetic and postmodal art is the multimedia work of Ryoji Ikeda. Ikeda is a multimedia artist who primarily creates glitch art. Understanding Ikeda’s work through the lens of computer music, one can quickly identify a few aesthetic features. These features include rapid on and off audio envelopes, cyclical patterns, and sonic material that contains an element of purity. Examining Ikeda’s audiovisual installation Test Pattern, one can

clearly see Ikeda's musical aesthetic manifested in the visual domain. Test Pattern is installed in a large industrial setting such as a warehouse. Projection visuals are cast onto the floor and one wall of the space. These projection surfaces are massive with some installations measuring hundreds of meters.

The projection visuals mirror the aesthetic quality heard in the audio. Rapid on and off envelopes are clearly ported to the visual domain by means of white and gray rectangles that rapidly fade on and off instead of fading in and out. Cyclical patterns are represented in the visuals through recurrence of color and shape. An element of purity is clearly discernible. The piece essentially uses no curves and most of the visual material consists entirely of squares, rectangles, and lines in black, white, or some shade of gray in between. Through full integration of all elements of the work by means of a portable aesthetic that is liberated from any one medium, the entire work becomes unified in a way that encourages the audience to focus on the gestalt, instead of the individual components forming the work.

My own research is an attempt to create a new work that is entirely postmodal from the ground up. The two main components involved in the work are musical feature extraction and virtual reality. I have attempted to integrate these two features in such a way that the lines between the mediums are significantly blurred. At every stage of the design process I made decisions about what was most representative of my portable aesthetic. The result is a simulation that integrates the two mediums in such a forged way that the user has difficulty delineating between the two.

To avoid going over the same ground, I've conducted a great deal of research in the fields of virtual reality, as well as in multimedia art from the computer musician perspective. The first section of this dissertation will outline the discoveries made by scholars in the fields of VR and computer music, as well as outsiders and fringe figures from other disciplines that have bearing on discoveries in these fields. I will detail a set of design principles that I have found to be helpful in the process of forging my own portable aesthetic and remaining relational to computer music but not bound by it.

Although I have worked in many different mediums, these postmodal concepts are difficult to write about in the abstract without applying them to a concrete example. The human

body cannot be studied without dissecting one. The concrete example that I have built is a fusion of virtual reality and digital audio into a unique medium.

How to Proceed

Approaching this kind of postmodal development without any kind of formal framework. I found it helpful to think about the design process both before creating the work and during the development phase. The question that was continuously at the back of my mind during the development process was “What is music’s unique contribution to virtual reality?”

I sourced my research extremely widely. When doing research on art that exists outside of a strict medium, it made sense to source from a wide range of formal and informal disciplines. After reading narrowly within the field of music technology, as well as widely in many other fields, it became clear to me that a survey of purely musical literature would not do for the creation of this VR project. Bringing in knowledge from other fields seemed to be at the very core of VR innovation, so it followed that sources for design frameworks should come from various disciplines. Sourcing widely is the most important design principle for computer musicians foraying into VR territory. The artist must constantly be observing and sourcing widely to create new design principles. VR is a major step in a progression in which various mediums will start to converge into postmodality. After a long period of segregation by medium, disparate fields will reintegrate. Richard Wagner’s only failure in his concept of gesamtkunstwerk was that he was a thinker too far ahead of his time. Wagner’s integration of various mediums created groundbreaking works of art, but unless one had robust financial support and extensive human resources⁵ it would have been nearly impossible for an individual artist to do this in a convincing manner during Wagner’s active years. Similarly, Jaron Lanier’s ideas for the VR platform were visionary but unfortunately too far ahead of the state of consumer grade technology, thus prohibiting their wide adoption, and ultimately enough monetary revenue to continue developing.⁶ These roadblocks are becoming less imposing with the introduction of new technologies that allow creators to make aesthetically pleasing works in any digital medium, and some physical ones. An example of this in the physical space is the 3D printer. The 3D

⁵ ...such as Wagner did.

⁶ One such idea was a haptic feedback glove (thekinolibrary 2017). This concept has now been expanded from glove to bodysuit, and is priced at the consumer level (Singletary 2017).

printer allows anyone familiar with 3D modeling software to fabricate their own physical goods, something that would've been prohibitively expensive until the introduction of this new technology. Opportunities for intersections of knowledge across fields are extensive, and have a long lineage in the arts, but are also starting to appear with more frequency in information science fields (Baguyos 2016).

When approaching creation in a new medium, the artist must consider what the component parts of the medium are and what might be researched to inform creation. Through the study of these component parts, the artist, applying their own portable aesthetic to the new field can begin to discover what rules work with their aesthetic and what rules go against it and should be broken. For building a music-based VR simulation, I decided to look at several component fields — science fiction, psychedelic drugs, video games/game studies, and music-based multimedia art.

When designing for any new technological medium, it is advantageous to look towards the writings of science fiction writers. Science fiction writings contain a wealth of insightful information about VR. The ideal sci-fi author to study has an established track record of reasonably correct predictions and creates concepts that are inspiring to the reader. William Gibson meets both criteria in the field of VR. Gibson's work *Neuromancer* (W. F. Gibson 1997) is the seminal work of the cyberpunk genre. Gibson coined the now widely used term "cyberspace" (W. Gibson 1982), predicted the ubiquity of the web, and foresaw the field of VR's expansion. Gibson also creates works that are inspiring to the reader. *Neuromancer* was the first novel to win the Phillip K. Dick Award, the Hugo, and the Nebula (Cumming 2014). The Cyberpunk genre as a whole is succinctly summed up as "high tech low life" (Ketterer 1992). I do not know of a more apt summary for the spirit of computer music's inventive spirit now applied towards expansion into virtual multimedia.⁷

Lineage

Before branching out it is advantageous to look for historical manifestations of postmodal art. A notable early example of historical postmodal art is the operatic work of Richard Wagner.

⁷ There are many other visionary authors that the computer musician can look to for models of how to use.

Let us therefore first agree as to whom we must consider the creator of the Art-work of the Future; so that we may argue back from him to the life-conditions which alone can permit his art-work and himself to take their rise.

Who, then, will be the Artist of the Future?

Without a doubt, the Poet.

But who will be the Poet?

Indisputably the Performer

Yet who, again, will be the Performer?

Necessarily the Fellowship of all the Artists. (Wagner 1892, 81)

Wagner's early experiential research and philosophy laid early groundwork for the development of postmodal art. His integration of various mediums and position as auteur of the creative process put his ideas and artistry at the center of development in all mediums to be employed during his productions. Due to the massive resources necessary to put on these kinds of productions it is not surprising that Wagner's new paradigm did not catch on outside of his own coterie at that time. The near impossibility of constructing such a media-diverse work at that point in history is undoubtedly one of the reasons his work is still considered so outstanding by scholars. At present day, media creation tools have become more accessible to artists using technology to such a sufficient level that Wagner's concept of gesamtkunstwerk will finally begin to catch on in the mainstream of artistic creation.

The Wagner excerpt above sets clear the path of development for postmodal art, as well as one of its central issues in development. Wagner specifies that the poet will be the artist of the future. I have chosen to interpret poet to mean a tone poet, i.e. a composer that tells a story through music. The central challenge that this highlights is how to keep music as the central generating force of postmodal art.

Summary

To successfully design a postmodal work with a musical basis, I first defined the scope of my project. I subsequently considered which mediums might feed into the work. The bounds of the work were defined as follows: the work would be for the VR head mounted display, the system would generate a virtual world based on real-time audio input, the audio input could

come from a musician wearing the headset and concurrently playing a musical instrument, or the user could stream music from whatever source they desire, such as Spotify.

After setting the bounds of scope for the work, I broke down the dependencies of this medium to see what kind of knowledge could be garnered from each, and how this knowledge could be transmuted into the other mediums involved in the development. I considered music's unique contributions to the medium. Music's primary contributions to virtual reality art were that musicians already had an existing skill set that could be leveraged in the design of the experience. Also, music's own existence necessitates the existence of time, and the placement of events in this temporal framework. I considered the essential parts and precursor technologies that helped to form VR. Unsurprisingly, one of these fields was video games. Video games, and the field of game studies are two of the most idiomatic additions to the project's foundation. This was a natural inclusion as the entire simulation would be constructed using a video game engine – Unity. The genesis of VR as medium itself would also play an important role in my design process. The history of VR, albeit brief is rich in detail and includes figures from the establishment tech world as well as fringe figures. Jaron Lanier and Ray Kurzweil are two figures under the umbrella of this topic that are representative of larger sects in the foundational tech world. For the purposes of limiting my research, I decided to focus primarily on these two figures. While researching the early days of VR in Silicon Valley, I became interested in many of the fringe figures that were involved in its development. These fringe figures included science fiction writers and psychologists, among others. Science fiction writers active around this time functioned as journalists of the collective vision of the future of technological development in Silicon Valley and larger, more decentralized countercultural movements. Psychedelic drugs and psychedelic drug culture also played an important role during this time. Psychedelic drugs served as a "unifier of mediums" for many having experiences with plant hallucinogens. Many of the reports given by users taking these drugs seem to suggest that these hallucinogens are chemical means of providing a postmodal experience — where the lines between mediums, blur, and meaning permeates multiple mediums making the distinction between them ultimately irrelevant. The culture surrounding these drugs is also deeply entwined with Silicon Valley at that time. Counterculture figures such as Timothy Leary had distinct visions for the future of VR. It was

not uncommon for counterculture figures such as Leary and his associates to mingle with the developers in Silicon Valley working on VR (hackertrips 2015).

Some practical more meta-level considerations had to be taken into account as well. At the time of this writing, I worked with a bulky HTC Vive headset. Due to the sheer physical constraints of this apparatus, display ergonomics must be considered. Most of these concerns were obvious but writing about and studying them explicitly aided in the avoidance of accidents in the lab.

In addition to serving as a proof of concept for my research, I wanted the VR experience to be able to stand alone as a work of art. Aside from embodying all of the considerations listed above, the work would have to be representative of my own aesthetic – a test that multiplies exponentially in its difficulty, and level of consideration required for execution when working with multiple mediums.

One composer and multimedia artist Ge Wang has experimented extensively within this topic and written about the results of these experiments. Wang functions in a multimedia landscape that is based in music. One of Wang's own design principles is to make a multimedia experience real time whenever possible (Wang 2014, 2).

Existing Research

Music-VR and Postmodal Art

Real Time Whenever Possible

This rule holds true on two different levels of development for the platform. Firstly, the environment must respond in real time to the user. This real time responsiveness invites users to play and interact as if the environment was a living thing. Overuse of fixed media on such a dynamic platform creates an experience that is stale for the user. An overly fixed environment allows a user to feel as though they are in the scene, but the lack of interaction creates a sense of being separated from the simulation. Secondly, the system must be as low latency⁸ as possible.

⁸ The term latency when referring to the VR platform in this dissertation should be taken to mean the time between physical action, and event rendered on screen, e.g. the time between a user moving their head, and the rendering of the virtual camera to represent this movement in 3D space.

On the VR platform, a low latency system would be less than approximately 50 milliseconds, and a high latency system would be more than approximately 90 milliseconds (Meehan et al. 2003). If latency is present in the system, it must be intentional, and thus the result of careful consideration and conscious design. Unintentional high latency risks unwittingly making the user sick at worst and disconnected from the experience at best.⁹ When in doubt, VR environments must have a high resolution of user response and utilize low latency unless there are intentional reasons for doing otherwise.

Real time input is essential to keep the composer, the tone poet at the center of postmodal artistic creation. Musicians are masters of time. Unlike studio art, music cannot exist outside of time. A musical sample frozen in time on the computer cannot be heard but can only be experienced and only exist over time. The same phenomenon cannot be applied to any other medium. Film is the closest application of this phenomenon. Film can partially exist outside of time. The fundamental unit of film is the frame. If one is to examine one frame of the film outside of the confines of time, the viewer will likely be able to extrapolate some limited meaning from the individual frame. Dance is another close representation of this time-necessary phenomenon. One of the primary features of dance is motion. Motion can only exist in time. However, eliminating time from dance and witnessing a dancer frozen in motion, frozen in time, the viewer may still be able to extrapolate meaning from things such as costume, posture, etc. Despite the recurring and persistent attempts of music technologists to force us to consider music as platonic, physical objects,¹⁰ music is the only medium that cannot exist outside of time.

The simplest and most accurate definition of time is change. In music, change occurs on micro and macro levels. At the micro level, there are soundwaves. Soundwaves by their nature consist of change, i.e. fluctuations in amplitude at various speeds. Musical change occurs at macro levels, such as when notes change in the progression of a scale or melody.

When I say that musicians are masters of time, I mean that they are masters of time through years of rigorous practice. Time is the unifying element between all genres of music. Pieces of music may evoke a sense of timelessness, such as Olivier Messiaen's *Quartet for the End of Time*, but they must still exist with time. If one is to examine the practice habits of the

⁹ Both states that may be desirable for the creator looking to intentionally invoke them.

¹⁰ See *Guide to Sound Objects* (Chion 1983).

classically trained musician, one will observe primarily that the practicing of scales and études form a significant portion of the musicians practice routine. These scales and études at the most fundamental level, are exercises for practicing change in a metered way that is aesthetically pleasing to the music that they intend on performing.

Musicians are also highly adept at creating a robust data stream in real time. If one is to consider their mastery of time a skill in the horizontal domain of music, then the vertical domain of music is the data resolution of events occurring across this horizontal domain. The data resolution is comprised by the notes, tones, techniques, etc. that occupy these time-spaces. Some of the musician's practice time is also dedicated to honing technique in this vertical domain. One such practice is "long tones". During long tone practice the musician sustains notes for long amounts of time paying minute attention to the quality of tone. This practice is undertaken with the goal of integrating the ideal tone into music that exists in the time domain. It is these two domains, time and data resolution, that make the musician and the musical instrument compelling tools for VR data input. The musician and instrument then become both a high speed and high-resolution input device for the system, the kind of which is unprecedented in existing models such as the handheld controller.

VR Musical Instruments

A small amount of research¹¹ has already been conducted by computer musicians in this domain. Serafin et al. in their paper *VR Musical Instruments: State of the Art, Design Principles, and Future Directions* propose that the computer musician designing for virtual reality "make use of existing skills".

Users of traditional instruments may not even be interested in using virtual replicas, since the original ones work well. Instead, we should discover the kinds of interfaces that are best suited for the VR medium. Using metaphors derived from interactions existing in the real world offer interesting possibilities. (Serafin et al. 2016, 27)

The gist of this principle is partially correct - VR musical interfaces should be unique to VR yet be based on existing musical instrument paradigms. This has been previously articulated

¹¹ In the years it has taken to write and revise this document, this field has exploded in popularity. I served on the paper review board for the sub-topic of music-VR interfaces for both the NIME and ICMC conferences.

by product designers such as Dieter Rams, e.g. "Good design makes a product understandable" (Domingo 2017). Understandable, from the musician's perspective, could be defined as using familiar gestures to the user's physical musical instrument. However, when designing for this platform, one must also consider that videogame-based paradigms have already been established. Considering that many computer musicians begin, at some point, as acoustic musicians, and at the very least are surrounded by acoustic musician colleagues during their academic journey, the point that must be discussed is acquisition of knowledge pertaining to video game-based VR paradigms. There are three useful acclimitization exercises for the computer musician attempting to make a foray into the VR platform: reading about VR development, experiencing VR games, and modding.¹² Reading about VR development can equip the computer musician with a robust theoretical knowledge of the platform. The research presented by Serafin, et al. does a wonderful job of synthesizing a wide range of papers in this vein. Yet, one should not devote all their time to this practice. To use a musical comparison, devoting all of one's time to reading papers on the topic would be akin to merely reading Beethoven scores, but never listening to the music — theoretical knowledge is obtained, but something profound is missed. Simply playing a wide range of VR games can be illuminating as to what game mechanics work well and which ones work poorly. This research can be thoroughly enjoyable. One should allow themselves to be immersed entirely in the game without critically thinking so that they have an authentic experience. After completing the game, one should immediately journal about the experience to turn the experience into actionable knowledge. Finally, another potent étude for computer musicians expanding into VR is to modify existing games. There is both an existing body of research on this practice¹³ and a huge online community of both niche and widespread mods. Mods in this online community range from practical ones such as higher resolution textures for existing games (Livingston 2017), to entirely new games built on an existing platform (Montero 2012). These considerations guarantee that computer musicians will be able to create environments that make use of both the idiomatic design elements derived from musicians as well as gamers.

¹² This is gaming parlance that refers to the practice of modifying existing games.

¹³ Further reading in (Weinel 2010; Scacchi 2011).

Whether music is being fed into the VR simulation from a live musician, or from a recording, the ideal simulation should be able to track significant changes in tone in a way that most accurately approximates real-time with minimal latency. What is minimal latency? Drawing from my own experience as a music technologist, I approached the question from the perspective of digital audio. A common introductory experiment in music technology is to play a sawtooth oscillator for an audience at its lowest frequency, for this example 5 Hz. At 5 Hz, the sawtooth oscillator produces a rhythmic clicking at the pace of 5 times per second. At this frequency every audience member can hear separate click events. As one increases the frequency of the oscillator, the clicks become faster, and eventually turns into a contiguous tone. The frequency at which this occurs can vary from about as low as 10 Hz for some individuals to about 30 Hz in others. The number most commonly given in this range as the low end of the range of human hearing is 20 Hz. The speed of oscillations at 20 Hz calculates to one oscillation every 50 milliseconds. Unsurprisingly this is the same latency time that Meehan et al. give as their proposal for latency speed in a “low latency” system. In the visual domain, other researchers have discovered that participants are able to extract some visual meaning from photos that were viewed for just 13 milliseconds (Potter et al. 2014).

My research suggests that to make a VR simulation perceived as real time to the user, the speed at which audio is tracked, musical analysis is performed, and a virtual manifestation of this data is created in the simulation should occur at an ideal speed of 13 milliseconds and must occur at a speed faster than 20 milliseconds. Speeds slower than this will be suboptimal for the user. Musicians in both recorded music and live music are the perfect data sources for this low latency system. Musicians are quite comfortable dealing with these extremely low latency time constraints, have the capability to provide high resolution data at these speeds, and are artistically expressive.¹⁴

Other Research Video Games

¹⁴ A key point. Many data streams meet the first two criteria but will not provide much, if any artistic gratification to the user.

Video games are projected to fuel development on the VR platform in the coming years (Intelligence 2015; Research 2017; Gaudiosi 2016). Creators can act in one of two ways in response to this information: rejection, or acceptance. Ignorance of this fact by computer music scholars interested in branching out into this platform risks creation of uninformed works. Acceptance of this trend opens a massive stream of information that computer musicians can implement in their own works. Concepts presented by commercial video games such as 3D interface design, game mechanics, gameplay frameworks, et al. evolve through a kind of capitalistic Darwinism. If a game is to be successful and make money in the industry, it must effectively interface with the end user. Due to this financial incentive, games that successfully interact with the user typically have idiomatic game play mechanics and interface design. What might the computer music composer, interested in creating for VR, learn if they experienced from playing – not only from reading – some of these notable video games? Might they then be able to take information about the success of *Rez*'s (Kobayashi 2001) audiovisual integration, and the failure of Alien Isolation's (Hope 2014) amplitude tracking mechanic (FredEd919 2014) and use this to create a more nuanced VR experience?

Game Studies

Although there is a lot of new research into the VR field from the perspective of computer music, there already exists an entire lineage of research into VR specific technology, and more broadly the game mechanics employed in these spaces. Game studies programs are more widely established, and generally accepted in academic circles than they were 15 years ago. Some more forward thinking institutions have even gone so far as to offer scholarships for students that play video games competitively (Deppe 2017; Murmane 2017).

As these programs grow, computer music composers interested in employing VR in their works can forge interesting collaborations with creators in game design programs in order to create simulations that are both well designed from a game design standpoint, and potentially utilize audio in a novel way (Simmons 2017) Many computer musicians are already extremely adept at creating game mechanics for musicians to explore. This point has been illustrated countless times through "game pieces" (Zorn 1984), graphic scores (Haubenstock-Ramati 1976; Feldman 1951; Stockhausen 1992), and real time interactive scores (Kim-Boyle 2014). In addition to the creative potential of these collaborations, a productive solidarity stands to be

gained from forging a strong connection between computer music and game studies. Game studies is still young compared to other programs in academia. Its establishment in academia mirrors the beginnings of early computer music programs. Computer music was the product of a coming together of engineers and musicians. At present day, a postmodern art field could be the product of a mutually beneficial coming together of computer musicians that could benefit from a collaborator with more computer programming prowess,¹⁵ and computer programmers that could benefit from a collaborator with a sensibility for game mechanics unprecedented so far in the industry.

Papers in the game studies corpus address wide ranging topics including techniques, psychological studies, musings on artistic topics, as well as many others. Papers detailing less rigorously game-specific techniques, such as those explaining the different ways in which audio can be used to describe narrative events in a game (Jørgensen 2008), contain a wealth of information that can be abstracted into the computer music domain, even in works that only employ audio. Jorgenson states, "...the results demonstrate that audio and gameplay are closely integrated, and that the specific function of any sound signal in the game is highly dependent on contextual interpretation." (Jørgensen 2008, 5). These findings could be applied to development in a purely musical domain. Human psychology is also explored throughout the game studies literature. One such compelling piece that may be useful to computer musicians is *Balancing Risk and Reward to Develop an Optimal Hot-Hand Game* (Williams et al. 2011). The purpose of William et al.'s experiment was to create a game that took advantage of the hot hand phenomenon. The hot hand phenomenon originated in basketball. The hot hand phenomenon is defined as follows — if a player experiences success in a random challenge, their belief increases that they will continue to experience success. The purpose of the simulation created by Williams,

¹⁵ It has anecdotally been my experience that most computer musicians are less skilled computer programmers than those in computer science programs. Despite this there is a false machismo surrounding the topic at conferences of computer music, and many claim to be extremely competent coders. This discrepancy manifests itself in needless obfuscation of simple concepts in journal articles. Many of the titles from recent ICMC proceedings appear to be rife with postmodern lingo, some of my favorites being *Computer, formalisms, intuition and metaphors - Xenakian and post-Xenakian approach* (Besada 2014) and *Examining the Analysis of Dynamical Sonic Ecosystems: in Light of a Criterion for Evaluating Theories* (Musick 2014).

et al. was to create a game that would give players the sensation of this hot hand phenomenon, and then use the game to research the statistics of the hot hand phenomenon. The implications of this research on music are plentiful. Computer musicians could use this information in the creation of their own game pieces, including multimedia, or not, to psychologically bait players into experiencing the hot hand phenomena. Not only is the game studies literature full of information that computer musicians can port to their own projects, it also offers a bridge between the computer music and game studies disciplines. This common understanding of jargon and concepts can more easily facilitate communication between collaborators, and inspire computer musicians to create more mindfully and with more regard for established practices for the VR platform.

Science Fiction

When designing for any new technological medium, it is advantageous to look towards the writings of science fiction writers. Science fiction writings contain a wealth of insightful information about VR. The ideal sci-fi author to study has an established track record of reasonably correct predictions and creates concepts that are inspiring to the reader. William Gibson meets both criteria in the field of VR. Gibson's work *Neuromancer* (W. F. Gibson 1997) is the seminal work of the cyberpunk genre. Gibson coined the now widely used term "cyberspace" (W. Gibson 1982), predicted the ubiquity of the web, and foresaw the field of VR's expansion. Gibson also creates works that are inspiring to the reader. *Neuromancer* was the first novel to win the Phillip K. Dick Award, the Hugo, and the Nebula (Cumming 2014). The Cyberpunk genre as a whole is succinctly summed up as "high tech low life" (Ketterer 1992). I do not know of a more apt summary for the spirit of computer music's inventive spirit now applied towards expansion into virtual multimedia.¹⁶ Although his company VPL Research is now defunct, Lanier still writes visionary works that include troves of information on possible frameworks and uses for VR technology such as You Are Not a Gadget (Lanier 2010).

Lanier, VPL, and Silicon Valley Culture

¹⁶ There are many other visionary authors that the computer musician can look to for models of how to use VR. Jaron Lanier coined the term "Virtual Reality" and was one of the platforms earliest, and most prolific developers.

Any writing on virtual reality must necessarily encompass thoughts in many different disciplines. Author, father of virtual reality, and entrepreneur Jaron Lanier serves as a connection point between many disparate disciplines. Jaron's foray into virtual reality began with his first company VPL Research. The "VPL" in VPL Research stands for "Virtual Programming Languages". Despite the company being most known for devices such as the DataGlove and the EyePhone, its original impetus was to create a programming language that used the virtual world to create programs in real time. The early products developed by VPL and early experiments conducted make up the fundamental DNA of modern day game development. Products such as the DataGlove were far before their time and suffered from a lack of technological advancement sufficient to manufacture them in their ideal forms. Despite working in a rudimentary way, peripherals such as the DataGlove lacked the high level of data resolution that has become desirable and to a degree necessary to sustain deep immersion within a virtual simulation. Evolution and proliferation of original VPL concepts such as the DataGlove can be seen in many modern day virtual reality peripherals such as the HaptX glove ("Haptx," n.d.).

Unfortunately, the process of embracing glitches in seeking to radically innovate is a drive that has become largely absent in large VR game studios. Lanier details. One of these such glitches:

It was time for me to enter a brand-new virtual world.

I squinted up at my hand against a perfectly clear blue sky. My gargantuan hand, soaring above downtown Seattle. It might have been a thousand feet from wrist to fingertip.

There was a bug, obviously. A hand should be about the right size to pick up an apple or baseball, not bigger than a skyscraper. You shouldn't have to measure a hand in feet, much less thousands of them. (Lanier 2017, xiii)

Instead of most companies embodying a visceral drive towards these kind of unique and unreal experiences, modern-day development holds realism in higher regard.

More importantly than VPL's, technological developments, was its status and function as a sociocultural hub of different ideas, and different groups of people that otherwise may have not met. These interactions between disciplines are fundamental for furthering innovation and allowing fields to evolve. Now more easily facilitated by technology, an increasing number of these interactions suggest that emergent forms of art will emerge so quickly and in such great number that one will be unable to formalize them before their next mutation. This phenomenon

increases the importance of studying early collaborations that occurred during a slower rate of technological advancement. John Chowning writes about one such important collaboration at the genesis of the field of computer music:

It is fortunate that these two scientists/engineers [John Pierce, and Max Matthews]-who cultivated a nexus between science and art, and who invited many composers and artists to their laboratories (e.g., Varese and Cage) to share the possibilities that they saw-were willing to place these nascent musical studies in the public view, confident in the intellectual content of their ideas, which few others could see (Chowning 2008, 1)

In the history of VR these collaborations are far reaching due to the fundamental nature of the platform being developed for. In the early days of Silicon Valley, Lanier had a run in with counterculture icon Timothy Leary. Lanier was required to sneak Leary out of a retreat he was leading in the trunk of a car (Lanier 2017, 150–52). After this initial meeting Leary worked at VPL (hackertrips 2015) Timothy Leary's main area of interest during this time was research on other mediums that could provide the LSD experience legally . This research resulted in a 1994 compilation of interviews and musings on this subject (Leary 1994). Included in the work are interviews with artists such as William S. Burroughs, Allen Ginsberg, Winona Ryder, David Byrne, William Gibson, and Susan Sarandon. The connection between psychedelics and virtual reality is an undeniably influential phenomenon that can be mined to engage all user groups. The bringing together of separate influences to see existing structures through novel lenses is an idea that is also at the core of postmodal art.

Psychedelic Drugs

The connection between psychedelic drugs and VR is undeniable, but often, if not completely ignored in academic literature. A full account of the possibilities for VR development must include this connection. This link has been made known at various points throughout the history of VR. Douglas Rushkoff's 1994 field report on cyberpunk culture Cyberia (Rushkoff 1994) is a notable account of this. In this work, he interviews programmer Marc de Groot:

"I think that people who like to expand their minds with things like higher math and computers and media are fundamentally the same people who would want to expand their minds with anything available. But this is a very bad political climate for talking about all this. You can't mix a thing like drugs with any intellectual endeavor and have it stay as credible." Yet, de Groot's apartment--which has one small bedroom dedicated to life's comforts and the rest filled with computer hardware--shows many signs of the alternative culture he prefers to keep out of the public eye. Dan Kottke's fractal Grateful Dead ticket is pinned to the

wall next to the computer on which de Groot designed sound systems for VPL, the leading "VR" interface design firm... Modern day (Rushkoff 1994, 24)

Although de Groot's musing on the invalidity of "mixing a thing like drugs with any intellectual endeavor" was certainly true in 1994 when Cyberia was published, these stigmas are gradually disappearing. Psychologist Rick Strassman has begun to study one of these drugs:

1991 began the first new research in the United States in over twenty years on the effects of psychedelic, or hallucinogenic, drugs on humans. These studies investigated the effects of N,N-dimethyltryptamine, or DMT, an extremely short-acting and powerful psychedelic. During the project's five years, I administered approximately four hundred doses of DMT to sixty human volunteers. This research took place at the University of New Mexico's School of Medicine in Albuquerque, where I was tenured Associate Professor of Psychiatry. (Strassmann 2001, xv)

Strassman includes various session reports from his subjects. If taken out of context, most of these session reports could be understood as descriptions of a VR experience. One of Strassman's subjects, Aaron recounts, "...I saw a psychedelic, Day-Glo-colored space that approximated a room whose walls and floor had no clear separations or edges. It was throbbing and pulsing electrically..." (Strassmann 2001, 182)

The connection between VR and psychedelic drugs for artistic purposes is also undergoing a resurgence. The internet forum website, Reddit has an entire section of the site devoted to "exploring the wonderful worlds created in VR whilst on psychedelics." (jonesRG, ShortBananaMan, and fightwithdogma 2015). In addition to this, avant-garde researchers are beginning to exploit existing games with the intent of creating "altered states of consciousness" in the user. The most eminent writer in this subfield is Jonathan Weinel. One of Weinel's experiments involves remixing the videogame *Quake*. Through use of a MaxMSP patch, Weinel creates a version of Quake that attempts to put users in an altered state of consciousness. Weinel notes that many commercial games have attempted to portray these altered states, such as *Super Mario Brothers*, *Grand Theft Auto: Vice City*, and *Duke Nukem 3D* (Weinel 2010, 23).

Design Principles for Postmodal Work

Display Ergonomics

...developers should be mindful of the potential strain and discomfort introduced by wearing an HMD and of the issues currently introduced by wires (e.g., a 360-degree turn can leave the user entangled). (Serafin et al. 2016, 28)

During the development of my VR environment, I began beta testing with musicians. A test with one of my subjects, Silk Road shakuhachi player, Kojiro Umezaki highlighted the importance of considering display ergonomics. Once Kojiro had put on the headset, he began with a few steady tones on the shakuhachi to ensure that the simulation was ready, and tracking audio. After verifying this, he launched into a quick flurry of notes, settling on a long, sustained tone. Throughout the duration of this sustained note, Kojiro began shaking his head more and more rapidly to create vibrato on the instrument, as is a common practice on shakuhachi. Due to the weight of the HMD being used , the headset migrated out of alignment on his head. These are important considerations to keep in mind for computer musicians developing for the current wave of VR HMDs. There is an exception to this consideration if one is working on long term development. The general sentiment is that the future of VR will be on mobile devices, not on bulky, computer-tethered HMDs. Eminent figures such as co-founder of Oculus VR, Jack McCauley have echoed this sentiment (TechRadar 2017).

Aesthetics

Some Aesthetic Principles

- 7) Simplify: identify core elements, trim the rest
- 8) Animate, create smoothness, imply motion: it is not just about how things look, but how they move
- 9) Be whimsical, organic: glow, flow, pulsate, breathe: imbue visual elements with personality
- 10) Aesthetic: have one; never be satisfied with “functional” (Wang 2016, 1)

The VR platform offers several existing tools that computer musicians can use to make their environment look more visually appealing. Distribution tools such as the Unity Asset Store (Unity 2010) offer free and paid downloads of 3D models, textures, shaders, etc. With so many free tools and resources such as the Unity Asset Store on the web, even a computer musician with a weak grounding in motion graphics can create something that looks to be of a higher quality than grey platonic solids . The VR platform is designed to be an intensely visual way of presenting content to the user. Ignoring this fact is to ignore the platform being developed for.

Conclusion

1. Music-VR and Postmodal Art

- Real Time Whenever Possible

- VR Musical Instruments

2. Other Research

- Video Games
- Game Studies
- Science Fiction
- Lanier, VPL, and Silicon Valley Culture
- Psychedelic Drugs

The rapidly shifting terrain of media technologies available to the modern composer is denser than any previous era. The composer has at their disposal an unprecedented number of creative tools all with various preconfigured assets designed to make creating more rapid. This unprecedented landscape of tools subverts existing compositional approaches. In previous eras, composing for a set instrumentation, and taking months of time to work on a composition made sense. During the time of Beethoven for example, the most immediate feedback providing tool that was at the composer's disposal was the piano. This audio feedback mechanism would allow a composer to "beta-test" pitches and rhythms but would not be capable of simulating timbre, envelope, or many other facets of sound. This rough approximation of the final composition necessitated a slower paced, more arduous compositional process. Despite the insistence of many composers steeped in this tradition, this approach must be questioned in regards to new technology available to the modern composer. Modern compositional technology allows hyper-realistic simulation of the final composition in the case of traditional composition.¹⁷ In many cases, such as in that of many types of electronic music, the composer now works directly with the final composition, in real time. Applying traditional approaches of composition to these new technologies is far from idiomatic.

Research on the avant-garde realm of compositional tools suggests that the very adherence of these tools to a strictly sonic medium is beginning to dissolve in favor of more postmodal paradigms. The lineage of research becomes more obfuscated as the tools being researched integrate widely disparate artistic disciplines. This obfuscation necessitates branching

¹⁷ Compositions utilizing Western standard notation intended for performance by acoustic musicians.

out into tangentially related fields of study. For the electronic music composer interested in expanding into VR development, research in video games, psychedelic drugs, and other fields have proven to be advantageous for research. In addition to these outside fields, studying writings on music technology, and abstracting these concepts into the postmodal domain should occupy the core of this research.

Music, VR, and Other Disciplines

Music, VR, and Other Disciplines

After having completed the music-based VR environment *Spektra*, testing it on participants, and using it in live performance, I reflected in a macrocosmic sense on the entirety of the project from the viewpoint of music composition. I wandered for some time in the VR realm, linked to music by a lengthy tether. In order to draw concrete conclusions from the work as it applies to modern music composition, I needed to create a framework of terminology and understanding that had previously existed in its components but not in its totality. This is always the charge of those that foray into VR development. VR does not have a long lineage like other artistic mediums, and it is essentially invisible technology since it can be used towards so many different practical, and wonderfully impractical ends. It seemed senseless to use the same frameworks posited by VR developers working in augmented reality surgery, or even to an extent, VR game design.¹⁸

VR is a hard topic to explain because it's hard to contain. It directly connects to every other discipline. (Lanier 2017, 54)

Following this argument, I conducted more research in order to forge a template for understanding, for containing a small subgenre of VR within a malleable net of definitions, and thus creating more music-based VR. This research was interesting, but ultimately not fulfilling as it related to music. Due to the music-centric nature of my approach, VR served merely as a vessel, my Kon-Tiki, that ferried me to the opposite shores of greater musical understanding. My

¹⁸ One should note however that there are varying levels of severity to this exclusion. VR game design provided some interested concepts, and even basic terminology for working with music-based VR, however it proved to be a pursuit more akin to shoehorning than science to force this genre of work into another genre if it was not a perfect fit.

journey as researcher paralleled Joseph Campbell's hero's journey: call to adventure (beginning the PhD program), night-sea journey (VR as vessel, research related musical performances), father atonement (linking my discovery with previous researchers in the field), return (putting this experience into words and concepts), and elixir (the dissertation document). This relation was interesting because of the significance I will detail later of Campbell's monomyth as it relates to music.

The question I was seeking to answer on my night-sea journey was posed eloquently by Pierre Schaeffer in his preface to Michael Chion's Guide to Sound Objects:

But perhaps, on the other hand, you will come across something unexplained, surprising. Indeed, is not musical meaning, to which I am constantly referring without being able to define it, like other questions in life to which we do not know the answer? After all, does life have a meaning? Who can define it? Is there consensus about it?

And even if we limit ourselves to music — to Music even — can these questions be answered? What is music? **What is its function? (or functions).** **Is it universal, singular, plural?** Are musical works objects, in the sense of a product, or means of communication amongst human beings, or **more than that, a glimpse beyond, into that which we call, for example, the spiritual?**

Now, without replying to such questions, since the sphinx itself gives up, we can accept or not accept that they are asked, that they prevail, somewhere, in the individual or collective unconscious. In short, in Music as well, we could distinguish, not atheists and believers, but those who believe in the here and now and those who believe in the beyond of music.

With the result that across this whole debate there is a subtext (or a misunderstanding) which it would be good to clarify once and for all. Yes, for my part, I believe that music is more than music, that it is not a run of the mill, utilitarian or aesthetic object, but a **spiritual undertaking**, or as an old Master used to say, a "beingful exercise", an activity of the whole being. So I cannot deny that, sometimes, in the course of the most trivial musical theory, the most apparently technical experiment, the thesis of the spiritual reappeared, the intention of a going beyond which is difficult to name, but even more impossible to deny.¹⁹ (Chion 1983, 3–4)

Since Schaeffer's writing there has been little academic investigation into areas that might illuminate the answer to some or all of his questions. The conclusion of Schaeffer's work is yet to be discovered, "...a treatise, not on musical objects, but on the musical work!" (Chion 1983, 3). I am yet unable to offer a treatise on the musical work, but the structural analysis I have conducted on the research of others, as well as my own has largely been done where most academics have so far shamefully deigned to look — in those disciplines deemed loosely related

¹⁹ Emphasis, mine.

to music, unacademic, fringe, etc. These disciplines included the study of myth, the Jungian concepts of the collective unconscious and dream interpretation, and psychedelic drugs. Within these disciplines is precisely where Schaeffer's treasure is to be found. What follows then, in this section is a map of the territory as I understand it, balancing between adherence to a common thread of music, and the creative proclivity, and necessity to wander.

The four interrelated starting points for this research will be presented first.²⁰ I will explain their interrelatedness to each other. While establishing the interrelatedness of these initial disciplines, I will provide information on how these topics are synthesized into story. Finally, I will detail the conclusions reached in the course of this research, generalize the emergent approach, and present impetus for moving forward with this more story-centric approach to music making. In order to retain the common thread of music throughout, musical examples from the compositions of others, as well as my own will be given as examples for concepts being detailed. If one is to consider the totality of the framework that I have constructed as a geometrical form, each topic will serve to form a mold, or impression of part of the overall framework's surface. It is interesting to note that the information must be unfolded in this vignetted manner despite the fact that all component topics suggest story, in a linear sense, to be the connecting feature.

Dreams

VR may be the most centrally situated artistic discipline (Lanier 2017, 54), but it shares a special bond with many fields, in this document I will explore the connections with dreams, drugs, and science fiction. As has been already established in the Design Principles section, many figures from each of these disciplines were involved in research spanning two or more of these topics: Douglas Rushkoff (drugs, science fiction), William S. Burroughs (dreams, drugs, science fiction), and Dr. Robert Anton Wilson (dreams, drugs, science fiction), just to name a few. Delving further into the most notable research in each of these fields begins to illuminate

²⁰ I have chosen four starting points that made sense for my own work, and seem as though they could be useful for the work of others beginning to explore this medium. It's useful to remember that "the map is not the territory" and that Lanier himself defines the VR field as amoebic. These were my own "jumping off" points but other researchers may choose others.

the hidden connections between the seemingly disparate disciplines. These obscured connections are quite clear once established and provide a path towards thinking about what is at the core of postmodal design. As with much research in this area however, the easiest inroad towards this understanding is through providing examples.

Jaron Lanier, as a figure whose research spanned multiple disciplines serves as a good starting point. Lanier's own writing suggests that the study of dreams is a useful influence on VR design:

Twentieth VR Definition: Like lucid dreaming, except that (a) more than one person can take on roles in the same experience, (b) the quality is not as good, and (c) you have to work to program VR if you want to be in control, which you should want. Dreams, meanwhile, are often best if you don't seek to control them. Even Stephen La Berge seeks to be nonlucid in most of his dreams since it is in untethered dreams that the brain surprises and renews itself. (Lanier 2017, 149)

In order to parse out the utility of dreams in VR design, Lanier's comparison must be dissected, and reconstructed through the lens of the artist. Points (a) and (b) are reasonable, but the artist will likely disagree with part of point (c). There is no "should" in art. Expectations of the audience can be constructed, but an audience member brings with them the totality of their experience when viewing a work of art. There are of course homogenizing factors between audience members (a concept that will be examined in great detail later), however Lanier does not make a strong case for why someone "should" want to control the VR experience. The utility of this statement is clear when considering the development goals of a team working on a AAA title VR video game.²¹ A video game such as this, is intended for mass markets, not intended to subvert any expectations, and supposed to fit most existing paradigms of VR use. Lanier was primarily working outside of these frameworks, thus his "should" remains confusingly motivated.

Control, understood in this excerpt to mean some kind of user-driven way of shaping the VR simulation, as opposed to passively watching a 360-degree video, is an erroneous construction. Existing research has clearly demonstrated that awareness is dynamic and not static (Chabris and Simons 2011, 18). This dynamic awareness can even be demonstrated through formats with a lower data-resolution than 360-degree VR video, such as traditional 2D video.

²¹ AAA title video games are to video games what the "Blockbuster film" is to cinema.

“Your moment-to-moment expectations, more than the visual distinctiveness of the object, determine what you see—and what you miss.” (Chabris and Simons 2011, 18). The users’ perceptions are secondary to a goal. This influence of expectations over visual perception suggest that the locus of control is distributed between choosing what one intends to be aware of, and one’s own physical, “control” actions. Thus, some degree of user control is still present even if the VR simulation is not designed to accommodate for it. Lanier’s account of La Berge’s desire to remain nonlucid in most of his dreams seeks to draw clear lines between control and non-control (Lanier 2017, 148–49). Upon waking, if some part of a dream is remembered, and another part is forgotten, there is then perhaps some control on the part of the dreamer as to how deeply to probe their memory for the “missing pieces” of the dream. These opposing states suggest that there is an ambiguity instead of a clear demarcation between what we perceive as control and non-control as it relates to a visual stimulus.

We have clearly established then, that with some modification to Lanier’s statement, there is a link between dreams and VR. A modified definition of the link between dreams and VR might be posed as a modification of Lanier’s own statement on the matter (Lanier 2017, 149) as such (my own refactoring of Lanier’s quote):

VR is like lucid dreaming except that it is possible to share the experience with multiple participants, as opposed to the solitary experience had in lucid dreams. Currently, VR technology cannot provide the same data resolution provided by the dream-world but extrapolating into the future the historical trajectory of technological advances, it is reasonable to assume that the data resolution of VR will be on par with the dream-world in the near future. The degree of control that the artist-developer wishes to give to the user is within their discretion and will ideally aid in portraying the modus operandi of the work of art. Simple actions such as awareness focal points, removing the physical headset, and sense-making of the experience will always be within the user’s locus of control.

Psychedelic Drugs

In order to properly delve into the research on the psychedelic class of drugs, it must first be clearly defined. Terrence McKenna was one of the most eminent researchers in this field. His research, presented in the book *Food of the Gods* outlines the history of these drugs, and their meaning in culture. McKenna outlines psychedelic drugs as follows:

Psychedelic plants and experience were first suppressed by European civilization, then ignored and forgotten. The fourth century witnessed the suppression of the mystery religions—the cults of Bacchus and Diana, of Attis and Cybele. The rich syncretism that was typical of the Hellenistic world had become a

thing of the past. Christianity triumphed over the Gnostic sects—Valentinians, Marcionites, and others—which were the last bastions of paganism. These repressive episodes in the evolution of Western thought effectively closed the door on communication with the Gaian mind. Hierarchically imposed religion and, later, hierarchically dispensed scientific knowledge were substituted for any sort of direct experience of the mind behind nature.

The intoxicants of the Christian dominator culture, whether plants or synthetic drugs, were inevitably stimulants or narcotics—drugs of the workplace or drugs to dull care and pain. Drugs in the twentieth century serve only medical or recreational purposes. Yet even the West has retained the thin thread of remembrance of the Archaic, hierophantic, and ecstatic potential that certain plants hold.

The survival through long centuries in Europe of witchcraft and rites involving psychoactive plants attests that the gnosis of entering parallel dimensions by altering brain chemistry was never entirely lost. The plants of European witchcraft—thorn apple, mandrake, and nightshade—did not contain indole hallucinogens but were nevertheless capable of inducing intense altered states of consciousness.

The Archaic connection of feminism to a magical dimension of risk and power was clearly perceived as a threat by the medieval church: As late as the Middle Ages the witch was still the [hagazussa], a being that sat on the Hag, the fence, which passed behind the gardens and separated the village from the wilderness. She was a being who participated in both worlds. As we might say today, she was semi-demonic. In time, however, she lost her double features and evolved more and more into a representation of what was being expelled from culture, only to return, distorted, in the night. That these plants were the basis for entry into other dimensions was the result of the relative paucity in Europe of hallucinogen-containing species.²² (McKenna 1993, 117)

If one looks past the densely ornamented prose that is characteristic of McKenna's writings, some key points emerge:

1. At present day, drugs are almost entirely used for recreational or medicinal purposes.
2. Psychedelic drugs enable easy communication with a universal consciousness²³ through reliable production of altered states of consciousness.

²² Paragraph formatting, mine.

²³ Another term for “Gaian mind” as understood in the context of *Food of the Gods*. The Gaia hypothesis posits that all living organisms and their organic surroundings form a synergistic system in their totality. For the purposes of this research, it is largely unnecessary to explore the biological implications of this concept, but important to examine it from a philosophical standpoint. As McKenna uses it in this excerpt, the Gaian mind is philosophically understood to imply a connection of all human minds, similar to the Jungian concept of the collective unconscious.

3. Despite the intentional oppression of the use of psychedelic drugs, it is people, i.e. groups that kept their use alive. The role of these people is archetypically significant, and observable across cultures and eras.

Examining each of these conclusions in more detail provides strong links between psychedelics, VR, and music. Their direct relevance to music, with corresponding point-numbers to the above is as following:

1. In the current musical era, music is primarily listened to for recreational or medicinal purposes such as boosting one's mood, entertainment, relaxing, etc.
2. An establishment of some form of collective unconscious is necessary for the musician to understand in order to create music that is relatable past the level of individual consciousness. It is the fundamental substrate for creating meaning in music.
3. The role of creative musician is archetypically similar to that of the roles occupied by the psychedelic takers — those that are permitted passage by the "hagazussa" that sits on the fence that separates order and chaos.

Drug-Induced Universal Consciousness

The collective unconscious, "does not derive from personal experience and is not a personal acquisition but is inborn." (Jung and Hull 1981, 3). This is what McKenna implies with his use of the term "Gaian mind". This can be deduced from other mentions of concepts related to the Jungian collective unconscious, such as, "[Psychedelics] cause us to connect and reconnect the contents of the collective mind in ever more implausible, beautiful, and self-fulfilling ways ." (McKenna 1993, 130). In Food of the Gods McKenna specifically lauds some of Jung's contributions to the research of shamanism, mentioning the collective unconscious specifically (McKenna 1993, 134).

Now that one can understand what McKenna implies by his use of the term Gaian mind, one can extrapolate the implications of this concept into the domains of psychedelics, VR, and music. A very clear articulation of the link between psychedelics, and VR is the cyberspace documentary Cyberia: Life in the Trenches of Hyperspace by journalist Douglas Rushkoff. Cyberia is a rare glimpse into the genesis of modern cyberspace. Written in 1993, Rushkoff

immersed himself in different tech subcultures – most of these also countercultures – in order to capture a moment of incredible idealism, potentiated by the nascence of digital technology. Rushkoff poetically describes this as, “a moment when anything seemed possible. When an entire subculture — like a kid at a rave trying virtual reality for the first time -- saw the wild potentials of marrying the latest computer technologies with the most intimately held dreams and the most ancient spiritual truths. It is a moment that predates America Online, twenty million Internet subscribers, Wired magazine, Bill Clinton, and the Information Superhighway.” (Rushkoff 1994, sec. Preface).

Based on Rushkoff’s well-researched definition of the titular concept, Cyberia, one can easily see the similarity between this tech-inspired concept, McKenna’s drug-induced Gaia, and Jung’s collective unconscious:

The people you are about to meet interpret the development of the datasphere as the hardwiring of a global brain. This is to be the final stage in the development of "Gaia," the living being that is the Earth, for which humans serve as the neurons. As computer programmers and psychedelic warriors together realize that "all is one," a common belief emerges that the evolution of humanity has been a willful progression toward the construction of the next dimensional home for consciousness. We need a new word to express this boundless territory. The kids in this book call it Cyberia. (Rushkoff 1994, 4)

Furthermore, it is clear that Cyberia can operate on a symbolic or nonphysical level. Although many figures in this subculture saw Cyberia as a physical implementation. For example Eric Gullichsen’s writing in a work compiled by Timothy Leary, viewed Cyberia as an, “isomorphic mapping of neural structure to silicon[...] a reification of Jung’s collective unconscious: the global information network.” (Leary 1994, 201). The definition reached in Rushkoff’s work is more nuanced and explains Cyberia as a Novakian transphysical space (Novak 1996, 3)

Cyberia is the place a businessperson goes when involved in a phone conversation, the place a shamanic warrior goes when traveling out of body, the place an "acid house" dancer goes when experiencing the bliss of a techno-acid trance. Cyberia is the place alluded to by the mystical teachings of every religion, the theoretical tangents of every science, and the wildest speculations of every imagination. Now, however, unlike any other time in history, Cyberia is thought to be within our reach. The technological strides of our postmodern culture, coupled with the rebirth of ancient spiritual ideas, have convinced a growing number of people that Cyberia is the dimensional plane in which humanity will soon find itself. (Rushkoff 1994, 4).

One can derive from Rushkoff's definition, and Gullichsen's then that Cyberia is currently a conceptual space. This conceptual space is tentatively transphysical, and this transphysicality is increasing over time. At some point Cyberia may become a physically inhabited place through some kind of human-computer interface, or it may remain a dialogue between humans and technology creating a kind of third unembodied consciousness.

The manifestation of the collective unconscious is regularly found in improvisation between two or more artists, or, a more Cyberian distinction, between artist and technology. This concept is eloquently put in the work *The Third Mind* by William S. Burroughs, and Byion Gysin:

While the history of painting and the plastic arts shows them generally to have been a collective affair in their conception and their realization—even after the notion of the artist-paradigm came to dominate every other mode of representation—literature has been a solitary practice, an ascesis, a withdrawal, a prison of words. Collaborations in this domain were rare. If we except certain accidental associations, the value of which is open to question, we find that few works have been composed as the result of a joint effort. (Burroughs and Gysin 1978, 9)

For *The Third Mind* Burroughs and Gysin developed a technique of literary improvisation, allowing the two to interact in real-time. In addition to fighting the “ascesis” of literary solitude, this practice allowed the writers to form a collective consciousness between them. Although Burroughs and Gysin do not discuss this process in depth past the excerpted passage, research into musical improvisation shows similar trajectories:

The success and coherence of our quartet improvisation then relies on the fact that each player in our group has a highly distinctive musical “signature” and that each makes consistently strong and imaginative musical gestures. Curiously, this creates a kind of structure that is both dialectical and narrative. It is narrative because the sound-action archetypes form a kind of “collective conscious,” a developing story or, more broadly, a narrative arc which is understood as the background against which events take place. At the same time the structure is dialectical because new archetypes can be introduced and meanings and archetypal roles may shift. The structure will also be dialectical in the sense that the kinds of archetypal meanings that may arise and the kinds of reactions to or manipulations thereof are fundamentally dependent on the cumulative experience of the individuals involved... (Burrows 2004, 11)

One can easily see the methods and discoveries of Burroughs and Gysin on display in this writing by Burrows. Burrows writes that each member of the quartet has their own style. Constituting this style is a series of gestures unique to the proclivities of each musician (individual cognition), and also a collective mind (group cognition, third mind) (Burrows 2004,

8). It is this collective mind that ultimately guides the micro-actions, or individual cognition of the ensemble members into a unifying, narrative structure .

I wish to now draw the reader's awareness towards two key points derived from studying the research in numerous fields through examples of creative practitioners both sober and under the psychedelic drugs. Firstly, Jung's collective unconscious can be seen masquerading as many different terms such as, but certainly not limited to, Gaian mind, third mind, and Cyberia. Secondly, this collective unconscious mind, posited by McKenna to be readily accessible through the use of psychedelic drugs, also appears accessible under other conditions. Eminent psychedelic researcher Rick Strassmann observed startling similarities between the psychedelic drug states and traditional Eastern meditation (Strassmann 2001, 25). It is not an unwarranted connection to make then, that activities such as the linguistic improvisation observed in the example of Burroughs and Gysin, or musical improvisation demonstrated by Burrows also embody these characteristics. The Jungian collective unconscious goes by many different names. Although psychedelics provide users with a facile method of accessing this state, other activities such as creative improvisation with a group, or with technology, also afford this possibility.

It is my assumption that there is little research in the subfield of musical collective unconscious due to its taboo nature. A robust and expanding tome of psychedelic research exists due to the fact that even undertaking research in this field is itself a taboo act. It is my hope that through drawing these clear parallels between practical musical study and states experienced under the influence of psychedelic drugs, we can shed this taboo and acquire the knowledge there that is ripe for harvest. Timothy Leary puts the impetus for this taboo most eloquently in the introduction to *Chaos and Cyberculture*:

For centuries there existed a fanatic taboo against scientific understanding. Why? Because of the fear of Chaos. The facts about our (apparently) insignificant place in the galactic dance are so insulting to the control freaks who try (so manfully and diligently and seriously) to manage Chaos that they forbade any intelligent attempts to look out there and dig the glorious complexity [sic].

At one point consciousness-altering devices like the microscope and telescope were criminalized for exactly the same reasons that psychedelic plants were banned in later times. They allow us to peer into bits and zones of Chaos.

Galileo got busted and Bruno got the Vatican microwave for showing that the Sun did not circle the Earth. Religious and political Chaos-phobes naturally want the nice, tidy, comfy universe to cuddle around them.

In the last century science has developed technical extensions of the human sensorium that specify the truly spooky nature of the complexities we inhabit.

Stellar astronomy describes a universe of fantastic multiplicity: a hundred billion tiny star systems in our tiny galaxy, a hundred billion galaxies in our teeny universe. (Leary 1994, xiv)

Personification

The hagazussa, the fence-sitter, between the wilderness and the village, “was a being who participated in both worlds” (McKenna 1993, 117). Most mythological canons have liminal deities such as hagazussa, including liminal deities separating order (village) from chaos (wilderness). Osiris was the liminal deity of Egyptian mythology. Osiris presided over the Underworld, a duty which required him to judge the dead, thus making the border between order and chaos selectively permeable instead of open. Osiris was also the flood god, another liminal myth, since floods create chaos for those caught in their path. In Haitian Vodou, one finds Legba occupying this role. Legba is the intermediary between the spirit world, and the living. He judges whether or not to allow the living to speak with those residing in the spirit world.

The broader symbolic implications of this concept found in some form in most major mythological traditions form the underlying story framework laid out by McKenna in his dissection of the use of psychedelic drugs. What all of these examples are pointing towards are a mytheme, specifically the katabasis and anabasis mythemes. Claude Lévi-Strauss originally explained this concept with the term gross constituent units, but later used the term mytheme:

These constituent units presuppose the constituent units present in language when analyzed on other levels, namely, phonemes, morphemes, and semantemes, but they, nevertheless, differ from the latter in the same way as they themselves differ from morphemes, and these from phonemes; they belong to a higher order, a more complex one. For this reason, we will call them gross constituent units. (Lévi-Strauss 1955, 431)

The mythemes of katabasis — call to adventure, descent into the underworld, and anabasis — rescue, return, resurrection, can, just like parts of speech, or chords in a piece of music, be arranged in any way the creator wishes. Just as in speech and music, there are ways to arrange these pieces that are more relatable, and less relatable to the human experience. It is for this reason that many surviving myths follow a progression of katabasis, and then anabasis. A katabasis without anabasis is merely a death. So many core myths across so many traditions

adhere to this progression of elements that Joseph Campbell's research suggests that is may be the only myth, dubbing this progression of elements the monomyth (Campbell 2008, 1, 210).

At this time, I wish to draw the reader's attention to the logically following conclusions:

1. Mythemes are the “gross constituent units” of myth.
2. Katabasis and anabasis combined in sequential order create the monomyth.
3. This progression of descent from order into chaos, and ascent back into order imply the presence of some kind of gatekeeper. This gatekeeper is present at the protagonist's final departure from order.
4. The gatekeeper often required a fee for passage.

Points 1 and 2 have already been established, but 3 and 4 necessitate more explanation. In Ancient Greece, Charon occupied the role of liminal god. Charon was the ferryman of the Underworld. Charon required a fee for passage. Many Ancient Greeks would be buried with Charon's obol,²⁴ i.e. a coin placed in the deceased's mouth as an offering for Charon to allow their safe passage to the underworld.

Since establishing these four points, they must now be clearly related to music and to psychedelic drugs. The keen musical reader will notice Charon's prevalence as a character in the *one of the most adapted myths by composers*, the myth of Orpheus's descent into the Underworld. A full retelling of the myth exceeds the limitations of this writing. Necessarily then, much of the myth must be omitted.²⁵ Some key points that the reader should be familiar with before a more in-depth discussion of the musical adaptations of the myth are presented are as follows:

1. Orpheus is a musician.
2. Orpheus has a wife, Eurydice.

²⁴ Also referred to as viaticum. The etymology: via (“road”, “path”) + -āticus (“pertaining to”), modified with the suffix “cum” (“with”), equates roughly to “something to take on the road”. Viaticum entered the common dialect of the time and came to be understood as “travelling money”.

²⁵ The reader wishing to delve more fully into a purer recounting of the myth should look into both *Metamorphoses* by Ovid, and *Georgics* by Virgil.

3. Eurydice is fatally bitten by a snake at her wedding.²⁶
4. Orpheus is advised by nymphs and gods to go to the Underworld to retrieve Eurydice.
5. Orpheus goes to the Underworld.
6. Once reaching the Styx, i.e. the liminal boundary between the world of the living and the Underworld, he is confronted by Charon, the gatekeeper.²⁷
7. Charon initially won't allow Orpheus passage, so he plays a song on his lyre that somehow convinces Charon to let him pass, or otherwise disarms him in some way.
8. Orpheus finds Eurydice and is permitted to take her back to the world of the living on the condition that he walks in front of her and does not look at her until they are out of the Underworld.
9. Just before leaving the Underworld, Eurydice keeps begging him to look at her, and he submits.
10. Once Orpheus looks at Eurydice she vanishes, ostensibly back into the depths of the Underworld, this time never to return to the world of the living.

Through browsing the main points of this myth, one can instantly understand how the story is ripe for musical adaptation. Orpheus embodies the role of the medicine man. Through the modern lens of psychology, Orpheus's distress over his wife's tragic death, could be understood as a temporary psychosis.

In every primitive tribe we find the medicine man in the center of society and it is easy to show that the medicine man is either a neurotic or psychotic or at least that his art is based on the same mechanisms as a neurosis or psychosis. (Róheim 1943, 38–39)

One could speculate that the reason this myth is so widely adapted by composers, is because Orpheus's plight is so relatable to everyone. This could be a literal relatability in the case of a woman whose husband has passed, or a more symbolic relation, in the case of someone who has lost a treasured, one-of-a-kind, possession.

²⁶ A snake biting the main female character of the story can also be found in the biblical story of Adam and Eve. This bite occurs preceding Adam and Eve's descent from order into chaos, just as Eurydice's bite precedes the same in her myth.

²⁷ Personifications of the gatekeeper role differ here and will be discussed more in the following musical examples.

Although the retelling of this myth is modified slightly from telling to telling, the main points outlined previously are present. In order to establish this, the liminal deity section of three musical adaptations will be examined; L'Orfeo by Claudio Monteverdi, Orfeo ed Euridice by Christoph Willibald Gluck, and, the oldest of the three, Euridice by Jacopo Peri.

In librettist Allessandro Striggio's telling of the myth, under the direction of Monteverdi, Charon will not permit Orpheus to pass into the underworld. The following declaration occurs in Act 3.

[Original]

CARONTE

*O tu ch'innanzi morte a queste rive
temerato ten' vieni, arresta i passi.
Solcar quest'onde ad uom mortal non dassi,
ne puo co' morti albergo aver chi vive.*

*Che? Vuoi forse, nemico al mio signore,
Cerbero trar de le tartaree porte?
O rapir brami sua cara consorte
d'impudico desire acceso il core?*

*Pon freno al foll'ardir, ch'entr'al mio legno
non accorro piu mai corporea salma,
sì de gli antichi oltaggi ancora en l'alma
serbo acerba memoria e giusto sdegno.*

(Monteverdi 1607, 59–60)

[Translation]

CHARON

*Ho, you who approach these shores
before your death, come no further;
no mortal man may venture on this flood,
nor may the living dwell among the dead.*

What? Would you, an enemy of my Lord, maybe,

*snatch Cerebus from the gates of Tartarus?
Or do you long to abduct his beloved consort,
your heart aflame with lewd desires?*

*Restrain your rash heroics, for in my boat
I shall never receive a living body,
since bitter memories and just resentment
of those old affronts still seethe within me.*
(Tarantino 2002)

Orpheus attempts to soften Charon's resolve by playing him a song but is unsuccessful.

[Original]

CARONTE

*Ben sollecita alquanto
dilettandomi il core,
sconsolato cantore,
il tuo pianto e 'l tuo canto.
Ma lunge, ah, lunge sia da questo petto
pieta, di mio valor non degno affetto.*
(Monteverdi 1607, 65–66)

[Translation]

CHARON

*I find great pleasure,
heartfelt delight,
disconsolate Singer,
in your tearful appeal and song.
But far, far be compassion from my breast,
a sentiment quite unworthy of my nature.*
(Tarantino 2002)

Orpheus attempts to use music on Charon again, and instead of softening his resolve, he puts Charon to sleep, allowing him to pass unimpeded into the Underworld.

[Original]

ORFEO

*Ei dorme, e la mia cetra,
 se pieta non impetra
 ne l'indurato core, almen il sonno
 fuggir al mio cantar gli occhi non ponno.
 Su dunque a che piu tardo?
 Tempo e ben d'approdar su l'altra sponda,
 s'alcun non e ch'il neghi,
 Vaglia l'ardir se foran vani i preghi.
 E vago fior del tempo
 l'occasione, ch'esser dee colta a tempo.*

(Monteverdi 1607, 67–68)

[Translation]

ORPHEUS

*He sleeps, and though my lyre
 could not inspire compassion
 in his hardened heart, at least his eyes
 cannot resist my song.
 Come then, why do I still tarry?
 It is high time I reached the farther shore,
 since my way is now unopposed;
 courage will prevail where prayers did not,
 and opportunity, sweet flower of time,
 must be taken while there is yet time.*

(Tarantino 2002)

Librettist Ranieri de' Calzabigi's telling of the myth in *Orfeo ed Euridice*, under Gluck's direction, takes a slightly different interpretation but still features a liminal deity of sorts as a gatekeeper. In Gluck's version, Orpheus encounters the Furies who will not permit him to pass into the Underworld. Through a "lute" accompanied aria, the Furies remit and allow Orpheus passage.

[Original]

ORFEO

*Men tiranne, ah! voi sareste
 Al mio pianto, al mio lamento,*

*Se provaste un sol momento
Cosa sia languir d'amor.*

CORO

*Ah quale incognito
Affetto flebile,
Dolce a sospendere
Vien l'implacabile
Nostro furor?
Le porte stridano
Su i neri cardini
E il passo lascino
Sicuro e libero
Al vincitor.*

(Gluck 1914, 67–71)

[Translation]

ORPHEUS

*Ah! You would be less harsh
to my weeping and lamenting
if for but a moment you could know
what it is to languish for love.*

CHORUS

*Ah! What unknown
feeling of pity
sweetly comes
to soften
our implacable rage?
Let the gates creak
on their black hinges,
and let the victor,
safe and free,
be allowed to pass.*

(Jones, n.d., 12)

Finally, one must examine the opera Euridice by Jacopo Peri. Euridice is of great significance in music history, as it is the oldest surviving opera. Research suggests that Euridice

is the second oldest opera, second only to *La Dafne*, also by Peri. The liminal-god in Peri's adaptation of the myth is Pluto. Orpheus is able to convince Pluto to allow Euridice to leave. In this telling of the myth, unlike that of Monteverdi's and Gluck's, *Orpheus and Euridice* successfully flee the Underworld to live happily ever after. This happy ending stands in stark contrast to other tellings of the myth. Through examining the performance conditions, one may gain insight as to the impetus for this different ending.

On the evening of 6 October 1600, as part of the week-long festivities celebrating the wedding by proxy of Maria de' Medici and Henry IV of France, a new type of *divertimento* was staged inside the Pitti Palace in Florence. The performance was given in the apartments of Don Antonio de' Medici (1576–1621) for the enjoyment of the official wedding guests of Grand Duke Ferdinando I de' Medici (1549–1609), as well as a small number of Florentine courtiers. The piece was a poetic text set to music, staging a happy-ended version of the myth of Orpheus and Eurydice in *stile recitativo*. It bore the title *Euridice* and is often considered today to have constituted the first courtly opera. The performance also included an element that is usually absent from most modern operas: it was enhanced by ballets, sometimes involving the whole cast, as during the finale. Euridice's libretto had been composed by the poet Ottavio Rinuccini (1562–1621), while the music was a creation of Jacopo Peri (1561–1633), both artists having worked in close collaboration with their patron, the Florentine merchant and music lover Jacopo Corsi (1561–1602). Corsi had financed and organised most of the court performance and went so far as to play the harpsichord to support the efforts of his protégés during the event. These men were not only tied by bonds of patronage and friendship; they were also tightly connected by their links to one of the major learned societies of late Renaissance Florence, the Accademia degli Alterati (1560–c. 1625), whose discussions on the pleasures of art and on the effects of dramatic spectacles may well have been the basis for many of the novelties of *Euridice*. (Blocker 2017, 77–78)

It is clear that pressures were exerted on Peri's production. The opera was during a wedding celebration. Adhering to the original ending of the myth, where Euridice is eternally stuck in the Underworld would likely not have been well received during such a celebration. There were also financial concerns. Blocker reports that Peri and Rinuccini worked closely with their patron. If the performance was not well received by the audience, it would make future commissions, and thus income, unlikely for the composer and librettist.

What can be gleaned from this myth's many manifestations in various operatic works, is the framework of a symbolic monomyth. I chose to use *Orpheus and Euridice* as an example here because of its clarity, pervasiveness, and historical eminence in the Western canon of music. The myth can be clearly understood in the framework of Campbell's monomyth. At a low-resolution

level of understanding, there is a call to action, katabasis into chaos during which a liminal deity is met and overcome, trials, and anabasis during which the protagonist ascends back towards order. The pervasiveness of this myth in the Western canon of music is indisputable, as it is one of the most used myths for operatic plots. Its historical eminence is also significant, as it is the second oldest opera, and the oldest surviving opera.

The individual that takes a psychedelic drug embodies the role of the monomyth's protagonist. The drug-taker embodies order in their everyday life, constituted by man-made concepts that are necessary for survival and social interaction, such as social roles, arbitrary measurement units, etc. The drug taker must confront a liminal deity. Historically in concepts with commonplace drug-taking rituals, this deity position has been occupied by the shaman or the medicine man. Mythologized, this concept turns into McKenna's hagazussa.

Some of the most definitive research on the shamanic process has been conducted by author Carlos Casteneda. While a student at UCLA in the late 1970s, Casteneda spent his summers with an old Yaqui Indian, named Don Juan, to learn about shamanism. Extrapolating McKenna's concept of the hagazussa — the deity that sits between the garden and the wilderness — one can assume that this liminal deity has access to both worlds. In the same way that Legba can address the living and spirit worlds, or how Charon can ferry individuals between the world of the living and the Underworld, Don Juan sits between the world of order and the world of chaos. Don Juan reports to Casteneda, "...the smoke is my ally [...] I don't need to smoke anymore. I can call him anytime, anyplace." (Castaneda 1977, 132). Throughout Casteneda's work *The Teachings of Don Juan, A Yaqui Way of Knowledge* Don Juan guides Casteneda's experiences with psychedelic drugs. Through this traditionally shamanic role, Don Juan occupies the mythological role of the liminal deity.

At first glance, this may seem to be largely unrelated to the role of the composer, but it is essential. Joseph Campbell defines the role of shaman, liminal deity, or medicine man in the following way:

The medicine men [...] are simply making both visible and public the systems of symbolic fantasy that are present in the psyche of every adult male in their society. (Campbell 2008, 84)

It is consistently the musical works that relate to something true, innate, and universal about the human condition that listeners are attracted to. The boldest example of this

phenomenon is the previously explained comparative analysis between musical recounts of the Orpheus and Euridice myth. There will undoubtedly be critics that accuse this argument of shoehorning music into a framework, of imposing this qualitatively analytical lens on pieces where it is not useful. I hope to allay such concerns by the technical information presented further on in this writing. I myself remained highly skeptical of the idea until I saw the breadth and utility of this framework. I saw this framework naturally fall into place over well-respected pieces by historical composers, those of modern contemporaries, and in my own works.

Full Circle, Musical Links

After highlighting areas of the multidisciplinary background that has been derived from the various aforementioned related disciplines, i.e. dreams, VR, and psychedelic drugs, connections can be drawn from these disciplines to the common thread of this work, music. In order to clearly establish these links, I will remind the reader of the conclusions reached in the previous sections:

1. VR is similar to lucid dreaming. Both “mediums” deal in the world of symbolic meaning.
2. VR and lucid dreaming differ in the sense that lucid dreams must be experienced solitarily.
3. Psychedelic drugs allow the user to explore a metaphorical underworld of consciousness that is not organized such as typical daily waking consciousness is.
4. Traditionally, psychedelic drugs have been administered by some kind of shaman that guides the user’s trip.

I will sequentially address each of these points and their relationship to music. I do this with the intent of furthering Pierre Schaeffer’s suggestion that “...music is more than music, that it is not a run of the mill, utilitarian or aesthetic object, but a spiritual undertaking...” (Chion 1983, 3–4).

VR is similar to lucid dreaming. Both “mediums” deal in the world of symbolic meaning. The most obvious research to examine in order to establish a connection between music and other symbolic mediums is that of Michael Chion’s *Guide to Sound Objects*.²⁸ While the

²⁸ *Guide to Sound Objects* although written by Michael Chion is primarily a work that elaborates on the ideas laid out by Pierre Schaeffer in his writings.

research presented by Chion is correct in suggesting that it can be advantageous to look past typical conventions of notated music when listening to any analyzing acousmatic music, the research is in many ways, a product of its times. Schaeffer's *Traité des objets musicaux* was written in 1966, less than a decade after Milton Babbitt wrote his scathing article "Who Cares if You Listen?" Babbitt offers a glimpse into the world of the composer at this time:

I do not wish to appear to obscure the obvious differences between musical composition and scholarly research, although it can be contended that these differences are no more fundamental than the differences among the various fields of study. I do question whether these differences, by their nature, justify the denial to music's development of assistance granted these other fields. Immediate "practical" applicability (which may be said to have its musical analogue in "immediate extensibility of a compositional technique") is certainly not a necessary condition for the support of scientific research. And if it be contended that such research is so supported because in the past it has yielded eventual applications, one can counter with, for example, the music of Anton Webern, which during the composer's lifetime was regarded (to the very limited extent that it was regarded at all) as the ultimate in hermetic, specialized, and idiosyncratic composition; today, some dozen years after the composer's death, his complete works have been recorded by a major record company, primarily- I suspect- as a result of the enormous influence this music has had on the postwar, nonpopular, musical world. I doubt that scientific research is any more secure against predictions of ultimate significance than is musical composition. (Babbitt 1958)

In this excerpt, despite professing not to, Babbitt attempts to conflate musical research with scientific research. Scientific research attempts to eschew any subjectivity, the research is focused on objective results based on hard numbers. Babbitt's music certainly reflects this approach, and Schaeffer's reasoning goes beyond it but is still marred by the predominance of the rigidly scientific thinking present at the time. Schaeffer's research while useful, by its language opposes the notion of story. Schaeffer's sonic unit, the "sound object" is by its title specifically not a subject. Stories can be written about objects, but humans will not identify with them. Humans identify with stories about subjects, i.e. characters that they can potentially self-insert themselves into. In addition to this distinction, despite Schaeffer's analysis of objects as a fundamental unit of listening, the fact that these objects are man-made is not sufficiently explored. Of course, it is very useful to have a syntax and theory surrounding acousmatic objects, but the composer must bear in mind that these symbols were unwittingly co-created by the nature of the listeners of the music.

These sound objects exist because we perceive them. Jung explains the history of this co-creation phenomenon, “The fact is that in former times men did not reflect upon their symbols; they lived them and were unconsciously animated by their meaning.” (Jung et al. 1968, 69) It has long been the task of the musical scholar to reflect upon these symbols in a technical sense, and Schaeffer’s work fits neatly into this historical lineage, however as musicians branch out into a terrain of compositional tools composed of technologies that sometimes arise and disappear in the blink of an eye, the need for a more symbolic, and human-centric understanding is necessary. Such postmodal understanding of human-relative symbols can be observed in my work for fixed audio and 3D animation, *bitPushIntersection*.

Example

bitPushIntersection was one of my first large-scale forays into 3D animation. I created the piece in anticipation of submitting it to one of the largest conferences in the computer music field, ICMC, that year (2014) being hosted as a joint conference with SMC. Due to the slow render equipment I was using at that time, the animation took longer than anticipated to complete, leaving me with a silent animation merely one day before the deadline. I rapidly created the audio to accompany the animation over the course of the final day pre-deadline and submitted the work. *bitPushIntersection* would go on to be accepted by the ICMC-SMC Joint Conference, and virtually every other major conference, and many less large-scale ones, in the computer music field, as well as one animation festival, and multiple film festivals.

The widespread success of this piece was intriguing to me. I knew objectively, through comparing the work to others of my peers, that the animation was of mediocre quality; to accommodate for the poor rendering equipment being used at the time, I made the decision to render much of the animation in a vector graphics style, eliminating the need for reflections, and lighting. In addition to this, the scene only had about 100 individual objects that were all present (albeit in different configurations) for the entire course of the animation, there were no drastic scene changes in terms of the “cast of characters” on stage.

The story told through audio and visuals can be explained in the following scenes, with corresponding events in each medium:

Scene	Audio	Animation
Chaos	Clinking noises	Free polygons jumping and rotating at random
Main Cross Introduction	Unintelligible vocal chops, noise, “bad” recording quality, first introduction of bass note	Cross appears on screen and begins shaking
Main Cross Ascent	Slow ascending screeches over a subtle bass drone	Cross ascends to upper region of screen
Small Crosses Ascent	Quick ascending bleeps and screeches over a bass drone	Small crosses are pulled upwards towards the large cross
Orbit	Beeps with unchanging pitch, significant bass drone	Small crosses orbit in a sphere around the large cross

Fig 1. Chaos:

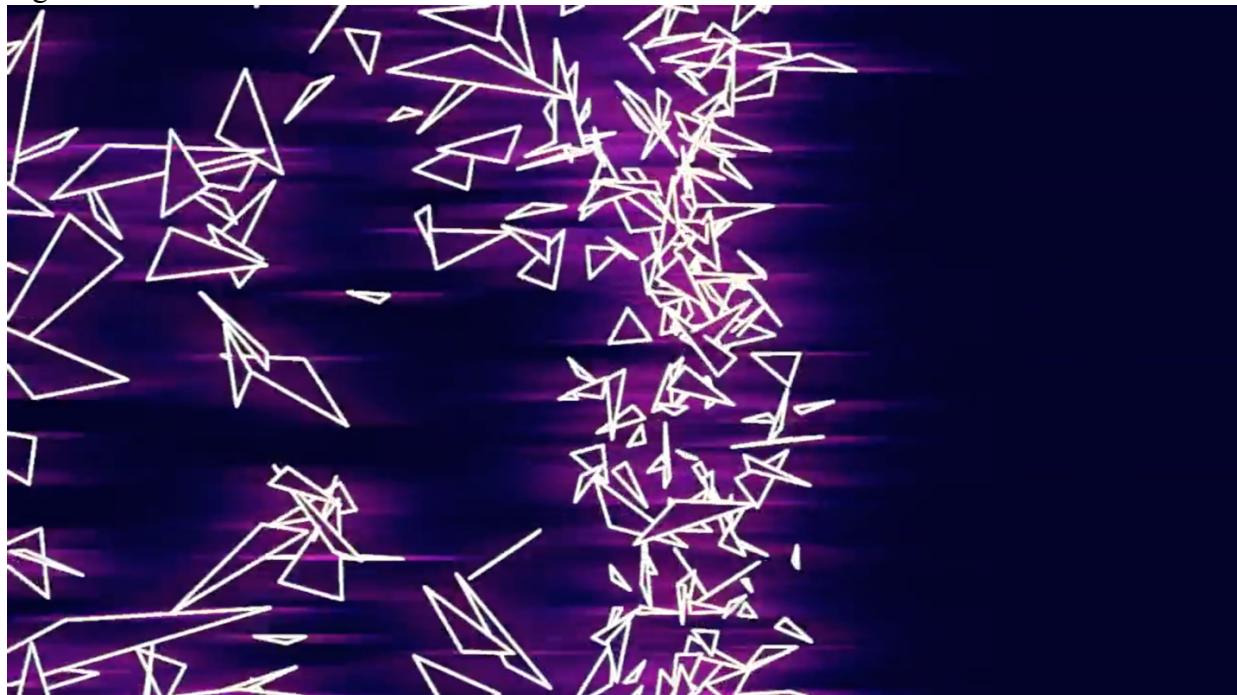


Fig. 2 Main Cross Introduction:

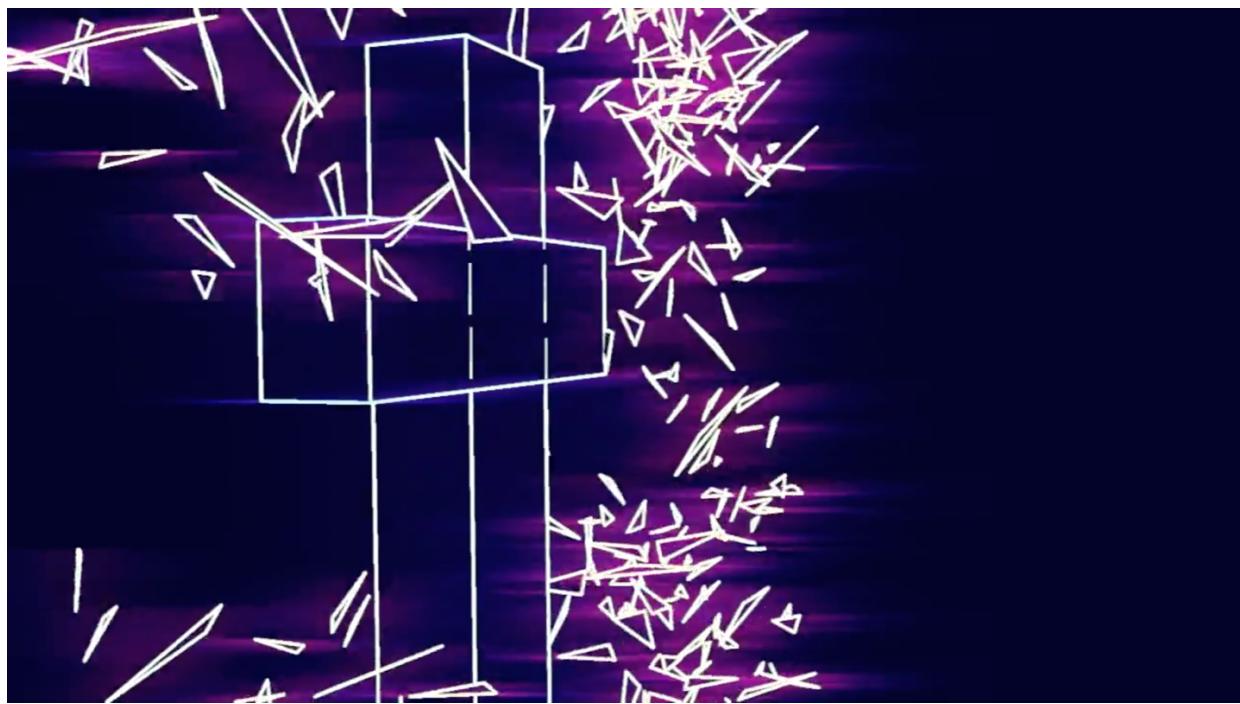


Fig. 3 Main Cross Ascent:

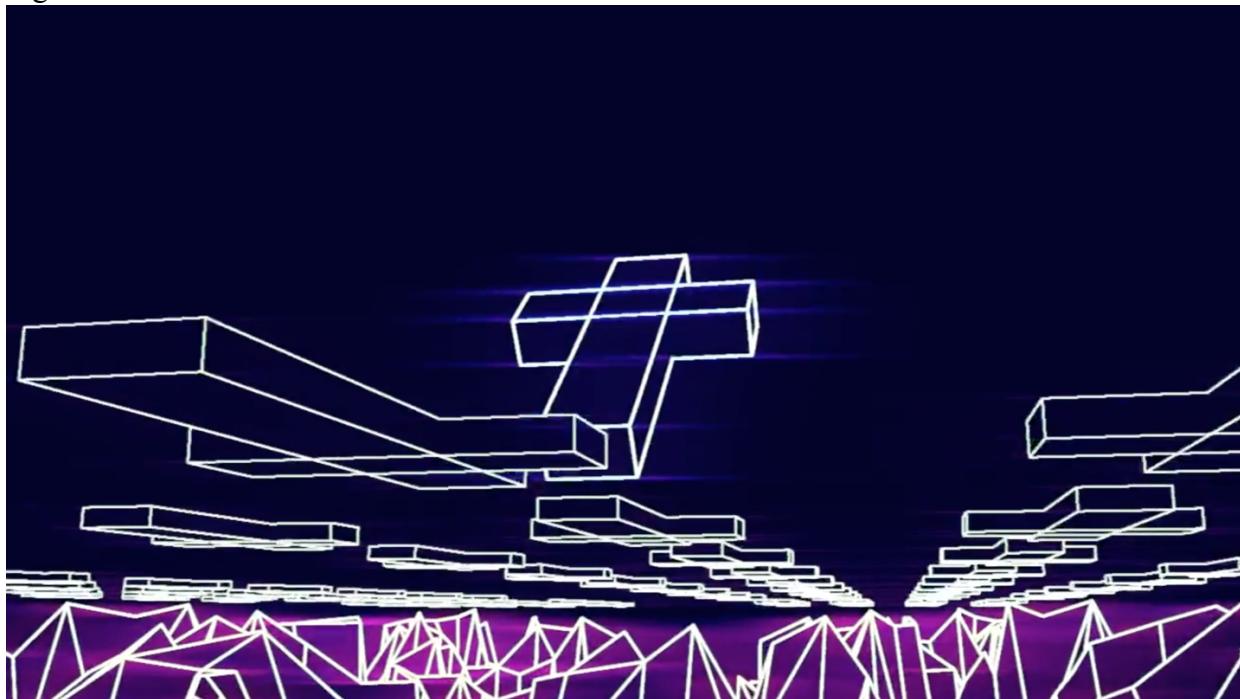


Fig 4. Small Cross Ascent:

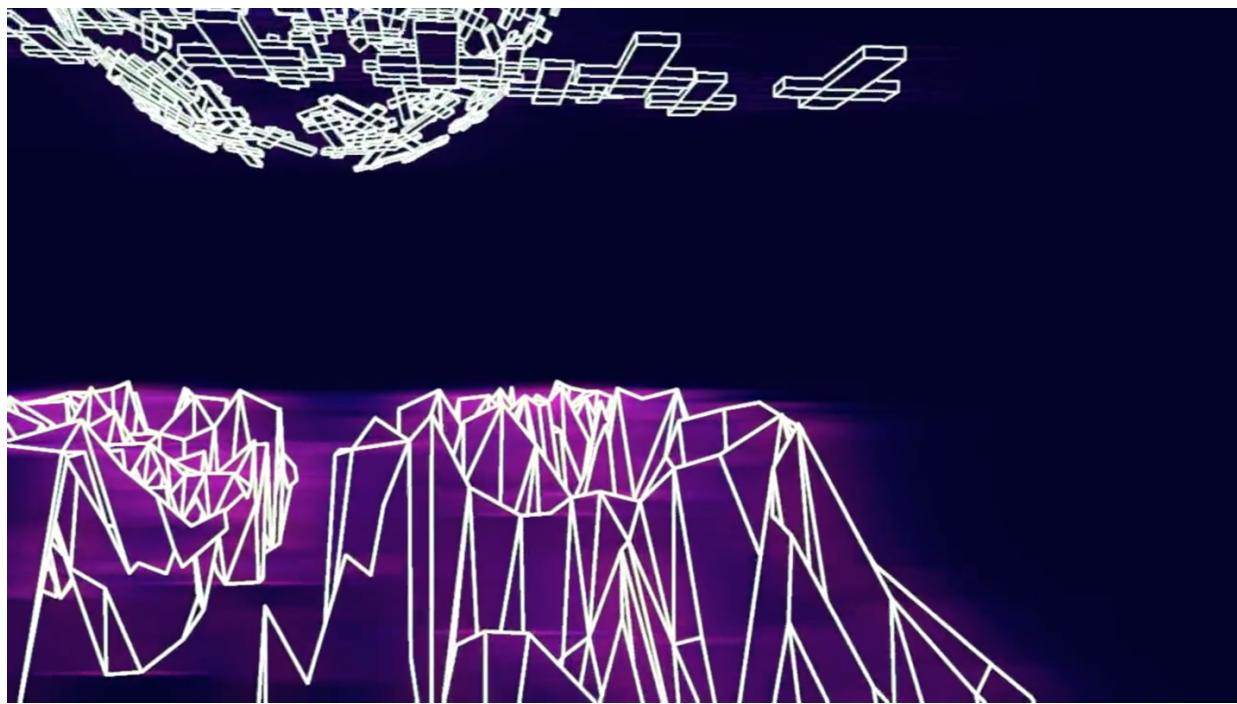
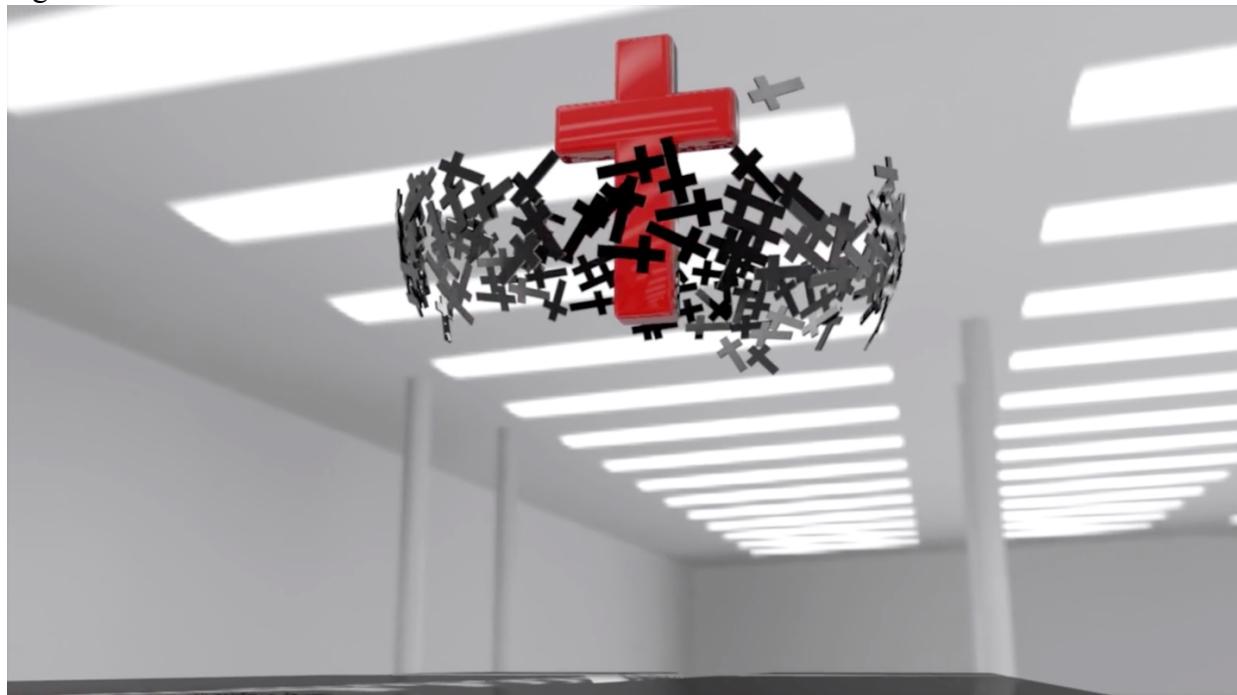


Fig. 5 Stutter Cuts of Different Textures



The festival success of this piece underscores the importance of symbolism as it relates to music. Reflecting on the piece, and many people's different experience with viewing it, I learned three things about symbolism as it pertains to postmodal art and is applicable to music composition. Firstly, those working in many artistic fields, especially music, are interested in

some kind of more unified approach to symbolism. Henry R. Clauser expoused this conclusion in an article written for Leonardo:

The third requirement for the development of a dynamic generative abstract art is the establishment of a formalism, which, as in the musical arts, would be didactic and have common acceptance by visual art composers, performers, and the public. Analogous to music, it would have a specified structural format and a symbolic language. (Clauser 1988, 17)

It's unclear which sect of "musical arts" Clauser is talking about, but it can be clearly established that there is no commonly accepted style of musical composition at present day, with several different genres, approaches, and styles existing simultaneously. By creating the visuals of *bitPushIntersection* first, I was able to create an easy to follow visual story using symbols as characters. When I composed the audio to accompany the animation, I was able to use very abstract representation that was then more easily perceived in the context of a story than if I was to simply exhibit the work as a tape piece with no visuals. My research suggests that there is an emergent formalism present in most, if not all works, that will be fully dissected later in this work.

Secondly, despite using a cross, the narrative was understandable as an empowering story, even across a number of cultures.²⁹ *bitPushIntersection* employs a dramatic progression of actions that suggest themes such as self-improvement, and social unity. Most individuals I spoke with about the piece self-inserted themselves as one of the small crosses or saw the small crosses as humanity in general. The ascent of these crosses suggests an improvement of their condition, over their previous state of simply lying on the ground, inanimate. Moreover, the audio mirrors this suggestion. During the ascent the audio is mangles and has a lot of "glitches" where waveforms are starting out of phase, thus snapping the speaker from its zero-point to a new position rapidly. The meaning of this is clear, self-improvement, while well worth the effort, is sometimes painful, and fraught with mistakes in the intermediary. The implications of social unity are clear as all of the crosses congregate and flow together after their ascent.

²⁹ The work was screened in Greece, Poland, the U.K., and various disparate regions of the U.S. I made a significant effort to solicit information from viewers about how they understood the piece.

Finally, the most powerful implication of the use of symbolism in *bitPushIntersection* is the use of the cross as the main symbol.³⁰ Though speaking of psychology, one can see the following statement by Jung as being applied clearly to artistic mediums:

That is why no textbook can teach psychology; one learns only from experience. We can see this point clearly when we examine certain well known symbols: The cross in Christian religion, for instance, is a meaningful symbol that expresses a multitude of suspect's, ideas, and emotions; but a cross after a name on a list simply indicated that the individual is dead. (Jung et al. 1968, 81)

The interpretation of the meaning of the cross, as previously mentioned, had some more universal interpretations, such as self-improvement, and social unity. The cross also has very disparate interpretations. In Jung's example, the cross can be perceived as meaningful or trivial. One can infer from the example that this perception is context dependent. It is my assumption that the reason the cross in *bitPushIntersection* was always perceived as deeply meaningful in some way was due to the fact that it was typically being presented at a festival among other very "serious" works of art. Although some factors about the cross's interactions were homogenous, some factors were highly divergent. Some viewers perceived the work as being highly critical of Christianity, while others perceived it as spreading the Christian teachings.

Leveraging symbols in a postmodal or musical work is a powerful way to connect with existing stories and associations. While there is no extremely rigid formalism in this undertaking, there are some broad frameworks that one can look to for employing symbols. One is to simply discern between symbol and sign.

The sign is always less than the concept it represents, while a symbol always stands for something more than its obvious and immediate meaning. Symbols, moreover are natural and spontaneous products. (Jung et al. 1968, 41)

A Brief Aside About Myth Scholarship

Much current music composition, and technology scholarship is being pigeonholed into a STEM paradigm. Although I have suspicions about why this is, I lack the space to give this theory its full treatment here. There seems to be a stigma against exploring thoroughly the "less scientific" aspects.

³⁰ The inclusion of the cross as a main symbol was hotly contested with my mentor at the time. Her suggestion that the symbol would polarize viewers too much and prevent the work's acceptance at festivals for personal, non-aesthetic reasons was my first indication that the material being worked with was powerful.

First there is a stimulus or stimuli. In this document, the stimuli of VR, dreams, psychedelic drugs, and music have been explored. As soon as this material is perceived by the audience, precognitive pattern recognition takes place. This is the stage of perception that precedes conscious thought. It is the animal brain component of every human that would have allowed us to see patterns in the foliage so that we would quickly recognize a lurking predator breaking up the pattern. It is also the aural animal brain component that would have brought our attention to disruptions in ambient environmental noise to alert us to the sound of the same predator stepping on a twig. Once “pattern” and “non-pattern” are precognitively established, the sense data goes through one or more relating circuits. This stage resides somewhere between precognition and conscious thought. It is to some degree influenced by training, and to some degree inbuilt. It is the grey area between the animal brain and conscious thought. The research of Claude Lévi-Strauss suggests that in the domain of music, there are three main types of relating circuits; code, message, and myth (Lévi-Strauss 1969, 30).

Circuit Type	Notable Composers	Methodology
Code	Stravinsky, Bach	Comment on rules of a particular musical discourse
Message	Beethoven, Ravel	Tell a tale
Myth	Wagner, Debussy	Code messages by means of elements that “already partake in the nature of narrative” (Lévi-Strauss 1969, 30)

Although Lévi-Strauss categorized these composers separately, those familiar with their works can see that these delineations are not clear-cut. Beethoven’s primary focus may have been on telling messages through music, but archetypal elements are clearly perceived in many of his works. One such example would be the invocation of the “hero” archetype in his Symphony No. 3 in E major, Op. 55. Another example can be easily seen in the work of Bach. Undoubtedly Bach’s main focus was pushing the norms of Baroque era composition to their absolute limits. However, one would be foolish to deny the presence of archetype in the listener’s mind when experiencing a performance of *St. Matthew Passion*. Therefore, multiple relating circuits may be

at play in the listener's mind, but myth, i.e. archetypal story, is so inbuilt as a function of culture that it is always at play wittingly or unwittingly. The final theoretical section of this document will focus on the components that make up a myth, provide a framework for how post-modal artists can use the concept as a framework for creating pieces in any medium.

Monomyth

Four

The Keys

The adventure can be summarised in the following diagram:



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The above figure is a graph of Joseph Campbell's monomyth. A story can begin at any point in this cycle, and the cycle can, and often does play out on many time and magnitude scales. Typically, a story begins at the 12 o'clock position of the graphic and progresses in counterclockwise fashion. A call to adventure is foisted upon the hero.³¹ The hero acquires one or

³¹ Of course, the protagonist can bow-out once approach by the call to adventure. This does not make for a notable story, and thus is not written. If it is written, it is not well received, and disappears. This mythological Dawinism is a key reason that Campbell's monomyth is universal. Imagine J.R.R. Tolkien's fictional universe in *The Lord of the Rings* trilogy. The story focuses on the protagonist Frodo because he heeds the call to adventure, along with associated characters. The comprehensive universe created by Tolkien could have easily focused on Rosie Cotton who

more helpers. There is a threshold crossing that can manifest in many forms, some commonly used ones such as the night-sea journey,³² or whale's belly³³ are outlined above. There are further tests, or trials for the hero and helper(s). Further helpers are acquired at this point, sometimes a deus ex machina, or conveniently encountered helpful figure.³⁴ A number of symbolic apotheotic things can occur at this point. There is then a flight, and some kind of returning action. The hero returns to their community with an elixir³⁵ won as a result of their trials which is shared with the community.

Campbell's research advances and refines the ideas about archetype put forth by Carl Jung. Instead of focusing on multiple archetypes like Jung, Campbell narrowed his research to that of one archetype, the hero. Other Jungian archetypes make appearances in Campbell's research such as the Divine Mother, or the Wise Old Man, but these characters are always ancillary and presented as in-relation to the hero. In the next section I will summarize Campbell's monomyth and its potential for use in postmodal creative work.

Monomyth: Summary

What follows is a brief summary of Campbell's monomyth as it applies to the postmodal artist. In Campbell's most detailed work on monomyth, *The Hero with a Thousand Faces*, he details 17 potential mythemes that fit under three larger gestures that make up the monomyth. In my description of how this concept applies to postmodal artistic creation, I have narrowed the 17 components down to only the most relevant. The three larger gestures which have already been detailed in this writing by different terminology are Departure, Initiation, and Return in Campbell's parlance.

remained in her homeland and did not accompany Frodo on his journey, but this would not have formed a particularly interesting story.

³² Hemmingway's *The Old Man and the Sea*

³³ *Pinocchio*

³⁴ In *Harry Potter and the Chamber of Secrets* these helpers come to Harry during a battle with the basilisk. Just as Harry is about to be vanquished, Fawkes the Phoenix brings Harry the Sorting Hat, from which he pulls the Sword of Gryffindor. Fawkes wounds and distracts the basilisk so that Harry can stab it with the sword.

³⁵ Elixir could be an actual elixir, new knowledge, etc.

Departure

The artist must start somewhere. Any artist that has been creating for some time realizes that one of the hardest parts of the creative process is getting started. Oftentimes, genuine creativity arises for the artist when he makes a mistake that leads him into uncharted territory. “A blunder—apparently the merest chance—reveals an unsuspected world, and the individual is drawn into a relationship with forces that are not rightly understood.” (Campbell 2008, 42). Regardless of if the artist begins with a blunder or direct intention, in our Western education system, a mentor is usually present, “...a protective figure (often a little old crone or old man) who provides the adventurer with amulets against the dragon forces he is about to pass.” (Campbell 2008, 57). This Departure stage symbolizes the passing of the artist from the world as they know it into the unknown—Orpheus crossing into the Underworld, or the drug taker leaving the garden and entering past the hagazussa into the wilderness, or the artist willing a new piece into existence.

...the hero goes forward in his adventure until he comes to the “threshold guardian” at the entrance to the zone of magnified power. Such custodians bound the world in four directions—also up and down—standing for the limits of the hero’s present sphere, or life horizon. Beyond them is a darkness, the unknown, and danger; just as beyond the parental watch is danger to the infant and beyond the protection of his society danger to the member of the tribe. (Campbell 2008, 64)

Initiation

The artist enters the world of the unknown, where he will be tested through a series of trials. Here the artist may be aided by advice or wisdom imparted by the protective figure he may have encountered during the departure phase. These trials for the artist can range from the trivial to the severe. Things such as computer problems or running out of art supplies could be seen in the vaguest sense as minor trials. More significant trials have notably been encountered by many artists—the fact that we have remembered and reported these details throughout history is a testament to the importance of the monomyth framework. The composer Dmitri Shostakovich had to have a microfilm version of the score for his *Symphony No. 7 “Leningrad”* smuggled out of Russia for its premiere due to the cultural tyranny enforced by Stalin’s totalitarian regime.

Terminology that Campbell uses to refer to these underworld trials include belly of the whale, and road of trials. The resolution to these low points include father atonement, which is a

reckoning with the archetypal father, or tradition, and apotheosis, which is a nullification of opposite-pairs, such as the Buddha realized during his enlightenment.

Return

Ceremoniously or unceremoniously, the artist finishes their work, or performance, and subsequently returns to the ordinary world. This ordinary world in artistic terms, could include interacting with the audience after a live performance, or releasing an album—in any of these cases, it is the point when the work largely leaves the control of the artist, or when the artist returns from the creative role. Ostensibly the artist brings something of value, an elixir back to the community. This elixir renews and reinvigorates the community that receives it, even if it is bitter medicine.

Of course, the artist can also refuse the responsibility of returning. “Even the Buddha, after his triumph, doubted whether the message of realization could be communicated, and saints are reported to have passed away while in the supernal ecstasy.” (Campbell 2008, 167)

Case Studies

I utilized the framework most succinctly put by Campbell in my development of the audio responsive VR environment *Spektra*. I found Campbell’s framework to be particularly useful when foraying into this mostly foreign and uncharted territory of development. Virtual reality, as explained throughout this writing, has a lineage, a set of preconceived notions and “best practices”, but at its current state offers to wipe the slate clean again.

Developing modern software takes the form of the box it is poured into. McLuhan’s *The Medium is the Message* provides sufficient evidence to back this claim. The hardware used for the project consisted of an HTC Vive headset, two HTC tracking base stations, and a modern computer using a Radeon RX480 graphics card. More peripherals were available, but since the hardware had to be moved from the laboratory into the performance space, economy of size was of the utmost importance.

The first prototype I constructed to test audio-tracking in VR was a complex and obtuse pipeline. The initial beta involved both my personal MacBook Air for musical information

retrieval, and the aforementioned VR-capable PC for data sorting, mapping, and live VR rendering. I initially used various audio-tracking libraries in the MaxMSP programming language to perform basic musical feature extraction. This data was then scaled to values residing between 0.0 and 1.0, the resolution of this range consisting of single-precision floating-point numbers. I provided fine-resolution interpolation to this data to smooth transitions. The smoothed data was then packaged into OSC format and broadcast over a local, ad-hoc WiFi network being hosted by the rendering PC.

The render PC was running Unreal Engine 4, a game engine software used for Realtime VR rendering. Unreal Engine 4 natively includes a graphical programming language called Blueprints for rapid prototyping. Using UE4-OSC, an “OSC plugin for Unreal Engine 4 to send and receive OSC messages with blueprints!” (Buisson 2014) I built a Blueprints script to receive the OSC data coming from the laptop. Then I mapped this data to the Y position of 4 cubes spaced proportionally in virtual space and rendered using Unreal Engine.

The prototype served as a working proof of concept, but the reliability of UE4-OSC and the use of an additional computer were both suboptimal features. At the time of this writing, the UE4-OSC code has not been updated on GitHub in over a year. Sometimes it would abruptly stop receiving data or behave in other unpredictable ways despite network speeds and fidelity that proved to be more than adequate in tests run outside of Unreal Engine.

My decision to work towards having the entire tracking and simulation operation run on one machine was a more philosophical one. I was interested in using VR for many reasons. One of which was the solitary experience it provided. In my research, this sort of out-of-the-ordinary experience had in solitude seemed to resonate with many shamanic traditions written about by figures such as Terrence McKenna, Richard Alpert, and Timothy Leary. Honoring this choice of medium, I extrapolated that the entire simulation should be a solitary experience. Many well-meaning voices during this development stage urged me to make the experience social, to somehow include other musicians, or other virtual avatars, but I wanted to employ the use of abstract symbols, gleaned from mythological and psychedelic drug research, to provide the user with a more profound experience.

I decided to continue to utilize musical information retrieval as a means of controlling the virtual world, but in honoring the solitary aesthetic suggested by the VR headset, I wanted the

entire experience to be self-contained, imperceptible to anyone outside of the headset. Through using a virtual loopback audio interface freely available on Windows (VoiceMeeter [sic]), I was able to reroute local audio, in most test cases from the Spotify app running in the background, directly to the VR simulation, and also to the headset-wearer’s headphones.

At this point of development, I began to work with a colleague in the program, and competent C# programmer, Mark Micchelli. Micchelli’s mastery of musical improvisation combined with his programming ability made him the perfect complement to the project. With Micchelli’s coding ability in C#, we were able to use the Unity game engine. Unity is comparable to Unreal Engine but does not natively include a visual scripting system. Thus, the game developer must use C# for all game scripting. After testing numerous candidate libraries, we settled upon one named “Reaktion”.

Reaktion was developed by Keijiro Takahashi and is distributed freely on GitHub (Takahashi 2014). Takahashi works for Unity, and his GitHub is full of repositories of avant-garde Unity engine technology, and scrapped development trees from earlier ideas. It is an important resource for any modern Unity developer. Reaktion is a Unity library dedicated entirely to receiving OSC data and mapping it to various game parameters. Furthermore, the software is open-source, so with Micchelli’s coding abilities, the possibility of modding and interpreting Reaktion data was available. The resulting simulation went through many iterations of development.

Showcase I Development Pipeline

At this point, the OSC data import problem, and local audio routing problem were both solved and development on a usable version of *Spektra* could formally commence. The development pipeline progressed in this manner: I would make rough paper sketches for a scene to be integrated into *Spektra*. I would then work on the 3D art for the scene and import it as discrete game objects into the Unity engine. After creating the static scene, Micchelli and I would brainstorm mappings to be made between audio stimulus and 3D reactivity. We would A/B test these mappings in the simplest form and choose the more effective ones. These would then

be neatly added to the code by Micchelli. We would perform further testing, and then fine tune the mapping values and ramp functions.

I completed all scene sketches for *Spektra* with Campbell's Hero Cycle in mind. The user would begin inside a large structure floating in outer space. This structure was symbolic of the womb, home, stasis, conception, a buffer against the freezing cold of outer space. To further enhance this connection, I created an egg-shaped assembly inside the structure that the user could walk into and be inside, and floating semen-like beams recurrently swimming towards the egg.

After this home/starting point scene, a lottery system was implemented in the code to select random scenes without repeating scenes until the entire aggregate had been completed. The inspiration for this development came from the serialists' use of the tone row in musical compositions. This slight randomization would become a core concept of the work. I wanted to project a clear message through *Spektra*, that of Campbell's Hero Cycle, but to also allow for two user freedoms: liberty to interpret the experience according to the user's own personal background and preclusions, and the freedom from having the same experience repetitively. A 360 video would have been a far better medium choice for presenting a self-similar, repeatable experience. Slight, thoughtfully constrained bits of randomness in the scene order and other facets of the code afforded numerous exploratory possibilities to the user over multiple uses of the simulation.

Restraining the amount of randomness to an acceptable amount, i.e. not utilizing a total range such as in Schoenberg's case, I was able to shape a story arc that changed slightly from viewing to viewing but would always provide the same Hero Cycle trajectory. After the womb scene, there would be a white flash to transition to the subsequent scene. This flash was to represent the "boundary crossing". There were 4 potential scenes that could then appear in any order for the duration of the simulation: tunnel, astral landscape, Godsphere, and asteroid field. Each of these scenes featured quick dynamic animation that was both randomized and responsive to the music. The only sonic input being actively tracked in the simulation was amplitude at about 120 Hz. The audio input was run through a narrow bandpass filter at this frequency and the resultant amplitude was then scaled, inverted, and/or mapped depending on what virtual-physical parameter it was to be mapped to.

While doing extensive testing Mark and I determined this frequency to extraordinarily significant across genres and eras of recorded music in terms of programming minimalistic form detection. The amplitude in this frequency area averaged over a two second time window was a reliable form trigger in almost all test cases involving distinct song sections. This trigger was used to force scene changes so that they coincided with switches between song sections such as the verse and chorus.

Along the lines of subtle randomization another musical idea was integrated into the simulation. I have had a longstanding fascination with analog modular synthesizers. One of the subtle control mechanisms in that medium is the LFO, or low frequency oscillator. Micchelli was able to create a reusable, duplicatable, variable rate, oscillating sine wave function within the code. An infinite number of virtual LFOs could then be mapped to various facets of the virtual world in the simulation. As the terminology implies, these were used in order to create extremely slow changes in VR attributes such as object colors, density of objects, XYZ position of objects, et al. The slow pace of some of these oscillations, especially around the 0.25 Hz to 3 Hz range created synchronistic effects where the music and an object in the VR simulation would appear to interact, although in fact the LFO was the driver of the object, not the music. Even slower speed LFOs were experimented with in the 0.01 Hz to 0.08 Hz range. LFOs running in this range of speed produced changes in object attributes that were below detection thresholds for most users unless they were indicated to directly observe the changing attribute. These ultra-slow LFOs served to create a more atmospheric background effect to the work, only subtly noticeable on some subconscious level.

All of these mappings worked in concert to create a dynamic user experience that portrayed different iterations of Campbell's Hero Cycle as mapped to real-time audio. User reception was generally positive in the later stages of testing, with the most notable development being the improvement in form tracking for scene changes – a task that before automation was simply randomized with a variable time grain, thus being noticeably unrelated to the music.

Findings

Outside of in-lab testing, *Spektra* was showcased publicly as part of a large-scale multimedia work titled MKUltra: Form Constant. The full work was presented in the xMPL performance space at the University of California Irvine. The *Spektra* apparatus was set up next to the performance area. Spectators could wander the space freely during the performance and put on the VR headset to experience *Spektra* in real time as it reacted to the live musical performance.

Reception at this event was generally positive and a number of viewing modalities were demonstrated by the various headset wearers.³⁶ Upon interviewing those that used the headset at some point during the performance, I discovered that most users had felt vulnerable when putting the headset on. This was primarily due to the fact that the headset completely obscures vision. Not only would the headset wearer have to stand in front of the entire audience, they would have to do so without being able to see the audience and infer their reactions from nonverbal cues.

Although I initially considered this to be a design flaw on my part in placing the headset at the front of the performance space, I have come to see it in a different light. Having an audience member come up on stage, next to the musical performer is a nonstandard practice. Having them voluntarily obscure their field of vision goes against two of most peoples' fundamental instincts; social anxiety and a base anxiety of having one's primary sense obscured. I found that most users were able to relax into the experience after an initial increase in their anxiety when first donning the headset. This is akin to the boost of energy a performer feels before going on stage, or even in the initial moments of a performance. To provide the opportunity for audience members to experience the same emotional trajectory, i.e. pre-symbolic story, not only represents Campbell's Hero Cycle on a microcosmic level, but also provides an emotional cohesion and investment with the musical performer. This is a concept that could be ported to various other mediums in the future, and I believe the initial investment, or leap of faith, encouraged the participants to view the entire performance in a more positive light than if they had not made this investment. This inference has been demonstrated widely in the scientific literature. One such experiment concluded the following:

³⁶ ...this can be seen throughout the full video of the performance here - https://www.youtube.com/watch?v=ex4d8l_EPjQ

This study demonstrated in a laboratory experiment that recipients of requests can increase their liking of the requester, find the requester to be more affectionate and sociable, and feel closer to the requester because of the affiliative motive that the request conveys, rather than because of cognitive dissonance or self-perception that results following the helping behavior. (Niiya 2016, 217)

One of the more common ways in which performers make an early request of the audience is through charging for admission to performances. My own research extracted from the user experience of MKUltra: Form Constant suggests that other requests, especially those involving voluntary confrontation of base anxieties may enhance this effect further.

Showcase II Development Pipeline

A few main design challenges became evident after the presentation of *MKUltra: Form Constant*. These challenges arose from my own critical view of the performance, audience feedback, and committee insights. The main challenges were as follows:

1. Simplify.
2. Integrate music in a more dynamic capacity.
3. More clearly emphasize postmodality.

Simplify

Many participants seemed to be very confused about how to approach the *MKUltra* performance. As the art director of all technology and mediums being used in the performance, this insight personally eluded me until several months after the performance had occurred. Viewing the project through a less technologically encumbered lens I was able to understand how the polydirectional nature of the work could have confused participants. Walking into the space was itself overwhelming. The participant would find themselves dwarfed by three floor-to-ceiling projections of flickering, vaguely prophetic phrases, individuals lying on the ground with their smartphones lying over their eyes, strange, loud synthesizer sounds swirling around the space, and a cyberpunk VR apparatus with wearer at what one would likely perceive to be the “front” of the space, although any conception of direction would have quickly evaporated upon entering the theater. I loved the chaos, and in a more open-minded time period

of “be-ins” and “happenings” this open-format concept could have succeeded, but for many of the participants experiencing *MKUltra* in 2018, in a traditional performance space, this kind of verbose and expansive non-narrative experience proved to be confusing.

The simplification of this setup took place in two phases. Firstly I began with a negative process of removal. Considering that the scope of my dissertation was to mainly be focused on the relationship between music and VR, I stripped away all unrelated elements first. I decided that the next iteration would not contain machine learning, non-VR visuals, lighting design, Google Cardboard applications, or even print materials. The second phase of simplification involved a more robust integration of music and virtual reality, which resulted in a more postmodal experience.

Integrate Music

In *MKUltra* the improvised synthesizer music dynamically affected what the VR-wearer saw in the headset. In the revised performance, titled *Abstruse*, I wanted to more clearly link the two mediums. In *MKUltra* the synthesizer music fit within the aesthetic that I was composing in at the time - heavily beat and drone based electronic music. In order to more closely mesh VR with the music, either the VR simulation, or the music would have to be modified. Due to the degree-focus being on music, and the advice of committee members to more completely develop and integrate the musical component of the work, I decided on modifying the music to more closely fit the simulation.

Instead of operating in a beat-based paradigm, I tried to exemplify various facets of the VR work through sound design. I drew on inspiration from the visual elements, as well as the technology used to generate them. Visually, and technologically, it is obvious that the most used animation technique in *Spektra* is particle physics. From both a technological and aesthetic standpoint, the analog to particle physics in the audio domain is clearly granular synthesis. In each technique, variably-sized bits of a whole are being rendered over time according to rules that are typically systems-based, i.e. turbulence in a particle system, or speed of sound grains in granular synthesis.

Using this technique, I developed an Ableton Live environment, utilizing multiple instances of MaxMSP to create a multi-track, high-density granular synthesis array. The source material to be granulated was largely unrecognizable after it had been granularized, so this

afforded me a good deal of creative liberty to choose from a wide variety of source sounds. I chose a selection of psychedelic era music as homage to the extramusical concept I attempted with *MKUltra*. For additional raw granular material, I used audio selections from the performance recording of *MKUltra* - granulating across adjacent areas of this audio ensured that I would be able to create harmonious mixes of granularized material if the visuals called for it.

Apart from granular synthesis, I also employed the use of software loopers, delays, and various other timbre shifting effects in the Ableton Live environment. These effects primarily served as real-time timbre modifiers on the raw output of my high-density granular synthesis array, allowing me to more tightly interweave the audio with the visuals.

Emphasize Postmodality

The concept of postmodality was at the core of *MKUltra* although it was not commonly understood by participants. Paring down the mediums used for *Abstruse* would help to more clearly communicate this concept, however I felt as though to make it abundantly clear I needed higher order integration of VR and audio. *MKUltra* featured lower order integration of many different mediums, briefly put, many mediums emerging from the same conceptual starter. *Abstruse* would attempt the opposite strategy: just two mediums featuring a very high order integration to the core concept of postmodality. The questions then were, how to more sufficiently link VR and audio, and how to best present the linkage.

Typically, in an improvisation between two musicians there is bidirectional communication. This bidirectional communication is arguably one of the facets of musical improvisation that makes it enjoyable, and complex. Considering just the music and VR elements, there was only unidirectional communication between musician (myself) and the VR simulation (headset wearer). The headset wearer could navigate the experience in their own way by moving in 360 degrees, but other participants, not wearing the headset, couldn't see the output of this navigation, and it only controlled the VR environment. In order to establish bidirectional communication between headset wearer and musician I designed and implemented a number of interventions.

Firstly the VR headset wearer had to graduate from participant to performer. I attempted this during the production of *MKUltra* by placing the headset wearer at the “front” of the performance space next to my synthesizer setup, but most participants concluded that the headset

makes any participant look unflattering, such is the current state of VR hardware... For *Abstruse* I decided to place the headset wearer behind the audience seating so that they were out of view. In order to highlight the headset wearer's participation, the live output of the headset was displayed on a floor-to-ceiling wall projection only a few yards in front of the audience (a technique to more fully immerse audience members with just a 2D display).

In addition to this enhanced display output, I coded a script to be executed inside of the VR software that would send packets of OSC data over an ad-hoc WiFi network containing pitch, roll, and yaw data of the headset. These packets of data would be received by custom software running inside of an instance of MaxMSP within Ableton Live that would control binaural spatialization of a virtual listener, thus changing the apparent location of the different granular sound sources in real-time and under the control of the headset wearer.

To complete the postmodal improvisation loop, I, as performer, would be able to view how the headset wearer navigated the space by means of the projection screen, and respond in real-time to scene, and navigation-style changes. In turn, my musical changes would inform the headset wearer how to navigate the virtual space. In this way, a postmodal realization of existing music-only improvisational models such as Burrows's Mediational Triangle (Burrows 2004, 3), or even the model of Group Cognition (*Ibid*, 8) would be reached. More user research is necessary to determine which model *Abstruse* fits into better, although the components and general relations exist for both.

Synthesis of Elements

Apart from the three design principles already laid out, a more overarching principle emerged during the development process. The main driving purpose of *Abstruse* was to test the theories presented in my research. Many pieces of tangential knowledge were acquired along the writing and production process, but the core theory that *Abstruse* would serve to illustrate was that of postmodality. As an artist, this divide between aesthetically true artwork, and technological exercise presented me with a fundamental decision to make in the production of *Abstruse* - would the piece be an authentic realization of my artistic sensibilities, or a technological manifestation of the theories put forth in my research. There was grey area to be found in this divide, but I chose to emphasize the latter.

MKUltra was an artistic work. In my artistic work, I prefer to incorporate elements of fringe-culture. I enjoy creating a sense of ambiguity for the audience. In *MKUltra* I was able to create false expectations, and surprise the audience by breaking them. While *MKUltra* was a very artistically fulfilling work for me, it did not do a good job of illustrating my dissertation research.

It is for these reasons that I chose to present *Abstruse* in a session-format instead of a performance. Participants were able to volunteer to use the headset, and there was open communication between myself and the participants between improvisations, which was very unlike the rigid fourth-wall maintained in *MKUltra*. In order to very clearly illustrate the connection between the downsized number of technologies being used, I briefly talked the participants through the setup before beginning, as opposed to “just starting” as I did in *MKUltra*.

Ultimately these considerations made *Abstruse* less artistically fulfilling, but a better and clearer representation of the core concepts laid out in my previous research. In future iterations of this performance, I would attempt to reintegrate more artistic elements, and some ambiguity back into the setup. Bringing the functional and creative elements into a more perfect balance would make the work fulfilling to me as creator, and audience as more than simply a technical exercise.

Conclusions and Future Directions

Findings

Over the course of my research in conceptualizing, developing, and deploying music-first VR software, many different conclusions, major and minor emerged. The three that best sum up the research are presented in this conclusion. The trajectory I have taken in conveying this information begins at the micro level, and gradually move outwards. Firstly I discuss the musical implications of this work. Secondly I discuss some of the medium-specific considerations that the artist must be aware of when putting together a multimodal work. Finally I explain the implications that this kind of research has in terms of a new postmodal field of research.

Audiovisual Connections

Before expanding into the more encompassing implications of this work, one must examine the connections between the smallest atomic elements used in my music and VR

combinations. Despite only two mediums being present, i.e. music and VR, a third element, user interaction must also be considered as an invisible third member of this atomic-resolution assemblage. Due primarily to the technical overhead necessary to create content in VR, it was clear that the VR environment should dictate initial considerations in the music and in the user interaction.

As laid out in the Showcase II details, one of the main integrations was the generative technique for visual and audio material. In the VR domain, particle physics dominated the visual landscape in most of the scenes. To mirror this in the audio domain, granular synthesis was used to create a shifting turbulent texture similar to those created by the particle physics. In addition to this generation method the visuals suggested some kind of psychedelic, otherworldly, outer space scene. In order to mimic this in the audio, sound material from psychedelic music was used as the granulation input.

The key conclusions of my research in this area were that the audio and visual components must, to the best of the artist's technical ability, be developed ideally in tandem, or at least conceptually in tandem. For my own work on this project, this meant using analogous technologies in each medium to create one layer of homogeneity, and then taking advantage of stylistic analogues to establish another layer of cohesion. The end result is a work that attempts to transcend medium, instead of being merely a soundtracked visual, or animated electronic music. Of course achievements in this domain sit on a spectrum and are seldom fully on one end or the other, but what I established with *Abstruse* was a step towards full medium-liberation.

Monomyth

At a very early conceptual stage of this work, the work of media theorist Marshall McLuhan seemed as though it would provide a strong basis for my own research. As the topic of my work evolved, McLuhan became a distant memory, but this forgetting happened at my own peril. McLuhan's assertion that the medium communicates more than the message it contains (McLuhan 2011) seems to increase exponentially for each medium added. This is the most significant conclusion derived from my work.

Among users that experienced various iterations of my VR and audio work over the span of my research, the most repeated remarks seldom involved mention of the audio or visual elements in their atomic form. A vocal minority of users offered significant commentary on the specific audio elements of the work. All members of this minority had advanced degrees in a music or sound-related discipline. This division brings up an interesting artistic and HCI consideration that has been recurrent in my work to which there is no “correct” answer, only the one that the artist chooses. At an early stage of development I constructed a design persona in my mind for the purpose of being able to clearly articulate development goals and to shape creative decisions. My persona, or “ideal user” would be an individual that enjoys listening to electronic music genres, maybe even more experimental ones, but does not have significant formal training in music. This persona ensured that targets and goals did not shift too dramatically during development, or if they did it was a reasoned and purposeful shift.

Most of the work’s target users, or those that more closely resembled my persona remarked both in usability testing sessions and demonstrations more often on the VR experience in itself, performance space, and interactivity than on the component audio and visual elements. This feedback echoes McLuhan’s assertion that the medium conveys more information than the message. Through receiving this feedback from user testing at multiple stages of development, I thought more broadly about how exhibitions of the work could be framed to have a more significant impact on users.

User experience experts suggest conducting usability testing in a nondescript environment to avoid contaminating user experience results (Krug 2000, 150). My lab testing setup was not in a nondescript office room, it was in a recording studio, an environment that musicians such as myself feel so at home in that the data barely registers as notable or exceptional. Through the eyes of the uninitiated however, this space undoubtedly set up some kind of framing for non-musician users. I attempted to exploit this technique in the presentation of my first showcase by creating a countercultural, medium-rich space to begin to put users into an altered state of mind. The inclusion of this many mediums (projection visuals, VR, dynamic lighting, improvised music, optional smartphone VR, no set or persistent seating arrangements) was so pervasive that few users spoke of the content, and primarily noticed the overwhelming nature of technologies present.

In the second showcase-iteration of my work in the Spring of 2019, I gave thoughtful consideration to which mediums would be included, and to how they would be framed by a physical space. I decided to have a dim blue lighting set in the xMPL black box theater. The lights would be dimmed as soon as the doors were open. This served to create a distinct and immediate separation between the world outside of the performance space, and inside of it. It was my hope that this gradual easing into an altered state of awareness would lessen the shock of going from the real world into the music-VR world.

The audience seating for participants not currently wearing the VR headset was put mere feet from a two-story tall projection screen that showed the inside of the headset. This proximity somewhat mirrored the full visual field one sees when wearing a VR headset, also preparing the participants for a gradual transition into the VR space.

These medium-specific considerations³⁷ helped to properly frame the experience in a manner that utilized medium to facilitate a surreal environment, but was not so pervasive as to completely override the message of the performance, i.e. the low-level components of the work. I believe this balance between thoughtfully considered mediums and low-level content was significantly improved from the showcase conducted in the previous year. Further user testing is essential to continue to explore this topic.

Future Directions

The next step in my own research is to perform a more quantitative analysis of user impressions in response to inclusion or reduction of mediums in a work to establish a correlation between the number of mediums included in a work and the level of perceived immersion. In order to do this I would create, or have an artist create a work that could be experienced through a variable number of mediums. An example of this might be an acousmatic piece, with an experimental (silent) film that accompanies it. A large number of users would then be shown either solely the acousmatic work, or the acousmatic work plus the film. User reports of roughly one page would then be solicited from participants. After collecting a large number of these user

³⁷ A full explanation of the performance setup for this particular performance can be found in the “Showcase II” section.

reports I would utilize natural language processing algorithms³⁸ to analyze the text to derive insights into if and how the number of mediums changed the users' perceived levels of immersion.

The future for this kind of development is promising. Although universities used to sit at the forefront of new technological developments, I believe that the biggest movers in this postmodal area are commercial industries, particularly small VR startups. This does not reflect a lack of innovation on the part of the university, but rather a confusion about how to successfully integrate a more postmodal approach to artistic creation without completely abandoning a traditional delination between mediums. There are of course many programs at academic institutions that go by names such as "multimedia art", "experimental media", etc. however these programs seem to emphasize adoption of one or more mediums instead of seeing the whole range of mediums as a continuum. It is my hope that these disciplines will continue to look across traditional intermedium divisions while still retaining a sense of artistry instead of becoming technologically dominant such as the computer science related disciplines.

³⁸ ...of the same kind I used to generate text for the projection visuals in my Showcase I performance.

Notes

<\$\$-ENDNOTES-->

Bibliography

- Aguilar De Arcos, Francisco, Antonio Verdejo-García, María Isabel Peralta-Ramírez, María Sánchez-Barrera, and Miguel Pérez-García. 2005. “Experience of Emotions in Substance Abusers Exposed to Images Containing Neutral, Positive, and Negative Affective Stimuli.” *Drug and Alcohol Dependence* 78 (2): 159–67. <https://doi.org/10.1016/j.drugalcdep.2004.10.010>.
- Babbitt, Milton. 1958. “Who Cares If You Listen?” High Fidelity, 1958.
- Baguyos, Jeremy. 2016. “New Roles for Computer Musicians in S.T.E.A.M.” In ICMC 2016 42nd International Computer Music Conference Proceedings, 280–89. Utrecht. <http://www.icmc2016.com/proceedings.pdf>.
- Bayle, F. 1993. *Musique Acousmatique, Propositions, Positions*. Buchet/Cha. Paris.
- Besada, José L. 2014. “Computer , Formalisms , Intuition and Metaphors . A Xenakian and Post-Xenakian Approach.” In A. Georgaki and G. Kouroupetroglou (Eds.), *Proceedings ICMC|SMC|2014*, 14-20 September 2014, Athens, Greece, 93–98. Athens. http://www.smc-conference.org/smc-icmc-2014/papers/images/VOL_1/0093.pdf.
- Blocker, Déborah. 2017. “The Accademia Degli Alterati and the Invention of a New Form of Dramatic Experience: Myth, Allegory, and Theory in Jacopo Peri’s and Ottavio Rinuccini’s Euridice (1600) Chapter.” In *Dramatic Experience: The Poetics of Drama and the Early Modern Public Sphere(S)*, edited by Katja Gvozdeva, Tatiana Korneeva, and Kirill Ospovat. Brill.
- Boiler Room. 2014. “Jamie Xx Boiler Room London x Young Turks DJ Set.” YouTube. 2014. <https://www.youtube.com/watch?v=HV-nNEXgsOk>.
- . 2018. “Bonobo Boiler Room New York DJ Set.” YouTube. 2018. <https://www.youtube.com/watch?v=uynCeLheCPc>.
- Buisson, Guillaume. 2014. “UE4-OSC.” GitHub. 2014. <https://github.com/monsieurgustav/UE4-OSC>.
- Burroughs, William, and Brion Gysin. 1978. *The Third Mind*. The Viking Press.

- Burrows, Jared B. 2004. "Musical Archetypes and Collective Consciousness : Cognitive Distribution and Free Improvisation" 1 (1): 1–15.
- Campbell, Joseph. 2008. The Hero with a Thousand Faces. Novato, CA: New World Library.
- Cascone, Kim. 2004. "The Aesthetics of Failure: "Post-Digital" Tendencies in Contemporary Computer Music." In Audio Culture: Readings in Modern Music, 392–98. Bloomsbury. http://www.bussigel.com/systemsforplay/wp-content/uploads/2014/05/Cascone_Aesthetics.pdf.
- Castaneda, Carlos. 1977. The Teachings of Don Juan: A Yaqui Way of Knowledge. New York City: Simon & Schuster.
- Chabris, Christopher, and Daniel Simons. 2011. The Invisible Gorilla: How Our Intuitions Deceive Us. Harmony.
- Chion, Michel. 1983. "Guide To Sound Objects.," 210. http://www.ears.dmu.ac.uk/spip.php?page=articleEars&id_article=3597.
- Chowning, John. 2008. "Fifty Years of Computer Music: Ideas of the Past Speak to the Future." Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics) 4969 LNCS: 1–10. https://doi.org/10.1007/978-3-540-85035-9_1.
- Clauser, Henry R. 1988. "Towards a Dynamic, Generative Computer Art." Leonardo 21 (2): 115–22. <https://doi.org/10.2307/1578545>.
- Comicus, Redazione. 2008. "RAMIN DJAWADI: COMPOSITORE DI IRON MAN." 2008. <https://www.comicus.it/index.php/mainmenu-interviste/item/46280-ramin-djawadi-compositore-di-iron-man>.
- Cumming, Ed. 2014. "William Gibson: The Man Who Saw Tomorrow." The Guardian. 2014. <https://www.theguardian.com/books/2014/jul/28/william-gibson-neuromancer-cyberpunk-books>.
- Dass, Ram. 1978. Be Here Now. Lama Foundation.
- Deppe, Mark. 2017. "The Cavalry's Here." UCI E-Sports. 2017. http://www.esports.uci.edu/news_articles/overwatch_announcement.html.
- Dhomont, Francis. 1996. "Is There a Québec Sound?" Organised Sound 1 (1): 23–28. https://econtact.ca/6_2/dhomont_quebecsound.pdf.

- Domingo, Muriel. 2017. "Dieter Rams: 10 Timeless Commandments for Good Design." Interaction Design Foundation. 2017. <https://www.interaction-design.org/literature/article/dieter-rams-10-timeless-commandments-for-good-design>.
- Feldman, Morton. 1951. "Intersection 2." New York City: C. F. Peters.
- FredEd919. 2014. "Alien Isolation Noise Detection - Laugh of Death." YouTube. 2014. <https://www.youtube.com/watch?v=C1zqIVnmhgE>.
- Gasser, Peter, Katharina Kirchner, and Torsten Passie. 2015. "LSD-Assisted Psychotherapy for Anxiety Associated with a Life-Threatening Disease: A Qualitative Study of Acute and Sustained Subjective Effects." *Journal of Psychopharmacology* 29 (1): 57–68. <https://doi.org/10.1177/0269881114555249>.
- Gaudiosi, John. 2016. "Virtual Reality Video Game Industry to Generate \$5.1 Billion in 2016." Fortune. 2016. <http://fortune.com/2016/01/05/virtual-reality-game-industry-to-generate-billions/>.
- Gibson, William. 1982. Burning Chrome. <http://www.soylentgreen.us/burningchrome.pdf>.
- Gibson, William F. 1997. Neuromancer. New York: Penguin Putnam.
- Gluck, Christoph Willibaud. 1914. Orfeo Ed Euridice. Edited by Hermann Abert. Wien: Artaria & Co.
- hackertrips. 2015. "An Interview with Mitch Altman (Inventor and Virtual Reality Pioneer from the 80's)." YouTube. 2015. https://www.youtube.com/watch?v=5TrRO_j_efg#t=4611.
- "Haptx." n.d. <https://haptx.com/>.
- Haubenstock-Ramati, Roman. 1976. Concerto a Tre: Fur Klavier, Posaune Und Schlagzeug. Copenhagen: Wilhelm Hansen.
- Hope, Al. 2014. Alien: Isolation. USA: Creative Assembly. <http://www.alienisolation.com/>.
- Intelligence, BI. 2015. "Here's How Gaming Will Fuel Rapid Growth in the Virtual Reality Market." Business Insider. 2015. <http://www.businessinsider.com/gaming-will-fuel-the-virtual-reality-market-2015-5>.
- "International Conference on New Interfaces for Musical Expression." 2012. 2012. <http://www.nime.org/>.
- Jones, Edward E. n.d. "Harvard University Memorial Church Orfeo Ed Euridice Program Notes." www.memorialchurch.harvard.edu.

- jonesRG, ShortBananaMan, and fightwithdogma. 2015. "RiftintotheMind." Reddit. 2015. <https://www.reddit.com/r/RiftintotheMind/>.
- Jørgensen, Kristine. 2008. "Audio and Gameplay: An Analysis of PvP Battlegrounds in World of Warcraft." *Game Studies* 8 (2): 1–19.
- Jung, Carl G., M.-L. von Franz, Joseph L. Henderson, Jolande Jacobi, and Aniela Jaffé. 1968. *Man and His Symbols*. Edited by Carl G. Jung, M.-L. von Franz, and John Freeman. Dell Publishing.
- Jung, Carl G., and R.F.C Hull. 1981. *The Archetypes and the Collective Unconscious*. Princeton University Press.
- Ketterer, David. 1992. *Canadian Science Fiction and Fantasy*. Indiana University Press.
- Kim-Boyle, David. 2014. "Visual Design of Real-Time Screen Scores." *Organised Sound* 19 (03): 286–94. <https://doi.org/10.1017/S1355771814000272>.
- Klüver, Heinrich. 1942. "Mechanisms of Hallucinations." In *Studies in Personality*, edited by Terman and Merrill, 175–207. New York: Mc-Graw-Hill. <https://doi.org/10.1176/ajp.156.5.805b>.
- Kobayashi, Jun. 2001. Rez. Sega.
- Krug, Steve. 2000. *Don't Make Me Think!* Berkeley: New Riders Publishing.
- Kurzweil, Ray. 2005. *The Singularity Is Near*. London: Penguin Books Ltd. https://doi.org/10.1057/9781137349088_26.
- Lanier, Jaron. 2010. *You Are Not a Gadget: A Manifesto*. New York City: Alfred A Knoff.
- . 2017. *Dawn of the New Everything: Encounters with Reality and Virtual Reality*. Henry Holt. New York City.
- Leary, Timothy. 1994. *Chaos and Cyberculture*. Berkeley: Ronin Publishing, Inc.
- Lévi-Strauss, Claude. 1955. "The Structural Study of Myth." *The Journal of American Folklore* 68 (270): 428–44. <https://doi.org/10.1111/an.1965.6.9.3.2>.
- . 1969. *The Raw and the Cooked*. New York City: Harper & Row.

- Livingston, Christopher. 2017. “Fallout 4 High Resolution Texture Pack Comparison Screenshots.” PC Gamer. 2017. <http://www.pcgamer.com/fallout-4-high-resolution-texture-pack-comparison-screenshots/>.
- McKenna, Terence. 1993. Food of the Gods: The Search for the Original Tree of Knowledge A Radical History of Plants, Drugs, and Human Evolution. Bantam Books. <https://doi.org/10.1017/CBO9781107415324.004>.
- McCluhan, M. (2011). The Medium is the Message. In *Understanding Media: The Extensions of Man* (Vol. 1964).
- Meehan, Michael, Sharif Razzaque, Mary C. Whitton, and Frederick P. Brooks. 2003. “Effect of Latency on Presence in Stressful Virtual Environments.” Proceedings - IEEE Virtual Reality 2003–Janua: 141–48. <https://doi.org/10.1109/VR.2003.1191132>.
- Montero, Carlos. 2012. Black Mesa. USA. <https://www.blackmesasource.com/>.
- Monteverdi, Claudio. 1607. L’Orfeo, Favola in Mvsica. Venice: Ricciardo Amadino.
- Murmane, Kevin. 2017. “The University Of Utah Offers Scholarships To Play Varsity Esports [Updated].” Forbes. 2017. <https://www.forbes.com/sites/kevinmurnane/2017/04/06/the-university-of-utah-offers-scholarships-to-play-varsity-esports/#29b55fa6179c>.
- Musick, Michael. 2014. “Examining the Analysis of Dynamical Sonic Ecosystems: In Light of a Criterion for Evaluating Theories.” ICMC, no. September: 154–61. <http://hdl.handle.net/2027/spo.bbp2372.2014.026>.
- Niiya, Yu. 2016. “Does a Favor Request Increase Liking Toward the Requester?” Journal of Social Psychology 156 (2): 211–21. <https://doi.org/10.1080/00224545.2015.1095706>.
- “NIME Workshop on Audio-First VR.” n.d. Accessed May 8, 2018. <https://audio1stvr.github.io/>.
- Novak, Marcos. 1996. “Transmitting Architecture : The Transphysical City Zero : Transmitting Architecture.” Time 0 (July 1995): 1–10.
- Pinker, Steven. 2002. The Blank Slate. New York City: Penguin Books Ltd.
- Potter, Mary C., Brad Wyble, Carl Erick Hagmann, and Emily S. McCourt. 2014. “Detecting Meaning in RSVP at 13 Ms per Picture.” Attention, Perception, and Psychophysics 76 (2): 270–79. <https://doi.org/10.3758/s13414-013-0605-z>.

- Research, Grand View. 2017. “Virtual Reality (VR) In Gaming Market Size Worth \$45.09 Billion By 2025.” 2017. <http://www.grandviewresearch.com/press-release/global-virtual-reality-in-gaming-market>.
- Róheim, Géza. 1943. *The Origin and Function of Culture*. New York: Nervous and Mental Disease Monographs.
- Rushkoff, Douglas. 1994. *Cyberia: Life in the Trenches of Hyperspace*. London: Flamingo.
- Scacchi, Walt. 2011. “Modding as an Open Source Approach to Extending Computer Game Systems.” *International Journal of Open Source Software & Processes* 3 (3): 36–47. <https://doi.org/10.4018/jossp.2011070103>.
- Serafin, Stefania, Cumhur Erkut, Juraj Kojc, Niels C Nilsson, and Rolf Nordahl. 2016. “Virtual Reality Musical Instruments: State of the Art, Design Principles, and Future Directions.” *Computer Music Journal* 40 (3): 22–40.
- Shaver-Gleason, Linda. 2017. “Beethoven’s Deafness and the Myth of the Isolated Artist.” *The Avid Listener*. 2017. <http://www.theavidlistener.com/2017/01/beethovens-deafness-and-the-myth-of-the-isolated-artist.html>.
- Simmons, Josh C. 2017. “Video Games as New Model for the Performing Arts.” <https://drive.google.com/file/d/0B00Wyx61nG1NWdlWnVqdXo4UG8/view?usp=sharing>.
- Singletary, Charles. 2017. “The Crowdfunded Hardlight VR Suit Lets You Feel Your Virtual Experience.” *Upload VR*. 2017. <https://uploadvr.com/crowdfunded-hardlight-vr-suit-lets-you-feel-virtual-experience/>.
- Stockhausen, Karlheinz. 1992. Nr. 7: *Klavierstuck XI*. London: Universal Edition.
- Strassmann, Rick. 2001. *DMT: The Spirit Module*. Rochester, Vermont: Park Street Press.
- Takahashi, Keijiro. 2014. “Reaktion.” 2014. <https://github.com/keijiro/Reaktion>.
- Tarantino, Todd. 2002. “ORFEO: Act 3.” 2002. <http://www.toddtarantino.com/hum/orfeoact3.html>.
- TechRadar. 2017. “Oculus Co-Founder Reveals the Future of VR at CES 2017.” YouTube. 2017. <https://www.youtube.com/watch?v=9hek393AEdY>.
- thekinolibrary. 2017. “1990s Jaron Lanier Presents VPL Virtual Reality Glove.” YouTube. 2017. <https://www.youtube.com/watch?v=E1q9zDSAQEw>.

- Thompson, Jamie. 2011. "Djent, the Metal Geek's Microgenre." *The Guardian*. 2011. <https://www.theguardian.com/music/2011/mar/03/djent-metal-geeks>.
- Unity. 2010. "Unity Asset Store." 2010. <https://www.assetstore.unity3d.com/en/>.
- Wagner, Richard. 1849. *The Art-Work of the Future*. Edited by William Ashton Ellis.
- . 1892. "Richard Wagner's Prose Works Vol. I. The Art-Work of the Future." In Richard Wagner's Prose Works Vol. I. *The Art-Work of the Future*, 422. London: Kegan Paul, Trench, Trübner & Co.. Ltd. http://javanese.imslp.info/files/imglinks/usimg/6/6a/IMSLP94177-PMLP194194-RWagner_Prose_Works_Vol1.pdf.
- Wang, Ge. 2014. "Principles of Visual Design for Computer Music." In A. Georgaki and G. Kouroupetroglou (Eds.), *Proceedings ICMC|SMC|2014*, 14-20 September 2014, Athens, Greece, 391–96. Athens. http://www.smc-conference.org/smc-icmc-2014/papers/images/VOL_1/0391.pdf.
- . 2016. "Some Principles of Visual Design for Computer Music." *Leonardo Music Journal* 26 (26): 14–19. https://doi.org/10.1162/LMJ_a_00960.
- Weinel, Jonathan. 2010. "Quake Delirium: Remixing Psychedelic Videogames." *Sonic Ideas* 3 (2): 22–29.
- Wighton, Kate. 2016. "The Brain on LSD Revealed: First Scans Show How the Drug Affects the Brain." *Imperial News*. 2016. <https://www.imperial.ac.uk/news/171699/the-brain-lsd-revealed-first-scans/>.
- Williams, Paul, Keith V. Nesbitt, Ami Eidels, and David Elliott. 2011. "Balancing Risk and Reward to Develop an Optimal Hot-Hand Game." *Game Studies* 11 (1): 1–16.
- Witts, Dick. 1995. "Karlheinz Stockhausen - Advice To Clever Children." *The Wire*. 1995. <http://www.stockhausen.org/ksadvice.html>.
- Zorn, John. 1984. "Cobra." 1984. <https://hermes.neocities.org/zorn-cobra-score.pdf>.