I

The Virtual Space

The impact of time-based signal processing

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Preface

Being the amorphous figure whom Paul Theberge labels “the singer-songwriter, producer, engineer, musician, sound designer” (Théberge 1997, 221–222), spatial effects are, if not the bread, at least the butter of my artistic practice. My fascination with these effects goes a long way back. Recalling my early teens when acquiring my first electric guitar. I would sit in my room, turning the reverb knob on the amplifier up, playing around for hours on end. In my late teens, when busking in various European cities, there was nothing more exhilarating than finding a narrow street or a subway corridor with tiled surfaces to accompany my voice and guitar. Or better yet, in my mid-twenties, when acquiring my first synthesiser, a Juno 106, putting the chorus on full and playing it through my reverb and delay pedals, creating lush landscapes and rhythmical patterns. Or today, when I am mixing music in the DAW, I am picturing myself as the sonic architect of unknown spaces. It still fascinates me; otherwise, I would never have endeavoured to embark on this *wet* and lonesome journey of putting this thesis together.

Chapter 1: Introduction

This thesis addresses the significance of virtual spaces in popular music production. The virtual space constitutes the sonic choreography of the music and is often rendered into aesthetic effects, allowing artists to uniquely present their own sense of self. It is, therefore, vital to the overall sound of a music production, its narrative potential, and, consequently, its effect on potential listeners.

This opens up a vast field of research possibilities. To narrow the focus of this research, this thesis primarily concerns how so-called time-based signal processors (by which I mean signal processors that fabricate or manipulate space by manipulating the temporal parameters of sound. This includes effects such as reverb, delay, chorus, flanger and phaser.) shape the virtual space. Regarding their impact on the virtual space, I am particularly interested in how the sonic signatures of historically grounded processors and the aesthetic norms concerning their use can reference the eras in which they were developed or popularised. It is further my notion that the current state of the music production industry revolves around the appropriation of sonic markers and signatures of past eras. The product catalogues of the major plug-in manufacturers today (e.g. Waves, Soundtoys, Universal Audio and Valhalla DSP) testify that there is a high demand among producers and artists for plugins modelled after various pre-digital sound processing devices renowned for their sonic signatures and their use in canonical recordings. Moreover, as Samantha Bennet writes, “the very issues that recordists once fought to eliminate are now desirable features in the form of plug-in emulations” (Bennett 2012). With this focus, I hope to supplement the existing research and shed light on technology’s role in creating musical expressions.

Research question

The initial research question for this thesis was: How can music productions reference specific past eras through reverb? As I gained more insight into the topic, I realised that this formulation excluded other interesting ways to approach the subject. Also, instead of focusing exclusively on reverb as a sonic marker, I extended my research to include other spatial effects, such as chorus, phaser, flanger and delay. Although these effects may sound different, they all rely on manipulating the temporal parameters of sounds and are powerful tools in the design of the virtual space. With this in mind, there are several ways this research question could be formulated. However, my research question for this thesis reads as follows: How

can virtual spaces function as a sonic marker of time? To answer this question, my main objectives throughout this thesis will be to demonstrate the following:

1. how time-based processing effects such as reverb, echo, chorus and flange affect our spatial understanding of the virtual space in recorded music.
2. How the norms regarding the design of the virtual space have changed over time.
3. How these norms are used as sonic markers in contemporary music productions to reference genres and eras of the past.

I have chosen a Practical/Theoretical approach for this thesis to shed light on these issues.

Method and Methodology

Focusing on the virtual space as a sonic marker involves identifying various historically grounded recording technologies. This provides this thesis with a few challenges. As Askerøi writes, "Recording technologies are perhaps the most challenging to identify specifically as sonic markers. In contrast to instruments and voices, they do not produces tonal or harmonic structures but rather affect the timbral qualities of musical elements. In this way, this equipment contributes to "colouring" the music to a significant extent" (Askerøi 2013: 31). This implies that even for the most trained listener, there will always be various aspects of the production that remain concealed from the listener but, nonetheless, colours the music making them essential to the production as a whole. Although these details may seem insignificant to the average listener, they are meaningful and contribute to the totality of the sound.

Identifying sonic markers in the virtual space thus involves differentiating between various reverb types and devices. An example that may be hard for a listener to discern within a mix is ambience reverbs, which due to their short decay time (0.5 seconds or less (Costello 2017)), are usually felt rather than heard. Another example would be discerning between various reverb devices, which through their use in canonical recordings, serve as sonic markers.

To overcome these challenges, I have used music production as a method. The advantage of practice-led research is that it can provide a deeper insight into the questions that are asked, given that the questions are related to and can be answered through artistic practice. Although this method gives me an omniscient insight into the processes within the

mix, it also comes with its pitfalls because one can quickly become too attached to the object of study to appraise it objectively. Other aspects not directly related to this project, such as poor songwriting, studio performance or unbalanced mixing, can also negatively affect the outcome.

As part of my artistic practice, I have written, recorded, produced, and mixed three songs, which will be analysed in the last chapter. The practice-led research has aimed to shed light on the concepts and questions asked throughout this thesis and give the reader of this thesis a broader insight into the topic discussed by engaging sensory experiences. The criteria for choosing a mediation is that they should complement each other and highlight different aspects of the issues addressed throughout this thesis. Each mediation highlights various aspects of the topics and issues addressed throughout this thesis.

My aim, however, has not been to produce music for demonstrational purposes; that is, producing for the sake of producing. Instead, I have used the concepts and techniques discussed throughout this thesis to encourage a more conceptual approach to the craft of mixing and producing. An important criterion has thus been that the processing should substantiate the established narrative and sonic markers of the tracks. This approach places my practice in a more realistic environment, as the production choices have been on the premises of the music and not the other way around. This has encouraged me to contextualise my work and to be critical in my aesthetic and creative approach to mixing and producing.

All the songs have been co-written and produced with the other members of my band Greatfruit, in which I am the singer, guitar/keys player, producer, technician and songwriter. Greatfruit is an Oslo-based psychedelic indie rock/pop band. The psychedelic pop explorers describe their music as a “kaleidoscope of late 1970s and early 1980’s nostalgia transmitted through a psychedelic lens”, which implies that there are a lot of sonic markers at play. My role as producer, technician and songwriter in the band provides me with a great degree of artistic freedom, which makes the productions suitable for this thesis.

This thesis could have been effectively executed by applying analysis of case studies as the primary method. Previous academic literature on the subject has to a large degree, rested on case studies as a method which has proved to be a valuable source for extracting data and illuminating various technological aspects of record production. In choosing production as a method, I hope to be able to contribute insights into this field and illuminate different ways to approach this subject.

Literature

"Music in Bits and Bits of Music", "The Magnetic Tape Recorded" by Ragnhild Brøvig-Hanssen, and "The Naturalised and Surreal" by Brøvig-Hanssen and Danielsen have been important sources in this thesis. They have provided me with a vocabulary and theoretical framework for discussing technological aspects within a mediation. In her doctoral dissertation, Brøvig-Hanssen introduces the dichotomy of opaque and transparent mediation, which are key concepts in this thesis. Opaque means that the mediation has a voice of its own, by making the presence of the mediating technology explicit, while transparent means that the mediation aims at a realistic reproduction of the recorded material. She also writes about how it has become a common practice among producers of the digital studio to use plugins emulating pre-digital equipment and playback media and how these sonic signatures have become an important part of the producer's palette. Although there seems to be a longing for the past, she writes that this is not an act of defiance of the modern but a commitment to it. A sentiment that reverberates through this thesis as well.

Reading Pop Production by Eirik Askerøi introduced me to some of the other key concepts used throughout this thesis. Sonic Markers, which he defines as "musical codes that have been historically grounded through a specific context, and through their appropriation, serve a range of narrative purposes in recorded music…" (Askerøi 2013). An example he uses which is relevant to this thesis is the slap-back echo which is often associated with recordings of the 1950s. Today, the slapback has lost its initial shock effect, but when appropriated in recent popular music productions, it becomes a sonic marker of nostalgia and rock'n roll.

Another term which is relevant in this context is retronormativity, "which labels the mechanism of placing the "past" in the"present"… Retronormativity further implies a nostalgia for technological artefacts in the return to the "sound" of the 1950s, 1960s, and so on" (Askerøi 2013)

Reverb and Echo by Peter Doyle gives a complete historical review of spatiality and different production aesthetics in early monophonic recordings (1910 - 1960). In his book, Doyle introduces the concepts of realist and impressionist production practice, which in some way resembles Brøvig-Hanssen's opaque and transparent mediation concepts. Still, I find it necessary to distinguish between them because a mediation can be both realistic and opaque simultaneously. Doyle describes his terms in this way: "The potential to record either with or without "depth" then presented record makers with a serious technico-aesthetic problem. A split soon arose whereby it become broadly acceptable to record classical orchestral music so

as to include room ambience (and thus aural depth), while "popular music" was in the main recorded "dry," with little or no discernable depth and minimal reverberation. The voices and sounds of high art were accorded virtual sonic space, while low art was denied it." As room ambience became common recording practice in popular music for creating depth and separation between instruments, there still was a realist pictorial approach to the use of reverb, this however changed with Rock'n roll, which instead of realistic pictorial soundscapes favoured an impressionistic synthetic sound, characterised by slap back delays and echo chambers which in no way resembled the actual recording.

Email Kraugerud's master thesis, *Spaces of sound: meanings of speciality in recorded sound,* and his doctoral dissertation Come Closer: *Acoustic intimacy in popular music sound*. Deals with spatiality in record production and is therefore related to this thesis to a large degree. It is also an example of how this type of research can be executed. Kraugerud also uses production to illustrate some of the challenges concerning artistic practice.

"*Space within Space: Artificial Reverb and the Detachable Echo"* by Jonathan Sterne is another paper that influenced this thesis. Although relatively short (only 18 pages), this is the only paper I have managed to find that addresses the sonic signatures of different types of reverbs, architectural, mechanical and algorithmic. Sterne writes with an insider perspective (the perspective of a producer), showing insight into different reverb plugins, their sonic signatures, and the equipment they are trying to emulate, as well as giving insight into shortcomings and the challenges programmers face when creating various reverb algorithms.

Through its 18 pages, Sterne gives excellent technical and aesthetic insight into different types of reverb and offers a different take on the subject. He also breaks down several myths concerning the realism or *lack* of realism of different kinds of reverbs. Sterne also broadens the conversation by drawing parallels to how modern architecture has changed our understanding of space.

Another important source has been various non-academic sources, such as music production forums, blogs and the websites of various plug-in manufacturers. These sources have provided me with information regarding mixing techniques, recording equipment and how various renowned music producers and mixers conceptualise the virtual space.

Outline of Thesis

This thesis consists of three chapters, including the introduction. Chapter 2 concerns the virtual space as understood in existing research. First, I will discuss some key concepts and frameworks, including dimensions of the virtual space (i.e. depth, size, character and texture).

Second, I will discuss how various time-based signal processors are used to shape the virtual space. Third, I will provide a historical review which aims to give the reader insight into how the development of studio technology and techniques has influenced the evolution of virtual spaces in popular music. This is key to understanding how virtual space can be implemented as a sonic marker of time.

Chapter 3 discusses various ways a mediation can be staged according to different aesthetic ideals and norms regarding the design of the virtual space. Using Ragnhild Brøvig-Hanssen's terminology (Brøvig-Hanssen 2018), we will begin by discussing the virtual space concerning two different production ideals, the "transparent space" and the "opaque space." Second, I will discuss the virtual space in relation to the ideal versus surreal event. After discussing these dichotomies, we will conclude this chapter by discussing how virtual spaces can be used as a sonic marker of time. By drawing on Eirik Askerøi's concept of sonic markers (Askerøi 2013), we will explore how strategies related to this concept can be applied to the virtual space and how it, in turn, can assert the identity and authenticity of the protagonist in the music.

Chapter 4 concerns the artistic practice. This chapter provides a detailed analysis of the tracks I have recorded and produced for this thesis. Here I will discuss the signal processing and the reasons for processing them in these ways. First, I will discuss the track "Love Police" – an experimental-sounding 1980s-inspired ballad. Next, I will discuss "The Thing That You Are" – an ode to psychedelic and progressive rock from the late 1960s to mid-1970s. Lastly, I will discuss "Key Largo" – a bossa nova/exotica-inspired track. Finally, I will reflect on how all the tracks have contributed insight into virtual spaces in an overall conclusion.

Chapter 2: Virtual space

Since musicians began incorporating virtual spaces in popular music, space became the object of an artistic palette. It has since then been used by artists as a means for conveying their own sense of self, the geographic, the social, the cultural and the personal. In this chapter, we will explore what virtual spaces in popular music are, how they are shaped and created, how the norms regarding their implementation have changed over time, and how this change has had an impact on the music made, as well as our notions of what music is. The following sections provide the reader with the theoretical and historical framework needed to explore and understand how virtual spaces can function as sonic markers of time, which will be the topic of chapter 2.

Fabricated virtual space is interesting in this context because it's not an inherent quality of the music itself but part of the compositional design, which in turn determines how the music is staged and perceived. Today, fabricated virtual spaces can be heard in almost any recording. Virtual space is thus fundamental to the *sound* of the music. Ragnhild Brøvig-Hanssen and Anne Danielsen write that the word *sound* often represents the identity of the music and is a set of sonic characteristics, which often can be summed up in a very brief moment (Brøvig-Hanssen and Danielsen 2013: 71). Since the 1920s, the unique designs of the virtual spaces have been among the primary sonic signifier responsible for defining the sound of genres, such as classic rock'n roll, dub and Hapa Haole (Hawaiian music). An investigation into virtual space as a sonic marker of time is thus necessarily an investigation of musical sound in a historical context.

The following chapter consists of four parts. The first part deals with the virtual space in recorded music and how the norms regarding its implementation have evolved and continue to evolve through the process of normalisation. We will then move on to the second part, where we will discuss some of the effects commonly used to fabricate virtual space in popular music. Any processing will ultimately have an impact on the virtual space. However, this thesis focuses on how time-based signal processors such as reverb, echo, chorus, and flanger affect the virtual space. The reason for focusing on these effects is that they all share the same technological kinship and principles. What sets them apart from other signal processors is that they manipulate the temporal parameters of sound. For instance, a delay can easily be made into a chorus or flanger effect. Similarly, a chain of delays can quite quickly

produce a convincing reverb. Apart from being related to each other and having spatial impacts on the sound they are being applied to, they are quite expressive and may potentially have a significant effect on the virtual space and the *sound* of the music.

After discussing the time-based signal processors, we will move on to part three, where we will look at how time-based signal processors are being used to shape the features and characteristics of virtual space and how this affects the depth, texture and timbre of the virtual space. Lastly, to contextualise the prior discussions, I have also included a historical review of the fabrication of space and virtual spaces in popular music.

The virtual space is usually conceptualised as a three-dimensional space consisting of width (panning), height (frequency range) and depth (a textual foreground, middle ground and background). The term is often used to describe various characteristics in recorded music. It has also been used as the conceptual cornerstone for several analytical models for mapping the organisation of sounds within a mediation, including the “sound box" (Moore 2001), the “sound stage” (Moylan 2002), and the “lydrom" (Danielsen 1991). However, throughout this thesis, when applying the term virtual space, I’m more concerned with the features and characteristics of the virtual spatial environments than the organisation of sounds within them. None of the formerly mentioned models illuminates this aspect of a mediation. There are probably various ways that a model which takes the features and characteristics of different reverberation types into account can be created. However, such a model runs the risk of becoming too complicated and thus loses its usefulness, as the benefit of the previously mentioned models lies in their simplicity. The features and characteristics of a reverb distinguish it from other types of reverb. For instance, a spring reverb and a plate reverb may have the same length and decay time; however, the characteristics of the two reverbs are nonetheless very different from each other. This becomes even more evident against digital reverbs that do not correspond with real-world spatial environments.

The virtual space

With innovations in the world of time-based signal processors over the past couple of decades, especially in algorithmic and convolution reverb, the mixer can simulate any physical space encountered in the real world, as well as otherworldly and non-natural spaces. These spaces are often rendered into aesthetic effects, allowing artists to uniquely present their own sense of self.

Jonathan Sterne writes that “as soon as engineers, artists, and musicians could fabricate space, they treated it as aesthetic raw material, sonic space itself became the object of an artistic palette” (Sterne 2015: 112). Throughout the history of popular music, the norms

regarding virtual space have undergone several transformations. Brøvig-Hanssen and Danielsen note that what we regard as normal or natural sounding is constantly in flux. Due to the process of normalisation, what was at one point in time considered utterly surreal, will at one point be regarded as the new norm to which new virtual spaces are measured[1] (Brøvig-Hanssen and Danielsen 2013: 76). This is particularly evident considering how the norms regarding the virtual spaces in recorded popular music have changed over the past century. We will return to this in the historical review.

Fabricated virtual spaces can now be heard in almost any popular music recording. However, it hasn't always been this way. Until the 1920s, the virtual spaces in popular music were depthless, meaning they were more or less completely dry. This was both an aesthetic norm and a consequence of technological constraints. The limited frequency range of the gramophone (162-2000 Hz) made reverberation unsuitable for the format. At this moment in recording history, the act of recording was more of a technical matter than an aesthetic one. As Brian Eno notes, musical recordings were typically created with the idea of presenting a faithful rendition of a real-life performance (Eno 2004: 128). Any creative or artistic intervention by the engineer would therefore diminish the faithfulness of the recording.

However, this changed with the advent of the electric recording in the mid-1920s, which offered a broader frequency range and new techniques and methods for recording sound. With these changes in recording technology, a sense of aural space was made possible. As a result, reverb became an essential means through which recording engineers could place music spatially. Electric recordings relied on condenser microphones to convert the audio signal into an electric signal. This innovation increased the sound quality and introduced new techniques for capturing space acoustically. At this point, reverb was essentially the by-

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[1] An example which illustrates our ability to normalise what was once considered surreal, is the normalisation of the microphone and amplifier. Brøvig-Hanssen and Danielsen writes that when singers in the 1920s began using microphones, they became aware that the amplification of the signal, could make the intimate talking voice penetrate in a concert hall. The sining style know as crooning, which is similar to the talking voice we experience in our everyday lives thus came about as a consequence of the implementation of this new technology. When audiences first experienced this in the 1920s, it was by many experienced as utterly surreal, as the sound they were exposed to didn't correspond to the microphones spatial location. Moreover, crooning foregrounded the use of the microphone as an instrument, which up until then wasn't regarded as a natural part of the sining performance. However, as time went by and people got used to the sound of the microphone, it eventually stopped producing any surreal effect on listeners, until it came to stand for the voice itself (Brøvig-Hanssen and Danielsen 2013: 75).

product of the microphone's distance from its sound source. The further away from the sound source, the more reverberant signals would be picked up by the microphone. Following these changes in technology and aesthetics, Doyle writes:

> The potential to record either with or without depth then presented record makers with a serious techno-aesthetic problem. A split soon arose whereby recording classical orchestral music to include room ambience (and thus aural depth) became broadly acceptable. In contrast, popular music was, in the main, recorded dry, with little or no discernible depth and minimal reverberation. The voices and sounds of high art were accorded virtual sonic space, while low art was denied it (Doyle 2005: 57).

Doyle argues that two different aesthetics rose from this split, realism and romanticism. The realist approach (that is, depthless recording) provided an effect of intimacy, the orchestra and soloist being transported into the living room; Romanticism conversely had the effect of bringing the listener into the concert hall (Doyle 2005: 57).

However, Doyle's claim that low art was denied virtual sonic space is problematic because a depthless virtual space is still a kind of virtual space. Rather than saying that low art was denied virtual space, I would rather say that low art was denied the possibility to shape the virtual space.

Although the depthless recording was the accepted norm in popular music, some popular genres gave way to more experimental use of reverberation. An early example of this is Gene Austin's "My Blue Heaven" 1927, where the up-front crooning vocal is contrasted with a distant and reverberant piano and cello. In the following years, reverberation migrated to several other genres and became a key aural marker in genres like Hawaiian music and cowboy songs.

Regarding early applications of reverberation in popular music, Peter Doyle observes that in genres such as hillbilly, classic rock'n roll and R&B, reverberation "would sometimes refer to specific geographic locations" (Doyle 2005: 5). He continues:

> Some of these spaces were pictorial, somehow referring me back to my own learned preconceptions of, say, the American West or the beaches of Waikiki (…) Other times sonic spatiality was less explicitly pictorial, tending toward the hallucinatory, in some way evoking a sense of strangeness or disquietness, suggesting movement through spaces without any special reference to real-world places. (Doyle 2005: 5-7)

What Doyle describes here constitutes cases where artists creatively used the virtual space for artistic purposes to create a sense of space and place. It also shows that the norms regarding the virtual spaces of today's popular music are a result of an evolution spanning back to the earliest recordings from the early 1900s.

Features and characteristics of the virtual space

Just like real-world spaces, the virtual spaces of stereophonic music consist of three dimensions. These are colloquially known as height (the vertical dimension), width (the horizontal dimension) and depth. (1) The height of the virtual space refers to the frequency range of the sounds. Low frequencies are located at the bottom, and high frequencies are located at the top of the vertical axis. (2) Width is the horizontal axis and refers to the width or placement of sounds in the stereo image. (3) Lastly, depth refers to the perceived distance, which is the result of volume and reverberation and timbre.

These three dimensions are the conceptual framework that several musicologists have used to create various analytical models for mapping the placement of sounds within a mediation. Among these models, we find the “sound box" by Allan F. Moore (2001), the “sound stage” by William Moyland (2002) and the “lydrom" by Anne Danielsen (1991). All models highlight different aspects of the virtual space. Despite the relevance of these models, I will refrain from using them, as my interest primarily revolves around how time-based signal processors affect the depth, character and texture of virtual spaces.

The following section deals with features of the virtual space concerning time-based signal processors. It’s not my intention to give a complete account of all aspects of the virtual space. Instead, I will stick with the features which are most important for this thesis.

Depth

Aural depth is now a quintessential part of most popular music genres. For any professional mixing engineer today, being able to shape to create a sense of depth in the virtual space is just as important as any other kind of processing, as it enables the creation of a three-dimensional mix by combining height and width. The definitions of what depth is and what is responsible for creating it varies among scholars and practitioners of music production. Many scholars agree that depth is represented by decreasing amplitude and increasing reverberation, with the additional variable of rolling off treble to denote distance (Doyle 2005: 26; See Wishart 1985). However, as Peter Doyle argues, this notion of depth introduces some problems. In genres like classic rock’n roll and R & B, the loudest element in the mix is often the most reverberated. Doyle uses examples like the guitar in Link Wray’s “Rumble” (1958)

and Elvis Presley's voice in "Baby Let's Play House" (1955), where reverb and echo are used more as a textural feature than as a depth-creating effect (Doyle 2005: 26). Serge Lacasse offers a different definition of depth, negotiating these notions, stating that "Although reverberation and loudness obviously contribute to our perception of distance, the fundamental parameter responsible for the perception of distance is the timbral definition of the perceived sound source" (Lacasse 2005: 3).

What further complicates the discussion is that the definitions of depth seem to vary between scholars and practitioners in the realm of music production. This is not to say that decreasing amplitude and increasing reverberation does not affect our perception of distance. However, within the world of music production, there seems to be a general agreement that perceived depth and distance are more complex. Moreover, reverberation does not necessarily have to be a signifier of a sound source's distance to the listener. Very often, reverberation is applied in ways that make it a signifier of space. Like a sonar, rather than indicating the sound source's relative distance to the listener, it indicates the distance to the nearest reflective surface.

For instance, a prevalent topic (on various blogs and music production forums[2]) in discussions concerning depth is the pre-delay settings of the reverb. The pre-delay setting is a powerful tool when it comes to enhancing the perception of depth and creating a three-dimensional mix. There is a prevailing notion that a longer pre-delay, say 80 ms, will add more depth, as the dry signal remains upfront in the mix while the reverb moves behind it. Rather than indicating distance, the reverberation becomes an indicator of the size of the virtual space of the mix. Shorter pre-delay settings, on the other hand, attach the reverb and the dry signal, which in turn determines how distant the sound appears to be.

Moreover, because a long pre-delay will sound more upfront in relation to the other, the contrast between the two settings ultimately enhances our perception of distance and depth. Other more sophisticated production techniques, such as reverb side-chaining, also have a significant impact on our perception of distance and depth as it causes the dry signal to remain upfront while the reverb swells behind it. From this, we can deduce that it's not just the reverb itself but also the character and the processing applied to the reverberation that is responsible for our perception of distance and depth.

Apart from reverberation and the processing applied to it, our perception of distance and depth is also affected by the distribution of sounds and frequencies in the vertical and

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[2] https://www.pro-tools-expert.com/production-expert-1/have-you-tried-the-delay-reverb-trick
https://producelikeapro.com/blog/the-best-old-school-reverb-trick/

horizontal dimensions as well. For instance, in a dense and cluttered mix, where various instruments compete in the same register (the same position on the vertical dimension), the phenomenon known as auditory masking is likely to occur. Masking is usually something that one wishes to avoid in a mix, as it can cause the virtual space to sound more closed and less spacious than if the frequencies were spread out on the vertical axis. If a sense of space and depth is desired, cleaning up the mix by removing unwanted frequencies and solving masking issues will result in a more open and spacious mix. An open and spacious mix often contributes to a greater sense of depth, as it gives more clarity, which leaves more space for the reverberation of each sound, which in turn provides our ears with more information regarding the character and size of the virtual space. The same approach can be applied to the reverberation itself. A reverb technique used at Abbey Road, colloquially known as the "Abbey Road reverb trick,"[3] is to set the high pass filter at 600hz and the low pass filter at 10khz. This preserves clarity in the mix, as it filters out low-end rumble and top, which leaves more space for the individual sounds in the mix while at the same time preserving the sheen and size that the reverb can impart to a sound.

The amount of width in a mix can also affect the perceived depth of a mix. For instance, panning instruments that compete in the same register to each side can bring more space and clarity to the mix, which leaves more room for the reverberation of each sound. Apart from opening up the mix, panning often creates the illusion of being pulled into the music, as the music suddenly surrounds you. Let's use an example: Imagine a band performing on a stage that is, say, 10 meters wide. At a distance, there won't be much stereo spread, as all the sounds originate from the same location. As you get closer to the stage, the stereo field becomes wider until you're on the stage with the musicians, where you are now immersed in the music.

Size

A fundamental characteristic trait of any virtual space is its size. Size usually refers to the length of the reverb. Some might argue that depth and size are the same things. However, the difference is that depth refers to the perceived distance of a sound source, while size refers to the perceived size of the virtual space. Some songs suit bigger virtual spaces than others. As a general rule, slow songs often suit longer and bigger reverbs, which indicates that the virtual space is big.

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[3] https://westlakepro.com/abbey-road-reverb-trick/

Conversely, up-tempo songs usually suit shorter reverbs, which produce a tighter feeling, indicating a small space. Movement and pulse are often achieved when the reverb time or delay corresponds with the feel and tempo of the track. A rule of thumb is that the reverb should be just long enough to fill the gaps between, say, the phrases of the singer or the gaps between each snare hit. This is a very conventional approach, which may enhance the rhythm, movement and pulse off the track. There are, however, always exceptions to the rules. An up-tempo song may, for instance, have a vocal performance with long sustained notes, which makes room for longer reverberation. Conversely, the reverb on a rhythmically busy vocal performance in a slow song will have to be shorter to prevent the reverberation from making the vocals unintelligible.

Character and texture

Apart from shaping the virtual space in terms of size and determining the distance of the sounds within it. Time-based single processors also affect the character of the virtual space. In the real world, two rooms of identical size may sound very different depending on the materials they are made of. Stone walls will, for instance, reflect sounds differently than wood, plaster or concrete. Similarly, plate, spring and digital reverb all produce different kinds of reverbs, although the length of the reverbs is precisely the same. With modern reverbs, we can choose between a seemingly endless amount of reverb characteristics. The character and characteristics of the virtual space are often in accordance with the genre of the track. What is considered natural-sounding in one genre may sound opaque and mediated in another. For instance, on an acoustic bluegrass track, natural-sounding reverbs like room or hall reverbs may be more suitable than expressionistic and unnatural sounding reverbs such as gated, shimmer or reversed reverbs. Conversely, in many electronic genres, where realism is neither the intention nor outcome, opaque-sounding reverbs are often desirable or even natural sounding as they correspond with the listener's expectations of the genre.

Apart from affecting the characteristics of the virtual space, time-based signal processors are often used as a textural feature that can modify sounds without necessarily locating them within an imaginable spatial environment. Several scholars have addressed the textural impact of time-based signal processors in terms of how they can affect a track's overall shape. Doyle, for instance, argues that, while the slapback echo heard on various Sun and Chess recordings throughout the 1950s inevitably had some spatial impact, its primary effect was rhythmic and timbral (Doyle 2003: 179). Similarly, Samantha Bennett argues that time-based signal processors are used in more complex ways than simply fabricating space. Stating that "they can simulate both real and imaginary spaces, create alternate sound worlds,

and impact greatly on textural and spatial attributes of a recording, thus greatly influence a track's overall shape" (Bennett 2016: 17).

Although dealing with music from different periods and musical genres, both Doyle and Bennett address cases where acoustically realistic representations of space are neither the intention nor the outcome (Bennett 2016). In Bennet's case studies, reverb, echo and chorus are foregrounded, a production aesthetic she traces back to the so-called "golden age" of record production and the creative recording and processing techniques used by Phil Spector, Joe Meek and Brian Wilson. Bennet further states that if the signal processing were to be removed from these recordings, the tracks would be significantly texturally diminished (ibid). In these cases, time-based signal processing is no less integral to the artist's sound and musical identity than any other musical element, instrument, or performance.

In summing up her findings concerning the impact time-based signal processors may have on a recording, Bennet writes that "time-based signal processors can be applied in order to:

- prolong and/or extend a sound in terms of its duration;
- control its density by means of manipulating diffusion;
- contain or release a sound;
- repeat it any given number of times;
- position it in a space alternative to that in which it was originally recorded" (Bennett 2016: 5).

Although identifying several textural properties that time-based single processors may inflict on a recording, her findings only state the properties of traditional reverberation and not experimental reverberators and other signal processors such as chorus and flanger. Consequently, her findings end up being somewhat deficient. Consider, for instance, the shimmer and modulated reverb mentioned earlier, which inflict on parameters such as pitch. Another example that challenges traditional reverberation conventions is the reverb unit "NightSky" by the company Strymon, which gives the user real-time control over parameters such as pitch, harmonics, resonance, shimmer and LFO, to name a few. It can therefore be applied to alter pitch, harmonics, tone, timbre and much more to the sounds they are being used on. On Strymon's web page, they write that the inspiration behind the unit "evolved from a desire to push the envelope and challenge the conventions of traditional reverb while also paying homage to the experimental reverberant sounds from decades past."[4]

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[4] https://www.strymon.net/product/nightsky/

Shaping the virtual space with time-based signal processors

Any kind of processing will ultimately impact the virtual space; however, time-based signal processors such as reverberation and echo are the most effective and frequently used effects when creating a sense of space and distance. Bennet writes that "Time-based processors are so-called because they fabricate, simulate, or otherwise manipulate temporal parameters of sound" (Bennet 2016: 6). Within this category of signal processors, we find effects commonly known as reverb, echo, chorus and flanger. Other time-based signal processing effects such as pitch shifters, harmonisers and vibrato also manipulate temporal parameters of sound. They, therefore, also fit into the time-based signal processors. However, these effects are arguably more specialised and would be interesting in a comprehensive study; for now, however, we will stick with the ones mentioned above as they are of greater relevance to the present context.

Due to their direct counterparts in nature, reverb and delay are indeed the most common time-based signal processors used in popular music productions and also the most common and impactful effects used to shape the virtual space. Chorus, flanger and phaser are more specialised but are nevertheless interesting in this context, as they can radically alter the texture, timbre and spatial character of the virtual space and cause it to display sonic features that could never exist in the real world. Although they are often overlooked in discussions regarding virtual space (as they are not usually regarded as spatial effects), they significantly impact spatial parameters such as distance and width. After their heyday in the late 1970s and 1980s, chorus and flanger have increased in popularity over the past ten years. A trend popularised by contemporary indie and psychedelic rock/pop acts such as Mac DeMarco, Conan Mockasin and Tame Impala, who, although musically located outside the mainstream, have had a significant influence on popular music in general over the past decade.

When dealing with reverberation and delay, the focus will primarily be on artificial reverb instead of natural reverb. Artificial reverb usually refers to reverb produced by echo chambers and mechanical or digital reverb devices. On the other hand, natural reverb usually refers to reverberation encountered in nature and built spaces such as rooms, cathedrals and concert halls or as the result of microphone placement relative to its sound source. However, the distinction between natural and artificial reverb is somewhat problematic, as any reverb emitting from built spaces, such as rooms, cathedrals, concert halls etc., is no less artificial than any reverb device. A concert hall, for instance, is not that different from a reverb device in that it is designed to control the propagation of reverberant signals and direct them towards the audience. Natural reverb should, therefore, only include reverbs encountered in nature, independent of human interaction with its environments such as caves, valleys, forests etc.

Despite this, I will still refer to any reverb produced by a building as natural reverb and any reverb produced by a reverb device as artificial because the terms are usually used in this way.

Artificial reverb is interesting in this research context because it can give the impression of space without resembling actual physical spaces encountered in the real world. Brøvig-Hanssen and Danielsen note that as humans, we have a natural tendency to compare spatial environments with previous experiences to make sense of a new one (Brøvig-Hanssen and Danielsen 2013: 73). As a consequence, when we are subjected to a virtual space that displays sonic features that could never occur in the real world, it appears as surreal. This, in turn, has created endless possibilities for musical expression. Examples range from the slapback delay heard on numerous Elvis Presley recordings, the gated reverb made famous by "In the Air Tonight" by Phil Collins, and the shimmer reverb that can be heard on several of Brian Enos' recordings.

Reverberation

Reverberation is one of the few audio effects in the modern studio with a direct counterpart in nature. Reverberation is not only essential to how records are produced today, but it has also played an important part in Western music traditions for centuries. Concert halls, for instance, have over the past centuries been designed specifically to control the propagation of reverberation in the room to redirect the sound waves to the audience.[5] (Izotope). Similar strategies were used in the Ancient Greek theatres. Chorus singers were here located in the reverberating orchestra, which served to enhance the music, while the actors were on the logeion, the narrow stage located at the back of the orchestra, from where the spoken voice could be heard loud and dry (Wiles 1991: 36-39).

To understand reverberation, how it works and why it's being used, we will start with an outline of the basics of acoustic reverberation. To avoid confusion throughout this section, reverberation and echo are sometimes used interchangeably.

Reverberation is essential to how we interpret and perceive our surroundings. Even in an apparently dead-sounding environment, reflections still account for the more significant part of the sound we hear (White 2003: 191). These reflections arrive later than the original sound and also from different directions depending on the locations of the surfaces they've been reflected from. Our brains use all this sonic information to evaluate our surroundings subconsciously.

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[5] https://www.izotope.com/en/learn/a-history-of-reverb-in-music-production.html

Reverberation is physically composed of a large number of echoes (that is, sound reflections). These echoes or reflections arrive so close together in time and in such large numbers that it becomes impossible to distinguish them from each other. (Lacasse 2000; see also Burd 1994:) Reverb occurs naturally in a room where the sound waves, hit an obstacle, after which it reflects into the room, hitting other surfaces and obstacles. Every time the sound waves get reflected, they progressively weaken before finally dying altogether (White 2003). The result is thus a prolongation of the initial sound

The echoes responsible for producing reverberation are divided into two categories: early reflections and late reflections. The early reflections are critical for our understanding of distance to a sound source in a three-dimensional space. The early reflections usually arrive within 30ms and are the first reflections to reach our ears. These reflections are direct copies of the initial sound rather than diffuse copies, which are present in the later reflections.

Because sound has a finite velocity, echo or delay, on the other hand, occurs when the distance between the listener and the nearest obstacle is large enough for the listener to perceive the reflective signal as a repetition of the initial sound. This occurs when the distance in time between the original sound and the reflected sound is more than 50ms. Therefore echo/delay and reverberation are often used interchangeably in settings concerning spatiality.

By placing the music inside a reverberant space, we are placing the music inside familiar surroundings. As Sterne puts it: “To imagine a sound without reverb requires us to imagine an impossible sound that exists outside relations, outside space, a sound that brackets its own historicity and situatedness” (Sterne 2015: 114).

In recorded music, reverberation is often referred to as front-to-back mixing. Applying reverb is an effective means for creating separation between instruments and voices and placing them spatially within the mix. This is often referred to as “Depth” and gives, as Allan F. Moore puts it, “the illusory sense that some sounds originate at a greater distance than others, giving a sense of textural foreground, middle ground and background” (Moore 1993: 106 (149 third edition)).

The chorus effect

As the effect’s name implies (chorus means a group of singers), the chorus effect was intended to simulate the effect of several instruments or voices playing or singing in unison. With a choir, the singers, although singing in unison, will never have the exact same pitch and timing, thus creating a chorus effect. Chorus also occurs naturally in several acoustical instruments due to various approaches and principles. The effect can, for instance, be heard

on 12-string guitars, where the G, H and high E strings are coupled with identical strings tuned to the same note. Because it's near impossible to tune the strings to be in perfect pitch in relation to each other, the guitar produces a chorus effect when played. The same goes for most pianos, where the keys of the higher notes also trigger several strings tuned to the same note but, because of slight pitch variations, produce a gentle chorus effect. The chorus effect thus becomes more noticeable with pianos that haven't been tuned for a while.

The chorus effect is achieved by creating one or several delayed copies of a dry signal, delaying them by 20-50 ms, and then modulating the delay time of the delayed copies, which causes subtle variations in pitch. The modulation is achieved by varying the speed of the delayed copy using the waveform of a low-frequency oscillator (LFO). The delayed copies are then blended with the original signal. If we were to remove the dry signal, the effect would be known as vibrato.

The chorus effect as we know it today was first popularised in the 1970s by the appearance of Roland Jazz Chorus (1975) - a guitar amplifier with a built-in stereo chorus effect, and the Boss-CE 1 (1976) - a standalone chorus pedal. Both units were mainly made for guitars and can be heard on a range of records from the late 1970s and 1980s when the effect reached its peak in popularity. However, it was first invented in the 1930s by Hammond, who used it on the Hammond organs to produce a richer tone, although this kind of Chorus effect relied on a different principle: Instead of using a modulated delayed copy of the original signal, the chorus was achieved by blending a vibrato signal and a dry signal.

The chorus effect often widens the sound it affects. Especially the stereo chorus because it spreads out the different delayed copies in the stereo image. This can give the impression of being immersed in the sound. It also makes the instrument or sound that it's being applied to sound more distant and ambient, as it loses some of its initial definition, thus pushing it further back in the virtual space of the mediation.

The flanger effect

The flanger, not to be mistaken with the phaser, works similarly to the chorus by adding a slightly delayed modulated copy of the original signal. The flanger distinguishes itself from the chorus by using a shorter delay time, usually less than 20 ms. This creates a comb filter effect, which results from destructive and constructive phase interference as the crest and troughs of the sound waves start to interfere with each other. Varying the speed of the delayed signal causes the peaks and notches of the comb filter to sweep up or down the frequency spectrum.

Tape flanging was originally achieved manually using tape recorders. To achieve the effect, the engineer had to playback a copy of the mix in sync with the original version. This required good timing and precision by the engineer and was often a time-consuming process of trial and error. Once in sync, the engineer would slow or speed up the copy to create the effect. There is some dispute about who originally invented the effect, but it is usually credited to Les Paul, who used it on his track “Mammy’s Boogie” (1952).

Like the chorus, the flanger can also be used to widen sounds, as the flanger units released in the 1970s and 1980s featured stereo modes, where the delayed copy and the direct get spread out in the stereo image.

The phaser effect

The phaser, often confused with the flanger, does not fit into the category of time-based signal processors. However, I will say a few words regarding the phaser to avoid confusion with the flanger later.

The first effect to be named “phaser" was initially intended to emulate the tape-flanging effect. However, the phaser used a different approach than the flanger. Just like the flanger and chorus, the Phaser creates a copy of the original signal, but instead of delaying it, sends it through an all-pass filter which inverts the phase of the signal at a set frequency. The Phaser works by stringing several of these all-pass filters together to create a series of non-harmonically related notch filters (Izotope[6]), thus simulating the comb filter effect created by flanging. Because the notches of the phaser are usually non-harmonically related, as opposed to the comb filter produced by flanging, the effect is considered gentler than the flanger. An LFO can then control the notches created by the all-pass filters to simulate the movement of the tape flange effect as the delayed copy speeds up or down. The advantage of the phaser upon its release was that it could be used in real-time, as opposed to tape flanging, which at the time only could be achieved in post-production.

A brief history of virtual spaces in music production

This historic review aims to give the reader insight into the evolution of virtual space in popular music. The evolution of virtual space is also a testimony of technologies role in music creation. It also illustrates how virtual spaces that were once experienced as surreal over time get normalised. This is key to understanding how virtual space can function as a sonic marker of time. Several of the norms discussed throughout this part will be discussed in

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6 https://www.izotope.com/en/learn/understanding-chorus-flangers-and-phasers-in-audio-production.html

more depth in chapter 3, which deals with production ideals and chapter 4, which deals with my artistic practice.

To give a satisfactory account of the evolution of virtual spaces in recorded music from its earliest implementation until today would require a book or several. As Doyle has demonstrated with his book *Reverb and Echo* (2005), which deals with virtual spaces in recordings from 1900- until the 1960s, it is challenging enough to give a satisfactory account with this limited timespan. Moreover, whereas the norms regarding the virtual spaces that Doyle deals with (1900-the 1960s) were limited by technological constraints, which makes the evolution of virtual space quite clear, from the 1960s and onwards, the narrative gets more complex. As new devices and techniques for fabricating space developed, the norms and ideals regarding virtual space in popular music began to change exponentially. This has, in turn, expanded the possibilities for musical expression, which has led to the birth of a multitude of music genres, which all have different norms regarding the implementation of virtual spaces. Giving a complete account of the evolution of virtual spaces in popular music would then require all of these genres and norms to be included, as no musical genre exists in a vacuum and, therefore, inevitably affects one another.

Another factor which makes this historic review challenging is that there is little literature on the evolution of virtual space in popular music from the 1960s until today. However, a handful of scholars have addressed the impact of digital reverberators and signal processors on the virtual spaces of popular music in the 1980s and early 1990s. There is also a substantial amount of data regarding the development of reverberation devices and time-based signal processors, which to some extent cover their impact on the eras they were popularized. From this, it's, to some extent, possible to deduce how they redefined the norms regarding the virtual spaces in the eras they were developed or popularised. This being said, to conclude this introduction, it's not my intention to give the reader a complete account of the evolution of virtual spaces in popular music. Instead, I will stick with the innovations and norms most important for this thesis's purpose.

1900 - the 1940s

Most music was recorded dry throughout the acoustical era (1877-1925). This was both an aesthetic norm and a consequence of technological constraints. The limited frequency scope of the gramophone (162-2000 Hz)[7] made the reverb unsuitable for the format. As the gramophone lacked the frequencies which add clarity and presence, reverberation would only

[7] See Brøvig-Hanssen 2013: 87, 88

reduce the clarity of the instruments. When recording a piece of music, the musicians performed live in front of the gramophone horn, which acted as a microphone. The balance of the mix was created by locating the various musicians at various distances from the gramophone horn. The positioning of the musicians, inevitably, had some spatial effect, but the rooms in which the musicians performed were treated to be as dry as possible, so the effect was minimal. At this moment in time, the act of recording was more of a technical matter than an aesthetic one. As Brian Eno notes, musical recordings were typically created with the idea of presenting a faithful rendition of a real-life performance (Eno 2004: 128).

The advent of the electric recording in the mid-1920s opened up many new possibilities for recording sound. The electric recording relied on condenser microphones to convert the audio signal into an electric signal. This innovation increased the sound quality considerably and introduced new techniques for capturing space acoustically; a sense of aural space was thus made possible. At this point, reverb was essentially the by-product of the microphone's distance from its sound source. The further away the microphone was from the sound source, the more of the reverberant signals of the room, and less of the direct signal would be captured by the microphone. One of the techniques that emerged with this new technology was multi-miking, which allowed engineers to use more than one microphone when recording. Consequently, multi-miking included more "room" in the recordings, as the microphones would pick up more of the reverberant signals of the room, as well as "spill" from other instruments and other incidental sounds. Following this change in technology and aesthetics, Doyle writes:

> The potential to record either with or without depth then presented record makers with a serious techno-aesthetic problem. A split soon arose whereby it became broadly acceptable to record classical orchestral music to include room ambience (and thus aural depth), while popular music was in the main recorded dry, with little or no discernible depth, and minimal reverberation. The voices and sounds of high art were accorded virtual sonic space, while low art was denied it (Doyle 2005: 57).

Doyle argues that two different aesthetics rose from this split, realism and romanticism. The realist approach (that is, depthless recording) provided an effect of intimacy, the orchestra and soloist being transported into the living room; Romanticism conversely had the effect of bringing the listener into the studio or auditorium (Doyle 2004: 57). Consequently, studios at the time began building purpose-made recording rooms designed for their ambience.

Throughout the 1930s and 1940s, the norms regarding virtual space in popular music began loosening up. It was now acceptable to include reverberation in the recording. However, it was only used on instruments while the vocals remained dry, anchored in the middle. It soon became a trademark of genres like Hapa Haole Hawaiian music to render the frequently used slide guitar reverberant. This production gimmick soon migrated into other genres like western music and hillbilly.

By the late 1940s, the recording process began turning from a technical to an aesthetic matter. In 1947, Bill Putnam produced the track "Peg O My Heart" by the Harmonicats, the first popular music recording to use artificial reverb as an artistic effect. The track became a big hit upon its release, which contributed to popularising the use of echo chambers to produce artificial reverb. Because custom-built echo chambers had not yet been developed, Bill Putnam transformed the toilets of the studio into an echo chamber. This was achieved by equipping the bathroom with a speaker and a microphone. The speaker would playback the recorded dry signal while the microphone picked up a combination of the dry and reverberant signal. Although prototypes of the echo chambers had been used ten years before "Peg O My Heart", using staircases and other large spaces, after the release of Peg O My Heart" echo chambers became the new industry standard for simulating big spaces. Not long after, the major studios at the time began building purpose-made echo chambers. Studios like Abbey Road and Gold Star Studios became renowned for their echo chambers. Today emulations of these rooms are available as DSP plugins.

Echo chambers had some obvious advantages compared to off-miking. When recording an instrument in a large space, there was no way of separating the instrument from the ambience after recording. This gave the Echo chamber some apparent advantages, allowing the mixer to add reverb in post-production. Another benefit was that separating the reverb from the dry sound allowed the engineer to process the reverb itself without affecting the dry signal. To preserve clarity and avoid low-end build-up, it became common practice in many studios to filter away the low end of the signal sent to the echo chamber. Something that could not be achieved with off-miking. More importantly, the advent of the echo chamber marks the moment in time when engineers started categorising sounds into dry and wet dimensions. The *dry* is the original sound source, while the *wet* is the reverberation. Sterne writes that this new categorisation of sound broke with the age-long relationship between sound and space, indicating that the reverb-free sounds (the essence of a sound) and their physical presence in a given space (its supplement) no longer had any necessary given relationship (Sterne 2015: 111).

The 1950s

In the 1950s, the magnetic tape recorder became the new standard for recording sound. The magnetic tape's sound quality and playing time were considerably better compared to the electric wire and phonograph. It was also cheaper to produce and easier to handle. In addition to these improvements, the move to tape opened up a host of new recording and editing possibilities which changed the very concept of recorded music. The tape was cuttable, mutable and erasable in ways that discs weren't. Another significant consequence of the tape recorder was that it enabled multitrack recording. Instead of recording all the parts onto a single track, each instrument (or a group of instruments) could be recorded and stored on individual tracks. The individual tracks could then be adjusted to the right volume, and processing effects such as reverb and echo could be added to the individual tracks after they were recorded, which enabled the engineer to mould whole virtual environments.

Initially, the tape recorder was just one track. However, the innovative guitarist and inventor Les Paul was among the first musicians to adopt multi-tracking by modifying his Ampex Model 300 with an extra playback head and altered tape path (see Brøvig-Hanssen 2013: 141-42). This way of recording would become central to how music was recorded and has remained so until this day. Brøvig-Hanssen writes that "the multitrack recorder was a huge step forward in the overdubbing technique, which had required musicians to erase all of the old tracks if just one overdub take was unsuccessful; it also solved the problem of degradation in sound quality that took place after each new overdub" (Brøvig-Hanssen 2013: 144). This brought about a new era in the history of recorded music and altered the way musicians, producers, and sound engineers worked in the studio while recording and mixing sound.

As mentioned earlier, aesthetic norms and technological constraints are often linked. Not surprisingly, this shift in recording technology had a significant impact on the music created. Eno notes that it's the first time it was acknowledged that the performance wasn't a finished item, and other layers could be added in the studio space after recording (Eno 2004: 128). This sentiment is only partly correct because, as Brøvig-Hanssen notes, overdubbing was also used occasionally with the mechanical and electromechanical recording. However, Eno is right in the sense that the phonograph was generally viewed as an archival medium rather than a creative tool (Brøvig-Hanssen 2013: 145). With the multitrack recorder, the praxis of overdubbing and adding new layers on top gradually became the standard way records were made and has remained so until this day.

Not surprisingly, the magnetic tape also had unforeseen consequences on the virtual spaces. Apart from improving the sound quality and enabling multitrack recording, the move

to tape also enabled new methods and techniques for fabricating and manipulating sound and space with effects such as tape echo and tape flanging. It has become a truism of rock history that Sun Studio was the first to adopt the use of tape echo as an effect in recordings. However, the use of echo/delay as an effect is credited to the innovator mentioned above, Les Paul. The echo effect (usually referred to as "slapback", characterised by a short delay with no feedback) was achieved by sending audio to a tape deck and then recording the delay caused by the distance between the recorder head and the playback head. His recording "How High the Moon" (1950) is considered the first track to use this production technique. Les Paul also made frequent use of another production technique known as doubling. He often made the singers in his productions double their parts, sometimes singing harmonies but more often in unison. Regarding the use of doubling and echo in recordings, Doyle remarks that "while the sort of delay and doubling inevitably had some degree of spatial impact, its primary effects were rhythmic and timbral. It modified sounds, in sometimes strange ways whiteout necessarily locating the action within an imaginable space" (Doyle 2005: 179).

"How High the Moon" became a big hit, and other studios began to adopt the slapback effect in their productions. Sam Phillips of Sun Studio started using the effect on artists such as Elvis Presley and Johnny Cash. The use of slapback had a distinct synthetic sound, giving the recordings a distinct character, which later became a quintessential trademark of the rock'n roll sound. This synthetic element broke with the realist aesthetic norms which characterised most recordings at the time. Doyle writes, "at first, the effect was used in the main to create unambiguous spatiality's, clearly and unmistakably 'authorised' by the song's narrative. The echoic voice remained in the distance, on the periphery of the imaginable field. Through the 1940s, the echoic voice moves ever closer to the centre stage, but until 'Blue Moon of Kentucky' (Elvis Presley), the anchoring narrative voice remains in the centre. After 'Blue Moon of Kentucky', the rock'n roll vocal would more often than not be rendered deeply reverberant." (Doyle 2005: 185). During the 1950s, the delay effect became a standalone unit, which got tape delay into the hands of the musicians instead of relying on producers and tape decks.

By the late 1950s, reverb and tape delay had become established studio essentials, and various companies started exploring ways in which reverb could be produced mechanically. In 1957 EMT launched EMT 140 plate reverb. The plate reverb was considered a reasonable alternative to the Echo chambers, as it required less space. The plate reverb functioned similarly to the spring reverb found in Hammond Organs since the 1930s, later in guitar amplifiers and stand-alone units. Instead of springs, the plate reverb used metal plates to generate the reverb. It functioned by using electromagnetic transducers, which caused the

plate to vibrate, which in turn created the reverb. In addition to producing a smooth and convincing reverb, the plate reverb had a significant feature; it was equipped with a dampening plate, which hung parallel to the reverb plate, and could be moved closer to the plate with a remote-control. The dampening plate offered more plasticity and control over the reverb in terms of frequency response and length. Although sounding more natural than the twangy spring reverb, the plate reverb still had a metallic ring, giving it a distinct artificial character. The reverb plate, became very popular in the 1960s when the company released a stereo model, as the former was in mono. The plate became widely used throughout the 1960s and 1970s.

The 1960s

Apart from the new plasticity of space offered by plates and several other portable reverberation units, such as spring reverb and clay units, the 1960s underwent several advances in recording technologies, which ultimately redefined the norms regarding virtual spaces in popular music. Susan Schmidt Horning argues that in the 1960s, the studio was no longer merely a place for capturing performances but came to be regarded as an instrument in its own right which musicians, producers and engineers exploited to create new sounds, rather than simply trying to capture them (Horning 2004: 704). All these innovations expanded the creative potential of the recording studio and the possibilities for musical expression. Consequently, the producer became an important figure in music-making, as the artists who favoured the creative use of studio technology needed someone who could handle this technology to harness its creative potential. Notable producers from this period include Joe Meek, Phill Spector, Brian Wilson and George Martin, who rightfully came to be regarded as auteurs who contributed to shaping and defining the sound of the 1960s. All of these innovations and improvements in recording technology, and the way it was used, openly challenged the notion of spatial reality (an example of this would be the tape flanger, popularised by the song "Itchycoo Park" by The Small Faces (1967), but credited to Les Paul[8], which among other effects, were well suited to express the disorienting effect of LSD in musical terms), and paved the way for the psychedelic music. This genre often relied on heavy use of electronic recording techniques.

Among notable recordings that challenged the norms regarding virtual space in the 1960s, we find the previously mentioned song, Telstar, by the British band The Tornados, produced by the British producer Joe Meek. Released in 1962, it was far ahead of its time,

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8 https://blog.zzounds.com/2016/08/10/a-quick-take-on-flanging/

featuring many effects that later would become key aural markers in psychedelic music and space rock, such as heavy feedback from a tape delay and flanging.

Phil Spector was another highly influential producer known for his production technique known as “the wall of sound”, characterised by extensive use of doubling, heavy use of reverb, and creative use of delay, which influenced other innovative producers and artists such as Brian Wilson (The Beach Boys), The Beatles, and decades later, shoegaze bands like My Bloody Valentine. During the 1960s, Phil Spector produced most of his recordings at Gold Star Studios in LA, which were renowned for their echo chambers which Spector used heavy-handedly on all his recordings.

It’s become a truism in rock history that the pinnacle of studio innovation in the 1960s took place at Abbey Road Studios. During this time, Abbey Road developed more and more in the direction of becoming a sound laboratory, where new inventions had to be made by the technicians to realise yesterday’s impossibilities. This development was led by the creative partnership between the producer George Martin, Paul McCartney, and John Lennon from The Beatles. They had by then retired from the concert scene and were entirely devoted to the studio. One of Abbey Road’s most significant innovations concerning spatiality was the ADT automatic double-tracking, developed by Ken Townsend and popularised by The Beatles. ADT was achieved by creating a delayed copy of the original signal, and blending it with the original signal, to simulate the effect of double-tracking.

The 1970s

Entering the 1970s, defining the norms regarding virtual spaces gets challenging. Throughout the 1960s, the norms were more or less defined by the producers and artists previously mentioned, and musicians were looking towards them to hear the new sound. In the 1970s, however, a myriad of new genres emerged, which all had their own norms regarding virtual space. On the one hand, there was a general turn away from the impressionistic aesthetic towards the realist aesthetic, exemplified by the popularity of genres such as country, folk, soul and singer-songwriter, which didn’t defy spatial reality. On the other hand, genres such as hard rock, progressive rock, jazz fusion, jazz-funk, dub and electronic music, which often relied on heavy use of electronic recording techniques, still maintained some of the expressionist aesthetic characteristics of the psychedelic music of the 1960s. Among other famous and influential genres from this decade, we find Funk, Disco and later Hip Hop and Punk. This myriad of influential genres makes it difficult to say anything about the norms regarding virtual space in the 1970s. That’s not to say that there were no norms regarding virtual space, but they varied between genres.

The 1970s also marks the beginning of the digital age. A range of new digital sound-processing devices was released, which would become hallmarks of the late 1970s and 1980s sound. In 1972 EMT released the first digital reverb, "EMT 144", a primitive digital reverb with limited capabilities. EMT 144 was largely unsuccessful, and it wasn't before 1976, when EMT teamed up with the American Company Dynatron to create the EMT 250 Electronical Reverberator unit, that the first practical digital reverb was born (Universal Audio[9]). The idea of digital reverb was conceived already in 1961 by the famous mathematician and acoustician Manfred Schroeder. Still, it wasn't before years later, when the technology had improved considerably, that the concept of digital reverberation could be realised (Kraugerud 2020).

Paul White writes that "digital reverb is a result of thousands of seemingly random delays, played back at short intervals, which makes them sound as one continues wash off sound. Somewhere between 1000 and 3000 separate echoes are needed every second to create the illusion of dense natural-sounding reverberation (White 2003: 196). The EMT 250 was, however, very expensive (15000$), and the market demanded a cheaper alternative, which was realised two years later with the launch of the Lexicon 224 (1978). From this point forward, it didn't take long before digital reverb reached its way into professional and home studios. The digital reverbs would typically have presets that emulated reverbs like chambers, halls, rooms, cathedrals and plates, often featuring adjustable parameters such as size, repeats, decay, and diffusion, terms that most sound engineers are familiar with today but which at the time were new, and consequently introduced a new level of plasticity to the reverb, allowing the user to alter the subtle textural nuances as well as transforming the very concept of reverb and how it could be used. Additionally, early digital reverberators like EMT 250 were multi-effects units, including effects such as chorus, phaser, and digital delay[10].

Simultaneously with the development of digital reverberators, the company Eventide released a range of dedicated electronic and digital effect units ranging from phasers, flangers, pitch shifters, delays and multi-effect units which would become sonic hallmarks of the 1970s and 1980s sound. Among their notable products, we find the "Instant Phaser" (1971), arguably the world's first studio effects unit.

The Instant Phaser simulated tape flanging, an effect that became popular in the 1960s and can, for instance, be heard on Small Faces' "Itchycoo Park" (1966). The Instant Phaser was quickly adopted by producers and musicians, and quickly found its way to the concert scene. It can, for instance, be heard in Led Zeppelin's song "Kashmir" (1975), where it was

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[9] https://www.uaudio.com/blog/emt-reverb-history/

[10] https://www.uaudio.com/blog/emt-250-electronic-reverberator-overview/

used on the drums throughout the whole song. Although the effect was aimed at simulating tape flanging, the Instant Phaser used phase shift and all-pass filters instead of delay, thus being the first phaser and the first to distinguish between phasing and flanging.[11] However, there is some dispute as to whether the Instant Phaser was the first phaser or not. The Univibe Phase shifter (1968), heard on many Jimi Hendrix recordings, is by many considered the first phaser, although it used a different technology which produced a different sound.

By the mid-1970s, electric pianos, like the Fender Rhodes and the Clavinet, were often treated with the phaser. The phaser was used to sweeten sounds (a term used when an additional effect or sound is used to improve a sound already recorded). Apart from sweetening the sound, the phaser gave the keyboards (especially the Rhodes piano) a distinct synthetic and dreamlike sound. This can be heard on various rock, pop, electric jazz and soul records throughout the 1970s. Examples can be heard on 10cc's "I'm Not in Love" (1975), where the phaser is used on the Rhodes, Lonnie Liston Smith and The Cosmic Echoes' "Summer Nights" (1975), and Idris Muhammad's "Could Heaven Ever Be Like This" (1977) where the phaser is heard on both the Rhodes and the drums throughout both songs.

In 1975 Eventide eventually released the Instant Flanger, which was used on several influential recordings in the preceding years. An example of the Instant Flanger can be heard on the detuned piano on David Bowie's hit "Ashes to Ashes" (1980) (In this particular case, the parameters of the flanger were set to the extreme, making it sound more like a vibrato than a flanger). With the Instant Flanger, flanging could be achieved in real-time. It also included more options than were available with tape flanging, such as a feedback knob, accentuating the notches and resonances, resulting in a more harsh and metallic timbre. [12]

The 1980s

Like the 1960s, the 1980s is characterised by experimentation and innovation, whereas the 1970s rested in the shadows of the 1960s. Although there were improvements in the realm of music production, the virtual spaces of the 1970s didn't challenge the norms set in the 1960s. But can almost be seen as regression and defiance of the 1960s. However, this changed in the 1980s, when the norms regarding the virtual spaces moved further toward the acceptance of the unreal.

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[11] https://www.eventideaudio.com/50th-flashback-1-the-ps101-instant-phaser/

[12] https://www.eventideaudio.com/50th-flashback-5-fl-201-instant-flanger/

The digital signal processors popularised throughout the 1980s transformed the possibilities for fabricating sound and space, and enabled the creation of clearly non-natural spatial environments, such as gated[13], reversed and modulated reverbs. Like the 1960s, from the late 1970s and early 1980s, artists such as Kate Bush, a-ha, David Bowie and Peter Gabriel were spurred by the desire to create something never heard before. Concerning the impact that the digital reverbs and other time-based signal processors had on the virtual spaces of popular music in the 1980s, Bennett notes that "Whilst the Lexicon 224, AMS and Eventide units became sonic hallmarks of 1980s commercial popular music, little is documented about their impact on the music of the era" (Bennett 2016: 8).

Apart from the popularity of digital reverberators and multi-effect units, the virtual spaces of the 1980s have to be seen in light of the technical innovations made in the realm of digital production technology. Throughout the 1980s, digital production technology came in full earnest, with digital synthesisers, drum machines, sampling devices, midi systems and digital audio workstations (DAW). Digital technology's simple editing possibilities enabled the creation of music with significant rhythmic precision, which gave birth to a range of musical genres throughout the 1980s and 1990s, like house, techno, and later trance and dubstep. All of these innovations combined contributed to the acceptance of the unreal.

Outside the mainstream, within genres such as dream pop and shoegaze, artists made innovative use of effect pedals and production techniques to produce ethereal, dreamy soundscapes. Bennet writes, "These artists often foreground the use of time-based signal processors in their music, and as such, the effects are not only easily sonically discernible but intrinsic to their very musical aesthetic" (Bennet 2016: 8).

Led by guitarist Kevin Shields, My Bloody Valentine has been the object of study by many musicologists and is often regarded as the most influential band within this genre. Writing for the Sunday Times, Paul Lester writes, "Kevin Shields is widely accepted as shoegazing's genius, his astonishing wall of sound, use of the studio as an instrument and

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[13] Pioneered by Hugh Padgham, "first on the drums on Peter Gabriel's third solo album from 1980 (*Peter Gabriel 3 [Melt]*, Charisma/Mercury/Geffen) and most famously on the drums on Phil Collins's 1981 hit "In the Air Tonight" (*Face Value*, Virgin/Atlantic)" (Brøvig-Hanssen and Danielsen 2013: 74). Hugh Padgham first achieved gated reverb on drums by recording the drums in a reverberant room using a combination of close mics and room mics. During the mix, the close mics would be treated normally, while the room mics, after being heavily compressed, were sent through a noise gate where the threshold was set so that it abruptly cut the reverb tail. Although gated reverb was first achieved using analogue technology. Gated reverb went on to become a common preset that could be found on various digital reverberators.

dazzling reinvention of the guitar making him a sort of hydra-headed Spector-Hendrix-Eno figure"[14]. As Lester suggests, there are clear allusions to Phill Spector's wall of sound aesthetic in the music of My Bloody Valentine. Regarding these allusions, Bennet notes that this notable and instantly recognisable production technique was applied in an exaggerated form to the indie, alternative, and shoegaze music of the post-punk era (Bennet 2016: 15).

1990s - 2010s

The next major innovation in artificial reverb development came in 1999 with the launch of the Sony DRE S777, the first convolution reverb. Convolution reverbs has a different premise for simulating spaces than algorithmic or mechanical reverberation. Instead of aiming for perceptual equivalence, the convolution reverb aims for precise mimicry. Convolution reverbs takes a sample of an acoustic space (called impulse response or IR), often exited by a snare, sweep tone, or gunshot, and use this to simulate spaces. By removing the initial sound, we are left with the reverb; the convolution program then turns this into a reverb, which can be applied to any sound. This allows you to sample the characteristics of any room.

Convolution is, however, not limited to sampling the acoustics of real-world spaces. Stern writes that "convolution is a kind of universal translator device. An impulse response can be taken of electronic equipment just as easily as of a physical room, and so a convolution reverb can also reproduce the setting of any other artificial reverberator or any other device" (Sterne 2015: 125). However, he warns us, "We should not make too much of this aesthetic of realism. Convolution processing is still significantly different from the sound one hears when sitting in a concert hall (…) Even with the increased power of contemporary computers, convolution processors still do not have enough computing power to account for every variable in the impulse response of a concert hall. Further, the same space will reverberate differently from moment to moment because of the circulation of heat waves. A single impulse response no more captures the motion of sound in a room over time than a photograph of a person walking captures his or her route" (Sterne 2015: 125). As a solution to this, some convolution reverbs use randomisation to simulate how the reverberation within a space change over time.

At the turn of the century, time-based signal processors progressed toward DSP plugins. Simulations of all the advanced and expensive hardware which left their mark on

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[14] https://www.thetimes.co.uk/article/sonic-cathedral-spark-shoegazing-music-revival-2cd7s9wjwgc https://web.archive.org/web/20090919185133/http://entertainment.timesonline.co.uk/tol/arts_and_entertainment/music/article6066716.ece

music history would soon be available on any computer. This had obvious advantages in terms of pricing and convenience and often matched or exceeded the hardware they were emulating. Indeed, many of the most popular plugins available today are the ones that emulate the iconic signal processors mentioned throughout this part.

This, in turn, has undoubtedly affected the music being produced today. The apparent advantages in pricing and convenience have made many iconic devices from the past 60-70 years available to any home studio. In retrospect, since the 1950s been a discernible trend where devices once exclusive to the producer and engineer end up in the hands of the artists and musicians. Thus the role of the engineer and producer merges with that of the musician.

Conclusion

The virtual spaces heard in popular music recordings today result from an evolution spanning back to the earliest music recordings. Due to the process of normalisation, it's easy to take the virtual spaces heard in modern music productions for granted. However, as discussed throughout this chapter, it took many years before the act of shaping and exploiting the spatial properties of spatial environments and devices became accepted praxis in music production.

When listening back on recordings such as Gene Austin's "My Blue Heaven", The Harmonicats' "Peg o My Heart", or any early Elvis Recording from our present vantage point in history, it's hard to grasp how these recordings were groundbreaking and pushed the norms and conventions regarding the virtual spaces of their time when they were released. This is because the creative production choices they popularised are now normalised to the extent that they are almost taken for granted. This has, in turn, changed the very idea of what music is and what it can be and made us accept that the virtual space is just as important to musical identity as any instrument or voice, for that matter.

When discussing the contents of this thesis with people who are not musicians, engineers or trained listeners, it's striking how unaware most people are that most music is located inside a virtual space. This shows that many of these spaces are normalised to the point where it escapes our attention. This was, however, not the case with the first recordings that exploited the aesthetic potential of reverberation and echo. Just like when singers began using microphones in the 1920s, the virtual spaces in these recordings were so different compared to other recordings at the time that they had a shocking effect when released.

Despite our ability to normalise virtual spatial environments once regarded as surreal or otherworldly, there are still spaces that evoke a sense of the surreal. This will be addressed in the following chapter.

Chapter 3: Production Ideals

Virtual spatial environments, now imperative to popular music, are often shaped and constructed to stage the music and the narratives presented in a given spatial and temporal configuration. Serge Lacasse defines the term staging as:

> Any deliberate practice whose aim is to enhance a vocal sound, alter its timbre or present it in a given spatial and/or temporal configuration with the help of any mechanical or electrical process, presumably in order to produce some effect on potential or actual listeners (…) For example, exploiting the particular acoustics of a given building - such as a cathedral - while speaking or singing constitutes a case of vocal staging. (Lacasse 2000: 4).

In other words, staging[15] is the sonic choreography and design of the virtual space of the mix. Any processing applied to an instrument or voice constitutes a case of staging. The mixer usually takes the role of both choreographer and stage designer and is responsible for the placement and processing of the various instruments and voices inside the virtual space. This virtual choreography allows the artist or mixer to convey messages to the listener through how the different voices and instruments are spatially located and presented in the mix. For example, a short reverb, say, 0,3 seconds, may give locational and emotional cues by giving the listener a sense of intimacy or claustrophobia. A long reverb—say, 5 seconds—may provide a sense of distance and arouse feelings like nostalgia. Moreover, virtual spatial environments that don't correspond with real-world environments—such as gated, shimmer and reversed reverb—may give a sense of the surreal or otherworldly. This, in turn, may add new layers of meaning to the mediation or reinforce the presented narrative.

This chapter sets out to discuss various ways a mediation can be staged according to different aesthetic ideals and norms. Using Ragnhild Brøvig-Hanssen's terminology (Brøvig-Hanssen 2018), we will begin by discussing the virtual space in relation to two different

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[15] For this thesis, the term "vocal staging" is somewhat limiting as it favours the vocal over other instruments. I will therefore skip the word "vocal", which leaves us with "staging". This slight modification of the term allows us to discuss all layers within a mediation without confusing the reader.

production ideals, the “transparent space” and the “opaque space.” After discussing this dichotomy, we will conclude this chapter by discussing how virtual spaces can be used as a sonic marker of time. By drawing on Eirik Askerøi’s concept of sonic markers (Askerøi 2013), we will explore how strategies related to this concept can be applied to the virtual space and how it, in turn, can assert the identity and authenticity of the protagonist in the music.

Opaque and Transparent Production Ideals

Any kind of processing will ultimately affect the virtual spatiality and the character of the virtual space. Using Brøvig-Hanssens terminology, we can divide the processing applied to a mix into two categories: Transparent and opaque. These two categories should be seen as analytical classifications of production ideals. In practice, these categories are not always clear-cut but are still valid regarding how mixers approach their craft.

Brøvig-Hanssen writes, "mediating technology is imperative to all forms of recorded music whether we notice it or not. When we don’t, it’s because we perceive the mediating technology as transparent, not because there is none. Similarly, when we do notice them, it’s not necessarily because there is more processing than usual, but because it is used in a way that attracts our attention towards it” (Brøvig-Hanssen 2018: 195). According to this terminology, opaque processing means that the track is processed in a way that attracts our attention to the mediating technology involved. For example, effects such as auto-tune or reverbs that do not correspond with real-world environments, such as gated, reversed and shimmer reverb, constitute some cases of opaque processing. As Brøvig-Hanssen points out, “it’s when sounds are defamiliarised that they are likely to be experienced as opaque” (Brøvig-Hanssen 2018: 201).

On the other hand, transparent processing has a different premise than opaque processing. It’s often applied in ways that escape our attention and conceal the presence of the mediating technology involved in the recording process. For example, creating a cohesive track out of, say, several vocal performances, applying subtle pitch correction to vocals, cleaning up competing frequencies, taming harsh sibilants and removing unwanted audio artefacts such as electrical noise, phase issues, clicks, pops and dropouts caused by the mediating technology involved in the recording process.

Despite being aesthetically motivated, some might argue that certain transparent processing actions have practical functions in the mix as they solve specific issues caused by the mediating technology during the recording process. Claiming that such applications are practical as opposed to creative or artistic is problematic because it’s challenging to draw a

line between what is purely creative and what one would consider practical, as both practical and creative processing choices are motivated by aesthetic reasons. Moreover, solving problems in a mix often requires creative solutions. Apart from being the object of an artistic palette, many engineers and producers will also argue that the fabricated virtual space may also solve issues in the mix and therefore serve a range of practical reasons in the mixing process. Nevertheless, because of its persistence in discussions on various mixing blogs and forums regarding reverberation, I will present some of the most common arguments.

The transparent space (or practical reasons for applying a fabricated virtual space)

The practical reasons for applying a virtual spatiality often derive from the producer, artist or mixer's desire to mask the stamp of technology involved in the production and to make the sum of the raw and unprocessed tracks sound like a coherent and transparent musical performance. For instance, the aesthetic ideals of certain genres might have similar concepts of transmitting something "authentic," like the sound of an acoustic guitar. In these cases, technology can often be seen as an obstruction in the communication of music as no mediating technology is entirely transparent. The stamp of technology may, for instance, be heard in the characteristic sound resulting from the microphone used to record the sound and its placement relative to its sound source. In such cases, the virtual space can be used to conceal the stamp of technology involved in the recording process. For instance, in live concerts and modern recording studios, close-miking is the most common recording technique. A close mike is typically a dynamic microphone placed close to the sound source. It captures the direct signal of the sound source, which preserves the clarity of the signal and isolates it from room ambience, incidental noise, and other instruments, leaving you with more options in the mixing process. A consequence of this is that what we hear when we playback a recorded signal is different from how we usually experience the sound with our ears. That is, recording with a close mike position results in a much dryer and more direct signal than if the microphones were to be placed further away from the sound source, which in turn would pick up more of the room ambience. If the close mikes are left untreated, we are left with a direct and dry sound that likely comes across as unnatural, as most people are not used to hearing a guitar amplifier, snare drum or any other instrument for that matter with one's ear right beside it. Such dry signals are most often seen as in need of staging. Moreover, if the different tracks are recorded at different locations, they may introduce conflicting spatial characteristics, which may be solved by staging.

If no room mikes were used during the recording, the most common way to overcome these shortcomings is to place the dry sounds inside a fabricated virtual space. This is often

achieved by sending the various signals to a designated reverb auxiliary track. In a transparent mix, a natural-sounding reverb such as a room or hall would be preferable. This, in turn, glues the mix's multiple elements together, masking conflicting spatial conditions. The sum of these outcomes may result in a more transparent and coherent sounding mix, as it masks conflicting spatiality's and the stamp of technology involved in the production, thus giving the impression that all sounds originate from the same space and moment in time. This approach is even used on recordings of live concerts, where all the tracks are recorded in the same space and moment in time. If only close mics were used during the concert, creating a convolution reverb based on an impulse response of the venue, and sending the various signals to a designated reverb auxiliary track reverb, may potentially correspond more with the experience the audience had of the performance than if no reverb were added. Transparent processing may thus create a virtual performance space that never actually existed but nonetheless sounds real.

This kind of processing is similar to the recording paradigm, which Brøvig-Hanssen calls the "ideal event", which is one of three paradigms—the "documentary event", the "ideal event", and the "surrealistic event—which serves as analytical classification categories of musical ideals. These three ideals originated from what she calls the *new* era of schizophonia[16], which was brought about by the tape recorder, which "enabled dramatic new possibilities for spatial and temporal disjuncture between sound and its source(s)" (Brøvig-Hanssen 2013: 145). The ideal event is the middle position between the documentary and the surrealistic events. Similarly to the documentary event, the ideal event is rooted in the event-based performance. However, as Brøvig-Hanssens writes, "According to the paradigm of the ideal event, then, it is the idea that matters—the sonic result alone—rather than its preexistence in 'real life'." (Brøvig-Hanssen 2013: 149). Contrary to the documentary event —which discards any recording or editing technique that disrupts the recording's faithfulness to an initial performance—the ideal event takes advantage of editing possibilities to create performances that potentially could have happened but never did.

The opaque space (or artistic reasons for shaping the virtual space)

Despite our ability to normalise virtual space, producers and mixing engineers can still create virtual spaces that manage to evoke a sense of the surreal or otherworldly (Brøvig-Hanssen

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16 The term derives from Pierre Schafer's term "schizophonia", which points to the invention of the phonograph, which challenged our traditional understanding of sounds as emerging directly from a live source. (See Brøvig-Hanssen 2013: 144).

and Danielsen 2013). Brøvig-Hanssen writes that when sounds are defamiliarised, they are likely to be experienced as opaque (Brøvig-Hanssen 2018: 201). This is because sounds are generally source-bonded; an essential part of listening is determining a sound's origin (Brøvig-Hanssen 2018; see also Smalley 2007). Consequently, when we fail to recognise the origin of a sound or its spatial environment, it is likely to be experienced as surreal. With innovations in music technology since the early 1950s, there are now countless ways in which the virtual space may be shaped and manipulated. Since then, artists have used these spaces to stage their music in spatial environments which evoke a sense of the surreal and otherworldly.

In his paper "Spaces within spaces," Sterne writes that "artificial reverberation may give a sense of cathedral by evoking 'cathedralness' rather than any particular building material; it may also give a sense of outer space, which is impossible since there is no sound in outer space" (Sterne 2015: 114). Although Sterne does not elaborate further on this remark, he nonetheless addresses a recurring sonic trope in popular music history, which is of particular relevance to the present context. By way of example, I will focus on spaces that evoke a sense of outer space concerning opaque mixing practices.

Since the beginning of the space age, which dates back to the space race in the late 1950s, outer space has been the object of fascination in popular culture. Since then, musicians, filmmakers and plugin designers have attempted to create a sense of outer space visually, musically, and spatially. Sean Costello, the founder of Valhalla DSP, has, for instance, designed a plugin specifically for this purpose. His plugin SuperMassive is a reverb plugin that ventures beyond the surreal. The plugin description reads as follows:

> # ValhallaSuperMassive
>
> Best for massive reverbs, harmonic echoes, space sounds.
>
> **Make some space**
>
> ValhallaSupermassive has been designed from the ground up for MASSIVE delays and reverbs. Blow your mind and your music to new levels of consciousness and experience. Get ready for luscious clouds of reverb, otherworldly delays, swelling waves of feedback unlike any you've heard before.[17]

[17] https://valhalladsp.com/shop/reverb/valhalla-supermassive/

Concerning the plug-in design, Sean Costello writes, "Since the ValhallaSuperMassive algorithms don't correspond to "real world" spaces, like halls or rooms, they have been given the names of celestial objects"[18]. Among these, we find names like LunarLander, SpaceVerb1999 and Lost Saucer, to name a few.

However, the link between outer space and temporal effect devices and plug-ins is not new. "Space Echo" (1974) and "Ursa major space station" (1978) are some examples of spatial effect units alluding to outer space. Several other time-based signal processors have followed the same themes. Consider, for instance, the visual design of the first commercial digital reverb, EMT 250 (1976). The futuristic design of the device resembles more the controls one would imagine finding in a spaceship than any other reverberation device available at the time.

In popular music, attempts to sonically evoke a sense of outer space date back to the early 1950s (Doyle 2005). Doyle writes that Johnny "Guitar" Watson's instrumental "Space Guitar" (1954) made use of radically fluctuating reverb to spatially create a sense of the self and the invading other by switching from near to in the distance. The near here represents the self, whereas the distant represents the invading other. This was achieved by turning the reverb on and off, resulting in an ambiguous spatiality. Since then, spatial representations of space have undergone several transformations. Doyle explains:

> The track was recorded before the launch of Sputnik 1 and well before the United States' more notable success in the space race. In the early 1950s, rather than being imagined primarily as a zone ripe for heroic colonising - the territorialised space of screen productions such as *Outer Limits*, *Star Trek* or *2001: a Space Odyssey*… - space as much a source of terror, from which nuclear weapons or grotesque hostile invaders might come, worldly or otherwise. It was the terror space of such early 1950's films as *Killers from Space* and *War of the Worlds*. (Doyle 2005: 159)

This shift is evident in the song Telstar by The Tornadoes (1962). "Telstar" displays many of the characteristics which later would become key aural markers of space rock, like the use of electronic keyboards (Claviolin or Univox, both forerunners to the analogue synthesiser) and reverberated guitars. The track opens with a delay unit driven into self-oscillation, which happens when the feedback is turned up so that it creates a self-oscillating feedback loop, an

[18] https://valhalladsp.com/2020/05/06/the-philosophy-of-valhallasupermassive/

effect frequently used to simulate the sounds of UFOs. The track's title refers to the communication satellite Telstar, which was launched into orbit the same year.

The virtual spaces associated with outer space also found their counterpart in psychedelic music in the 1960s, which often sought to depict the disorienting effect of LSD in musical terms. Apart from evoking a sense of outer space, these expressionistic virtual spaces seemed to carry powerful references to "inner spaces" to the zones of the psyche. Ken McLeod, who has analysed the impact of "alien and futuristic imagery" on popular music, writes that the use of alien and space themes is often linked with drug use and that it appears symptomatic of a general alienation from late-twentieth-century life and of an increasing need to strive for higher, alternative ideals and states of being (McLeod 2003: 353). This sentiment resonates well with the description of the Valhalla Super Massive plugin mentioned above: "blow your mind and your music to new levels of consciousness and experience". This quote suggests that apart from evoking a sense of outer space, they carry a powerful reference to the zones of the psyche. This link is also evident in expressions such as "spacy" or "far out", often used to describe psychedelic music and experiences. McLeod writes:

> Pink Floyd's Dark Side of the Moon (1973) provides yet another use of space imagery from the early 1970s. Pink Floyd's association with drugs is well known, and the album's title is typically interpreted as referring to the exploration of alien worlds of madness and drug-altered consciousness, the unknown side of the human experience. (McLeod 2003: 346)

McLeod rightfully points out that the primary means for sonically evoking a sense of alienation and outer space is through synthesisers and the heavy use of electronic recording techniques (ibid). However, he does not mention the impact of virtual space and time-based signal processors in sonically depicting a sense of outer space or the zones of the psyche.

There are, however, plenty of examples of artists who have used time-based signal processors to evoke a sense of outer space. Among influencing artists alluding to outer space, we find Brian Eno. Throughout the 1980s, Eno experimented with the Shimmer Reverb, a reverb produced by sending the wet signal through a pitch shifter that pitches the reverb up an octave. On his track "Deep Blue Day" from the album Apollo (1983), the shimmer reverbs creates the lush pad heard throughout the song. The reverb produces a sense of otherworldliness, suggesting a vast space. Although there are no synthesisers on this particular track, the reverb creates a synth-sounding texture. Eno would later use the shimmer reverb on various tracks, including the soundtrack for the science fiction movie *Dune* (1984).

The iconic soundtrack of Ridley Scott's science-fiction noir classic *Blade Runner* (1982), composed by Vangelis, is yet another take on the alien futuristic imagery which manages to evoke the movie's bleak futurism with emotive synthesiser sounds enshrouded in massive reverbs. Vangelis created the enormous virtual spaces of the score by running his instruments through the iconic Lexicon 224 digital reverberation sound processor which complemented the vast and otherworldly landscapes depicted in the film[19]. The soundtrack has become very influential in electronic music genres, especially for Vangelis' use of synthesisers. Here again, the primary means for evoking futuristic imagery is through the use of synthesisers.

However, the soundtrack of *Blade Runner* is not Vangelis's only take on the space, alien futuristic imagery. His ambient track "Création du Monde" (1974) displays early use of modulated reverb. The massive reverb heard on this track was, according to Costello of Valhalla DSP, presumably created by stringing four tape delays in succession[20]. Because of the somewhat unreliable playback speed of most tape delays at that time, detune and flutter of the wet signal were inevitable. Stringing three tape delays with a fair amount of feedback after each other then leads to a noticeable amount of detuning as the reverb decays (examples of this kind of reverb will be demonstrated later in this thesis).

Given that the transparent spaces discussed in the previous section correspond to the paradigm of the documentary and ideal event. In that case, the opaque and surreal spaces discussed in this part correspond to the surrealistic event, favouring musical events that could not exist without the recording and editing possibilities made possible through technological mediation.

The virtual space as a sonic marker of time

Apart from referencing real-world and imaginary spaces, the virtual space can also reference specific decades from the past. In other words, the virtual space can function as a sonic marker of time. Several scholars and journalists have addressed how musical sound and technology from the past are appropriated in recent music productions (See, for example, Taylor 2001, Barlindhaug 2007, Bennet 2012, Alan Williams 2018, Askerøi 2013, Reynolds 2011, and Brøvig-Hanssen 2012). However, few have addressed how this translates to the virtual space. Therefore, the following section aims to illuminate how the virtual spaces used in popular music and film scores function as sonic markers of time.

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[19] http://www.nemostudios.co.uk/bladerunner/

[20] https://valhalladsp.com/2009/08/01/early-examples-of-modulated-reverbs/

Before going further, a definition is in order: Askerøi defines sonic makers as "musical codes that have been historically grounded through a specific context, and through their appropriation, serve a range of narrative purposes in recorded music" (Askerøi 2013: 17). By his definition, sonic markers range from vocal peculiarities to instrumental stylings and technological aspects of music production. As well as serving narrative purposes, they "act as compositional tools in pop production and in turn play a major role in the formation of musical identity" (Askerøi 2013: 1). Askerøi further states that "the effects that accompany certain singing styles, musical instrument 'sounds' and uses of recording technologies can be traced to specific decades, studios or scenes through their cultural codification. And it is through their use in recordings that they then appear as sonic markers" (Askerøi 2013: 28).

Although it does not produce tonal or harmonic structures, there are several ways the virtual space can appear as a sonic marker. As discussed in chapter two, ever since musicians began incorporating virtual spaces in popular music recordings, the aesthetic norms of the virtual spaces have been in constant flux. These changes were often pushed forward by innovations in recording technologies, which accelerated new styles and trends which created the demand for new technologies. Because aesthetic norms and recording technology change, any given recording represents the technology in the era it was recorded. Moreover, the technology used to create these spaces contributes to colouring the music to a significant extent. The producer can, then, sonically reference any decade by appropriating technologies, aesthetic norms and technological artefacts typical of a given decade. An example of a sonic marker that Askerøi uses is the slap-back echo. The slap-back echo has now lost its initial shock effect, but when appropriated in recent music productions, it becomes a sonic marker of the 1950s Rock'n Roll and Elvis Presley (Askerøi 2013). Similarly, the gated reverb, popularised by Phil Collins in the 1980s, can become a sonic marker of the 1980s when used in a modern recording.

Sonic markers are also source-bonded. For a listener to perceive a sound or a configuration of sound as a sonic marker of something, it requires that they have previous experience with that sound. For instance, a listener unfamiliar with, say, the sound of the slap-back echo is unlikely to perceive it as a sonic marker of Rock'n Roll, the 1950s, Elvis Presley or any other artist or genre that has historically grounded the effect. Thus, it has to be acknowledged that the use of sonic markers of time is somewhat elitist. The messages it communicates can only be understood and appreciated by the initiated. In the context of this thesis, that is listeners who are familiar with Western popular music's history.

Moreover, a sound is never neutral or universal. It can evoke completely different associations depending on the listener. For instance, the sound of a police siren will likely

produce different meanings depending on the perceiver. To people living in a white upper-class neighbourhood, the sound may signal help or rescue, while it may be perceived as a threat in a poor black neighbourhood. I make this point because it should be acknowledged that I—the writer of this thesis, being a privileged white man within a field of study concerning music produced in the West, historically conducted by privileged white men in the West—can only see one side of the story.

Both sonic and visual markers of the past are evident in several aspects of our current culture. The soundtrack from the TV series *Stranger Things* is a good example of this trend; it's celebrated for its authenticity to the time it is set in. In the series, both the visual and sonic aesthetic complement each other in their reference to the 1980s. The score is created in the present, but the songs used in the series are from the 1980s (except for "Separate Ways (Worlds Apart) - Bryce Miller/Alloy tracks remix" by Journey and Steve Perry). Interestingly, it's hard to distinguish between the music created or remixed in the present and the music created in the 1980s. This is particularly evident in the Worlds Apart remix and the main theme for the series. When comparing the music from the present and the music from the 1980s, the music created in the present resembles more our current notions of the 1980s than those made in the 1980s. As if attempting to sound like the 1980s, the producer has exaggerated the sonic markers of that era. From a music production perspective, the primary means for evoking a sense of the 1980s in these instances are through the use of vintage-sounding synthesisers and the excessive amount of reverberation and chorus. *Stranger Things* is a good example in this context because the iconic soundtrack is crucial to the series' appeal. The series has arguably had a tremendous effect on popular culture in general. It undoubtedly hit the zeitgeist of our era and contributed to spurring the 1980s mania that reached its peak in the last half of the 2010s, influencing various aspects of our popular culture, from fashion to popular music to movies and TV series.

So why do we appropriate sonic makers of the past? With *Stranger Things*—as with other historic and time-specific movies and series—the scores appropriate sonic makers to stay authentic to the time period in which the film or series is set. Popular music, on the other hand, has different motives for using sonic markers: it is not necessarily created to complement anything other than itself. While the reason behind the use of sonic markers in score music is to stay authentic to the *time period* the movie is set in, the motive behind the use of sonic markers in popular music is to remain faithful to the *sonic ideal* it's referring to. For instance, in genres and musical expressions which focus on sounding "authentic" through specific references to sonic ideals of the 1960s or 1970s, the presence of digital artefacts (or the lack of analogue artefacts) and production techniques typical of the present may sound

anachronistic in ways that harm the track's authenticity. This is, however, not to say that anachronisms can't be used creatively; if done well, they can create unique expressions displaying a broad cultural awareness. Askerøi uses the term retronormativity to address this creative use of anachronisms, describing it as "the mechanism of placing the 'past' in the 'present'." (Askerøi 2013: 42). Askerøi uses Beck as an example and demonstrates how Beck's "musical identity has been constructed from his eclectic, retronormative play with sonic markers of other eras" (Askerøi 2013: 42). Askerøi further argues that rather than harming Beck's authenticity, his retronormative play with sonic markers asserts his good taste (Askerøi 2013: 166).

Many scholars have addressed the tendency of looking back in time through sound. Alan Williams links this increased interest in technological precursors and sonic ideals of the past to the successful creation and marketing of a complex web of mythologies that "continue to exert a powerful influence over recording practices and the reception of the resulting artefacts". Williams argues that these mythologies are not based on fact but often on contradicting narratives, hearsay and loose threads of historical memory. He links some of these mythologies to the proliferation of books and documentaries in the 1970s and 1980s about the recording practices of The Beatles and other major figures and canonical works which emphasised process over product. The successful marketing and reception of these books and documentaries later inspired a host of other books and documentaries, and movies, like the Classic Album series (1997-), Sounds City (2013), Sonic Highway (2014), and many more which continue to strengthen these mythologies by preaching the gospel of analogue technology and its associative practices.

Williams also suggests that the appropriation of musical sound and technology of the past "signals a deep discomfort with the present/future—a longing for an era that predates one's birth" (Williams 2018: 161). He links this discomfort with the present/future and the interest in technological precursors to another widespread mythology in popular discourse; technology as a weapon of mass deception. This mythology can be traced back to the 1920s when singers began using the microphone, or the 1950s, when the tape recorder with its new recording and editing capabilities became the standard way of making records, or today with digital technology's seemingly unlimited editing and manipulation capabilities. In short, this kind of Luddism becomes relevant every time a new technological invitation is introduced, which challenges the norms of what music is and how it's created. Both mythologies support the notion that the music created with analogue technology and associative practice is superior to the music produced today using digital technology.

So how do these mythologies affect the way music is created? Williams writes that "recording musicians inherit a complex web of associated mythologies, whether hunkered over a software program with a graphic representation of a piece of recording equipment they have encountered only as a mythological icon or comfortably ensconced in a world-famous facility, absorbing the atmosphere of the location where canonical records were made" (Williams 2018: 157). These mythologies are now deeply embedded in the music production industry. For instance, many of the most popular and successful plug-in manufacturers today offer a broad range of plug-in emulations of iconic analogue recording equipment and effect units. These are marketed and sold to booth studio professionals and home recordists.

Gaute Barlindhaug argues that the software emulations of analogue recording technologies are a result of a technological counterrevolution fuelled by a desire to revive pre-digital tools (Barlindhaug 2007: 87). In response to scholars claiming that the interest in technological precursors and sonic ideals of the past is Luddite, Barlindhaug argues that sometimes what inspires the producer to revisit analogue technologies is simply the character and sound they impart to the signals they process: "Whereas analogue recording had a destructive reproduction process, digital technology enabled the infinite cloning of sound (...) These aspects, often described as the advantages of digital recording, have turned out to be a problem. The soft distorted, compact sound of analogue recordings during the sixties and seventies defined how a recording should sound" (Barlindhaug 2007: 77-78). This is an essential point because it illuminates a simple fact often ignored in the discussion of technostalgia: Sometimes, analogue processing sounds warmer and better than its digital counterpart. Although, as Williams argues, nostalgia is an essential aspect of why analogue technologies are being appropriated in the digital era, owing it to nostalgia alone is too simple.

Not only has the presence of vintage technologies become more prevalent since the early 2000s, but, as Bennet argues, "the very issues that recordists once fought to eliminate are now desirable features in the form of plug-in emulations" (Bennett 2012). Barlindhaug explains this trend, arguing that the strength of digital tools lies in their ability to simulate their digital precursors; thus, "digital technology helps to create an acknowledgement of analogue aesthetics" (Barlindhaug 2007: 90). This tendency is present not only in music production but in media culture in general, where analogue media technology from the past is re-appropriated and remediated in various digital media applications. Instagram, for instance, allows users to add specific analogue filters to images. Another interesting aspect regarding the appropriation of vintage technologies is that it's not just any decade from the past that gets appropriated. As Williams argues, there are wrong pasts and right pasts in the sense that

some past eras are favoured over others. For instance, many of the most popular Instagram filters and plugin emulations shared during the early 2010s were that they appropriated technologies with specific references to the 1960s and 1970s. However, during the past seven years, sonic and visual markers of the 1960s seem to have gone out of fashion in favour of the late 1970s and the 1980s. This is exemplified by bands and artists such as Leisure, Khruangbin, Tame Impala, The Weekend and many more.

So far, we have discussed how the sonic signatures of analogue devices, recording equipment and techniques can be used to reference past eras. Another way of referencing the past is by appropriating stereo configurations specific to a particular decade. Artists who focus on sounding "authentic" through specific references to sonic ideals of the mid-1960s often tend to appropriate stereo configurations from this era. Tame Impala's "Feels Like We Only Go Backwards" (2012) is a good example of a track that references the mid-1960s through the placement of sounds along the horizontal axis. In terms of the stereo field, the sonic marker is most evident through the slightly off-centred placement of the bass. This stereo configuration may sound out of balance for listeners today, as we are used to hearing the bass in the centre of the mix, functioning as the anchor of both groove and chord changes. However, in the mid-1960s, the off-centred bass was both an aesthetic norm and a consequence of technological limitations. Ruth Dockwray and Allan Moore write that "an over-prominent bass would result in too much movement for the stylus, making it tend to leave the groove; therefore, the level of bass on a track would impact the way the track was cut to vinyl. To avoid this, many producers balanced an off-centred bass with instruments in the opposite channel" (Dockwray, Moore 2012: 187).

In "Feels Like We Only Go Backwards", the bass is not responsible for alluding to the 1960s, rather it substantiates the sonic makers already established in the production. First, the title of the song seems like a commentary on the nostalgic tendency in popular music. Second, there's a striking resemblance between the singer Kevin Parker's voice and that of John Lennon. Moreover, the combination of reverb, echo and doubling applied to the vocals bears an uncanny resemblance to the production style and techniques of Phil Spector. Lastly, the song structure, instrumental stylings and harmony share many similarities with the popular music of the 1960s.

Despite the various allusions to the 1960s, several instruments on the track are atypical of the 1960s, such as the prominent use of synthesisers and the absence of guitars. However, these retronormative arrangement choices do not undermine the song's authenticity

but give the arrangement a futuristic Wrecking Crew[21] characteristic. Lastly, there's a technological aspect, such as the use of phasers, distorted drums and self-oscillating tape delays typical of psychedelic music of the 1960s and early 1970s. When all these sonic markers, specific to the 1960s and 1970s, are combined, they form a convincing whole. Despite the various sonic markers particular to the 1960s and 1970s, the intentional use of anachronisms gives the track a contemporary sound, at least compared to the standards of the early 2010s. This is primarily owed to the use of synthesisers on the track—most likely a Juno 106—which creates a duality between the present and the past.

Summary

This chapter set out to discuss how virtual spatial environments are shaped and constructed to *stage* the music in given spatial and temporal configurations and how this virtual choreography allows artists and mixers to convey messages to the listener through the staging of voices and instruments in the mix. The focal point has been on production ideals regarding the virtual space. First, drawing on Brøvig-Hanssens terminology, I wanted to discuss virtual spatiality in relation to the dichotomies of the transparent and opaque ideal; The transparent space here is the realistic or "natural-sounding" space while the opaque space evokes a sense of the surreal or otherworldly. We discussed how a transparent space could make a disjointed-sounding mix sound cohesive by staging all sounds in a coherent and natural-sounding virtual space. This is especially useful in mixes where the elements sound like they were recorded in different spaces. In this sense, the transparent space can mask the stamp of technology involved in the recording process. The opaque space, by contrast, is more dramatic; it evokes a sense of the surreal and otherworldly by staging the sounds in spaces that do not correspond with real-world environments. Contrary to transparent spaces, opaque spaces tend to grab our attention and thus dramatically alter the character of the mix.

Lastly, drawing on Akerøi's concept of sonic markers, we discussed how the virtual space can be shaped and constructed as a sonic marker of time. I examined how artists reference specific past eras by appropriating aesthetic norms, ideals and technologies that have been historically grounded through a specific context. To provide some contextual background to this part, I linked this to the discussion of digital vs analogue aesthetics and the prevalence of digital appropriations of analogue technologies which have contributed to creating an acknowledgement of analogue aesthetics. By way of example, I provided a brief

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[21] The Wrecking Crew was a group of Los Angeles-based session musicians that contributed to a great number of famous studio recordings during the 1960s and 1970s.

analysis of the track “Feels Like We Only Go Backwards” (2012) by Tame Impala to illustrate how the virtual space can substantiate the sonic markers in a popular music production.

The purpose of this chapter has been to provide the reader with the contextual and theoretical framework on which I have based my artistic practice. In doing so, I hope to have broadened our understanding of virtual spatiality by acknowledging that time-based signal processors are more than depth and space-creating effects. Apart from creating the illusion of depth and space, they can evoke a sense of the surreal and otherworldly, as well as reference past eras by drawing on the listener’s previous engagement with sound and music, thus significantly impacting the mix’s virtual choreography.

Chapter 4: Artistic Practice

I have recorded and mixed three songs as part of my artistic practice for this thesis, which will be analysed and discussed in the following chapter. I have been working on these songs simultaneously as writing this thesis. Consequently, the artistic practice has influenced many aspects of this thesis and vice versa, thus creating a positive feedback loop. The artistic practice has been an essential part of my research into the topic. It has given me an insight I could not have acquired had I relied only on the literature on the subject. I have used these productions to experiment with various creative ways of applying and shaping virtual spaces and experiment with and testing the validity of claims by other musicologists. Still, I have been careful not to overuse any effects or tools in ways that don't sound musical.

The temporal signal processing on the three tracks does not merely signify space but also impacts on textural attributes of the tracks. The main goal of the following section is then to illustrate in practical terms how

1. the virtual space can be used as a sonic marker of time eras; and
2. how the virtual space affects timbral, textural and spatial attributes.

All three songs were recorded with the drummer and bass player in my band Greatfruit. They were recorded in the rehearsal/studio space using more or less the same microphones, techniques and recording equipment. The song "Love Police" stands out as it was recorded live and later overdubbed. On the two other songs, "Key Largo" and "The Thing That You Are", we recorded all instruments separately.

Because the virtual spaces of the tracks were mainly shaped during the mixing process, to narrow the focus, I have chosen to focus on the time-based signal processors used in the mixing process. There are many aspects besides the use of time-based signal processors that affect the spatial design and the virtual space of the tracks, such as microphone placements, compression and equalisation. Despite this, and in accordance with the theoretical part of the thesis, I will mainly stick to the time-based signal processors and how they affect the spatial design of the virtual space of the mixes.

In the previous chapters, I have presented some key concepts and frameworks, including (1) dimensions of the virtual space (i.e. depth, size, character and texture; (2)

production ideals (i.e. opaque versus transparent mediation, and ideal versus surreal events); and (3) virtual spaces as sonic markers of time eras. I will revisit these concepts throughout the analyses.

With respect to dimensions, as the focus is on how time-based signal processors affect the virtual space, I have primarily focused on depth in the previous theories and will do so in this chapter as well.

With regard to production ideals, my artistic practice falls between the dichotomies of transparent and opaque. This is a typical sonic trait within the psychedelic rock/pop genre—which I classify my artistic practice as belonging to—historically associated with studio wizardry and authentic performances. Within this genre, there are aesthetic norms of both opaqueness and transparency that I adhere to. On all tracks, we find ourselves, on various occasions, "listening *to* rather than *through* the mediating technology" (Brøvig-Hanssen 2018). However, I have carefully avoided overuse of effects according to the aesthetic norms of the genre as this may alienate listeners and diminish the integrity of the performance, creating something that may sound undynamic and inhuman.

In relation to production ideals, I also discussed the recording paradigms "ideal" and "surreal event" (Brøvig-Hanssen 2013) in chapter two. I characterise the meditations as falling between the ideal and the surrealistic event. This is typical for the genre within which I situate my music, which has, since its conception in the 1960s, exploited the creative possibilities made available through multitrack recording. The instruments on all three tracks have been mixed and processed according to the ideal event to sound like a performance that could have taken place. In terms of the surrealistic event, although I might be stretching the concept beyond its original intent, I would, for instance, argue that it is evident in "Love Police", which features sounds of dolphins and other maritime sounds as well as artificially harmonised vocals. The same aesthetic norms apply to the virtual space. Although they arguably lean more towards the surreal, I have carefully organised and distributed the reverbs to make the instruments sound like they are emitting from the same virtual performance space. That being said, none of these spaces could exist in reality.

Regarding the use of sonic markers in relation to the virtual space, the spatial design of the tracks substantiates and exaggerates the sonic markers established through the composition, arrangement, production, performance and choice of instruments, making the established references to past eras more explicit. This chapter shows that the most extreme and opaque spaces and processing choices are also the most explicit sonic markers. For a given recording technology to function as a sonic marker, I will argue that it has to be opaque. The more a given technology colours the sound it processes, the more recognisable it

becomes as a sonic marker of the era in which it was developed or popularised. By contrast, if the mediating technology is transparent, it will not colour the sound to the same degree and therefore becomes more anonymous and sometimes even unrecognisable even to the most experienced mixer, recordist or producer.

This chapter will provide a detailed analysis of each track and discuss the signal processing and the reasons for processing them in these ways. I will start by discussing the track "Love Police" – an experimental-sounding 1980s-inspired ballad. Next, I will discuss "The Thing That You Are" – an ode to psychedelic and progressive rock from the late 1960s to mid-1970s. Lastly, I will discuss "Key Largo" – a bossa nova/exotica inspired track. Finally, I will reflect on how all the tracks have contributed insight into virtual spaces in an overall conclusion.

Love Police

"Love Police" was written, recorded, arranged and produced over a week in early March 2021. The recording process and approach on this particular track are untypical of how we usually record our material. Therefore, before jumping to the mix, I find it relevant to dwell a little on the recording process, as this laid guidelines for how the recordings were later processed.

"Love Police" stands out from the other songs I have chosen to discuss because it was built on top of a live recording. Moreover, it was poorly recorded. We had no plans to record anything when we arrived at the studio/rehearsal space during the initial recording day. By chance, the drums were already partially mic'd up—mono overhead, snare and kick—and connected to the interface, so all we had to do was connect the bass, Rhodes, and a computer to the interface. The objective behind that day's session was to work on new ideas. However, as we were all connected to the interface, we decided to record what we were playing. We didn't know it then, but what eventually happened during this session was that we recorded the foundation of what would later become "Love Police." We never had any concrete plans of using the recording as none of us had faith in its applicability. Moreover, up until that point, we had never used anything that we had recorded live. Despite this, the fifth take of that session ended up being the take used in the production.

At this point, we had recorded bass, drums and Rhodes. After balancing the instruments, I realised that, despite the poorly recorded drums (the kick was recorded with an SM57 microphone), and considerable bleeds from the bass and Rhodes in the drum recording, there was something soothing about the recording. After listening to the recording

with my bandmates, we decided to use this as a foundation and record the rest of the instruments on top of it. This decision was not based on the quality of the recording but because the performance sounded authentic. This unconventional and lo-fi approach to recording ended up being used when recording the overdubs as well. The backing vocals, for instance, sung by myself, the drummer and the bass player, were recorded simultaneously in the same room using three handheld SM57 microphones.

From a mixing engineer's perspective, this approach to recording may not be ideal. The snare and kick, for instance, had to be triggered with samples. However, from an artistic perspective, it worked well as it enabled us to work fast and, most importantly, stimulate creative output. In the end, the quality of the performance matters more than the quality of the recording. See figure 1 for an overview of the instruments used on the track and the equipment used to record them.

Recording specifications (Love Police)				
Instrument:	**Type:**	**Microphone:**	**Effects:**	**Live/overdubbed**
Drums		2x SM57 (kick and snare) (Mono overhead mic)		Live
Bass	Fender Precision	DI directly into the interface. We also used an amp which was not miced, but got picked up by the drum mics		Live
Keys	Yamaha CP Reface	DI	Chorus: Yamaha CP Reface Reverb: Yamaha CP Reface Delay: Yamaha CP Reface	Live
Guitar fender Stratocaster	Fender Stratocaster Amplified by a Fender Twin Reverb	SM57	Delay and reverb	Overdubbed
Lead vocal		Electro-voice RE20	EQ: Warm Audio WA73-EQ	Overdubbed
Backing Vocals		3x SM57 (hand held)		Overdubbed, but recorded simultaneously

Recording specifications (Love Police)				
Instrument:	**Type:**	**Microphone:**	**Effects:**	**Live/overdubbed**
Synth	Juno 106	DI directly into interface	Chorus: built in chorus Reverb: Boss RV6 Delay: Boss RE 20 Space Echo	Overdubbed
Saxophone		Electro-voice RE20		Overdubbed

Figure 1: Overview of the instruments used in "Love Police" and the equipment used to record them.

It was clear from the beginning that this would be a 1980s ballad type of song. Apart from specific references to the 1980s, I also wanted to invoke an "underwater" feeling. The slow tempo (76,5 bpm) and feel of the song invoked a feeling of being underwater, and one of my objectives was to substantiate this feeling through the virtual space. This informed many of the aesthetic choices made during the mix, including the spatial design (such as the long reverbs and the prominent use of chorus).

Spatial design

The reverbs and delays have the most significant impact on the virtual spatiality of the track. The reverbs and delays were organised according to an approach from the analogue era. This approach is often referred to as being "old school". Rather than placing the reverb directly onto the track or creating designated reverb buses for each track, this technique forces you to use a limited number of reverbs and delays. The virtual space of this track is primarily shaped using three different reverbs. These reverbs thus function as colours of the spatial pallet. I used one short ambience reverb with a duration of 0.3 seconds, one medium reverb lasting for 3 seconds, and one long/fx reverb with a duration of 5 seconds. In addition to these three reverbs, the vocal has its designated reverb bus. The delay "buses" (bus channels) are organised similarly. This technique was common among mixing engineers in the analogue era when studios were limited regarding the number of delay and reverb devices available. A studio would typically have three or four reverb devices. To use the same reverb on several instruments, each reverb was set to the desired setting and sent to a respective auxiliary track. The idea was to organise the reverbs to create a sense of foreground, middle ground and background. Although this technique may seem obsolete or Luddite today, as we no longer

need to limit ourselves to a given number of reverbs, this technique has a few advantages. Limiting the number of reverbs makes the mix sound more cohesive, giving the listener the sense that all sounds originate from the same space. It also reduces processing power, which allows one to work more efficiently.

To further enhance the sense of depth on the track, I used another reverb technique commonly used in the analogue era. The idea behind this technique is to give each instrument a dedicated pre-delay using only one reverb. The pre-delay informs our ears of the sound source's relative distance from our ears. A long pre-delay indicates that the sound is close to the listener, while a short pre-delay suggests that the sound is located in the back of the room. Longer pre-delays also have the advantage of separating the dry signal from the wet signal, which can be practical in several settings.

To achieve a dedicated pre-delay for each group of instruments using only one reverb, I chose the medium reverb bus mentioned above as my "room reverb". This was a plate reverb with no pre-delay. I then created a dedicated bus for each group of instruments, each containing a delay set to 100% wet (Keep in mind, the bus routes the signal on an alternate signal path independently of the dry signal). I then selected the main reverb bus as the output signal of each bus. This way, the delay functions as the pre-delay, as it allows me to delay the signal of any instrument or voice going into the reverb. This opens up many possibilities for creating depth and realism in the virtual space. For instance, a long pre-delay allows me to add a lot of reverb to the vocals without making them sound like they are in the back of the room. I also arranged most of the pre-delays to have a rhythmical function in the mix. For instance, the vocals have a 196 ms pre-delay, which equals a 1/16 note in this tempo. Another advantage of this technique is that it allows us to equalise the signal of each instrument before entering the reverb without affecting the dry signal or the main reverb. This can be handy in reverb-heavy mixes like this one because it allows me to be generous with my reverb without masking the dry signal. On the drums, for instance, there was a build-up at 150hz because of the snare. To preserve clarity and prevent a build-up of unwanted frequencies in the mix, I did a 3db cut at 150Hz on the signal going into the reverb. I did the same with the vocals, where the most prominent information was around 300hz and 1khz. See figure 2 for an overview of the processing effects used on the track.

Reverb Bus	Duration of Reverb	Reverb type	Plugin
Bus 1	0.3s	Chamber reverb	Space Designer, Logic Pro

Reverb Bus	Duration of Reverb	Reverb type	Plugin
Bus 2	3s	Plate reverb	Little Plate, Soundtoys
Bus 3	5s	Digital reverb (algorithmic)	ValhallaSupermassive, Valhalla DSP

Figure 2: Overview of the processing effects used on “Love Police”.

The Spatial Design of Individual Tracks

Next, I will discuss the spatial design of the individual tracks more thoroughly. Some tracks, such as the atmospheric sounds, are left out as they have no particular impact on the virtual space.

Drums

Reverb processing on drums can be quite complex due to the number of tracks that makes up the entire set. I only used three microphones on this particular kit, but I triggered the kick and the snare to make up for the flaws in the recording, leaving me with twice as many tracks (I used two samples for the snare). For the drums, I used three different reverbs and one delay. I applied a short ambience reverb to the drum bus, affecting the whole kit. The purpose was to glue drums to the rest of the mix.

Moreover, the ambience reverb produces a similar sound to room mics and can make the otherwise direct signals sound more natural. The second reverb is the room reverb. This was also applied to the drum bus, affecting the whole kit. To preserve clarity and avoid a build-up of low frequencies from the kick, I set the high pass filter at 200hz on the signal going into the reverb. Apart from improving the kit’s sound, the room reverb also glued the drums to the rest of the mix as all instruments were fed into this reverb, making it sound like all the instruments and sounds emit from the same space. In addition to this, I used the long reverb on the snare. The long reverb is set relatively low in the mix and adds air to the drum kit.

The most interesting feature of the spatial design of the drums is the use of delay. The overhead, snare and snare samples were all routed to the delay bus. Before reaching the delay, the signals went through a noise gate that gated everything except the snare sound. Accordingly, only the sound of the snare was sent to the delay. The delay was set to 16th notes with a lot of feedback. The character of the delay emulates the iconic Space Echo. A characteristic of the space echo setting is that it defuses the signal by filtering out the lows

and highs of the delay. Moreover, there is considerable pitch wobble on the delay, as the plugin also emulates the flaws commonly encountered with this unit. Although coloured by the technology, I still think it sounds more realistic than certain digital delays, which are direct copies of the sound. In real life, the echoes get more and more diffused before dying out as certain frequencies get absorbed earlier than others. To make the delay sound more interesting, I selected the drum bus as the output of the delay bus. This way, the delay gets processed the same way as the signals going into the drum bus.

Although the delay affects the drums' spatiality, the effect in this instance is, first and foremost, rhythmical and textural. It is rhythmic in the sense that it is a rhythmic extension of the kit itself, with repeated sounds added in the temporal domain. Textural, because it increases the density of the drums by filling in the gaps between each drum hit. Apart from affecting rhythmical and textural parameters, the processing does not correspond with real-world environments and, therefore, sounds opaque. It also gives the drums a distinct opaque sound reminiscent of the psychedelic era.

Vocals

As with all my mixes, I spend much time getting the vocal reverb right. I wanted the vocals to be wet and present at the same time. For the vocals, I have used two reverbs and two delays. The first reverb is the room reverb, set relatively high in the mix. To make it sound both present and reverberant, I chose a 16th note pre-delay, which is a very long pre-delay. A long pre-delay may result in the reverb being perceived as spatially behind the vocals, thereby creating the illusion that the vocals are in close proximity to the listener. I also used a longer reverb to create a sense of air around the vocals. It is the same long reverb as I used on the other instruments, but to preserve the presence of the vocals, I duplicated the reverb bus and applied sidechain compression to the reverb using the original dry sound as the input. As discussed in chapter 2, this causes the reverb signal to "duck" (be muted) when the dry signal plays and "swell up" (gradually retain its amplitude level) when the dry signal doesn't play. Although quite wet at this point, I wanted to create more air and space around the vocals. I achieved this by sending the vocals to a delay bus, set to 8th note delay. I also applied sidechain compression to the delay using the original dry sound as the input. To make the echo sound more realistic and push it back in the mix, I sent it to the room reverb. As mentioned earlier, echoes sound more natural with reverb. The second delay is a 2nd note delay. This delay is only used two times during the song to compliment the lyrics and strengthen the song's narrative. It first appears in the first verse delaying the words "miles away" and then in the third verse delaying the same words. To make the echo sound as if it is

actually “miles away”, I sent the delayed signal to the same reverb and delay busses used on the vocals but mixed it much wetter than the vocals.

I also used a vocal doubler emulating the Eventide H3000. The doubler is a delay, creating two duplicates of the original signal. The pitch of the duplicates gets slightly altered and delayed by a few milliseconds and then spread out in the mix. The result is similar to a chorus and a short slapback but has a characteristic sound. The doubler is kept subtle in the mix but adds clarity and depth to the vocals.

Bass

Although I usually like to keep the bass dry in most mixes, I sent a modest amount of the bass signal into both the ambience reverb and the room reverb bus in order to glue the bass to the rest of the mix, especially the drums. To avoid frequency build-up in the mix, I attenuated the low and low-mid frequencies of the signal going into the reverbs so that only the high-mid frequencies from the bass were fed into the reverb room. In addition to reverb, I also sent a modest amount of the signal into a slapback delay bus, which gave the bass an interesting character and texture and an ambiguous placement in the virtual space.

Keys

The Rhodes, recorded rather wet, to begin with, is the instrument located furthest back in the mix. In terms of spatiality, there are several things apart from the reverb and delays that place it in the back of the mix. The stereo chorus, for instance, widens the sound of the instrument by creating a modulated duplicate of the sound. The dry signal and the modulated copy are then panned hard to each side. This makes it sound more ambient and affects the instrument’s perceived placement. The chorus makes the instrument sound more opaque, as it has a synthetic character. It also strengthens the underwater effect I wanted to achieve because it adds shimmer to the sound, giving it an elusive and liquid character. Lastly, I added a stereo delay with dotted and straight eight notes to further increase the stereo spread.

Juno 106

The Juno 106 was also recorded with the stereo chorus. To further emphasise the underwater feeling created by the splashy synth sound and the chorus effect, I added a phaser which substantiated the elusive and liquid character. The phaser also attenuates the higher frequencies and places the synth further back in the mix, as well as adding motion to the sound. The synth is then fed to the room reverb bus and a delay with dotted eighths. I also sent the signal into the long reverb bus, which added a bit of shimmer and air to the sound.

Guitar

The guitar was recorded with reverb, delay and a mono chorus. Therefore, I only added a modest amount of room reverb to glue it to the rest of the mix. Although recorded with a chorus, I also added a stereo chorus to make it sound more ambient, which strengthened the underwater feeling.

Saxophone

The reference for the saxophone in "Love Police" was the saxophone heard in the song "Love Theme" from the soundtrack of *Blade Runner* (1982) by Vangelis, which features an extremely wet saxophone playing the melody throughout the song. The saxophone in "Love Police" is mixed quite similarly to the lead vocal. However, the simplicity of the performance allowed me to mix in more reverb and delay. The reverb pre-delay on the saxophone is the same as the vocals but is automated throughout the song to create the illusion of movement in the room. When the sax is playing the lead melody, the pre-delay is 98 ms, whereas when it is playing in the verses and chorus, the volume is turned down, and the pre-delay is turned down to 20 ms, which causes it to blend in with the wet signal, making it sound as if it is located further back in the virtual space. To give it a 1980's character, I chose a long artificial-sounding digital reverb (lasting for ca 6 seconds) and a dotted eighth delay, creating a more ambient atmosphere while still keeping the sax in the foreground. Another interesting and unusual feature of the sax is the use of the "microshift" plugin, which gives it a more opaque and synthetic character.

For an overview of the spatial design of the individual tracks of "Love Police," see figure 3.

Spatial design (Love Police)			
Instrument	**Reverb**	**Delay**	**Other**
Drums	Room reverb (49ms pre-delay). Ambience reverb Long reverb on snare	16th note delay on the snare and overheads	
Bass	Ambience reverb Room reverb (65ms pre-delay)	Slapback	

Spatial design (Love Police)			
Instrument	**Reverb**	**Delay**	**Other**
Rhodes	Room reverb (18ms pre-delay) Long reverb	Slapback and stereo delay	Stereo chorus
Synth	Room reverb 18ms pre-delay), Long reverb	Slapback delay Stereo delay	Stereo chorus and phaser
Guitar	Spring reverb Room reverb (24ms pre-delay)	Space echo	Stereo chorus
Saxophone	Ambience reverb Room reverb (98ms pre-delay) Long reverb	Stereo delay	Doubler (microshift)
Lead Vocals	Room reverb 98ms pre-delay) Long sidechain reverb	Sidechain delay	Doubler (microshift)
Backing vocals	Room reverb (32ms pre-delay Long sidechain reverb	Slapback	Doubler (microshift)

Figure 3: Overview of the spatial design of the individual tracks of "Love Police."

Discussion

Regarding the virtual space as a sonic marker of time eras, the spatial design of "Love Police" strongly alludes to the 1980s. Part of what makes the virtual space allude to the 1980s is the opaque and otherworldly character and texture of the reverbs. The reverbs used on "Love Police" are digital sounding. The reverb tails, for instance, have a lot of high-frequency information compared to real-life environments, making the reverb sound cold, opaque and surreal. Apart from the reverbs, the delayed drums are yet another allusion to the 1980s. Lastly, the chorus effect—most prominent on the Rhodes and the synth—also alludes to the 1980s. Apart from the signal processing, several aspects of the production, such as the songs' form, structure, instrumentation and arrangement, alludes to the 1980s. However, the design of the virtual space of the track substantiates this allusion.

Regarding the production ideals discussed in the previous chapter, the design of the virtual space of "Love" Police is opaque and otherworldly ("surreal"). However, rather than evoking a sense of outer space, as discussed in the previous chapter, the virtual space of "Love Police" creates a sense of being underwater, as if the band is performing inside an

underwater cathedral. The chorus effect substantiates the underwater feeling, which gives the mediation a liquid and opaque character.

The Thing That You Are

"The Thing That You Are" was written, recorded and mixed in January and February 2022. In terms of mix and production, "The Thing That Your Are" is an ode to psychedelic and progressive rock from the late 1960s and 1970s, laden with sonic markers of this era.

In contrast to "Love Police", this track was based around a pre-existing demo, and the production was more straightforward. All instruments were recorded separately, and microphone placements were meticulously chosen. For this reason, I will not dwell on the recording process.

See figure 4 for an overview of the instruments used on the track and the equipment used to process and record them.

Recording specifications (The Thing That You Are)				
Instrument	**Type**	**Microphone/DI**	**Effects**	**Amplifier/ preamp**
Drums	Kick: Ludwig Vintage 22" Snare: Mapex Daisy Cutter 14" Hi-Hatt: Zabian 14" Ride: Zabian thin crash 16"	Kick 1: D1017 Kick 2: SM57 Snare (over): SM57 Snare (bottom): SM57 Hi Hatt: SM57 Wurst: Electro-Voice RE20 Overheads: 2x SE7		
Guitars	Gibson Les Paul	Close mike: Electro-Voice RE20 Room mike: ….	Phaser (Bad Stone, Electro Harmonix) Spring Reverb, Twin Reverb, fender) Delay	Twin Reverb (fender, amplifier)
Bass	Fender Precision (Fender)	DI		EQ/Preamp (Warm Audio WA73-EQ)
Synths	Juno 106 (Roland)	DI	Chorus (Juno Chorus, Roland)	
Rhodes	E-Piano (Logic)	Midi		

Recording specifications (The Thing That You Are)				
Instrument	**Type**	**Microphone/DI**	**Effects**	**Amplifier/ preamp**
Lead vocal		Electro-Voice RE20		EQ/Preamp (Warm Audio WA73-EQ)
Backing vocal		Electro-Voice RE20		EQ/Preamp (Warm Audio WA73-EQ)

Figure 4: Recording specifications of "The Thing That You Are."

Spatial Design

I wanted to create a dense, gritty, vintage-like space for this mix. The reverb buses on this track are organised similarly to "Love Police." However, while "Love Police" used cold and digital-sounding reverbs to avoid anachronistic production artefacts, I only used emulations of reverbs and delay units typical for the late 1960s and 1970s, such as emulations of rooms, halls, plates and tape (see figure 5), which in my opinion add more warmth and colour to the sound.

Special notice has to be given to the long-lasting reverb I have used for this track. This reverb affects several instruments in the mix but is most audible on the snare. This reverb was created from scratch, stringing three space echo emulations in succession. I was inspired to try this after listening to "Creation Du Monde" by Vangelis, mentioned in chapter 2, and after learning that the modulated reverb was presumably created by stringing four tape delays in succession. I experienced a similar reverb effect by stringing three space echo emulations in succession. This emulation filters out the signal's low- and high frequencies, in which the remaining mid frequencies give the delay a dirty character. Moreover, the emulation I used has quite a lot of pitch wobble; therefore, the resulting reverb has a lot of pitch modulation, which gives it an interesting character. Similarly to the opaque spaces discussed in chapter 3, this reverb provides the mix with an otherworldly feeling.

Because there is a lot of information in the low- and low-mid frequencies on this track, I used a technique colloquially referred to as the Abbey Road reverb trick to keep it wet while at the same time preserving clarity. This simple technique was applied to the plate reverb bus, which served as my main reverb. The method involves adding an equaliser with the high pass filter set to a 12 dB/octave slope and cutting everything below 600hz. The EQ is placed ahead of the reverb not to affect the dry signal but only the signal going into the reverb. This allows you to add a lot of reverb while at the same time preserving clarity.

Although quite experimental sounding, the mix is relatively straightforward in terms of signal processing. It's mainly the drums and vocal processing that are responsible for the experimental sound. Therefore, I will not go into all the details concerning the processing of the bass, keys, synths, guitars and backing vocals. All the spatial processing can be seen in figure 6. The reverbs I have used will be referred to as ambience reverb, hall reverb, plate reverb and modulated reverb. See figure 5 for an overview of the organisation of reverbs and delay buses used for this track.

Bus setup (The Thing That You Are)			
Bus	**Type**	**Length**	**Plugin**
Bus 1 (ambience)	room	0.4 seconds	Space Designer (Logic)
Bus 2 (Short reverb)	Small hall	2 seconds	Space Designer (Logic)
Bus 3 (medium reverb)	Plate	3 seconds	Little Plate (Sound Toys)
Bus 4 (Long Reverb)	Modulated reverb (Daisy chain of three space echos)	5-6 second	Echoboy (Sound toys)

Figure 5: Overview of the processing effects used on "The Thing That You Are".

Spatial Design of Individual Tracks

I will now turn to the spatial design of the individual tracks.

Drums

The spatial design of the drums has completely transformed the drums and the track's overall feel. I used two reverbs on the drums: one ambience reverb and one reverb with a long duration (so-called long reverb). The ambience reverb is felt rather than heard and adds a slight sense of space and glue to the drums. The long reverb, however, grabs the listener's attention. It only affects the rimshots heard on every 7th beat (given that we regard the tempo as 121 bpm and not 60,5 bpm, as both tempos make sense), accentuating the groove by strengthening the halftime feel. In this sense, the reverb becomes an extension of the instrument. Although used sparsely, it transforms the spatial design of the drums. Rather than indicating distance, it indicates space. The dry kit signals that the drums are in close proximity to the listener, while the reverberated rimshots signal that the space where the

performance takes place is big. Moreover, the reverb itself has a dirty and gritty character to it. This is partly because of the unorthodox design of the reverb itself but also because the reverb is sent to the drum bus, where it gets distorted and compressed.

As well as affecting the drum's spatiality, the reverb increases the density of the entire track as the length of the reverb is adjusted to fill the space between each rimshot. Thus, the reverb never dies out and fills the empty spaces or, as Alan Moore would put it, the holes that would otherwise occur in the soundbox (Moore 2012).

Apart from reverb processing, the whole kit gets processed by a phaser. As mentioned in chapter two, a phaser is not a time-based signal processor, but I find it relevant to include it in this context due to its impact on the virtual space in the mix. Rather than affecting the spatiality of the virtual space, effects such as the phaser and the flanger affects, at least to me, our perception of the virtual space. Phaser on drums was a common production trick in psychedelic music. As mentioned in the previous chapter, psychedelic music often sought to sonically depict the disorienting feeling of LSD in musical terms, and the phaser was often used to achieve this. When the phaser is applied to the drums, it has a far more dramatic and disorienting effect than if it is applied to any other instrument. To me, it sounds as if the drums get stretched out in time and space. It tricks our senses into questioning the validity of our perception. On this particular track, the phaser is used to strengthen the transitions between the different parts.

Vocals

The vocal processing on this particular track is the most opaque and experimental of all the mediations discussed in this chapter. Vocal processing often involves attenuating unwanted frequencies and adding clarity to the vocals. However, the processing applied to this track has a different premise: rather than adding clarity, it obscures and creates distance between the singing voice and the listener. The most striking feature is that a Leslie Speaker emulation processes the voice. Invented in 1941, the Leslie Speaker was originally designed to give the Hammond Organ a church-like sound. However, in psychedelic, progressive rock and hard rock of the late 1960s and early 1970s, its field of application was expanded to include the processing of instruments such as guitars, bass and vocals (listen, for example, to "Planet Caravan by Black Sabbath and "Tomorrow Never Knows" by The Beatles). On this particular track, the rotating speakers create a sort of weird vibrato effect, giving the voice a dreamlike and liquid quality, as if the voice is emerging out of a distant dream. Although not a time-based signal processor, the Leslie Speaker greatly impacts the perceived distance of the voice. It may thus give the listener the sense that the voice is emitted from inside a small enclosed

space, which is actually true as the rotating speakers inside the Leslie Speaker, called “horn” and “drum”, are enclosed by a wooden box. Furthermore, the Leslie Speaker leaves out some of the high frequencies, making the vocals sound more distant.

The reverb processing of the vocals is quite simple. I only applied the medium reverb bus with 123ms pre-delay and an emulation of a Telray delay with a 2nd note delay. To further obscure the vocals, I added quite a lot of plate reverb. With its emphasis on the mid frequencies, the plate gave the vocals a gritty, metallic and vintage-like quality that suited the overall character of the track.

Apart from the processing mentioned above, a doubler also processes the vocal. This is perhaps the most anachronistic production choice. However, it’s mixed in quite discreetly and gives the vocals an interesting texture and character.

Backing vocals

Regarding reverberation, the backing vocals are treated similarly to the lead vocals but are not sent through the Leslie Speaker. This creates a contrast between the lead vocals and the backing vocals. I also added the long reverb to the backing vocals to make them sound more distant.

Rhodes

The Rhodes is processed by the hall reverb, the plate and the modulated reverb bus. The long reverb is the most audible and particularly affects the Rhodes as the pitch modulation gives the long-sustained notes a liquid and quivering chorus-like sound. The two other reverbs serve as glue. In addition, I added a chorus and a phaser to it.

Guitar

The guitar was recorded with a phaser, pitch-modulated delay and spring reverb. It was, therefore, already quite wet before mixing it. To glue it to the rest of the mix, I added a lot of the plate reverb and a moderate amount of the ambience reverb. As it was recorded in stereo, I widened the guitar by panning each channel to either side.

Bass

We recorded two bass guitars on this track. The first, which can be heard throughout the whole track, is mixed relatively conventional. Regarding the spatial design, I only added some of the ambience reverb to glue it to the rest of the track. The other bass guitar, however, is more interesting. It can be heard at the end of the 2nd verse (2.43–3.05 min). This bass

plays a lead melody rather than a regular bass part. The processing applied to this bass guitar is yet another tribute to the psychedelic music of the late 1960s and early 1970s. The bass, like the vocals, is also processed by an emulation of a Leslie Speaker. To avoid muddying the track with low-frequency information, I cut out everything below 200hz. I also added plate reverb and delay to it.

Lead Synth

Both the lead synth and pad synth were recorded with the Juno 106. The spatial design here is quite conventional. The lead synth is sent to the ambience reverb for glue and the plate and modulated reverb for air. The signal is also sent to a reversed delay to give it more character. The signal from the pad synth is processed similarly, with the exception of the reversed delay. Because it had some harsh frequencies, I sweetened the synth with a phaser. This also added more movement to the sound.

For an overview of the spatial design of the individual tracks of “The Thing That You Are”, see figure 6.

Spatial design (The Thing That You Are)			
Instrument	**Reverb**	**Delay**	**Other**
Drums	Ambience reverb Long reverb		Phaser (Soundtoys)
Bass	Ambience reverb		
Bass Overdub	Medium reverb Long reverb	8th note delay	Rotor Cabinet Doubler (microshift, soundtoys)
Rhodes	Short Reverb Medium reverb Long reverb		Stereo chorus Phaser
Lead Synth	Short Reverb Medium reverb Long reverb	Reversed 8th note delay	
Pad Synth	Short Reverb Medium reverb Long reverb		Phaser (Soundtoys)
Guitar	Ambience reverb Medium Reverb	8th note delay (Space Echo, Echoboy, Soundtoys)	

Spatial design (The Thing That You Are)			
Instrument	**Reverb**	**Delay**	**Other**
Lead Vocals	Medium reverb	Slapback delay 8th note delay	Leslie Speaker (Rotor Cabinet, Logic) Doubler (Microshift, Soundtoys)
Backing vocals	Medium reverb	8th note delay	Doubler (microshift)

Figure 6: Overview of the spatial design of the individual tracks of "The Thing That You Are."

Discussion

The time-based signal processing used in "The Thing That You Are" profoundly affects the overall shape of the track. The reverbs and delays on this track are perceived as warmer, more vintage, and gritty than the cold and digital sounding reverbs on "Love Police". In contrast to "Love Police", which alludes to the 1980s, the processing here alludes to psychedelic and progressive rock from the late 1960s and early 1970s. The track, in its entirety, is a homage to the music from this era. For instance, the chords in the turnaround at the end of the chorus are borrowed from the album "The Dark Side of The Moon" by Pink Floyd, where it is used on several tracks throughout the album. The track's outro alludes to "Come Together" by The Beatles. At the same time, the spatial design and processing substantiate the sonic markers established in the production. For instance, the vocal processing and performance refer to "Planet Caravan" by Black Sabbath, while the phased drums allude to "Kashmir" by Led Zeppelin.

Regarding time-based signal processing, the most significant features of this track are the drum and vocal processing. The reverb affecting rimshots transforms the groove and feel of the otherwise dry drum kit by strengthening the halftime feel, thus changing the virtual space of the track. Apart from the reverb, the phaser also alters the virtual space. Rather than affecting the virtual space's depth or width, the phaser affects the horizontal axis by sweeping up and down the frequency spectrum. The Phaser effect is also used on the guitar and the Rhodes on this track; however, due to the broad frequency spectrum of the drum kit, it has a more transformative and disorienting effect when applied to the drums.

The vocal processing creates a particular spatiality, as if the vocal is emitting from a different space than the other instruments in the mix. The intention here was to obscure the vocals by drawing attention towards the mediating technology. The result is an opaque-sounding virtual space.

Key Largo

"Key Largo" was originally written and recorded in 2018; since then, it has had many guises. This is the fourth and final version of the song. The reason it has been recorded so many times is that I was never completely satisfied with the result. Despite this, I never stopped believing in the song and that it could be arranged and produced more satisfactorily. Of the three tracks I have chosen to focus on in my artistic practice, "Key Largo" is the most complex in terms of form, arrangement and virtual spatiality.

This version of the track was recorded in two sessions. The first session was in February 2021, and the second was in august 2022. The first version in 2021 is similar to the final version, but I still felt that the track hadn't reached its full potential. In August 2022, we recorded acoustic drums and percussion in the chorus, as the former version was without either. We also re-recorded the vocals and the classical guitar. I also changed the groove of the drum machine. In the previous versions, the drum machine played a Bossa Nova groove. On the final version, it plays a basic backbeat groove. The changes were simple but transformed the feel of the track.

See figure 7 for an overview of the instruments used on the track and the equipment used to record them.

Recording specifications (Key Largo)				
Instrument	**Type**	**Microphone/DI**	**Effects**	**Amplifier/ preamp**
Acoustic Drums	Kick: Ludwig Vintage 22" Snare: Mapex Daisy Cutter 14" Hi-Hatt: Zabian 14" Ride: Zabian thin crash 16"	Kick 1: D1017 Kick 2: Sm57 Snare (top): SM57 Snare (bottom): SM57 Hi Hatt: SM57 Toms: 2x D1017 Overheads: 2x SE7		
Drum Machine	Samples of CR 78			
Maracas		AKG C214		
Woodblock	Sample			
Classical Guitar		2x SE7		
Bass	Fender Precision (Fender)	DI		EQ/Preamp (Warm Audio WA73-EQ)

Recording specifications (Key Largo)				
Instrument	**Type**	**Microphone/DI**	**Effects**	**Amplifier/ preamp**
Synth	Juno 106 (Roland)	2 x DI	Chorus (Juno Chorus, Roland)	
Electric Guitar	Fender stratocaster	SM57	Space echo delay, spring reverb	Fender Twin Reverb
Lead vocal		Electro-Voice RE20		EQ/Preamp (Warm Audio WA73-EQ)
Backing vocal		Electro-Voice RE20		EQ/Preamp (Warm Audio WA73-EQ)

Figure 7: Overview of the instruments used in "Key Largo" and the equipment used to record them.

Spatial design

The spatial design of "Key Largo" stands out from the other tracks as it is the dryest and most transparent space and is characterised by a "less is more" approach. Every aspect of the song, from arrangement to structure to virtual spatiality, is a play with sonic markers of retro-normativity. The song was initially written as a Bossa Nova song, and I wanted to pay homage to the Brazilian Bossa Nova of the early 1960s (e.g. classical guitar and percussion) and 1960s and early 1970s pop, rock and exotica (e.g. delays, percussion and drum processing) as well as using instrumentation typical of the 1980s (e.g. the characteristic CR78 drum machine and the Juno106 synth).

The reverbs on this track are organised in the same fashion as on the previous tracks. That is, one reverb is designated as the "main reverb". As on the other tracks, I used a plate. However, the reverb length is shorter, only two seconds, making it more discreet and natural sounding than on the other tracks. The ambience reverb—the short reverb—is more prominent on this track than on the others. It gives the track a tight and transparent-sounding character. Instead of using long reverbs on this track, I used delays, which resulted in a cleaner sound.

Throughout the track, the spatiality changes between transparent and opaque, by which I mean that the verse sections (if we ignore the reverberated woodblock in the transitions) are dry and intimate, corresponding to real-world environments, while the chorus is wet and dreamy. Apart from being aesthetically motivated, the changes in spatiality

throughout the track serve a narrative purpose as it follows the narrator's point of view. In the verses, the narrator sings in a third-person perspective. I staged the verses to make it sound like the band and the narrator are performing the music inside the bar in which the song's male protagonist is situated throughout the track. Apart from the spatiality, the football match heard in the solo helps to stage the music within the imagined bar as the protagonist is watching a football match throughout the verse sections.

In the chorus, the perspective changes from third-person to first-person perspective. To substantiate the shift in point of view, I staged this part to sound like the protagonist's inner thoughts. To emphasise this, the choruses, in contrast to the verses, feature surreal-sounding self-oscillating and rhythmic delays, which do not correspond to real-world environments. Apart from the changes in spatiality, changes in the composition and instrumentation also make the choruses sound dreamy and surrealistic compared to the verses. For instance, the song's key modulates from major to minor, and the drum machine is replaced by an acoustic drum kit playing a halftime groove.

Spatial Design of Individual Tracks

In this section, I will turn to the spatial design of the individual tracks.

Drums

This track uses both a drum machine and a drum kit. As previously mentioned, the drum machine—a logic software emulation of the iconic CR78—is heard in the verses. The drum kit is heard in the chorus. The drum machine and the kit are left more or less dry, which gives the track a tight and transparent feeling. Like nearly all other instruments on the track, they are only sent to the ambience reverb. The ambience reverb is transparent in the sense that it is felt rather than heard. It adds a subtle sense of space without making it sounds wet. Furthermore, it glues the drums to the rest of the track, making them sound like they emit from the same space.

There is little processing on the drum machine. The drum kit, however, is processed to sound like the classic dry and dead 1970s drums.

Classical Guitar

The classical guitar was recorded in stereo using two microphones. The idea was to widen the guitar by panning the two microphones to each side. However, the guitar ended up being mono as it sounded more retro. Moreover, it gave more body to the guitar when mixed in mono.

Regarding the spatial design, the classical guitar is sent to the ambience reverb and a designated reverb chamber. The guitar is panned slightly to the left. To balance the guitar, the reverb chamber is panned to the right.

Although the classical guitar is considered transparent compared to the electric guitar, which relies on technological mediation, I have processed it to sound like the classical guitars heard on the Bossa Nova records of the early 1960s, which were coloured by the recording equipment they were recorded with. To achieve a similar sound, I added quite a bit of distortion to the signal and set a low pass filter at 8kHz, which removed the signal's high frequencies. This made it sound warmer and more vintage sounding. I also added tape flutter, which affects the pitch. This colours the guitar and gives it an opaque character.

Percussion

There are three different percussion instruments on the track; woodblock, maracas and congas. The processing applied to the woodblock is the most interesting in this context. It is the track's most characteristic trait and becomes its signature sound. The woodblock itself is a sample. The most interesting thing about the woodblock is the delay that is applied to it. The delay is set to 8th notes and creates a new and more complex rhythmical pattern. Still, the intention is to make the delay sound like a delay and not like it's played. Thus, the delay rhythmically complements the dry signal while giving it an opaque and technologically mediated character.

Vocals

The lead vocal is more transparent than the other tracks, and the processing is straightforward. I have, for instance, avoided using sidechain reverbs and delays or any other complex reverb and delay techniques as this tend to sound more modern and opaque. Regarding the spatial design, the vocal is sent to a slapback bus, the ambience reverb bus, and the main reverb bus. In the chorus, it is also sent to a 4th note delay. The slapback, set to 99ms, is quite discreet but adds space to the vocal without spilling all over the mix and making it sound washed out. The ambience reverb gives more punch and depth to the vocal, while the main reverb creates air around it. The 4th note delay in the chorus compliments the long-sustained notes sung in this part and opens up the mix by making more space around the vocals.

The vocal is also doubled in the chorus. The double uses the same reverbs as the lead vocal but is much wetter. To keep the focus on the lead, I set a low pass filter at 8kHz. The double also strengthens the transitions from verse to chorus. Right before the beginning of the

chorus, the double is sent to a 16th note delay with a lot of feedback. This transforms the vocal space right before the chorus, giving the impression that the vocal is disappearing into the distance.

Electric Guitar

The electric guitar was recorded in mono. The guitar heard in the chorus is heavily compressed and distorted. It is also processed by a vibrato which causes it to drift in pitch. Regarding the spatial design, it is sent to the slapback, the main reverb, the ambience reverb and the 4th note delay. The combination of this processing gave the guitar a big and gritty retro sound.

The Solo guitar is processed similarly but less compressed than the chorus guitar. The most striking feature is the flutter vibrato which gives it a quirky and unstable sound.

Synth

The synth is sent to the main reverb and the ambience reverb. The character of the synth sound on this track sounded quite wet from the beginning. To keep the mix clean, I sent a moderate amount of the signal to the main and quite a lot to the ambience reverb.

For an overview of the spatial design of the individual tracks of "Key Largo," see figure 8.

Spatial design (Key Largo)			
Instrument	**Reverb**	**Delay**	**Other**
Acoustic drums	Ambience reverb		
Drum Machine	Ambience reverb		
Maracas	Ambience reverb		
Woodblock	Ambience reverb Main reverb	8th note delay (space echo, echo boy)	
Classical guitar	Ambience reverb Designated reverb (Dense room, Chroma verb)		
Bass	Ambience reverb		
Synth	Ambience reverb Main reverb		
Electric guitar	Ambience reverb Main Reverb	4th note delay (Echoboy, Soundtoys)	Vibrato (RC-20 Retro colour, XLN Audio)

Spatial design (Key Largo)			
Instrument	**Reverb**	**Delay**	**Other**
Lead Vocals	Ambience reverb Main reverb	Slapback delay (Echo Boy) 4th note delay (Echo Boy)	Doubler (microshift)
Backing/double vocals	Ambience reverb Main reverb	Slapback delay (Echo Boy) 4th note delay (Echo Boy)	Doubler (microshift)

Figure 8: Overview of the spatial design of the individual tracks of "Key Largo."

Discussion

Although time-based processing significantly impacts "Key Largo", the processing is less transformative for the overall sound than on the other tracks. Compared to the other songs, the virtual space of "Key Largo" has a more explicit narrative function. I wanted to create a sense of intimacy and realism in the verses by staging the instruments and voice inside the imagined bar where the song's protagonist is situated. Therefore, the reverbs in the verses are primarily short ambience reverbs that correspond to real-world environments. On the other hand, the chorus contrasts the dry verses creating a sense of otherworldly, unconscious and dreamy as I wanted to stage the instruments and voices inside the protagonist's mind. The result is that the spatial design becomes more opaque sounding.

Although the processing is less transformative for the overall shape of the song, certain sounds are completely transformed. For instance, the song's signature sound, the reverberated woodblock—heard in the chorus and the verse transitions—is both rhythmically and texturally transformed by a delay. The combination of reverb and delay gives it an opaque character and creates a sense of distance which serves a narrative function in the song. In an exaggerated way, the woodblock is staged as a sonic maker of the exotica genre—popular during the 1950s to mid-1960s—which often sought to sonically depict a sense of the enchanted, tropical and exotic. This brings to mind Doyle's observations regarding the reverberant steel guitars typical of Hapa Haole and Hawaiian music. A genre which often depicted Hawaii as a dreamlike and enchanted place. The songs' narratives typically ended with the American male protagonist leaving his Hawaiian lover and returning home to his everyday life (Doyle 2005). The reverberant steel guitar, which became a sonic marker of the genre, thus, signified the distant moans of the lover left behind. Similarly, in "Key Largo", the protagonist laments that his lover has left him and travelled to Key Largo. The woodblock is

heard every time the line “Key Largo” is sung, thus becoming a signifier of the distant, enchanted, exotic Key Largo.

Because of the kaleidoscopic play with sonic markers on this track, compared to the other songs, it is hard to pin it to a specific decade. For instance, The composition, harmony and form are typical of the bossa nova of the 1950s and 1960s. The percussion and classical guitar substantiate this reference. On the other hand, the iconic CR78 drum machine and Juno 106 synth allude to the 1980s. At the same time, the drums reference the dry and dead drum sounds of the 1970s. Because the spatial design is mostly transparent on this track, it does not reference any era as explicitly as the other songs. The most explicit reference here is the spatial design of the woodblock, which becomes a sonic marker of exotica of the 1950s and 1960s transmitted through a psychedelic lens.

Conclusion

The purpose of the artistic practice has been to demonstrate how time-based signal processors shape the virtual space of recordings. Through this chapter, I have shown in practical terms how time-based signal processors can affect a mix’s texture, timbre and density. As well as its narrative potential. I have also demonstrated how historically grounded reverbs, delays, norms and ideals regarding the design of the virtual space can reference past eras and substantiate the sonic markers.

In terms of the concept of opaque and transparent mediation, all mediations lean towards the opaque. Yet, the mediating technology used on the various tracks captures the listener’s attention to various degrees. Regarding the use of sonic markers, the spatial design of the tracks functions as sonic markers by substantiating and exaggerating the sonic markers established through the composition, arrangement, performance, production and choice of instruments. By this, I mean that the spatial design makes the established references more explicit.

Because the initial research question was motivated by my experience and interest in music production, it was natural for me to use artistic practice as a method. The choice of method also emerged from a desire to transfer theories and knowledge into practice. Through my artistic practice, I have acquired knowledge and experience that could not have been obtained otherwise. The artistic practice has thus been an essential counterpart to the theoretical part, as several parts of this thesis are based on reflections I have made during my artistic practice and vice versa. Moreover, when dealing with a topic that is as abstract and elusive as virtual space, I find it useful to explain and demonstrate my findings by engaging

the auditory senses of the reader of this thesis. My artistic practice is thus a way for me to share this insight.

After working on this thesis, my approach and taste regarding virtual space have changed. Not only has my artistic practice shaped the theoretical part, but the theoretical part has changed my artistic practice. I'm now more inclined towards small and transparent spaces than before this thesis. This is evident in the selection of songs I have chosen to discuss. There is a discernible trajectory where my productions get more inclined towards smaller and more transparent spaces as we progress. On "Key Largo", which I mixed in august 2022, I was careful not to overuse spatial effects. Moreover, the choice of reverbs is less opaque-sounding than"Love Police", which was recorded and mixed in march 2021. Looking back on "Love Police", I see now that I could have been more selective with the distribution of reverbs by allowing some instruments and sounds to be wet while leaving some sounds dryer.

Conclusion

Throughout this thesis, I have addressed the significance of virtual space in popular music productions. The virtual space constitutes the sonic choreography of the music and is often rendered into aesthetic effects, allowing artists to uniquely present their own sense of self. It is, therefore, vital to the overall sound of a music production, its narrative potential, and, consequently, the effect it produces on potential listeners. The purpose of this thesis has been to contribute insights into (1) how time-based processing effects, such as reverb, echo, chorus and flanger, affect our spatial understanding of the virtual space in recorded music; (2) how the norms regarding the design of the virtual space have changed over time; and (3) how these norms are used as sonic markers in contemporary music productions to reference genres and eras of the past.

To address these issues, I have approached them from different angles. In chapter 2, I began by explaining what the virtual space is and how it is understood in existing research, that is, as a three-dimensional space consisting of width (panning), height (frequency range) and depth (a textual foreground, middle ground and background). I then moved on to a technical discussion of time-based signal processors and how these are used to design the virtual space, allowing the mixer to simulate any physical space encountered in the real world, as well as otherworldly and non-natural spaces. Lastly, I provided a historical review of the evolution of virtual space in recorded music. The evolution of virtual space is also a testimony to technology's changing role in music creation; virtual spaces that were once experienced as surreal are eventually normalised. This changing perception of technology is key to understanding how virtual space can function as a sonic marker of time.

Chapter three concerned production ideals. Here I set out to discuss various ways a mediation can be staged according to different aesthetic ideals and norms regarding the design of the virtual space. Using Ragnhild Brøvig-Hanssen's terminology (Brøvig-Hanssen 2018), this part provided this thesis with another set of key concepts and theoretical frameworks. More precisely, I discussed the virtual space concerning two different production ideals, the "transparent space" and the "opaque space". In the context of opaque and defamiliarised spaces, I further discussed spaces that evoke a sense of outer space. The point here was to illustrate how certain opaque and surreal spaces get historically grounded

over time. This section was relevant to my artistic practice. Although none of the virtual spaces of my productions alluded explicitly to outer space, they draw on historically grounded opaque spaces to evoke a sense of the surreal and otherworldly (such as the underwater atmosphere in “Love Police”). Lastly, this chapter discussed Erik Askerøi’s concept of "sonic markers" (Askerøi 2013). The focus here was on how technology can be used to reference past eras. To provide some contextual background to this part, I linked this to the discussion of digital versus analogue aesthetics and the prevalence of digital appropriations of analogue technologies, which have contributed to creating an acknowledgement of analogue aesthetics. By way of example, I provided a brief analysis of the track “Feels Like We Only Go Backwards” (2012) by Tame Impala to illustrate how the virtual space can substantiate the sonic markers in a popular music production.

The final chapter, chapter 4, concerned my artistic practice. Here I analysed three of the songs I have recorded, mixed and produced over the course of this thesis. Although all tracks lean more towards the opaque, each track highlights various sonic markers of time and different aspects of the topics discussed throughout this thesis. While analysing “Love Police”, I illustrated how the design of the spatial design alludes to the norms concerning virtual spaces of the 1980s and how this substantiates the sonic markers already grounded through various aspects of the production. This is primarily owed to the sonic signatures of the cold, digital sounding reverbs, and the prominent use of chorus. In contrast to “Love Police”, “The Thing That You Are” alludes to psychedelic and progressive rock from the late 1960s and early to mid-1970s. The reverbs and delays on this track are perceived as warmer, more vintage, and gritty than the cold and digital sounding reverbs on “Love Police”. Apart from the reverbs used on this track, in terms of processing, the most distinct sonic marker here is the use of Leslie Speaker emulation on the vocal which becomes a sonic marker of the 1970s. Lastly, On “Key Largo”, I discussed how the kaleidoscopic play with references makes it hard to pin it to a specific decade. The composition, harmony and form of Key Largo are typical of the bossa nova of the 1950s and 1960s. The percussion and classical guitar substantiated this reference. On the other hand, the iconic CR78 drum machine and Juno 106 synth allude to the 1980s. At the same time, the drums reference the dry and dead drum sounds of the 1970s. Because the spatial design is mostly transparent on this track, it does not reference any era as explicitly as the other songs. The most explicit reference here is the spatial design of the woodblock, which becomes a sonic marker of exotica of the 1950s and 1960s transmitted through a psychedelic lens.

Because the initial research question was motivated by my experience and interest in music production, it was natural for me to use artistic practice as a method. The choice of method was also inspired by a desire to transfer theories and knowledge into practice and vice versa. Through my artistic practice, I have acquired knowledge and experience that could not have been obtained otherwise. The artistic practice has thus been an essential counterpart to the theoretical part, as several parts of this thesis are based on reflections I have made during my artistic practice. Moreover, my theoretical investigations have also contributed insights into my practical work. It has made me reflect on the virtual space of my productions in ways that I have not done previously or to the same extent. Furthermore, when dealing with a topic that is as abstract and elusive as virtual space, I find it useful to explain and demonstrate my theoretical discussions and findings by engaging the auditory senses of the reader of this thesis. My artistic practice is thus a way for me to share this insight.

Further Research

While this thesis focused on the impact of time-based signal processors concerning the virtual space and sonic markers of time, it would be interesting to investigate how other signal processors impact the virtual space as well. For instance, through my artistic practice, I became more aware of how other signal processors, in particular, compression, can impact the virtual space's overall texture, density and shape. And how it, regardless of relative amplitude and reverberation, also affects parameters such as depth. Furthermore, to capture the sonic signatures and inconsistencies associated with vintage recording equipment and signal processors, effects such as tape emulations, vintage compressors, equalisers, noise generators and pitch and wobble generators were equally important as the time-based signal processors in creating and substantiating the sonic markers in the productions. Thus, research investigating how other signal processors affect the virtual space can contribute further insight into the issues discussed throughout this thesis.

Moreover, I think this kind of research can benefit from qualitative interviews with plug-in designers, especially those dedicated to re-creating the sonic signatures of vintage recording equipment and signal processors. In research like this, it would be interesting to hear their thoughts concerning digital technology’s role in creating acknowledgement of the sonic signatures of vintage recording equipment and signal processors. Judging by the various blogs found on the websites of plug-in and software manufacturers such as Eventide, Izotope, Universal Audio and Ableton, musicologists concerned with music-technological

parameters would have much to benefit from the technological insight of the practitioners within these fields.

References

Bibliography

Agnello, T. (2021). *50th Flashback #5: FL 201 Instant Flanger*. Eventide. https://www.eventideaudio.com/50th-flashback-5-fl-201-instant-flanger/. [Last accessed: October 31, 2022].

Agnello, T. (2021). *50th Flashback #1: The PS 101 Instant Phaser*. Eventide. https://www.eventideaudio.com/50th-flashback-1-the-ps101-instant-phaser/. [Last accessed: October 31, 2022].

Askerøi, E. (2013). Reading Pop Production: Sonic Markers and Musical Identity. PhD. diss., University of Agder, Kristiansand.

Barlindhaug, G. (2007). Analog Sound in the Age of Digital Tools: The Failure of Digital Technology. PhD. diss., UiT Norges arktiske universitet, Tromsø.

Bennet, S. (2016). Time-Based Signal Processing and 'Shape' in Alternative Rock Recordings. *Journal of the International Association for the Study of Popular Music,* 6: 3-21.

Bennet, S. (2012). Endless Analogue: Situating Vintage Technologies in the Contemporary Recording and Production Workplace. *The Journal on the Art of Record Production,* 7, https://www.arpjournal.com/asarpwp/endless-analogue-situating-vintage-technologies-in-the-contemporary-recording-production-workplace/. [Last accessed: October 31, 2022].

Bennett, S. (2016). Behind the Magical Mystery Door: History, Mythology and the Aura of Abbey Road Studios. *Popular Music, 35*: 396-417.

Brown, G. (2020). A History of Reverb in Music Production. Ableton. https://www.izotope.com/en/learn/a-history-of-reverb-in-music-production.html. [Last accessed: October 31, 2022].

Brøvig-Hanssen, R. (2013). Music in Bits and Bits of Music: Signatures of Digital Mediation in Popular Music Recordings. PhD. diss., University of Oslo, Oslo.

Brøvig-Hanssen, R. (2013). The Magnetic Tape Recorder: Recording Aesthetics in the New Era of Schizophonia. In: *Material Culture and Electronic Sound,* edited by F. Weium and T. Boon, pp. 131–57. Smithsonian Institution Scholarly Press/Rowman and Littlefield Publishers.

Brøvig-Hanssen, R. (2018). Listening *To* or *Through* Technology: Opaque and Transparent Mediation in Popular Music. In: *Critical Approaches to the Production of Music and Sound*, edited by S. Bennett and E. Bates, pp. 195–210. Bloomsbury Academic.

Brøvig-Hanssen, R., and Danielsen, A. (2013). The Naturalised and the Surreal: Changes in the Perception of Popular Music Sound. *Organised Sound*, 18/1: 71-80.

Burd, A. 1994. Studio Acoustics. In: *Sound Recording Practice*, *4th edition,* edited by J. Borwick*,* pp. 105-123. Oxford University Press.

Danielsen, A. (1993). 'My Name is Prince': en studie i Diamonds and Pearls. MA thesis, Department of Music and Theatre, University of Oslo, Oslo.

Costello, S. (2017). Effect-O-Pedia: Reverb Types. Valhalla DSP. https://valhalladsp.com/2018/05/14/effect-o-pedia-reverb-types/. [Last accessed: October 31, 2022].

Costello, S. (n.d.). Valhalla Super Massive. Valhalla. https://valhalladsp.com/shop/reverb/valhalla-supermassive/. [Last accessed: October 31, 2022].

Doyle, P. (2005). *Echo and Reverb: Fabricating Space in Popular Music Recording 1900-1960.* Wesleyan University Press.

Dockwray, R., and Moore, A.F. (2010). Configuring the Sound-Box 1965–1972. *Popular Music, 29*: 181-197.

Eno, B. (2004). The Studio as Compositional Tool. In: *Audio Culture: Readings in Modern Music*. Edited by C. Cox and D.N. Warner, pp. 127-130. Bloomsbury Publishing.

Goodman, E. (2018). The Abbey Road Reverb Trick. Westlake Pro. https://westlakepro.com/abbey-road-reverb-trick/. [Last accessed: October 31, 2022].

Horning, S.S. (2004). Engineering the Performance. *Social Studies of Science,* 34: 703-731.

Huart, W. (2020). The Best Old School Reverb Trick? Produce Like A Pro. https://producelikeapro.com/blog/the-best-old-school-reverb-trick/. [Last accessed: October 31, 2022].

Mcleod, K. (2003). Space Oddities: Aliens, Futurism and Meaning in Popular Music. *Popular Music,* 22: 337-355.

Mason (2016). A Quick Take on Flanging. zZound. https://blog.zzounds.com/2016/08/10/a-quick-take-on-flanging/. [Last accessed: October 31, 2022].

Moore, A. F. (2001). *Rock: The Primary Text*, 2nd ed. Ashgate.

Kody, A. (2020). Understanding Chorus, Flangers, and Phasers in Audio Production. Izototope. https://www.izotope.com/en/learn/understanding-chorus-flangers-and-phasers-in-audio-production.html. [Last accessed: October 31, 2022].

Kraugerud, E. (2016). Spaces of Sound: Meanings of Spatiality in Recorded sound. Master's Thesis, University of Oslo, Oslo.

Kraguerud, E. (2020). Come Closer: Acousmatic Intimacy in Popular Music Sound. PhD. diss., University of Oslo, Oslo.

Lacasse, S. (2000). 'Listen to my Voice': the Evocative Power of Vocal Staging in Recorded Rock Music and Other Forms of Vocal Expression. PhD. diss., Liverpool University, Liverpool.

Lester, P. (2009). Sonic Cathedral Spark Shoegazing Music Revival. *The Sunday Times* (April 12). https://www.thetimes.co.uk/article/sonic-cathedral-spark-shoegazing-music-revival-2cd7s9wjwgc. [Last accessed: October 31, 2022].

Moylan, W. (2002). *The Art of Recording: Understanding and Crafting the Mix*. Focal Press.

Mäkelä, M., Nimkulrat, N., Dash, D.P., and Nsenga, F.X. (2011). On Reflecting and Making in Artistic Research. *Journal of Research Practice*, 7: 1-12.

Smalley, D. (2007). Space-Form and the Acousmatic Image. *Organised Sound,* 12: 35-58.

Shanks, W. (n.d.). From Chambers to Plate to Digital. Universal Audio. https://www.uaudio.com/blog/emt-reverb-history/. [Last accessed: October 31, 2022].

Shanks, W. (n.d.). The EMT 250 Electronic Reverberator. Universal Audio. https://www.uaudio.com/blog/emt-250-electronic-reverberator-overview/. [Last accessed: October 31, 2022].

Jonathan S. (2015). Space within Space: Artificial Reverb and the Detachable Echo. *Grey Room* , 60: 110–131.

Steve, D. (2021). *Have You Tried the Delay Reverb Trick?* Production Expert RSPE Audio Solutions. https://www.pro-tools-expert.com/ https://www.pro-tools-expert.com/production-expert-1/have-you-tried-the-delay-reverb-trick. [Last accessed: October 31, 2022].

Strymon (n.d.). Nightsky Time-Warped Reverberator. Strymon. https://www.strymon.net/product/nightsky/. [Last accessed: October 31, 2022].

Théberge, P. (1997). *Any Sound You Can Imagine: Making Music/Consuming Technology.* University Press of New England.

White, P. (2003). *Creative Recording, Part One: Effects and Processors (Second Edition)*. Sanctuary Publishing Limited.

Wiles, D. (1991). *The Masks of Menander: Sign and Meaning in Greek and Roman Performance*. Cambridge University Press.

Williams, A. (2018). Weapons of Mass Deception: The invention and Reinvention of Recording Studio Mythology. In: *Critical Approaches to the Production of Music and Sound*, edited by S. Bennett and E. Bates, pp. 157–174. Bloomsbury Academic.

Wishart, T. (1985). *On Sonic Art*. Imagineering Press.

Discography

The Beatles, 1969. “Come Together.” *Abbey Road.* Apple.

Black Sabbath, 1970. “Planet Caravan.” *Paranoid.* Vertigo.

Brian Eno, 1983. “Deep Blue Day.” *Apollo: Atmospheres and Soundtracks.* EG.

David Bowie, 1980. “Ashes to Ashes.” *Scary Monsters (And Super Creeps)*. RCA

Elvis Presley, 1954. “Blue Moon of Kentucky.” *Blue Moon Of Kentucky*. Sun.

Elvis Presley, 1955) “Baby Let’s Play House.” *Baby Let’s Play House*. Sun, 217.

Gene Austin, 1927. “My Blue Heaven.” *My Blue Heaven*. Victor, 20964.

Greatfruit, 2021. “Love Police.” *Love Police.* 9AM Records.

Greatfruit, Forthcoming. “Key Largo”. (Unreleased).

Greatfruit, Forthcoming. “The Thing That You Are”. (Unreleased).

Harmonicats, 1948. “Peg O’ My Heart.” *Peg O’ My Heart*. Vita Records.

Idris Muhammad, 1977. “Could Heaven Ever Be Like This?” *Turn This Mutha Out*. Kudu.

Les Paul, Mary Ford, 1951. "How High The Moon.” *How High The Moon*. Capitol Records.

Les Paul & Mary Ford, 1952. “Mammy’s Boogie.” *Bye Bye Blues/Mammy’s Boogie*. Capitol Records, 1041.

Led Zeppelin, 1975. “Kashmir.” *Physical Graffiti*. Swan Song.

Link Wray, 1958. “Rumble.” *Rumble*. Cadence 1347.

Lonnie Liston Smith, 1975. “Summer Nights.” *Visions of a New World*. Flying Dutchman label.

Pink Floyd, 1973. *Dark Side of The Moon*. Harvest (UK), Capitol (US).

Small Faces, 1967. “Itchycoo Park.” *Itchycoo Park*. Immediate.

Tame Impala, 2012. “Feels Like We Only Go Backwards.”*Lonerism.* Modular

Johnny “Guitar” Watson, 1954. “Space Guitar.” *Space Guitar*. Federal.

The Tornadoes, 1961 “Telstar.” *Telstar*. Decca.

Vangelis, 1974. Création du Monde.” *L'Apocalypse des animaux.* Polydor

Vangelis, 1994. *Blade Runner: Original Motion Picture Soundtrack.* East West (Europe), Atlantic (US).

Vangelis, 1994. “Love Theme.” *Blade Runner: Original Motion Picture Soundtrack.* East West (Europe), Atlantic (US).

Journey, 2022. “Separate Ways (Worlds Apart) - Bryce Miller/Alloy tracks remix”. *Separate Ways (Worlds Apart) - Bryce Miller/Alloy tracks remix.* Legacy 10cc, 1975. “I’m Not In Love.” *The Original Soundtrack*. Mercury.

Videography

David, L. 1984. *Dune.* Dino De Laurentiis Production.

The Duffer Brothers, 2016. *Stranger Things.* Monkey Massacre Production, Upside Down Pictures.

Scott, R. 1982. *Blade Runner.* Warner Bros.

Stanley K. 1968. *2001: A Space Odyssey.* Stanley Kubrick Productions.