Reducing and Removing Barriers to Spatial Audio

Applications of Capital as a Critical Framework to Promote Inclusion in Spatial Audio

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Supervisory Committee

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Abstract

The research within this thesis aims to address the question of whether barriers of capital to the field of spatial audio can be reduced or removed.

Spatial audio is the musical utilization of space, where spatialization is the salient feature of the musical work. As a field, it primarily exists within academic and art institutions. Because of this, there are numerous barriers that prohibit people from engaging with the field. These barriers include significant technical requirements, the need for education, the expense of large spatial audio systems, amongst others. These barriers mean that those who are excluded have little to no pathway to engage with the field.

This thesis explores the barriers in spatial audio through the lens of capital. Viewed as one’s level of resource, a lack of economic, social, symbolic, cultural, and physical capital can exclude many from engaging with spatial audio. The research within this thesis identifies barriers of capital that exist within the field through qualitative and quantitative survey analysis as well as literature review. The identified barriers are then addressed through practice-led and practice-based research with the creation of new spatial audio works and compositional strategies, alongside user surveys to ascertain the efficacy of the research.

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He aha te mea nui o te ao? He tangata, he tangata, he tangata.

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Oh, and thanks Johnny, ya cutie xox

Table of Contents

Table of Figures

Tables

Publications Arising from the Thesis

Book Chapters (Peer Reviewed)

Austin-Stewart, Jesse. “Do You Hear My Point? Addressing Accessibility Issues Within Spatial Audio.” *Curating Access: Global Exhibitions Creative Accommodations*, edited by Amanda Cachia, 2022 (in press).

Journal Articles (Peer Reviewed)

Austin-Stewart, Jesse, Bridget Johnson. “The Multichannel Monophonic Simulation Tool.” *Chroma*, 2022. (in press)

Conference Papers (Peer Reviewed)

Austin-Stewart, Jesse, Bridget Johnson. “Multichannel Monophonic Spatial Application.” *Australasian Computer Music Conference*, Online, 2021.

Austin-Stewart, Jesse, Bridget Johnson. “Spatial System Design as a Spatial Composition Strategy.” *46th International Computer Music Conference*, Online, 2020 (part of the 2021 proceedings).

Austin-Stewart, Jesse, Bridget Johnson. “Multiple Monophony and the Multichannel Monophonic Compositional Framework.” *Australasian Computer Music Conference*, Online, 2020.

Conference Performances (Peer Reviewed)

Austin-Stewart, Jesse. “Still Moving.” *47th International Computer Music Conference*, Limerick, Ireland, 2022 (upcoming).

Austin-Stewart, Jesse. “Still Moving.” *New York City Electroacoustic Music Festival*, 2022 (waitlisted and upcoming).

Austin-Stewart, Jesse. “miss u, RD1 – woof woof lol.” *New York City Electroacoustic Music Festival*, 2022 (upcoming).

Austin-Stewart, Jesse. “miss u, RD1 – woof woof lol.” *Australasian Computer Music Conference*, Online, 2021.

Austin-Stewart, Jesse. “lighthouse auralization.” *International Society of Contemporary Music Virtual Collaborative Series*, Online, 2021.

Austin-Stewart, Jesse, “Four Swinging Speakers.” *Tuning Into The Pandemic*, Massey University, Wellington, Aotearoa New Zealand, 2020.

Austin-Stewart, Jesse, “beyond nearsightedness.” *Australasian Computer Music Conference*, Monash University, Melbourne, Australia, 2019.

Draper, Charley, Jesse Austin-Stewart. *Critical Mass*. 2019 Prague Quadrennial of Performance Design and Space, Prague, Czech Republic, 2019.

Panels

Austin-Stewart, Jesse. *Making Music Accessible Panel*. Massey University, 2021

Performances/Installations

Austin-Stewart, Jesse, *Waterfront Monophony*. Funded by Ministry for Culture and Heritage, Wellington, Aotearoa New Zealand, 2021/22.

Austin-Stewart, Jesse, *Four Swinging Speakers*. Audio Foundation, Auckland Aotearoa New Zealand, 2020.

Austin-Stewart, Jesse, *Multiple Monophony*. The Engine Room, Wellington, Aotearoa New Zealand, 2020.

Austin-Stewart, Jesse, “lighthouse auralization,” *A excursion to Putangirua*. Putangirua Pinnacles, Pyramid Club, Cape Palliser, Aotearoa New Zealand, 2020.

1 Introduction

1.1 Barriers of Capital to Spatial Audio

Spatial audio is the musical utilization of space, where spatialization is the salient feature of the musical work. The field has various barriers that make it difficult to engage with. This thesis identifies the barriers to engaging with the field through the lens of capital (Bourdieu 1984) and seeks to reduce or remove the barriers through mixed-methods research.

Spatial audio is a field that predominantly exists within academic and art institutions. This is evidenced in literature, which focuses on works almost exclusively within these spaces. The realization of spatial audio works is through spatial systems. A spatial system is a system of sound devices (most commonly loudspeakers) where those devices are used to produce the spatiality of a work. This is achieved through appropriate positioning of the sound devices relative to the audience to achieve the desired spatialization. Many spatial systems that are used within spatial audio require a large amount of money to construct due to advanced technical requirements. The issues of cost and technical requirement illuminate areas where audiences may find it difficult to engage[1] with the field of spatial audio. This presents opportunities to both investigate further ways in which audiences find difficulty engaging with the field, and to find new ways to reduce or remove identified barriers. In this thesis, capital will be used as a framework for establishing and analyzing an audience's ability to engage with spatial audio.

The notion of capital as "accumulated labor (in its materialized form or its 'incorporated' embodied form)" (1986) was developed by Pierre Bourdieu. Capital, broadly, can be considered the level of resources one has and their ability to use and convert those resources (Bourdieu 1986; R. Moore 2013; Pinxten and Lievens 2014; Neveu 2018; Casey 2008; Cottrell 2002). In the context of this thesis, spatial audio will be analyzed through the lens of economic, social, symbolic, cultural, and physical capital. The prominent and standardised spatial systems within the literature, as well as common performance and installation contexts, will be viewed and critiqued through the lens of capital. Where there are situations which require capital to engage with spatial audio, identified barriers of capital will be sought to be reduced or removed.

[1] In this thesis, the term 'engage' will be used when referring to an audience's ability to participate in spatial audio experiences if that audience desires. Engagement will be further explored in Chapter 6, and the broad definition used widely in the thesis will be adapted based on the literature to suit a more specific context of engagement.

This research explores creative solutions to barriers within spatial audio through the development of new creative works, hardware and software design, and gamification of spatial audio. These novel contributions to the field are then analyzed through quantitative and qualitative surveys to ascertain their effectiveness at removing barriers of capital to spatial audio for audiences. The respective formats and their methodologies and effectiveness are discussed in subsequent chapters.

The conclusion of this thesis discusses the efficacy of the attempts to reduce and remove barriers to spatial audio with the intention to increase the potential engagement with the field. It identifies ways in which barriers of economic, social, symbolic, cultural, and physical capital have been removed for audiences.

This research creates novel artistic work in the field of spatial audio aiming to make the field less exclusive. It uses capital as a novel critical lens to examine the field and the creative works developed.

The results from this thesis pose some serious questions to the field. Firstly, it calls for reflection on the ways the field excludes significant amounts of people based on capital. Secondly, it asks the field to reflect on why, that when these issues of exclusion are evident, significant work is not being done to overhaul spatial audio to be more inclusive. This research serves as a critique of the institutional power that exists within spatial audio (and beyond) and as a call to arms towards dismantling it.

1.2 Document Outline

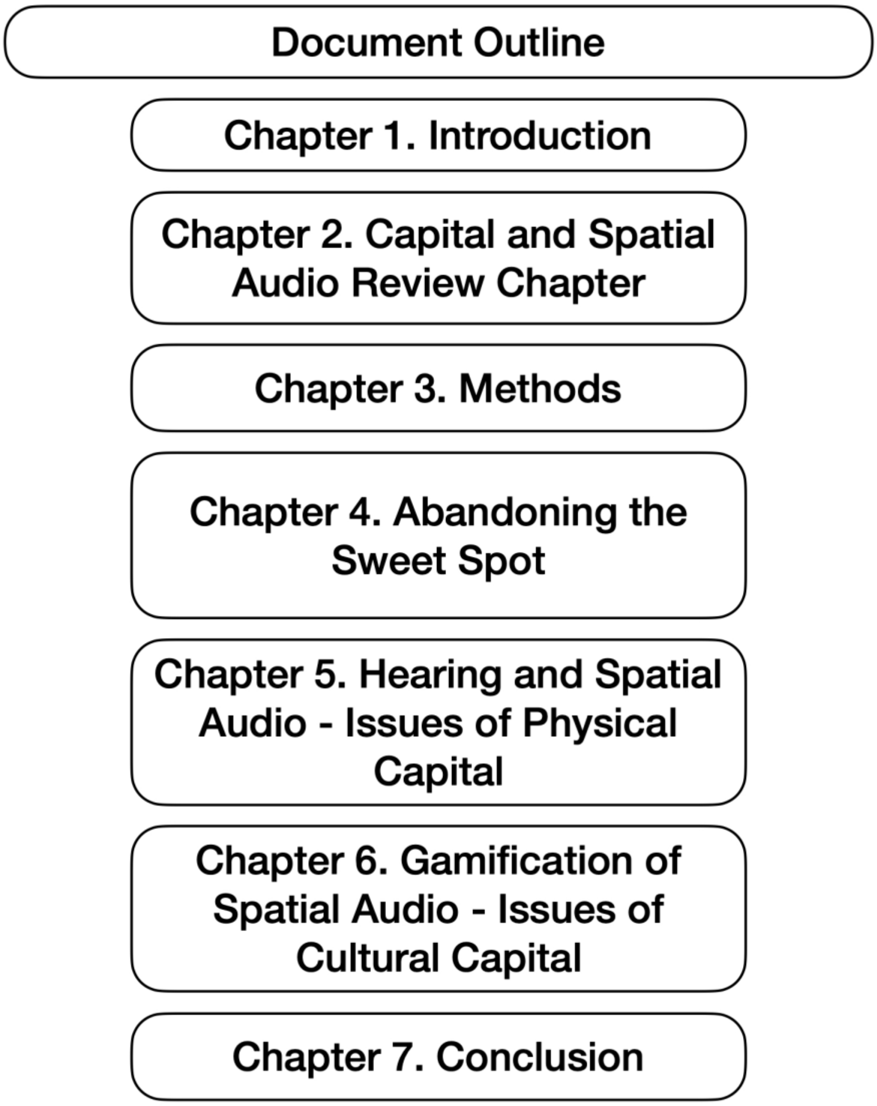

Figure 1 - Document outline

This thesis aims to answer the initial question posed above: how to reduce and remove barriers of capital to engagement with spatial audio? The outline of this document is illustrated diagrammatically in Figure 1. Following this introductory chapter, Chapter Two provides an understanding of capital, with particular attention paid to cultural capital and the way it intersects with spatial audio adjacent fields (such as music education and art). The chapter completes a review of spatial compositional strategies that exist to provide context for compositional and research decisions made later in the thesis. The chapter then reviews the variety of spatial systems that exist, analyzing them through the lens of capital established in the first half of the chapter. These findings are summarized to determine what evident and hypothesized barriers of capital there are to spatial audio.

Chapter Three looks at the various methodological techniques used when implementing the research methodology that is discussed later in this introductory chapter.

Chapter Four investigates the barriers of capital associated with the ‘sweet spot’. The sweet spot is widely considered by audiences and practitioners to be the ideal listening position, yet comes with issues of economic, social, symbolic, and physical capital. Once identified, these issues of capital are addressed through the creation the *Multichannel Monophonic Compositional Framework*. This framework seeks to dismantle the sweet spot by giving composers strategies to write works for spatial systems that don’t rely on a sweet spot. The subsequent works were reviewed by audiences and the composers themselves to determine the efficacy of the compositional framework at assisting the creation of non-sweet spot oriented spatial works in relation to sweet spot oriented works. The survey results led to the creation of further works utilizing the framework and the development of software tools to assist in the composition for non-sweet spot oriented spatial systems.

Chapter Five explores barriers of physical capital to spatial audio for audiences who are hard of hearing and d/Deaf[2]. These audiences have been historically excluded from sound art. Where some artists have addressed issues of exclusion within other sound art fields, inclusion of people with all types of hearing has not been explored within spatial audio. This chapter interviews two hard of hearing spatial audio composers to understand their experiences of exclusion within the field and the barriers of physical capital that they face. These interviews have informed the development of the new spatial compositional strategies of *imagined localization*, *static spatialization*, and *haptic spatialization*. The strategies have been used in the creation of new spatial audio works which were reviewed by the above discussed composers to determine their efficacy and whether they remove barriers of physical capital to spatial audio.

Chapter Six explores issues of cultural capital within spatial audio. Due to the lack of prominence of spatial audio outside of academic and art institutions, it was the hypothesis of the author that there is a relationship between one's cultural capital and their engagement with spatial audio. This chapter seeks to explore whether that hypothesis is evidenced, and also seeks how to increase

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[2] d/Deaf (with two d's) is a term used to represent diverse d/Deaf identities. Uppercase 'Deaf' is often used by individuals who identify as culturally Deaf and connect with the Deaf community. Lowercase deaf refers to the physical condition of having no hearing and don't identify as culturally Deaf. These lines are not always clear and individuals identify with the term they are most comfortable with regardless of their cultural Deafness. The use of d/Deaf includes both expressions of identity.

engagement to spatial audio for those with lesser relevant cultural capital if the hypothesis is accurate. To increase engagement, the decision was made to gamify spatial audio to convey the conventions of the field in a format that doesn’t require field specific knowledge to understand. A definition of and method for measuring engagement was developed based off the relevant literature. A test was devised in which survey participants (with a range of levels of relevant cultural capital) participate in a traditional spatial audio activity and a gamified spatial audio activity. The method to measure engagement is then used to determine, firstly, if there is a relationship between relevant cultural capital and spatial audio engagement, and if gamifying spatial audio increases engagement.

Chapter Seven concludes, summarizing the barriers of capital that have been addressed and the ways they have been addressed within the thesis. While the thesis provides some interesting responses to the present barriers of capital within the field, there is still much work that can be done to further remove barriers of capital from spatial audio. This chapter also provides avenues for future research within this work.

Appendix Five discusses compositional considerations of the works composed by the author. Appendix Six displays the ethics permissions and Appendix Seven displays image copyright permissions. Other appendices will be discussed when relevant throughout the thesis.

The research towards this thesis has produced a range of creative works. Documentation of these works can be found in the accompanying digital files folder. The works embody the new knowledge and novel approaches outlined in this thesis and should be viewed symbiotically with this written document. In summary the works comprise:

Chapter Four:

- *Multiple Monophony*
- *Four Swinging Speakers*
- *Multichannel Monophonic Simulation Tool*
- *24x multimono*
- *Some Swinging Speakers*
- *Waterfront Monophony*

Chapter Five:

- *Still Moving*
- *Spatial Vibrations*

1.3 Methodology

This research uses an understanding of capital to inform its methodological approach. The investigations within Chapters Four, Five, and Six all used individualized methodological approaches that are specific to the particular research context, though they all follow the same three step method.

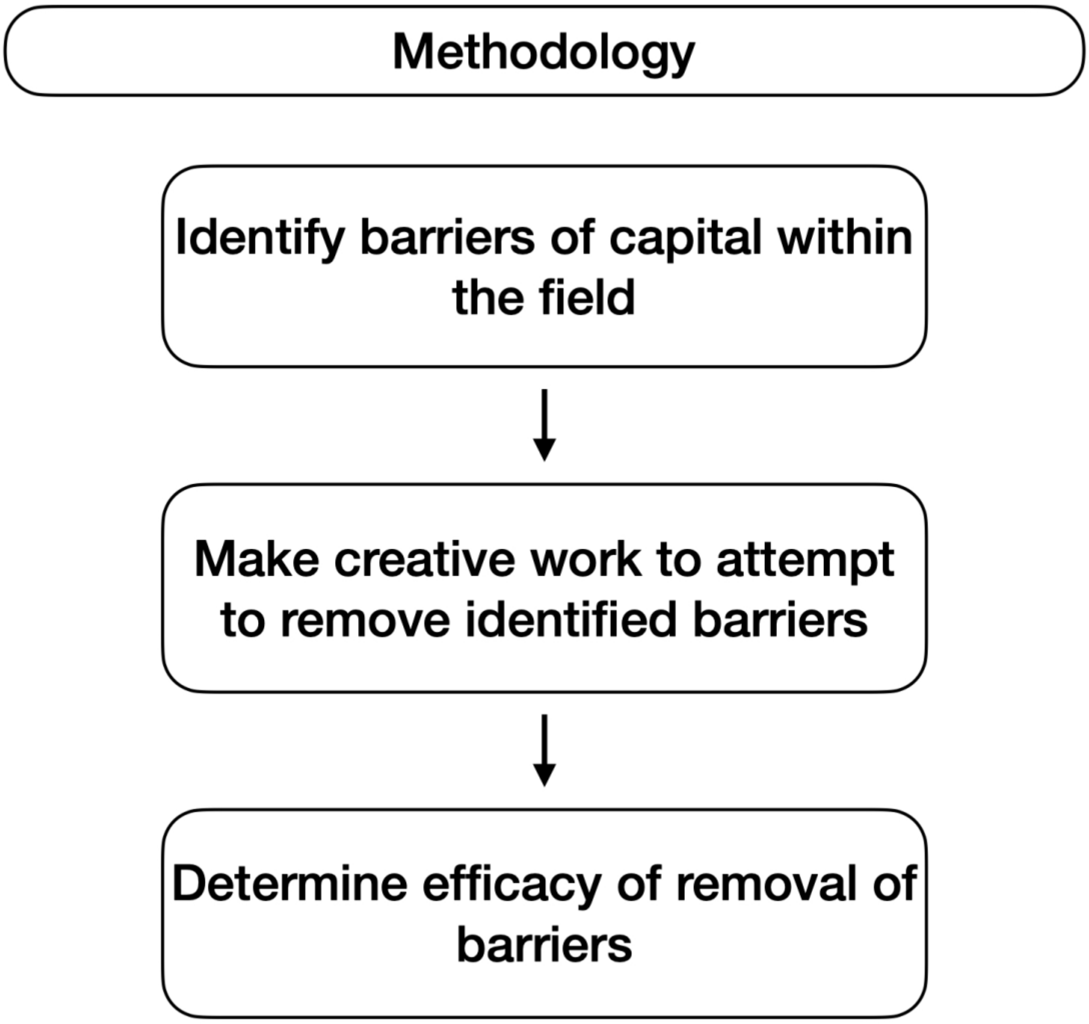

Figure 2 - Methodological workflow

Firstly, capital was used as a lens to identify barriers within the field. In some cases, barriers to the field were identified through anecdotal evidence which was then interpreted through a lens of capital. In other cases, the field was analyzed through various types of capital to identify barriers that weren't presented through anecdotal evidence. Practice-led creative work was then made in an attempt to address the barriers identified. Thirdly, qualitative and removing the barriers of capital that were identified. The various methods used are discussed in Chapter Three, and chapter-specific methodologies are discussed within the relevant chapters. In Chapter Four, after the three methodological steps were completed, further practice-based creative works were made to address remaining barriers of capital.

The research in this thesis uses capital as a lens to look at, critique, and respond to the field of spatial audio.

2 Capital and Spatial Audio Review

2.1 Introduction

This chapter reviews extant literature on capital and spatial audio while also specifying the methodological practices used within the thesis. The chapter begins with a review of capital and an introduction of the varying types of capital relevant to this research context. Sound localization is discussed to provide an understanding of how the varying spatial systems are interpreted. The field of spatial audio is then reviewed, firstly looking at relevant spatial compositional strategies, followed by particular attention placed on prominent spatial audio systems. The chapter follows this logic so that the spatial audio systems reviewed can be understood through a lens of capital that has already been established. The analysis of spatial audio systems through a lens of capital helps to establish the barriers of capital within the field that are then addressed later within this thesis. This section concludes by summarizing the associated barriers of capital with the spatial systems discussed.

For the purpose of this review chapter, it is important to note that seminal spatial audio works are not discussed unless relevant to the spatial systems being explored. This is because discussion of the aesthetic qualities of those works is not relevant to the research question. What is relevant, however, is the spatial systems that are used by these seminal works as the spatial systems and their contexts are what house the barriers of capital, as opposed to the seminal works themselves. Please see the below footnote for more discussion surrounding seminal works[3].

2.2 Capital Review

The notion of capital as “accumulated labor (in its materialized form or its ‘incorporated’ embodied form)” (Bourdieu 1986) was developed by Pierre Bourdieu. Capital, broadly, has been considered by scholars to refer to the level of resources one has and their ability to use and convert those resources (Bourdieu 1986; R. Moore 2013; Pinxten and Lievens 2014; Neveu 2018; Casey 2008; Cottrell 2002). Used broadly, capital can be used to consider a wide “system of exchanges whereby assets of different kinds are transformed or exchanged within complex networks or circuits within and across different fields” (R. Moore 2013). These resources may range from financial assets to professional relationships etc. Variations of capital have been developed by scholars such as Shilling (2004) and Cottrell (2002) to better understand power relations. The types of capital relevant to this thesis are economic capital, social

[3] While seminal spatial audio compositions are not discussed within this thesis unless relevant to the research question, the reader may wish to look to Enda Bates’ *The Composition and Performance of Spatial Music* (2009) or Maria Anna Harley’s *Space and Spatialization in Contemporary Music: History and Analysis, Ideas and Implementations* (2016).

capital, symbolic capital, cultural capital, and physical capital. The choice of these capitals to investigate spatial audio relies heavily on discussions of capital in art contexts and apparent barriers of capital related to the field.

Economic capital broadly refers to the financial resources and assets that one has, ranging from money, land, investments. Social capital is the human-networks and relationships one has. This type of capital can be used to leverage opportunities or affordances based on these relationships. Symbolic capital is where one's reputation, prestige, awards, qualifications are mobilised as a resource. Physical capital views the physical abilities of one's body as a resource. For example, depending on context, those who are more physically athletic would be considered to have more physical capital than those who aren't (Shilling 2004) [4]. These four types of capital (economic, social, symbolic, and physical) have been well discussed in literature in a large range of cultural areas, including sports, education, business, entertainment, and more (R. Moore 2013; Pinxten and Lievens 2014; Neveu 2018; Cottrell 2002; Scott 2012; Brändström 1999; Dumais 2002; Perkins 2015; Shilling 2004). In addition to these forms of capital is cultural capital. Cultural capital relates to an individual's knowledge and education, and can be strongly tied to their understanding of the

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[4] The use of 'physical' capital here differs from Bourdieu's use of 'physical' capital, where Bourdieu sees physical capital as an embodiment of cultural capital (recognising size, shape, and appearance of the body). Bourdieu fails to recognise the physical abilities one's body may have/not have, the way those abilities (one's physical capital) can be used to obtain other forms of capital (economic, cultural, social, symbolic), and the barriers that may exist due to a lack of physical capital (Shilling 2004).

arts. It is for this reason, cultural capital must be explored with more depth to understand more specifically the ways in which it relates to a spatial audio context.

2.2.1 Cultural Capital

Like with economic, social, symbolic, and physical capital, cultural capital again is understood as a resource, yet in this case is viewed broadly as the skills and education of an individual.

Bourdieu demonstrates how occupational and educational differences were closely related to both awareness and appreciation of specific music pieces (Bourdieu 1984). In order to understand these works, Bourdieu claims 'formal appreciation structures' are needed to understand particular types of music, and that these structures are shaped by cultural intermediaries such as 'conservatoires, teachers, curators, and were inextricably linked to the material distribution of wealth in society' (de Boise 2016). Bourdieu identifies the knowledge of these 'formal appreciation structures' gained through conservatoires, teachers, and curators as cultural capital.

2.2.1.1 Cultural Capital in Music

Cultural capital is resource in that it gives one more power to obtain other capitals. This is displayed in studies of music scenes and society (V. C. B. Bates 2019; Brändström 2000; Cottrell 2002; G. Moore 2012; Perkins 2015;

Wright and Davies 2010). It is explicitly demonstrated in a local Aotearoa New Zealand example where DIY musicians are seen to act as cultural entrepreneurs (Scott 2012). Scott claims that the lack of economic capital that DIY musicians or early career artists have can result in a seeking of cultural capital that may eventually result in economic capital. This use of Bourdieu's model of cultural capital has been used widely throughout music education studies (V. C. B. Bates 2019; Born and Devine 2015; Brändström 2000; Dumais 2002; Green 2012; G. Moore 2012; Perkins 2015; Wright and Davies 2010). In some cases, seeking after cultural capital may be seen as a way to accommodate those who have a high education but relatively low income as a way of increasing their symbolic capital to others (Brändström 2000; Dimaggio and Useem 1978).

2.2.1.2 Habitus

In addition to Bourdieu's development of cultural capital, his work on habitus in *Distinction* (Bourdieu 1984) has garnered much attention within sociology. Habitus can be viewed as the physical embodiment of cultural capital, where one's life experiences form the way they act and react. Our behaviours "are rooted in class-based practices and manifest in physical embodied responses toward certain cultural forms and practices" (de Boise 2016). One's habitus informs one's decisions. Bourdieu defines habitus as "the durably installed generative principle of regulated improvisations… [that produces] practices" (Bourdieu 1991). Habitus can be seen to be manifested on the sports field, where successful athletes not only understand the rules and techniques required theoretically, but also through their habitus. This knowledge is held “as much in the body as in the conscious mind” (Schirato and Webb 2002). This ‘practical knowledge’, for Bourdieu, is largely unreflexive. It is in relation to this that we must look into reflexive knowledge.

2.2.1.3 Bourdieusian Reflexivity

Reflexive knowledge and action requires one to become aware of their habitus, field, and practice and how they are situated within it. Bourdieu defines reflexivity as “an interrogation of three types of limitations—of social position, of field, and of the scholastic point of view—that are constitutive of knowledge itself” (Bourdieu and Nice 2000; Schirato and Webb 2002). To approach something with Bourdieusian reflexivity, one must question the methodologies and ways of thought, the field and the practical knowledge associated with the field, and the position one takes within the field. An example given by Schirato and Webb (2002) looks at how If an unjust penalty was awarded in a soccer match, an example of a player moving outside their habitus may seem them

> *“foregoing the penalty, deliberately kicking the ball wide of the posts, appealing to the crowd to be fair and equitable in their barracking, or admonishing the player who had dived. For Bourdieu, the habitus of the players, strongly informed by a competitive ethos, would render such behaviour unthinkable”* (Schirato and Webb 2002).

Bourdieusian reflexivity calls us to move beyond the thinking of our habitus in order to question the assumed codes[5].

The ideas of cultural capital and habitus are relevant to an understanding of music and have featured significantly in music education research. Music, as Bourdieu illustrates (Bourdieu 1984), is a powerful device for obtaining, maintaining, and illustrating cultural capital. It can be used as a way of excluding those who are deemed without the appropriate habitus, and often serves the foundation for cultural elitism and exclusion.

2.2.1.4 Music Education and Bourdieu's Ideas

Much research has been done within music education to draw links between musical education success and existing cultural and economic capital and participants' existing habitus. This research (discussed in this section) seeks to determine whether there are inequalities and inequities in music education systems that privilege individuals with large economic and cultural capital, while excluding individuals who have less.

[5] A 'code' is a knowledge framework relating to a particular field. It can include an understanding of relevant language, approaches, concepts, and aesthetic and can be informed by one's formal and informal education and social experiences and is often embodied in one's habitus (Wright 2008; Wright and Davies 2010; Dimaggio and Useem 1978)

Various studies within music education serve to reinforce the theory that music education is a way to increase one's cultural capital. Work by Brändström (2000) and Dimaggio and Useem (1978) shows how music education and/or attendance of high-class music events are often seen as ways by those with high education and low income (such as teachers) to increase their own or their children's cultural capital. In the case of Brändström's work, cultural capital is shown to be passed down generationally through the encouragement of participation and learning of music by parents who already have high cultural capital. Other work has identified that certain music education programmes (traditional tertiary music programmes where classical music is privileged) in some instances have a large class, particularly in relation to more contemporary music technology courses (Born and Devine 2015).

Research on the relationship between tertiary music students' habitus and their perceptions of their abilities has shown that those whose habitus and cultural capital adheres to the dominant ideologies (specifically within Western art music traditions) feel much more comfortable with the course content and the entrance requirements. Those with less cultural capital within the dominant ideology report feeling unaware of the expectations of the admission test and do not value the dominant course content, seeing it as unnecessarily complex and not useful (G. Moore 2012).

Within music education, observations have been made that it often serves to preserve cultural elitism, however, often through attempts to dismantle that elitism, the elitism remains but is transformed (Green 2012). This illustrates the importance of applying a Bourdieusian reflexivity to the analysis and deconstruction of the field within this research, so that attempts to address cultural capital related issues do not end up reinforcing the same issues. An example from Wales (Wright 2008) shows a teacher who, through somewhat of a Bourdieusian reflexivity, acknowledges her Western classical habitus and attempts to teach students through what she deems as a more relevant lens to them and their popular music habitus. Noble in its attempt, students critique the programme with examples of where their habitus and the programme's content don't align, much through a lack of thorough Bourdieusian reflexivity.

Broadly, it can be observed how obtaining and distributing cultural capital within music education primarily has the role of preserving the dominant ideologies (Wright and Davies 2010). The existing education systems within the institutions surveyed serve these ideologies, and in turn privilege students whose habitus' adhere to those ideologies, creating an insular and circular approach to music education and music as a whole. When aware that habitus has such an effect on students' grades (Dumais 2002), it needs to be acknowledged that habitus has a massive effect on one's ability to obtain cultural capital as well. Analysis and critique of music education, and music more broadly, must be done with a Bourdieusian reflexivity in which one attempts to be aware of those who the current system is excluding and where one seeks to construct a system more holistically inclusive. If educators are able to recognise their musical habitus, then, with 'a Bourdieusian reflexive approach it is possible to analyse musical hierarchies and injustice in music education practice so as to be able to reach out to those who most need musical empowerment' (Södermain, Burnard, and Hofvander-Trulsson 2015).

Some technology research has determined that though school students have similar levels of technology use, they have varying levels of program-specific use (North, Snyder, and Bulfin 2008). It was suggested that these program-specific skills were ultimately determined by the student's habitus. This suggests that lower gender diversity within music technology courses (among other reasons) (Born and Devine 2015) may also come down to students' habitus. It may also explain, however, why there is more class diversity within the music technologies, as it requires a habitus of program-specific technological literacy but less cultural capital in comparison to a programme (such as traditional classical music courses) that requires a person to have a high level of cultural capital (and associated habitus) where program-specific technological literacy is mostly irrelevant.

Much can be taken from the investigations into music education and technology and applied to an understanding of spatial audio as a practice and a field. To appropriately apply this understanding of capital, the surrounding context of spatial audio must be properly understood.

2.3 Sound Localization

In order to understand the spatial systems discussed within this chapter, one must first understand how sound localization occurs. Sound localization is the process of identifying where a sound is coming from (Clarkson 2008). This is informed by the difference in time between a sound entering a listener's left ear compared to their right ear, and also based off reflections within the space the listener is within. The brain analyzes the types of sound heard in order to determine what has more/less reflections, prioritising the direct sound when localizing (Blauert 1996; Lopez-Poveda 2014; Middlebrooks 2015). Depending on the type of sonic material, it can either be easier or more difficult to localize. The frequency itself affects a listener's ability to localize, with lower frequencies being more difficult to localize than higher frequencies (Hartmann 1983; Rakerd and Hartmann 1986). Additionally, more reverberant material is difficult to localize, as is material with less harmonic content (Barrett 2002; Rakerd and Hartmann 1986; Hartmann 1983; Kendall 2010). Material with a transient onset is also more simple to localize for listeners (Rakerd and Hartmann 1986).

Additional to this and discussed further in Chapter Five, those who are hard of hearing may have particular difficulty in localizing sound because of their type of hearing.

2.4 Spatial Composition Strategies Review

In discussing the conceptual gap between spatio-compositional strategies and sound spatialization technologies, Marije Baalman describes spatial composition techniques as strategies that "embody the artistic approach to the use of space, [that] are strongly related to or part of the artistic concept of the work" (Baalman 2010). This section provides a brief summation of existing spatio-compositional strategies including spatial illusion, spatial allusion, spatial movement, timbre spatialization, temporal nature of space, localization characteristics of varying types of sonic material, and loudspeaker system design and selection. This section helps to provide context for understanding compositional and research decisions throughout this thesis.

2.4.1 Spatial Illusion

Spatial illusion is described by Natasha Barrett as where "the perceived space appears real, but we are listening to an illusion in stereo or multi-channel space produced through the phantom images from two or more loudspeakers" (Barrett 2002). Barrett claims that there are three main considerations when working with a spatial illusion.

> *"(1) The nature of an enclosure can be indicated through an object sounding within the enclosure.*
>
> *(2) The size of a space can be indicated through the relation between sounding objects.*
>
> *(3) The size of a space can be indicated through the motion of sounding objects"* (Barrett 2002).

Barrett continues, claiming that the perceived space seems real through the maintaining of real 'spatial laws'. These 'laws' include the effect of sound transmission, the properties of the reverberant field, object image size and multiple object relationships, and Doppler shifts and gestural-spatial definition (Barrett 2002). Spatial illusions depend on at least one of these four aspects.

Use of spatial illusory methods allow the composer to create perceptibly immersive sonic environments. In all cases, spatial illusion relies on stereophony[6].

2.4.2 Spatial Allusion

"When space is implied without a direct illusion, or without a direct connection to the interrelated acoustic laws of objects sounding in spaces, we can begin to discuss the spatial allusion" (Barrett 2002). This requires the composer to make assumptions as to the aural interpretation, and listeners have a much more active role in regards to their spatial perception. When considering a spatial allusion, we must consider the immediate source-bond and also non real-world sounding implications (Barrett 2002).

Use of spatial allusory methods allows composers to direct listeners into perceiving a particular space, even if the sonic material or spatial system construction does not allow for the creation of a spatial illusion. This may or may not be done through the use of stereophony.

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[6] Stereophonic spatialization is the utilisation of two or more loudspeakers to create a phantom image and movement of sound through the use of phantom imaging (Ratcliff 1974; Kendall 2010). Phantom imaging is where two loudspeakers suggest a sound is between (and can move between) two loudspeakers by varying the amplitude of a sound in those loudspeakers.

2.4.3 Spatial Movement

Sound and sound objects may be moved around (a) space. This movement may cause spatial illusion to occur and will cause spatial allusion to occur, as for a sound to perceptibly move from one point to another, the listener will perceive an imagined size of the space. This is through phantom imaging which makes use of complex panning algorithms. Where spatial movement goes beyond methods of spatial allusion and illusion is through methods of diffusion and localization serialization (where sounds are moved discretely from loudspeaker to loudspeaker in a serialized motion).

Diffusion systems, such as BEAST (Wilson and Harrison 2010), Gmebaphone (Clozier 2001), and the Sonic Laboratory (Queen's University Belfast n.d.) allow composers to position sound around a space. Methods of spatialization for diffusion systems can vary from creating an immersive sonic space, where sound surrounds you, to focusing sound to very specific singular points, or even just one speaker. While there may be moments that exhibit spatial illusion and allusion, there is much that happens spatially outside of that, where listeners may not perceive to be within a particular space, or they may perceive that a particular sound is emanating from outside of that space and the illusion/allusion is broken.

Movement can also occur spatially without constructing a spatial allusion/illusion through methods of location serialization (Baalman 2010). Used by Stockhausen, Baalman suggests of how location as a serial parameter “introduce[s] a choreography of sounds” (Baalman 2010). The serialization of a sound’s temporality and location removes any existing spatial illusion.

The ability to move sound around a space allows the composer to manipulate the perceived size of the space as well as the level of spatial activity within that space. This can be done through stereophonic and monophonic spatialization[7] methods.

2.4.4 Timbre Spatialization

Robert Normandeau’s idea of timbre spatialization is a spatialization method exclusive to the acousmatic medium. In describing the performance of instrumental works, Normandeau says that “the sound and the projection source are linked together”, but with the acousmatic medium and its virtuality “the sound and the projection source are not linked” (Normandeau 2009). With the ability of loudspeakers to play any type of timbre, one can fragment sound spectra amongst a group of loudspeakers. When an acoustic instrument is played, “the entire spectrum of the instrument sounds, whereas with multichannel electroacoustic music, timbre can be redistributed over all virtual points available in the defined space” (Normandeau 2009).

[7] Unlike stereophonic spatialization methods, monophonic spatialization methods explore spatialization without creating an intentional phantom image between loudspeakers.

Timbre spatialization allows composers to spatialize a single source, by breaking it into frequency bins, allowing for alternative spatial perceptions of sound objects. This method can lend itself to both monophonic and stereophonic spatialization methods.

2.4.5 Temporal Nature of Space

Barrett points to how our memory plays a key role in our understanding of space within a work and our treatment of it. A "listener's spatial perceptions can be linked to an experience of the world outside the context of the music" (Barrett 2002). A listener's experience of space within a work may also exist upon a spatial memory that is formed within the context of the piece. "The spatial information presented over time can be unique to the context of that particular work, and therefore requires listeners to train their memory through the act of listening" (Barrett 2002). Wishart also illustrates how various spatial gestures can be combined to create a spatial form across a work (1985).

Variations in sound spatialization throughout a work allow the composer to create an effective spatial form. This method can lend itself to both monophonic and stereophonic spatialization methods.

2.4.6 Localization Characteristics of Varying Types of Sonic Material

Due to listener's perception of different sounds, varying amplitude envelopes, onsets, timbres, and/or frequency may be used to either reinforce, confirm, confuse, or make ambiguous the listener's perception of their space. Rakerd and Hartmann note that "impulsive tones were localized quite accurately… while the slow-onset tones were localized poorly as to reach the upper limit of our ability to measure the localization error" (Rakerd and Hartmann 1986). They claim that "a steady-state sound field of a sine tone does not provide useful localization in a room… [unless] it has an onset transient" (Rakerd and Hartmann 1986). This extends some of Hartmann's previous research where, through testing, concluded that "it is impossible to localize a steady low frequency sine tone in a room… [and] the localization of steady noise can be significantly degraded by increasing reverberation" (Hartmann 1983).

Barrett also says, backed up by Blauert (1996), that as "our aural perception can locate higher frequencies and texturally varying material more easily than lower frequencies and static material, the intrinsic nature of sound will play an important part in the composer's choice of material" (Barrett 2002).

The manipulation of various types of sonic material and their relationship with one another throughout a work allow the composer to further manipulate the listener's perception of space. This method can lend itself to both monophonic and stereophonic spatialization methods.

2.4.7 Loudspeaker System Design and Selection

Spatial system design can be considered the intentional construction of a loudspeaker system to achieve a musical goal. Various case studies are looked at by the author in investigating this idea, where varying loudspeaker configurations have been devised in order to achieve particular spatial goals within the context of a piece (Austin-Stewart and Johnson 2021). The peer reviewed paper argues that this construction of a spatial loudspeaker system is as much of a spatio-compositional strategy as the other strategies discussed. Similarly, the selection of a spatial system may be considered a spatio-compositional strategy also. Both points are supported by Baalman's definition of a spatio-compositional strategy to "embody the artistic approach to the use of space, [that is] strongly related to or part of the artistic concept of the work" (2010).

Considering spatial system design and selection as a spatio-compositional strategy encourages composers to more specifically consider the configurations they work with and compose for. A greater critical understanding of spatio-compositional strategies has the potential to inform broader creative outcomes by encouraging artists to expand beyond standardized systems of spatialization. This method can lend itself to both monophonic and stereophonic spatialization methods.

2.5 Spatial Systems Review

There are a wide variety of spatial systems available that allow composers/artists to explore spatial aesthetics. These systems range from comprising a single loudspeaker to systems with hundreds of loudspeakers. This review collates the most standardised spatial systems (evidenced through their prevalence within the literature), provides a description of the system and the system's history, and addresses associated barriers of capital. The barriers of capital, or lack thereof, are also reflected on in relation to the affordances and limitations of each system.

This review provides context and understanding of the variety of existing systems and associated barriers of capital of those systems so that those barriers can be further addressed within this thesis. This section is followed by a summary of the barriers of capital inherently associated with the systems, but is not exclusive of other barriers of capital potentially associated with spatial audio.

2.5.1 High Density Loudspeaker Arrays

A high-density loudspeaker array (HDLA) is a loudspeaker system comprised of numerous loudspeakers (mid-20s to hundreds of loudspeakers). They may be in a variety of configurations. The loudspeakers may be in fixed positions within a fixed system, modular within a fixed system, or moveable within a portable system. These systems may allow for many different types of spatial techniques to be used that can include spatial diffusion, high order ambisonics (HOA), and vector based amplitude panning (VBAP). Barrett breaks HDLAs up into two categories; the permanent HDLA (P-HDLA) and the loudspeaker orchestra HDLA (LO-HDLA) (Barrett 2016). This grouping allows us to understand the LO-HDLA and P-HDLA as facilitating two separate performance and compositional practices, rather than an evolutionary progression from loudspeaker orchestra to P-HDLAs.

2.5.1.1 Loudspeaker Orchestra HDLAs (LO-HDLAs)

A loudspeaker orchestra is a collection of loudspeakers used for live performance, often for diffusion of stereo works and use of non-specific approaches to spatialization [8]. The first loudspeaker orchestra was developed in 1974 by François Bayle at GRM, called the Acousmonium, with more than 80 loudspeakers (Bayle 1993). The mid-70s saw the introduction of IMEB's Gmebaphone (Clozier 2001) and Birmingham University's BEAST system was later introduced in 1982 (Wilson and Harrison 2010). These, among other systems, varied significantly from one another in terms of system specifications. The Gmebaphone initially had 22 loudspeakers and its design and configuration varied significantly over its first 25 years, with its transition into the Cybernéphone (Clozier 2001).

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[8] *Non-specific* spatialization may be described in terms of general movement of sound (close, distant, intimate etc). This is distinct from *specific* approaches to spatialization, where a sound object's positioning may be encoded within the work (such as within ambisonics). It is here that a significant distinction is found between LO-HDLAs and P-HDLAs, where P-HDLAs tend to allow for and encourage specific approaches to spatialization, while LO-HDLAs tend to allow for and encourage non-specific approaches to spatialization (Wilson and Harrison 2010).

Figure 3 - Deruty, E. (2012, January). Loudspeaker Orchestras. Sound on Sound. https://www.soundonsound.com/techniques/loudspeaker-orchestras [permissions for photo granted by copyright holder Scott Wilson]

2.5.1.2 Permanent HDLAs (P-HDLAs)

A permanent high-density loudspeaker array (P-HDLA) is a fixed loudspeaker system comprised of numerous loudspeakers "distributed evenly around the space, either in an approximate hemisphere or across the walls and ceiling to create a cuboid. In this way, a P-HDLA maximises audience area, eliminates laborious and time-consuming setup time, and accommodates most commercial and non-commercial multichannel formats (by either using the complete array or using a subgroup of loudspeakers), with the exception of stereo sound diffusion." (Barrett 2016). This is a departure from non-permanent HDLAs, such as loudspeaker orchestras, not just through the system setup and specifications, but what those specifications allow composers to achieve spatially through newer techniques such as ambisonics. Developments in high order ambisonic (HOA) decoders have allowed P-HDLAs “to depart from the limited choice of specific geometries required by traditional Ambisonics decoder conventions.” (Barrett 2016).The availability of this amount of loudspeakers allows for high detailed spatial movement and synthesis.

Along with this, P-HDLAs encourage the use of newer spatio-compositional methods (such as HOA) and recontextualization of older methods (through the development of VBAP, a three-dimensional development of two-dimensional amplitude panning (Pulkki 1997)).

2.5.1.3 HDLA Barriers of Capital

For the most part, both types of HDLA exist within academic institutions, which literature shows are spaces that exclude groups of people based on class (Dimaggio and Useem 1978). The research in this thesis hypothesizes that a lack of education in acousmatic music and spatial audio results in audiences engaging with the material written for spatial audio systems less than those with the relevant education. If this hypothesis is accurate, it would also present another barrier of cultural capital.

Additionally, if a listener is unable to sit within the sweet spot (the ideal listening position at the correct distance and angle from all loudspeakers that allows phantom imaging to occur), there is a likelihood that they may have a less compositionally intended spatial experience. While it hasn't been explored directly within the literature, there appears to be social and symbolic capital associated issues with listeners' ability to acquire a sweet spot listening position.

The expansive number of loudspeakers used in LO-HDLA and P-HDLA configurations often mean that these types of systems are inaccessible to those who do not live near where these systems are installed. If an individual is within proximity of these systems, they may also not have the required economic capital (if they have to pay to use a system), social capital (they may not have the social networks to allow them to use the system), or symbolic capital (they may not have the reputation to allow them to use the system) in order to be allowed to use the relevant HDLA.

If an individual wished to set up an HDLA themselves, the large number of loudspeakers required, the space needed, and associated technical equipment required would be a significant barrier of economic capital. To put simply, the prominence of expensive LO-HDLA and P-HDLA systems within spatial audio excludes many from this artistic field. There is quite "the possibility of a partial reversal of the democratising effects of cheap multichannel audio and computer hardware through the growth of institutionally affiliated largescale multichannel presentation and research systems… with all the issues of access and exclusivity that one associates with the early institutionally based days of electroacoustic music history" (Wilson and Harrison 2010).

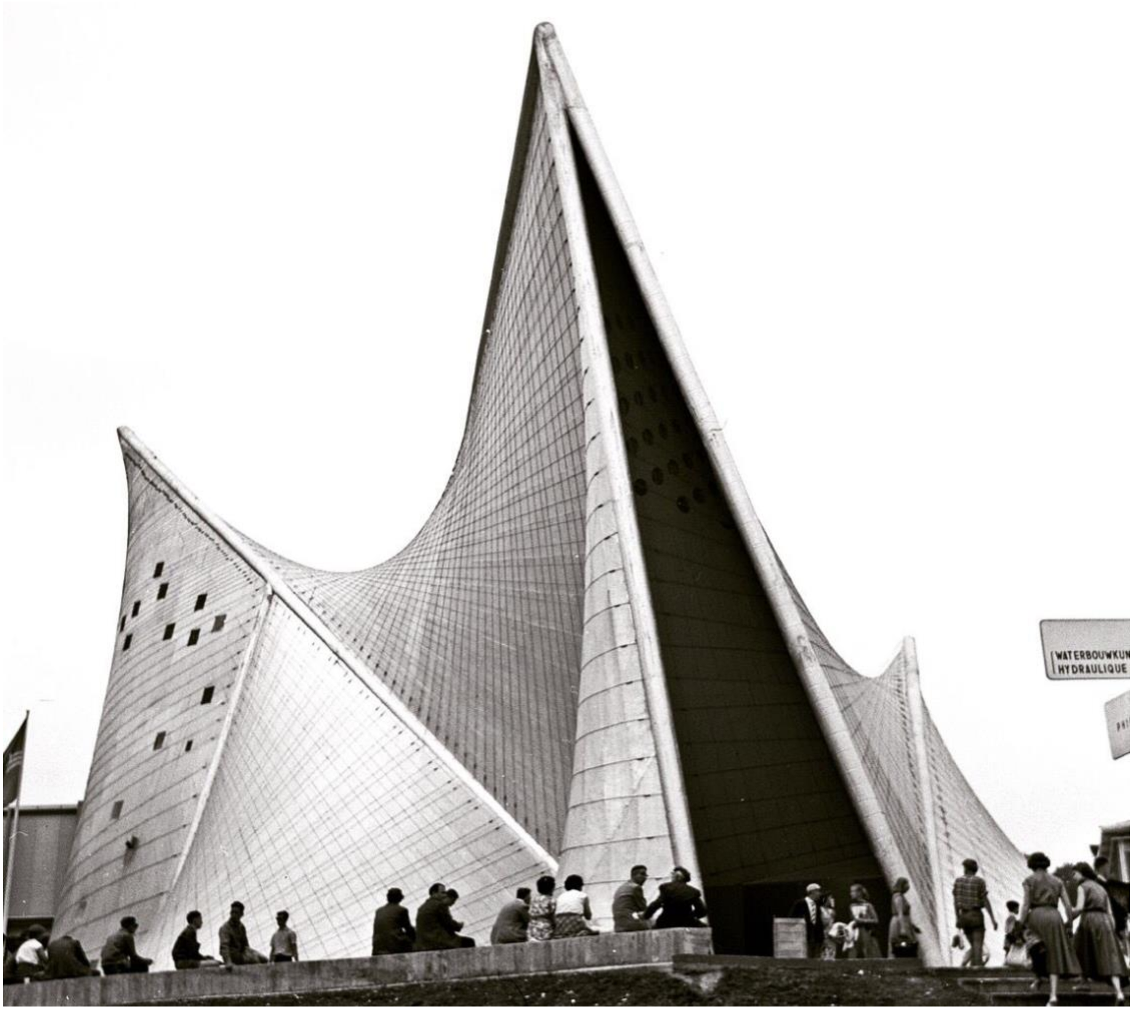

Figure 4 - The Philips Pavilion at the 1958 World Fair, housing Xenakis' 11chanel, 425 loudspeaker system. Hagens, Wouter. 1958. Philips Pavilion. https://commons.wikimedia.org/wiki/File:Expo58_building_Philips.jpg. Licensed under Creative Commons 3.0

On top of the significant economic capital required to set up a system, there are also other forms of intersecting capital needed to install an HDLA due to the significant technical requirements. There is also required cultural capital when writing music for the systems, as there is a technical understanding required to translate a desired spatialization into a realised one.

HDLAs have significant barriers of economic and cultural capital and also have minor barriers of social and symbolic capital.

2.5.2 Wave Field Synthesis

Wave field synthesis (WFS) itself is not a spatialization system, but rather a method for sound spatialization, for which systems are built specifically to explore. WFS systems typically require 100s of loudspeakers and have no sweet spot, but instead has a large listening area (Baalman 2007). This means that at no point in the listening area is the reproduction more idealised than at other points in the listening area. “As the listener moves through space, [their] perspective on the sound scene will change, just as if there were real sound sources at the virtual source positions” (Baalman 2010).

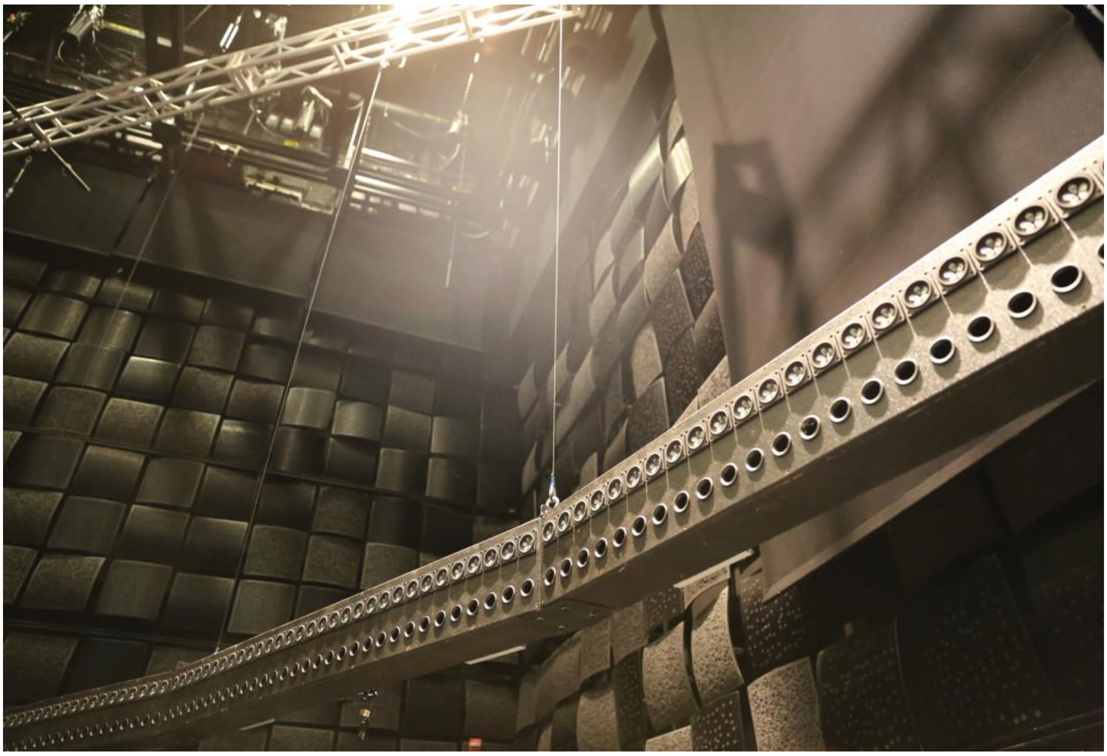

Figure 5 – High Resolution Modular Loudspeaker Array for Wave Field Synthesis installed in Studio 1—Goodman in 2016 at EMPAC, The Curtis R. Priem Experimental Media and Performing Arts Center at Rensselaer Polytechnic Institute. Photo courtesy EMPAC/Rensselaer.

A WFS system standard is not present either in terms of the physical system or the software system. This makes moving works between systems a laborious task and requires system specific knowledge, suggesting the system has barriers of cultural capital through the system's required technical knowledge. WFS systems also exist predominantly within academic and art institutions, bringing with it the same associated cultural capital related issues as with HDLAs.

The required economic capital to install a system proves prohibitive to many (Baalman 2007; Ziemer 2018), not only meaning that fewer institutions have access to a WFS system, but also because of this, that fewer public and artists have access to a WFS system as well.
The conditions of WFS systems demonstrate the systems have large barriers of economic and cultural capital. They also contain minor symbolic and social capital related issues. Unlike HDLAs, WFS systems not having a sweet spot means that audiences are not excluded from compositional intention based on their listening position. This means WFS systems will not have the hypothesised associated barriers of social and symbolic capital of the sweet spot.

2.5.3 Quadraphonic and Octophonic

Popularity of stereophonic techniques with larger loudspeaker systems grew in the 1950s. Composers such as Karlheinz Stockhausen and John Cage developed works with quadraphonic and octophonic systems with innovative techniques. Stockhausen's *Kontake* (1958-60) made use of a loudspeaker on top of a rotating table surrounded by four microphones that were recording. This allowed for retention of spatial information from capture during playback if the loudspeakers were placed in the same position as the microphones (Maconie 2005). With quadraphonic and octophonic systems, unlike 5.1, the loudspeakers are to be placed equidistant from one another. In the case of quadraphonic, the loudspeakers are to be placed at 90° of separation from one another in a square shape. At this angle, the phantom image between loudspeakers is extremely fragile and can break down (Theile and Plenge 1977). With a circular horizontal octophonic system, the loudspeakers are to be placed with 45° of separation from one another. Two common variations of this system are the octophonic point and octophonic flat systems where the first loudspeaker is either oriented at 0° or at 22.5°. Works for both quadraphonic and octophonic systems increased in frequency from the 1960s onwards.

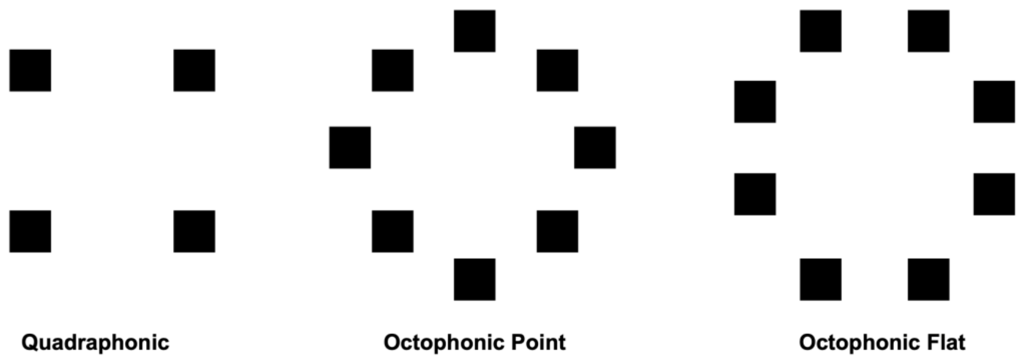

Figure 6 - Comparison of quadraphonic and various octophonic loudspeakers configurations

Quadraphonic systems in particular grew in popularity with the release of 4-channel rock albums in the 1970s, by artists such as Aerosmith, Black Sabbath, Chicago and many more (groonrikk n.d.).

Octophony, with its ability to create convincing phantom images all around the listener, can provide a 360° two-dimensional spatial image. Its versatility for decoding B-Format for ambisonics and use of stereophonic pair-wise amplitude panning methods, while remaining the smallest sized setup for creating a convincing surround image, has assisted its popularity, leading some to describe octophonic as the new stereo (Wilson and Harrison 2010). Tools for decoding and composing for octophonic arrays have become readily available with free tools such as the Ambisonic Tool Kit (ATK). While this is all the case, standardisation is still an issue with octophonic arrays. Prominence of the octophonic flat (the 'French' eight channel array) and the octophonic point (the 'American' double diamond system) vary between systems creating difficulty in moving pieces from one system to another if a piece isn't in B-Format. Even loudspeaker order is an issue, with multiple varying loudspeaker orders. This creates an issue where artists have to know in advance what the system they are working with is compared to a system such as stereo where it is universally standardised.

Like with HDLAs, quadraphonic and octophonic systems are most commonly found in academic and art institutions so also contain barriers of cultural capital, as well as the barriers of social and symbolic capital associated with the institutions. While significantly cheaper than HDLA systems, these systems still have barriers of economic capital relative to systems such as stereo loudspeakers/headphones and 5.1, however, they offer much more spatial possibilities than those systems. Octophonic and quadraphonic (like HDLA systems) also rely on the use of a sweet spot which may have barriers of social and symbolic capital associated.

Octophonic and quadraphonic systems contain barriers of economic and cultural capital, though these barriers are smaller than the same barriers of capital for HDLA and WFS systems. This comes at the expense of spatial possibilities, where octophonic and quadraphonic systems allow for less spatial opportunities than the larger systems.

2.5.4 Spatial Sound in Film

The pairing of spatialised sound to film has helped enhance the realism and immersion of multimedia film experience. Developments in film sound have seen the introduction of various systems, most prominently 5.1 and object-based systems.

With digital sound the established norm by the 2000s and the introduction of the DVD format, 5.1 became standardized within cinema and home viewing (Kafity 2004; Kerrins 2011). The introduction of Dolby Atmos, and other object based audio systems were a departure from channel based systems[9] such as stereo and 5.1.

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[9] Channel based systems are loudspeaker systems that send sound discretely to specified channels. The channels audio is sent to are not varied from system to system, regardless of loudspeaker positioning. Object based systems place and pan sound objects in software within

5.1. is widely available at a low price to consumers in a ‘plug and play’ format requiring minimal knowledge for setup. For home use, 5.1 requires relatively low economic capital for a cheap system such as Logitech’s Z607 5.1 system (“Logitech Z607 5.1 Surround Sound Speaker System with Bluetooth” n.d.). While the cost of a film ticket requires relatively low economic capital, larger channel based systems and object based systems still require a large amount of economic capital to setup.

With the association with cinema, spatial audio for film does not have the associated barriers of cultural capital that come with HDLA, WFS, and octophonic and quadraphonic systems, as spatial audio systems for film are not associated with academic and art institutions. While its association with cinema removes barriers of cultural capital, it presents a listening situation where the audio, particularly the spatiality, is not the salient feature of the experience.

With cinema spatial audio systems’ reliance on the sweet spot, there may also be social and symbolic capital associated issues with listener’s acquiring a sweet spot listening position. There may also be issues of economic capital at play here, with sweet spot position tickets costing more money at some cinemas.

Relative to the other systems explored so far within this chapter, spatial audio systems for film require relatively low economic capital to engage with unless an

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a virtual space. This is then encoded to metadata, which is decoded to whatever loudspeaker system the cinema has.

individual wants to set up their own system. There are also still the presumed social and symbolic capital issues associated with the sweet spot and works for the format that don't prioritize spatiality.

2.5.5 Stereo (Headphones and Loudspeaker)

In terms of system construction, stereo can be thought of in terms of a loudspeaker setup or a headphone system. While all works that can be played on one system can be played on the other, there are different perceptual effects that occur (or don't occur) due to which system you are listening to based on the positioning of the sound sources. Technologies such as head-related transfer function (HRTF) and binaural recording work effectively with a headphone system, as HRTF and binaural recording either work with audio captured at the same position as a listener's ears or synthesize audio so it appears to have been captured at the same position as a listener's ears. This results in a listening experience that is either similar or that simulates a real world listening experience when played back through headphones, as the sound source (the headphones) is placed at the point of capture. Playback through loudspeakers, however, would result in a breakdown of the spatial illusion, and, as a result, a less convincing spatial render. Similarly, in the case of binaural beats, headphones are able to deliver differing frequencies to separate ears with complete acoustic isolation from one another, causing the listener to perceive a third tone depending on the original tones' frequencies in relation to one another. Again, this would be unable to be achieve through stereo loudspeaker playback. Due to the acoustic isolation, a listener's experience will also not be altered by the space that they are listening in as it would if they were listening over loudspeakers.

The personal computing boom in the 2000s (with the increase in ownership of laptops and the development of smartphones, the rise of formats such as MP3, and distribution methods of audio such as iTunes and online pirating) meant that stereo audio was even more accessible wherever and whenever. Increased download speeds and storage on personal devices and the rise of prominence of streaming services in the 2010s has allowed almost instant and mostly free access to almost any stereo recording that a listener wants to hear, providing the copyright owner wishes to provide it.

While the spatial possibilities of stereo headphones and loudspeakers are limited, there are substantially less barriers of economic and cultural capital relative to the other systems discussed. As with the other systems with a sweet spot, if listeners are unable to obtain a sweet spot position when listening to a stereo loudspeaker system, they may not be able to hear the spatial intentions of a piece. Like with other systems, there may be social and symbolic capital associated issues with listeners acquiring a sweet spot listening position. While headphones allow listeners to always obtain a sweet spot position, they do require the listening experience is a solitary one.

The use of stereo headphones and loudspeakers reduces the required economic and cultural capital to engage with the system. While this is the case, the spatial opportunities of both systems are incredibly limited relative to the other systems discussed. If listening with a group of people, there is also the potential to have a less compositionally intended spatial experience based on listening position due to issues of social and symbolic capital.

2.5.6 Novel Systems

Novel systems are spatial systems where the system has been designed or created for a particular work or it is a non-standardised system that has been created or devised by a composer/engineer. This category has little literature on it and the literature that there is surrounding novel spatial systems is about individual systems. The access to novel spatial systems is heavily dependent on what the system is. If the system relies on a pair of loudspeakers and the listener can devise the system themselves, then barriers of economic and cultural capital would be relatively low. If it is a system such as Bridget Johnson's *speaker.motion* (Johnson 2015), if one wished to build a similar

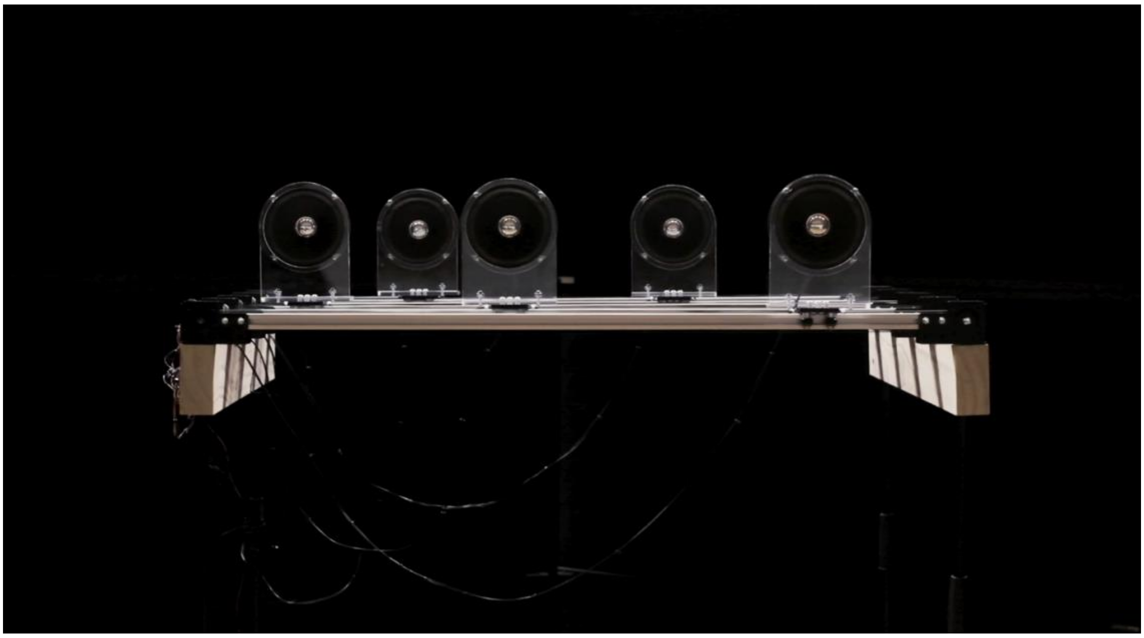

Figure 7 - 5 Moving Speakers, a novel spatial loudspeaker system by the author

system then there would be significant barriers of economic and cultural capital. Additionally, if a listener or composer wanted to use or listen to the system, then there may also be social and symbolic capital related barriers. Other examples of novel systems are Bernhard Leitner's *Gallery of Mirrors* (Leitner 2003), the system used by Janet Cardiff for *Forty Part Motet* (Cardiff 2001) and the author's *5 Moving Speakers* (Austin-Stewart 2018). A commonality between these systems is that they are all systems designed for installation, rather than concert performance. This departs from many of the systems discussed above. Novel system design is not a stranger to an installation context, unlike many of the other discussed systems.

The barriers of capital with novel systems vary significantly from system to system, however their novelty inherently makes the range of people who can experience them quite limited, mostly due to factors of economic capital (because the systems may have significant costs to build) and cultural capital (because the systems may require significant technical knowledge to build).

2.6 Summary of Systems and their Barriers of Capital

Throughout the system review section of this chapter, it was made clear that there are significant barriers of economic capital across all systems that afford users and listeners a large amount of spatial opportunities. Only when those spatial opportunities decrease do the barriers of economic capital decrease also. The only systems to the contrary of this are the object based film sound systems, such as Dolby Atmos, where they do not require much economic capital to engage with as a listener, though this comes at the expense of spatial interest (where visuals and other sonic aspects are prioritised over spatiality).

There is a similar trend with barriers of cultural capital also. The larger more spatially opportunistic systems predominantly exist within academic and art institutions, excluding people both based on their level of cultural capital (as the more educated you are, the more comfortable you are likely to be within those spaces (Dimaggio and Useem 1978)) and their social capital (those who aren't engaged in those spaces may not have the social networks to feel comfortable engaging with those spaces). Additionally, the author also hypothesized that a lack of education in acousmatic music and spatial audio will result in audiences engaging with the material written for systems in institutions less than those with the relevant education. If this hypothesis is accurate, it would also present another barrier of cultural capital (this hypothesis is investigated in Chapter Five and is suggested to be correct).

The sweet spot listening position also presented potential issues of social and symbolic capital. All systems discussed (expect WFS, which requires a large amount of economic and cultural capital to engage with, and headphones, which affords limited spatial opportunities) rely on a sweet spot listening position, and with only a handful of people able to take a sweet spot listening position, some will be excluded from the intended spatialization of the work. There is potential that a listener may be able to leverage their social networks and reputation (social and symbolic capital) to gain this listening position. Conversely, a listener may feel as if they do not have the social networks or reputation (social and symbolic capital) to take one of those listening positions from someone else. This hypothesis has been explored within Chapter Four which has led to the exploration of non-sweet spot oriented spatial systems that requires less economic and/or cultural capital to engage with than WFS, but offers more spatial opportunities than headphones.

The limited nature of the larger, more complex spatial systems (HDLAs, WFS, octophonic and quadraphonic arrays) means that the listening and compositional use of these systems is also limited. To receive preferential access to these systems, individuals may have to leverage economic, social, or symbolic capital.

Though not discussed within the system review, it is also important to mention barriers of physical capital. The ability to accurately localize sound requires equal spectral and amplitudinal hearing in both ears. Listeners and/or composers who are hard of hearing or d/Deaf (who have less physical capital in the context of spatial audio) will therefore be excluded from all the discussed systems, as their lower level of contextual physical capital relative to hearing individuals means they may not be able to experience the intended spatialization of a work. These issues have not been explored within the spatial audio literature.

Electronic art music does little to critique the exclusionary spatial systems, but rather celebrates them through publication and concerts. Attempts to include people, such as Cube Fest being “open to the widest range of aesthetic possibilities" ("Cube Fest 2020" n.d.), guises as inclusion but maintains the status quo, lacking Bourdieusian reflexivity. To attempt to break down barriers of capital within spatial audio cannot mean maintaining the status quo while breaking down small or faux barriers. It means that there must be a radical cultural shift in the way spatial audio systems, spatial audio experiences, and spatialization are thought about so that people are not continually excluded from the field.

3 Methods

In investigating the connection between capital and spatial audio, the range of methodological tools used within this research must be addressed. The mixed-methodology of this thesis is comprised of a variety of approaches discussed in this chapter.

3.1 Practice-Led and Practice-Based Methods

Practice-based and practice-led research recognizes that the creation and embodiment of new knowledge is not limited to traditional written scholarly conventions. Practice-led research is where the “main focus of the research is to advance knowledge about practice, or to advance knowledge within practice” (Candy, n.d.). Practice-led research often falls into the area of action research. In the case of this thesis, this is used when creative works are developed for the purpose of answering a research question. This has been exhibited when enquiring how to remove barriers of capital. Hypotheses have been created that varying creative methods will help to remove barriers of capital. The creative works have then been made and surveys were completed to determine the work’s efficacy at removing the barrier of capital to spatial audio. Practice-based research methodologies are also used throughout this thesis. Practice-based research…

> *"is an original investigation undertaken in order to gain new knowledge partly by means of practice and the outcomes of that practice. … Claims of originality and contribution to knowledge may be demonstrated through creative outcomes in the form of designs, music, digital media, performances and exhibitions. Whilst the significance and context of the claims are described in words, a full understanding can only be obtained with direct reference to the outcomes"* (Candy, n.d.).

In some cases, within this thesis, practice-based research is created in response to the results of some practice-led research.

The practice that underpins this research includes composition, sound design, curation, commissioning, installation, performance art, and interface design. Chapter Four demonstrates all of the described practices. Chapter Five uses composition, sound design, and interface design, while Chapter Six illustrates use of sound design practice.

Based broadly upon practice-centered research methods, this thesis also draws on a range of other research methods to inform the iterative creative methodology that underpins all works featured. The rest of this section discusses the range of research tools used within this thesis.

3.2 Survey Methods

Chapters Four, Five, and Six use a variety of survey methods. Surveys have been used throughout this thesis to determine the efficacy of various attempts to remove barriers of capital from spatial audio. These surveys have employed both quantitative and qualitative questioning.

Regarding quantitative questioning, Likert-type response scales have been used regularly throughout the surveys within this thesis. Chapters Four and Six use Likert-type response scales. Participants were given a question with five different responses along a spectrum.

> *"Likert-type responses can be thought of as ordered, but since the distance between each response choice is not necessarily constant or well-defined, Likert-type responses reflect ordinal rather than interval data. This data format makes the application of parametric statistical methods inappropriate"* (Batterton and Hale 2017).

Use of Likert-type responses allows for the use of non-parametric methods such as the mode and median (O'Neill 2017; Batterton and Hale 2017; Willits, Theodori, and Luloff 2016) which have been used in this thesis within survey analysis to ascertain the average response to questions.

When qualitative questioning has been used, responses have been through a single or double-cycle coding process depending on the context, using deductive and inductive coding. Chapters Four and Six use coding processes. Inductive coding is where the data is analyzed and codes are developed based off of themes that emerge within responses. Deductive coding is where the data is analyzed looking for pre-determined themes that emerge from the responses. Within this thesis, deductive coding has been used within single-cycle coding when specific themes were being looked for within participants’ responses. A combination of inductive coding and deductive coding has also been used in a double-cycle coding process where the first cycle was inductive (identifying the relevant themes) and the second cycle was deductive (searching responses for the relevant themes that emerged within the first cycle). The use of coding in this research context allows for the quantifying of qualitative data. This coding methodology has been informed by relevant literature (Saldana 2021; V. Elliott 2018; Auerbach and Silverstein 2003; Linneberg and Korsgaard 2019).

3.3 Open and Close Ended Questions

Chapters Four, Five, and Six draw on open and close-ended questions. Within the surveys completed by participants and the interviews conducted with participants, open-ended and close-ended question techniques were used. Many of the survey and interview questions used within this thesis have the purpose of determining the efficacy of new creative works or systems in removing or reducing barriers of capital to spatial audio. Utilizing open-ended questions acts to remove bias from suggesting responses to individuals. The questions within this research required responses in the form of a written or oral response. In some cases, close-ended questions were used to confirm information about participants to determine whether their responses were relevant to the research methodology. Open-ended and close-ended interviewing techniques are used in a wide variety of research areas, including but not limited to science, politics, public services, and humanities and social sciences. The contextual usage of open-ended and close-ended questions were informed by relevant literature (Farrell 2016; Hammer and Wildavsky 1993; Friborg and Rosenvinge 2013; Baburajan, Abreu e Silva, and Pereira 2021; Reja et al. 2003).

3.4 Usage of Terminology

While gathering data towards informing my works, the term ‘interesting’ has been used to gauge and report on participant engagement. The use of this term – as opposed to disciplinary specific conventions and/or terminology - allows for a blunt yet broad comparison between newly developed works and other spatial audio works without falling into discussions about the relationship between affect and value (which is worthy of further exploration, but conceptually lies outside of the practical scope of this thesis).

Specifically, in the context of surveys which ask respondents to report their engagement, it is useful to determine if works maintain ‘interest’ without specifying either the value-based codes of spatial audio, which may or may not be challenged through my work, or their affective response to the work (see Elliott, 2000; Hesmondhalgh, 2013; Higgins, 2011; Trehub et al., 2010).

In terms of the former, coded presumptions about quality - of ‘good’ or ‘bad’, ‘successful or ‘unsuccessful’ - are well understood to be based on entrenched tradition, and conventions (Cook 2000; Frith 2004) and as this thesis attempts to uproot the surrounding value-system based context of spatial audio, there are advantages to avoiding measurements of value or quality. In terms of the latter pitfall, the author is not seeking to measure affective responses, and so participants are not asked to report how works make them *feel* (see Elliott, 2000; Hesmondhalgh, 2013; Higgins, 2011; Trehub et al., 2010).

Somewhat more free of disciplinary baggage, the openly subjective nature of term ‘interesting’, renders it suitable for my purpose, which is to provide a broad measurement of engagement while avoiding disciplinary pitfalls. Pragmatically speaking, as a form of measurement, it also sits on a continuum with ‘disinterest’ as its opposite, making it useful for survey reporting such as Likert scales. In acknowledging the subjectivity of this term, participants are often followed up in qualitative interviews, where they can elaborate on what interest means for them in that specific context.

3.5 Curatorial Methods

Within Chapter Four, various curatorial methodologies have been used. Curatorial practices vary with curators deciding to address various aesthetic, historical, and social issues within their work. Within curatorial practices, curators develop individual methodologies that aid in addressing the relevant issues. Amanda Cachia has established a new creative methodology around curating disability and access (2014). Lori Beck has developed a curatorial methodology that has the intention of building community systems that sustain artistic practice (2008). In *Between Zones, Spaces and Sites: A Methodology of Curating*, Rosemary Donegan develops a methodology that is reflexive of her artistic and curatorial practice (1996). Michelle McGeough (2021) demonstrates incorporation of indigenous curatorial methods in practice, and deMontigny (2018) and Reilly (2018) discuss situations where particular curatorial methodologies have been used to attempt to remove institutional barriers for marginalized identities. These examples demonstrate that various curatorial methodologies can be developed to suit particular contexts. Various individual curatorial methodologies can be seen in instances of sound art practice as well (Søndergaard 2015; Burzynska 2018; Dunn 2018; Belford 2021; van Eyk 2018). The various examples of researchers developing individual curatorial methodologies to suit their research aim, as well as similar curatorial methods being developed within sound art, provides impetus to develop a unique curatorial practice within the research of this thesis. Curation, within this thesis, primarily explores the commissioning of artists to write works for new systems. The curation methodology has been implemented in a manner that best suits the objectives of the research aims.

3.6 Author Observations and Perspectives

There are various points across Chapters Four, Five, and Six where the author's observations inform decision making. In some cases, these observations have informed research direction. Where this is the case, interviews with open-ended questions have been completed to confirm that it is not just an observation of the author, but also one of people within the field. In the case of the thesis, these observations are presented as observations of interviewees and not of the author. In other cases, observations inform the methodology. This is where the author has drawn on their experience within the field, the research completed within the thesis, and the relevant literature to make informed decisions about possible directions for the research. While these observations are not articulated within the thesis and chapter methodologies, it is important to note their impact on research direction.

To understand the perspective from which this thesis is written and the observations made, it is important to understand the context from which the author comes come. Their artistic practice spans songwriting, music production, installation art, performance art, composition, music technology, and interface design. They have a bachelors and honours degree in Sonic Arts from an institution that is deeply rooted in the acousmatic tradition and continues to uphold that tradition.

3.7 Limitations

Limitations specific to each work are addressed in the chapters accordingly. There are various limitations within the research methodology. Firstly, the scope of the research often does not allow for repeat experiments. Because of the breadth of the research, ways to remove barriers of capital from the field have been looked at in a variety of areas. This means there is room for future research repeating and expanding upon the tests of new strategies and ideas developed within this thesis

Secondly, there is room for further experiments with larger sample sizes. Various factors including COVID-19, budget, and geography limited the amount of participants that could be involved as survey respondents and interviewees. This presents an opportunity for future research where the same investigations are tested and larger sample sizes are employed.

This research sees the development of new strategies and approaches to the removal and reduction of barriers of capital to spatial audio. The results of this thesis suggest many of these strategies may be successful in their aim. This research, however, does not explore the ways in which these strategies may be implemented within the field in a way that promotes a cultural change. There is room for further research and activism to promote the utilization of these newly developed strategies to make spatial audio more inclusive.

The limitations and opportunities for future research are discussed in each respective chapter.

3.8 Chapter Methodology Summary

Individual mixed-methodologies have been used within each chapter. Chapter Four uses a combination of practice-led and practice-based methodologies, surveys, interviews (from written and oral responses), and curation. Surveys within this chapter have used Likert-type questions and the interviews and surveys have been coded to observe themes. Chapter Five uses practice-led methodologies as well as interviewing with oral responses. Chapter Six uses surveys (from written responses) which use Likert-type questions and open-ended and close-ended questioning. Qualitative responses within surveys have been coded with single and double cycle coding depending on the context, and have been coded inductively and deductively depending on the context. These methodologies are further discussed within their respective chapters.

4 The Sweet Spot – Addressing the Associated Issues of Capital

There are barriers of capital related to the sweet spot listening position that exclude people from engaging with spatial audio. These barriers of capital were examined through the experiences of various composers that helped identify the need to explore whether the sweet spot can be abandoned. The idea of abandoning the sweet spot was investigated through developing new compositional frameworks, practice-led research, and quantitative surveys examining audience responses to the creative works developed. Based on this research, further practice-based creative work has been completed with the purpose of removing further barriers of capital. Through this research, it is hoped that by abandoning the sweet spot, barriers of capital to spatial audio can be removed to allow for increased engagement with the field.

4.1 Background

The 'sweet spot' is an area that is seen as the most desired listening position. This position is equidistant from all loudspeakers and allows for the correct angle between the listener and loudspeaker for phantom imaging to occur[10]. Phantom imaging is the auditory illusion of a sound appearing between two loudspeakers. By varying the amplitude of sound in the loudspeakers, one can manipulate the listener's perception of where that sound sits. It is upon this illusion that stereophony is built.

The use of stereophony can allow for complex spatializations, particularly when used in conjunction with large spatial audio systems. If the listener is outside of the sweet spot, however, then this auditory illusion can become broken, with the angle between listener and loudspeakers potentially being greater than will

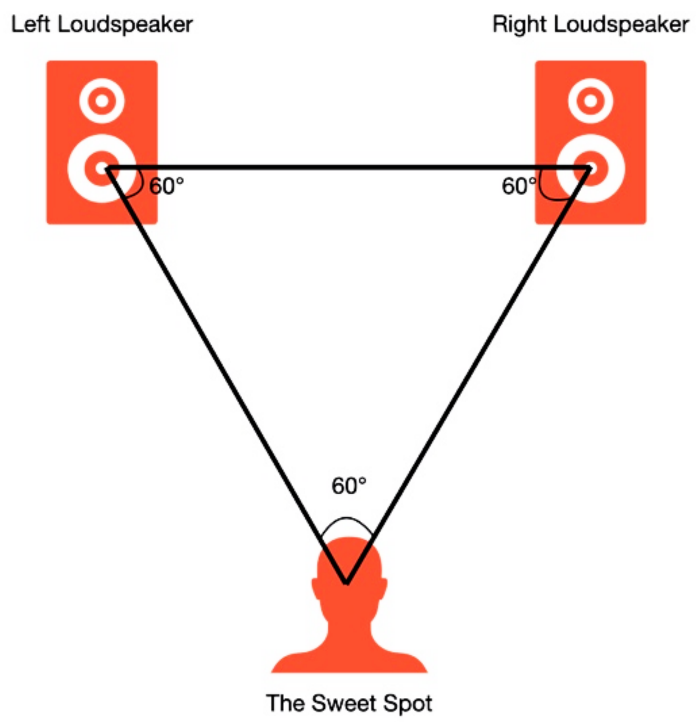

Figure 8 - The sweet spot listening position, equidistant from both loudspeakers

[10] The size of this sweet spot can vary depending on the type of system (e.g. the higher the level of higher order ambisonics, the larger the sweet spot).

allow for phantom imaging and with the potential for the arrival time difference[11] being such that the phantom image is either altered or broken (Kendall 2010; Ratcliff 1974; Theile and Plenge 1977). This arrival time difference is such that even moving 34 centimeters from the sweet spot causes a time difference between loudspeakers of one millisecond where the apparent phantom image shifts towards the loudspeaker that is leading in time (Kendall 2010). The fragility of the sweet spot and the problems it present have been widely noted in the literature (Malham and Myatt 1995; Rodenas and Aarts 2001; Baalman 2010; Okuro and Kajikawa 2012). In contrast with the spatial opportunities afforded by the sweet spot, there are also barriers of social, symbolic, and physical capital that accompany it.

4.1.1 Barriers of Capital to Sweet Spot Listening

If one person is listening to a speaker system by themselves, then they will not usually run into issues accessing the sweet spot. However, as soon as multiple people wish to listen to a system at the same time, there will be people unable to be within the sweet spot. If everyone were able to have their own system within their own space and listen to a work at the same time, then everyone would be able to sit within the sweet spot together. Due to limited economic

[11] The arrival time difference is the difference between when the sound from one loudspeaker reaches the listener compared to another loudspeaker. If a listener is in the sweet spot, there will be no arrival time difference. The closer a listener gets to one loudspeaker over the other, the larger the arrival time difference becomes (Kendall 2010).

capital, this hypothetical situation is highly unlikely to occur, particularly when systems have a higher number of loudspeakers.

There are two existing spatial sound systems which are outliers in this situation; headphone listening and wave field synthesis. As headphone listening is an individual experience it allows all listeners to be within their individual sweet spot (though headphones afford composers and listeners limited spatial opportunities). Systems that allow for the use of wave field synthesis create a non-sweet spot oriented listening experience, however, WFS systems require a relatively large amount of economic capital to set up.

Outside of headphones and wave field synthesis, audiences are often required to listen outside of the sweet spot (to spatial works which are optimized for listening within the sweet spot) due to the size of the audience. Whoever gets to sit in the sweet spot, however, is often a result of listeners' social or symbolic capital, as section 4.3 discusses.

4.2 Methodology

In order to successfully abandon the sweet spot, and therefore remove barriers of capital to spatial audio systems and experiences, a mixed methodology was used that involves practice-led and practice-based research and use of quantitative and qualitative surveys. Having attempted to abandon the sweet spot, the methodology of how this was achieved is discussed.

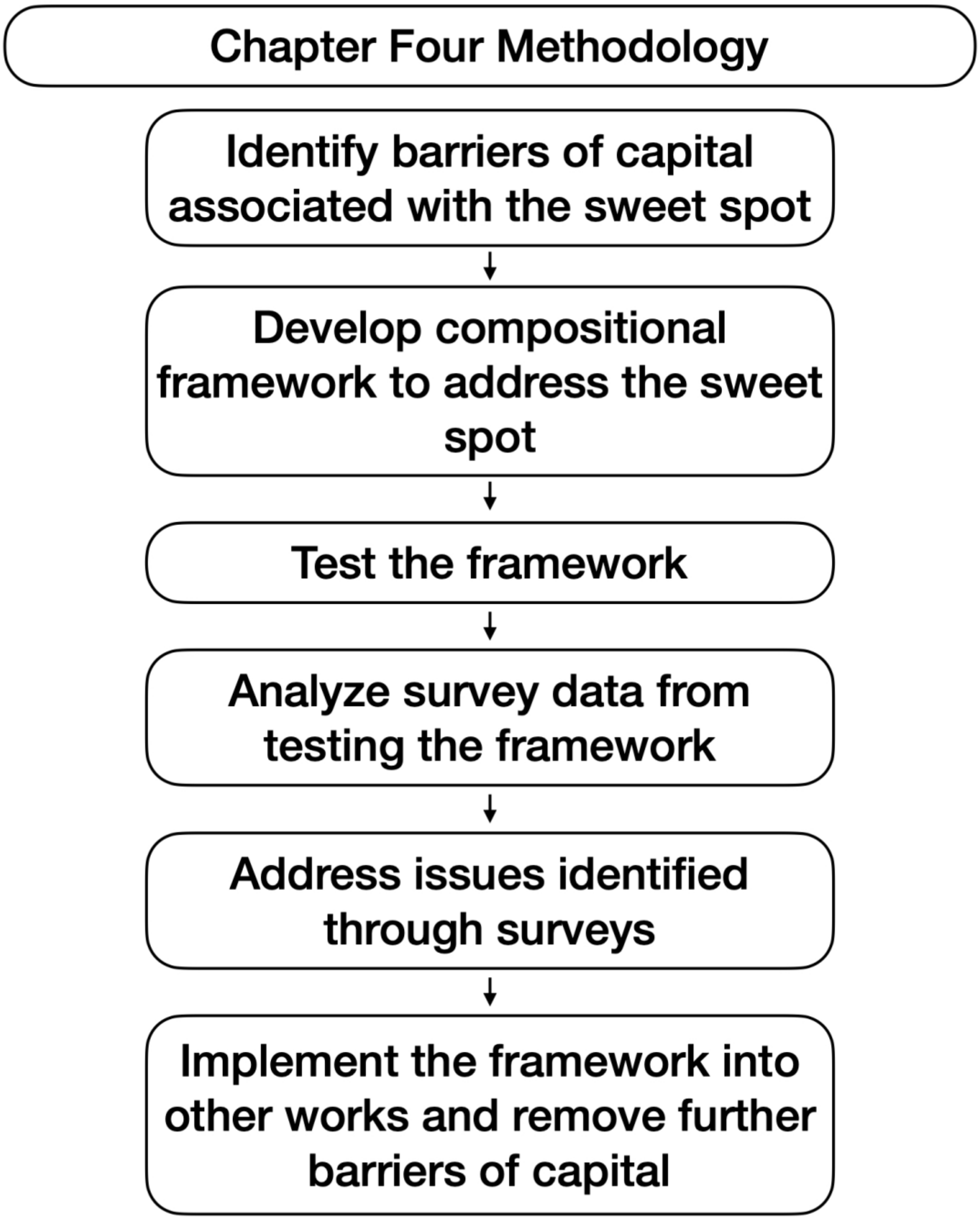

Figure 9 - Chapter Four methodology

Firstly, issues with the sweet spot and associated barriers of capital were identified through associated research and composer interviews. A compositional framework called the *Multichannel Monophonic Compositional Framework* was then developed in an attempt to give composers strategies to compose for a non-sweet spot system. Following this, practice-led test cases of this framework were implemented, obtaining quantitative and qualitative survey responses from composers and audiences to ascertain the efficacy of the compositional framework in allowing for the creation of non-sweet spot spatial audio experiences that are equally interesting from multiple positions. Following this, issues with the framework identified through composer surveys were addressed through the creation of new software to remove barriers of capital. Finally, the *Multichannel Monophonic Compositional Framework* was used in further practice-based works. These works identified and attempted to remove barriers of capital beyond those associated with the sweet spot.

This research was then reflected on in relation to both its success at removing the sweet spot and in its ability to reduce the capital required to engage with spatial music.

4.3 Issues with the 'Sweet Spot'

4.3.1 Composer's Comments on the Sweet Spot

While it is established within the literature that the sweet spot can be small and fragile (Kendall 2010), the barriers of capital that prevent an individual from being able to obtain a sweet spot listening position have not been addressed.

Three spatial audio composers who were known to the author were interviewed. Two of these composers had master’s degrees in the field and one has a PhD. They were interviewed regarding their experience with sweet spot listening. Some composers touched on reasons why they would not want to take the sweet spot listening position. The following responses in this section come from those interviews.

One composer stated:

> *“ Even when encouraged to sit in the middle by the composer, I will usually allow others to get to the "sweet spot". … This comes from a people-pleasing mentality. …*
>
> *Another factor is social anxiety… [being] in a room with better known or older artists. … I do not want to talk to anyone or have my experience influenced by their presence, chatter/conversation, or the thought that I will need to make conversation with them after” (Spatial Audio Composer 1 2021)*

The first part of this composer’s response demonstrates they are reluctant to take the sweet spot in order to gain social capital by giving that listening position to others. In the second part of the composer’s response, they perceive they lack symbolic capital, relative to other listeners, and are wary of engaging with them. This part of the quote indirectly acknowledges that the composer sees the sweet spot as a place for those with the most symbolic capital within that space.

The first composer's response shows that both a low amount of social and symbolic capital can create a listening environment where one does not feel comfortable to take a listening position within the sweet spot.

Another composer stated:

> *"I routinely felt comfortable sitting in the sweet spot around my lecturers and peers. … This said, I have experienced [not wanting to take the sweet spot listening position] when it comes to film. When listening in theatre environments with film professionals, I generally take a seat further back from the sweet spot than the professionals. … My reluctance to move nearer the sweet spot does at least partially stem from a level of discomfort with approaching a professional during multichannel listening.*
>
> *There are two reasons for this. First, their reputation and sense of authority in the film sphere makes it difficult to relate to them in a casual setting (making it easier to sit with peers). Second, my hearing difficulties do make it hard to risk discussion. What if they hear something I don't? What if they ask me about this and I couldn't hear anything? It is much less risky if I just ensure I have a different listening experience." (Spatial Audio Composer 2 2021)*

This composer mentions finding it difficult to relate to some film music professionals due to their reputation and sense of authority. In this case, the composer lacks the symbolic capital to gain the social capital that has previously enabled them to sit in the sweet spot. They also identify sitting in the sweet spot as a “risk” due to the type of hearing that they have. In this case, they are concerned that their lack of physical capital may result in a loss of their symbolic capital and prefer to sit outside the sweet spot in order to not risk that.

The second composer’s responses have shown that if one has high enough social capital, they may be able to take a sweet spot listening position, but that a low amount of symbolic capital may also prohibit one from gaining a listening position within the sweet spot. Their response also illustrates how one may choose to deliberately to sit outside of the sweet spot to draw less attention to their lower physical capital in order to preserve symbolic capital.

A third composer stated:

> *“It would be common for me to sit outside of the sweet spot for multiple reasons, and I would definitely feel like I’m taking a privileged position by sitting in the middle. This means I’ve listened to multiple performances from outside of an octophonic array, as there were too many people to fit within the ring. During these works, I would end up having an experience of the work that most likely didn’t quite equate to what the composer intended in terms of spatial movement…*

> *I don't want to take that privileged spot from someone else, especially if they have more investment in the work than I do."*
> *(Spatial Audio Composer 3 2021a; 2021b)*

This "investment" may be seen in multiple ways. An individual could be more invested because they wrote the piece or worked on it in some way, they could have a closer relationship with the composer having more social capital, they could be more involved in spatial audio having more cultural capital, they could be funding the event having more economic capital, and many more reasons. Regardless, the finite amount of listening positions within the sweet spot and lack of relative investment in a work has resulted in this third composer listening from outside of the sweet spot which they describe as an experience that likely doesn't "equate to what the composer intended in terms of spatial movement".

4.3.2 Summary of Composer's Responses

The composer's responses illustrate that there are many barriers of capital to accessing the sweet spot beyond the barriers of economic capital discussed earlier. The composer's responses have shown that a lack of social and symbolic capital of individuals can either lead them to not feeling comfortable taking the sweet spot (as they don't see themselves with enough symbolic capital or they aren't comfortable enough with the other listeners to take it - they don't have enough social capital) or they want to give the sweet spot listening position to others in order to gain social capital. The responses also show that depending on one's physical capital, some may avoid taking the sweet spot if it means they lower the risk of losing symbolic capital. The responses from the third composer also illustrate that there may be a variety of influencing factors as to why someone doesn't want to or can't access the sweet spot listening position.

Whatever the reason, the composer responses illustrate how the sweet spot is a privileged listening position that, for a variety of reasons, many are unable to access. This suggests that for as long as the sweet spot continues to exist in group listening situations, there will continue to be people less able to engage due to barriers of capital.

4.3.3 Abandoning the Sweet Spot

As previously discussed, wave field synthesis and headphone listening solve the issues that sweet spot oriented systems present. However, headphones are spatially limited and wave field synthesis uses systems that require a relatively large amount of economic capital. If one wants to a create a multichannel listening environment that doesn't require as much economic capital as wavefield synthesis and has more spatial opportunities than headphones, the present options mean one would have to select a sweet spot oriented system to use (unless utilizing a novel system). As discussed, the use of a sweet spot oriented system results in many people unable to access the sweet spot due to various symbolic, social, and physical capital related barriers. While the sweet spot remains, so do these barriers, so to remove these barriers means removing the sweet spot and abandoning stereophony.

Instead of approaching multichannel musicmaking as a stereophonic task, this research suggests rather to approach multichannel spatialization as a monophonic task. In abandoning stereophony, the need to create accurate phantom images is also abandoned.

4.4 Multichannel Monophonic Compositional Framework

In trying to remove the sweet spot, a compositional framework has been developed to be used to aid the creation of non-sweet spot spatial audio experiences. To do this, spatialization must be looked at outside of a stereophonic lens. Where stereophony is spatialization from moving sound between loudspeakers by varying the amplitude of a sound object to create an accurate phantom image, monophony is the spatialization of sound without the use of stereophonic methods within a channel based spatial system. As discussed, for accurate phantom imaging to occur within stereophony, a sweet spot is needed. Without the need for phantom imaging in monophony, the need for a sweet spot can be disregarded. Though, the questions remain, how does one approach monophonic spatialization and is it an effective spatialization method?

With a heavy emphasis on stereophony within spatial audio, compositional approaches for monophonic spatialization have not been addressed within the literature. The author has created a compositional framework called the *Multichannel Monophonic Compositional Framework*. Its intentions are to allow for the creation of spatial music that does not rely on a sweet spot, have more spatial opportunities than headphones, and have fewer barriers of capital than wave field synthesis

The framework has been written as to communicate the spatial ideas to composers who are familiar with spatial audio and academia, but also to composers outside of this paradigm to include those without as much relevant cultural capital. The framework has been tested to determine the efficacy of creating non-sweet spot spatial audio experiences to see if the framework enables one to create equivalently ‘interesting’ spatial audio works. Early iterations of this framework were presented at the Australasian Computer Music Conference 2020 (Austin-Stewart and Johnson 2020). The full framework can be viewed in Appendix One.

4.5 Testing of the Framework

This section provides two test cases of use of the *Multichannel Monophonic Compositional Framework*. These test cases were done through the installations *Multiple Monophony* and *Four Swinging Speakers*. Audiences were surveyed as to their experience of the installations and composers were surveyed on the compositional outcome to determine the efficacy of the implementation of the framework.

4.5.1 Multiple Monophony

Supporting files for this section can be found in the digital files folder. These include:

- Video documentation and photos *of Multiple Monophony* (4.4.1. Multiple Monophony Video and Pictures)
- Recordings of seven composers' works *for Multiple* Monophony. There are five recordings of each composer's work from five different positions in the
  room. These were recorded with an ambisonic microphone and have been decoded to binaural. (4.4.1. Composer's Pieces)
- *Multiple Monophony* audience survey responses (4.4.1. Multiple Monophony Audience Survey Responses)

Multiple Monophony (Austin-Stewart 2020b) was a spatial audio installation at The Engine Room, Massey University in January 2020. The installation consisted of seven acousmatic works by different composers for a novel, non-sweet spot oriented 12 channel loudspeaker system. The composers were invited to use the *Multichannel Monophonic Compositional Framework* (found in Appendix One) to assist their composition and were not told where the speakers were going to be positioned while they were composing (though they were told how many loudspeakers there would be). The composers also had no opportunity to listen to their piece with the loudspeaker system up until the installation was publicly opened. By placing the composers in this position, their spatial compositional ideas needed to rely on the framework they were

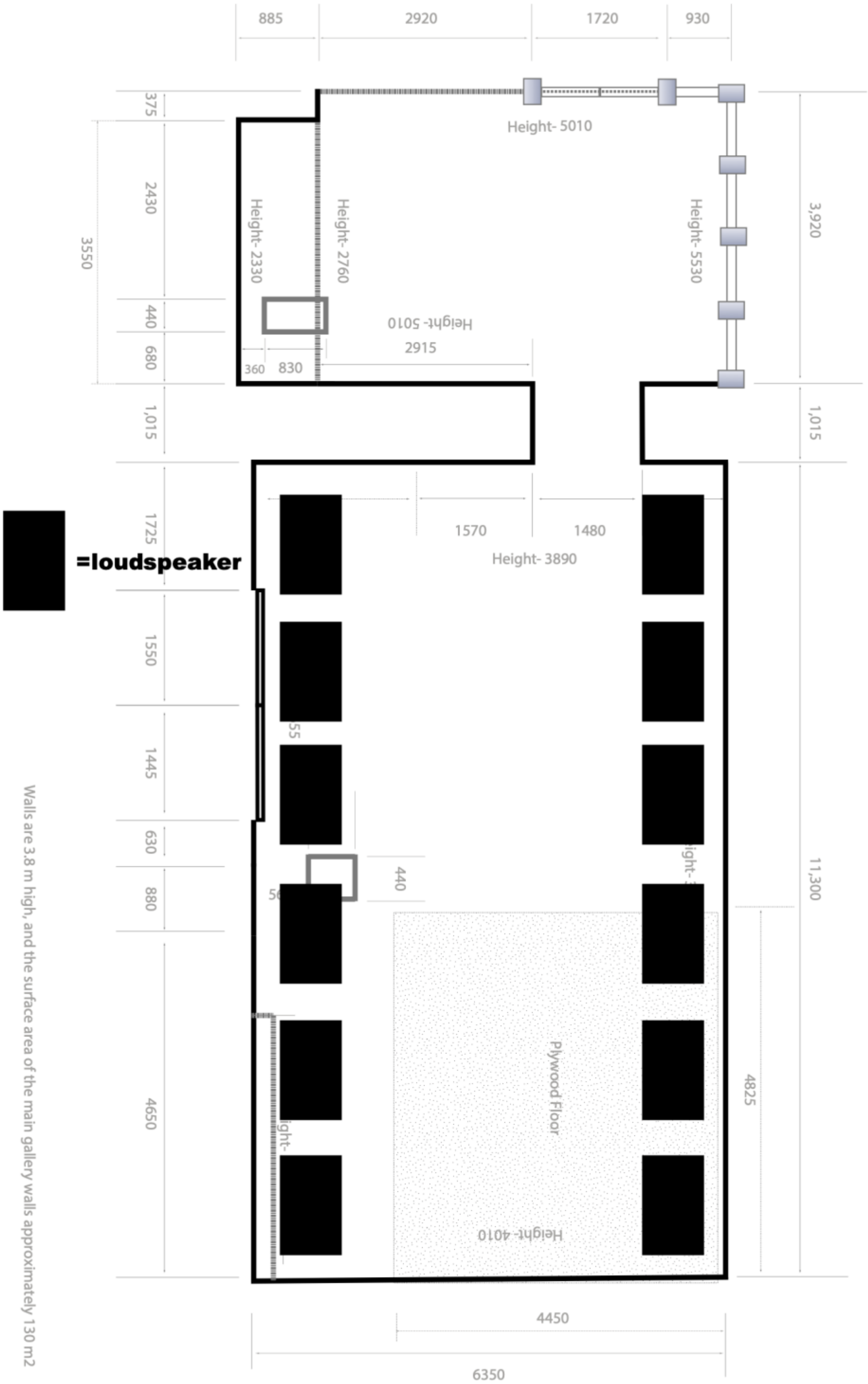

Figure 10 - Layout of loudspeakers at Multiple Monophony

were also unable to try and achieve specific spatialization through moving sounds between specific loudspeakers.

In doing this, one can ensure that the composers can't intentionally achieve stereophony. It creates an environment for spatial works without a sweet spot that can be used to test whether the spatial music that has been informed by the framework can lead to the creation of 'interesting' spatial audio works, relative to other spatial audio works.

Figure 11 - Loudspeakers laid out in Multiple Monophony, photo by Andy Hockey

The loudspeakers were laid out on the ground, facing towards the wall, in parallel lines with six loudspeakers on each side. The speakers used were 12" Turbosound iQ12's. The seven pieces in the installation were looped. While the pieces were performed in an installation context, the presentation of the works, was not unlike a concert context, with the main difference between a concert context and this installation being that audiences had more autonomy over when to attend.

During the installation, listeners were asked to complete a survey that was used to determine whether the *Multichannel Monophonic Compositional Framework* was effective in creating a non-sweet spot loudspeaker system that listeners found equivalently interesting to other spatial audio experiences that they had had. The audience had the ability to move around the space at their own discretion, with no implied sweet spot, thus there was no listening position hierarchy. In doing this, the barriers of capital related to the sweet spot have been removed. What is left to ascertain is whether the result of removing the sweet spot and a listening position hierarchy meant that the listening experience was less spatially interesting than comparative sweet spot spatial audio experiences.

The composers for *Multiple Monophony* were Flo Wilson, Mia Kelly, George Johnston, David Currie, Hakopa Kuka-Larsen, Alexis Weaver, and Blake Johnston. The composers were personally known by the author and invited to write works for *Multiple Monophony*. This selection of composers were chosen as they cover a range of education relative to spatial audio and sound art, from those who have no experience in the field, to those with undergraduate degrees, honours degrees, masters, and PhD’s. The range of education means that the composer survey responses are reflective of a wider variety of relevant cultural capital. From this point on, the composer’s responses and their works have been referred to anonymously, as per their ethics agreement.

4.5.1.1 Composer Works Summary

Across the seven works the composers take a variety of aesthetic approaches while still exploring the spatial strategies suggested in the *Multichannel Monophonic Compositional Framework*. There is use of spatiality of localization characteristics of varying sonic material in the works of all composers. Composer Three explores some timbral spatialization within their work, while Composer Five makes use of spatial allusion. Various composers have made use of spatial movement in their works with varying approaches, and their use of the temporal nature of space helps many of them create a spatial form within their works. Ambisonic recordings of the composers works from different positions in the room (which have been decoded to binaural) can be viewed in the digital files folder at (4.4.1. Composer’s Pieces).

4.5.1.2 Learnings from the Composer Survey

After the installation, the composers were sent five recordings of their works from different positions within the room and were asked to complete a survey in regards to their compositional experience and the musical result. The recordings were done with an ambisonic microphone and decoded to binaural stereo files. Full composer responses can be found in Appendix Two.

Four respondents felt the recordings of theirs works were fairly or quite representative of their spatial intentions. Those who didn’t feel this way, felt that way due to a lack of anticipation as to the effect of the room sound on their work. One composer did not answer this question.

Five of the respondents found the spatial aesthetic of the varying recordings as ‘interesting’. One of the remaining two respondents felt some of the recordings felt uninteresting. The other respondent described the recordings as somewhat spatially interesting.

Five respondents felt the recordings were equally representative of their spatial intentions. Composer 1 felt the first recording was most representative of their spatial intentions and Composer 6 felt the fourth recording was most representative of their spatial intentions.

Five respondents described the spatial aesthetic of the various recordings to be equally interesting from multiple positions. Composer One didn’t address the question and Composer Six found some recordings more interesting than others. One composer did not answer.

The sound of the room had quite an effect on their work, with four composers commenting on the effect it had and the difference on their intended compositional result. One composer mentioned there was spatial gesture that appeared more prominent than they intended. Three composers felt the works represented or more than represented their intentions (one did not address this).

The responses illustrate a few things about the use of the framework in the compositional context of *Multiple Monophony*. The majority of composers found the recordings from various positions were fairly or quite representative of their spatial intentions, found the spatial aesthetic ‘interesting’, found the recordings to be equally representative of their spatial intentions, and found the spatial aesthetic ‘interesting’ from multiple positions.

There were a range of approaches as to how to use the framework. For some, it informed their work conceptually and they used it as priming for coming up with compositional ideas. For others, they chose specifically to explore the compositional ideas within the framework. Others used it to help them recontextualize previously completed works. For most of the composers, their use of the framework meant that they deliberately engaged with those spatial compositional ideas.

Five composers commented on how the spatial composition strategies assisted them in approaching their composition. Six composers (one did not answer) to some extent described the framework as helpful for creating a work for this system and in effect a spatial experience that was interesting from multiple positions. While this was the case, some composers expressed difficulty with the inability to work with the array and therefore understand how their work would sound within the space when it was fully realized. Some composers also expressed difficulty imagining what the end result would be.

The findings suggest that, in the case of *Multiple Monophony*, the framework was overall successful in guiding composers to create music for a system with an unknown loudspeaker configuration and without a sweet spot, where the majority of composers deemed the result to be spatially aesthetically ‘interesting’ and equally ‘interesting’ from multiple positions, while also maintaining their spatial intentions from multiple positions. However, the findings also suggest there is need for more guidance for composers to understand the acoustic environment they are composing in and that an understanding of the loudspeaker positioning would be helpful for some. The former point is addressed in the upcoming section *4.6.1. The Need for a Multichannel Monophonic Simulation Tool*.

In summary of the findings, they suggest that, from a composer’s perspective, the framework (in the context of *Multiple Monophony*) allows for the creation of non-sweet spot oriented spatial music that is spatially aesthetically interesting from multiple positions. This suggests that the framework can give composers strategies to write works that remove the barriers of capital associated with the sweet spot. While the framework can be deemed a broad success for composers in the case of *Multiple Monophony*, audiences must be further surveyed to determine and confirm its efficacy at achieving that goal.

4.5.1.3 Audience Survey Responses to the Installation

Listeners at the installation were asked to complete a survey. Over the course of the four days that the installation was running, over 50 people attended, with

48 completing listener surveys answering questions regarding their experience. Within the survey data, relevant responders were identified. These were participants who we were able to identify as familiar with spatial audio. This way, their responses could be understood as being informed by a knowledge of the culture, language, and musical conventions of spatial audio. Relevant responders needed to have moved around while listening to the works, which suggests that they would be able to provide answers based off of multiple listening positions. Additionally, relevant responders needed to have previously had an issue with being positioned in a spot where they felt they had an inferior listening experience (most likely outside of the sweet spot), as their experience at *Multiple Monophony* could be looked at in relation to that.

From the relevant survey responses, one can ascertain the degree to which the *Multichannel Monophonic Compositional Framework* was successful in helping to create a spatial audio experience that not only removed the sweet spot, but did so in a way that had a comparative level of spatial interest to sweet spot spatial audio experiences for people who are familiar with spatial audio. Additionally, one can also ascertain whether the spatial audio experience was 'interesting' from multiple positions and whether there was a listening position that proved more spatially 'interesting' than another. This provides an understanding of whether, in this context, the barriers of capital associated with the sweet spot can be removed without losing spatial interest.

Of the 48 responders there were 11 who had attended 6+ spatial concerts/events/installations in the preceding two years who also identified the regularity of their attendance at spatial concerts/events/installations as either ‘semi-regularly’ or ‘as much as possible’. Of the 11 responders, 10 listened from multiple positions, and of those 10, seven had said that in previous spatial concerts/events/installations they had perceived that they had had ‘an inferior or less intended spatial experience because of where [they] were positioned in the room’.

Figure 12 - Loudspeakers laid out in Multiple Monophony, photo by Andy Hockey

It was these seven responders that were determined as relevant responders as they can be defined as having regular engagement with spatial audio, as to be familiar with the conventions, they listened to the installation from multiple positions so were able to compare the different listening positions, and they had previously felt they had had an inferior or less intended listening experience based on their position in the room, meaning they could compare those experiences with their experience at *Multiple Monophony*.

The full data from the surveys can be found in an excel spreadsheet in the Chapter Four digital files folder.

The responses to the selected questions by those seven participants are the following:

Survey Question 7: How interesting did you perceive the work/s to be in regard to their spatial aesthetic (meaning the effectiveness of how sounds move and interact and move through the space during the work/s)?

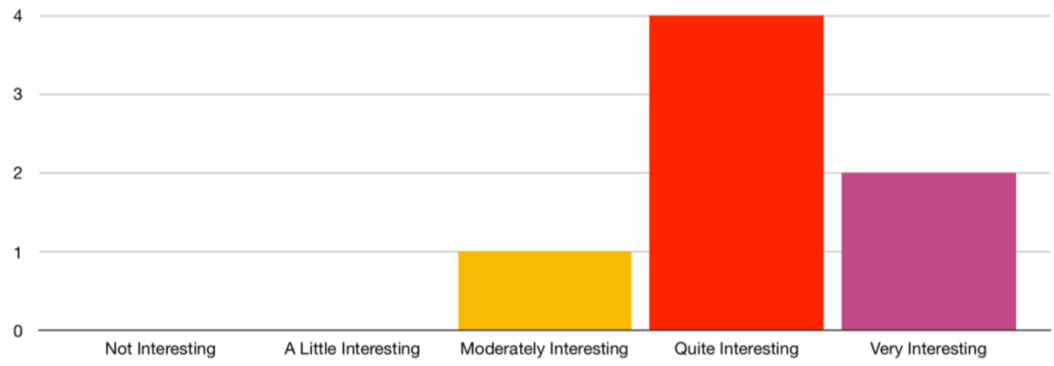

Figure 13 - Bar chart that reflects the relevant answers to Multiple Monophony listener survey question 7

Mode – “Quite Interesting”
Median – “Quite Interesting”

Survey Question 8: If you listened to the works from more than one position, how interesting was the 'spatial aesthetic' of the works in those different positions?

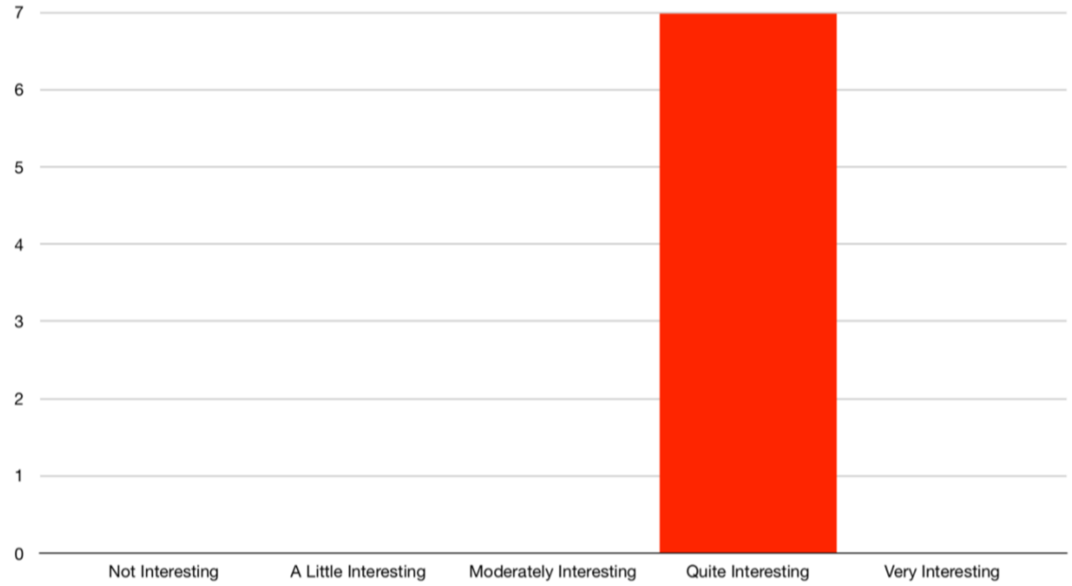

Figure 14 - Bar chart that reflects the relevant answers to Multiple Monophony listener survey question 8

Mode – "Quite Interesting"
Median – "Quite Interesting"

Survey Question 10: When listening to the work/s in this exhibition from various positions, did you feel as if any of the positions you were in meant that you had an inferior or less intended spatial experience?

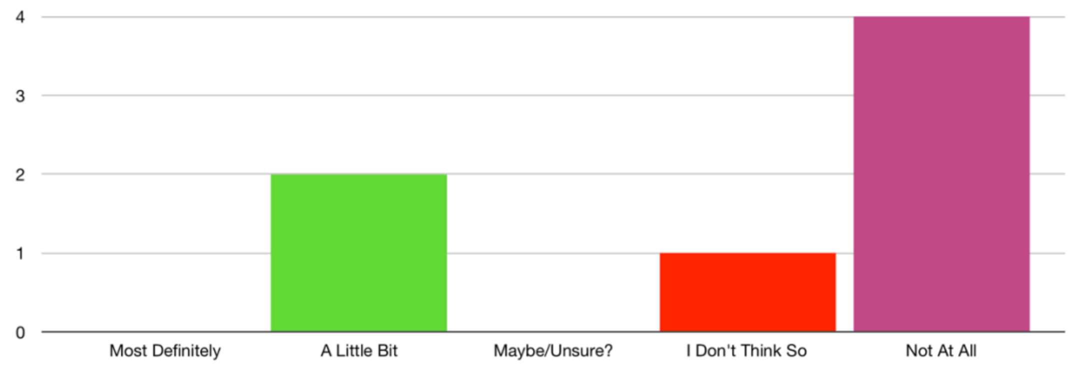

Figure 15 - Bar chart that reflects the relevant answers to Multiple Monophony listener survey question 10

Mode – "Not at all"
Median – "Not at all"

Survey Question 11: How spatially interesting did you find these work/s in this exhibition in comparison to works at other spatial concerts/installations/events you have attended?

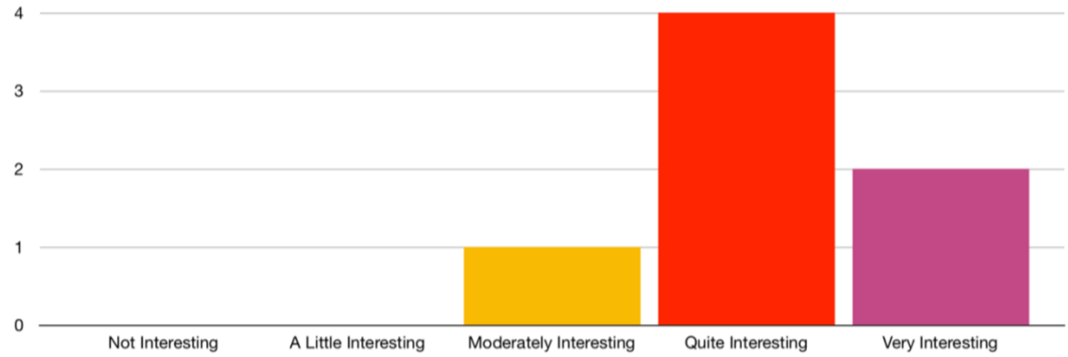

Figure 16 - Bar chart that reflects the relevant answers to Multiple Monophony listener survey question 11

Mode – “Quite Interesting”
Median – “Quite Interesting”

The results suggest that the *Multichannel Monophonic Compositional Framework*, in the context of *Multiple Monophony*, was overall effective in giving composers devices to compose works with ‘interesting’ spatial aesthetics for a loudspeaker array that doesn’t rely on a sweet spot. The results also suggest that, in this context, when the composers don’t know the loudspeaker positioning, listeners that are familiar with spatial concerts/events/installations do not feel as if their experience is ‘inferior or less intended’.

The results show that, in this instance, the *Multichannel Monophonic Compositional Framework* appears to have been effective in removing the sweet spot for both listeners and composers to spatial audio experiences and systems while also maintaining integrity to the composers’ intentions. Through this, the sweet spot associated issues of symbolic, social, and physical capital discussed earlier in this chapter appear to be directly removed via the system design and compositional framework.

4.5.2 Four Swinging Speakers

Supporting files for this section can be found in the digital files folder. These include:

- Video documentation of *Four Swinging Speakers* (4.4.2. Four Swinging Speakers Video)
- Recording of *Four Swinging* Speakers. This was recorded with an ambisonic microphone and have been decoded to binaural. B-Format and binaural files contained within the folder. (4.4.2. Four Swinging Speakers Audio)
- *Four Swinging Speakers* audience survey responses (4.4.2. Four Swinging Speakers Audience Survey Responses)

Four Swinging Speakers (Austin-Stewart 2020a) is a second test case of the *Multichannel Monophonic Compositional Framework* attempting to abandon the sweet spot. It was an audio installation installed in the Audio Foundation in October 2020. It comprised four bluetooth loudspeakers hung from the ceiling that listeners could swing at their own discretion. This gives an element of control of the spatiality to the listener and, from the loudspeaker’s movement, breaks down the potential for a sweet spot regardless of the positioning of the loudspeakers. The audio composed for the array was made by the author and was composed in accordance with the *Multichannel Monophonic Compositional Framework*.

As done with the installation of *Multiple Monophony*, listener survey data was collected from *Four Swinging Speakers* to determine the efficacy of the framework in aiding the creation of a spatially aesthetically interesting work without a sweet spot which can be compared to the results of *Multiple Monophony*.

Figure 17 - Screengrab from Four Swinging Speakers documentation, footage by Oscar Keys, desighn by Andy Hockey

The bluetooth loudspeakers are playing back audio from $20 NZD mobile phones. The use of cheap mobile phones and readily accessible bluetooth loudspeakers reduces the economic capital required for those who wish to construct a similar system.

4.5.2.1 Audience Survey Responses to the Installation

Listeners at the installation were asked to complete a survey. Over the course of the installation, 29 listeners completed surveys asking questions regarding their experience. Of these 29 responders, there were eight who were determined relevant responders (based on the same criteria for a relevant responder for Multiple Monophony)

Figure 18 - Screengrab from Four Swinging Speakers documentation, footage by Oscar Keys

The eight responders were determined as relevant responders based on the same criteria for relevant responders for *Multiple Monophony*.

Full audience survey responses can be found in an excel file in Chapter Four of the digital files folder.

The responses to the key questions by those eight participants are as follows.

Survey Question 7: How interesting did you perceive the work/s to be in regard to their spatial aesthetic (meaning the effectiveness of how sounds move and interact and move through the space during the work/s)?

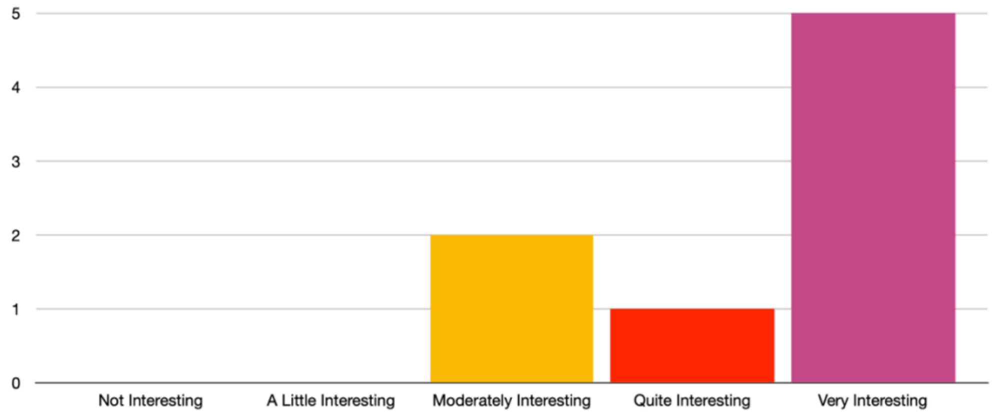

Figure 19 - Bar chart that reflects the relevant answers to Four Swinging Speakers listener survey question 7

Mode – “Very Interesting”
Median – “Very Interesting”

Survey Question 8: If you listened to the works from more than one position, how interesting was the ‘spatial aesthetic’ of the works in those different positions?

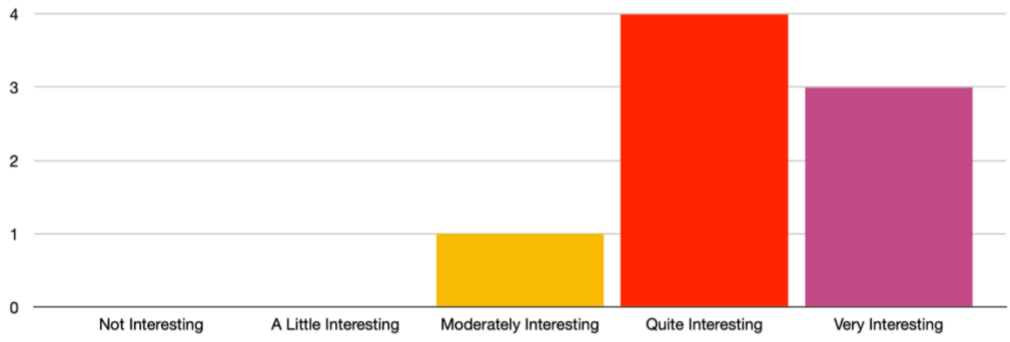

Figure 20 - Bar chart that reflects the relevant answers to Four Swinging Speakers listener survey question 8

Mode – “Quite Interesting”
Median – “Quite Interesting”

Survey Question 10: When listening to the work/s in this exhibition from various positions, did you feel as if any of the positions you were in meant that you had an inferior or less intended spatial experience?

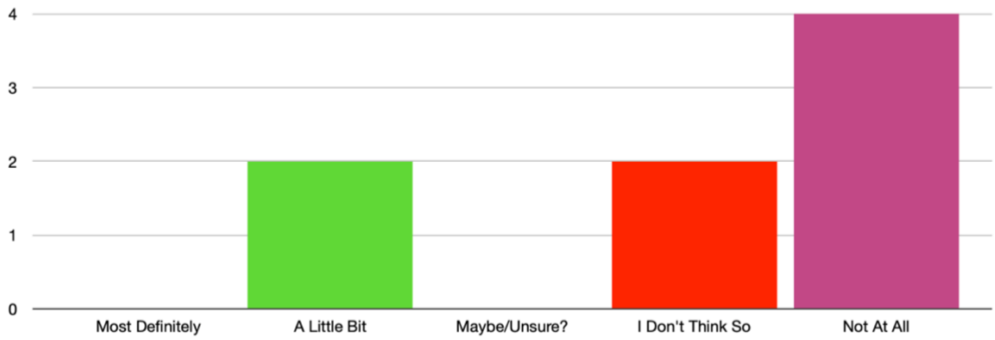

Figure 21 - Bar chart that reflects the relevant answers to Four Swinging Speakers listener survey question

Mode – "Not At All"
Median – "I Don't Think So" and "Not At All"

Survey Question 11: How spatially interesting did you find these work/s in this exhibition in comparison to works at other spatial concerts/installations/events you have attended?

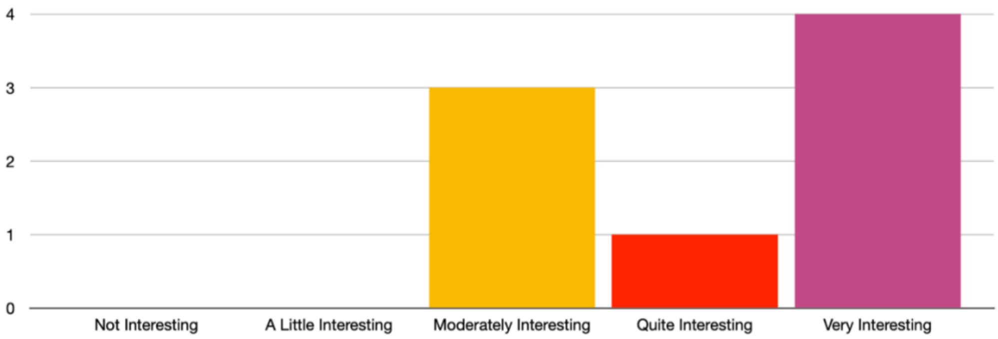

Figure 22 - Bar chart that reflects the relevant answers to Four Swinging Speakers listener survey question 11

Mode – "Very Interesting"
Median – "Quite Interesting" and "Very Interesting"

The results suggest that the *Multichannel Monophonic Compositional Framework*, in the context of *Four Swinging Speakers,* is effective in giving strategies to compose works with interesting spatial aesthetics for a loudspeaker array that doesn't rely on a sweet spot.

The results from this work, regarding the audience's experience, suggest that the *Multichannel Monophonic Compositional Framework* has been effective in removing the sweet spot for both listeners and composers to spatial audio experiences and systems without losing spatial interest. Through the removal of the sweet spot, the issues of symbolic, social, and physical capital discussed earlier in this chapter have been removed without losing spatial interest.

4.5.3 Test Case Listener Results Summary

There have been two demonstrations of the usage of the *Multichannel Monophonic Compositional Framework* (in the form of *Multiple* Monophony and *Four Swinging* Speakers) that have been deemed successful, on average, in giving audiences experiences that do not rely on a sweet spot, are spatially aesthetically interesting, and equally spatially interesting from multiple positions. This demonstrates that in both instances, the framework has been used to remove barriers of capital from the removal of the sweet spot without losing spatial interest.

4.6 Responding to Composer Feedback

The test cases of the *Multichannel Monophonic Compositional Framework* have suggested that the framework is effective at giving composers strategies to create spatial audio works that don't rely on a sweet spot that are deemed spatially interesting from multiple positions. While this is the case, composers reported issues with not being able to work with the system prior to the performance and an inability to determine the acoustic properties of the presentation space. This section addresses those concerns.

4.6.1 The Need for a Multichannel Monophonic Simulation Tool

After the installation of *Multiple Monophony*, in listening to their own works, the composers reported that the sound of the room had quite an effect on their work, with four composers commenting on the effect it had and difference on their intended result. Additionally five composers either wanted to know what the space sounded like or wanted to work within the space during the compositional process. Four composers wished to work with or know what the loudspeaker configuration was. One composer mentioned the desire to work with a plugin that could simulate the loudspeaker configuration.

While not knowing the loudspeaker setup was an important part of the installation (in removing composers ability to attempt phantom imaging), their other concerns would not have been able to be met during the compositional process. The setup of the installation took place in the preceding two days before opening, leaving no time for composers to test and make alterations. There was an inability to access a fully setup system prior to installation for the artists due to economic capital (don’t have the money to set up a system), social capital (don’t have the social connections to access a system), or symbolic capital (don’t have the reputation to access a system).

This leaves two issues for composers when writing in a similar situation for a novel array: firstly, the inability to work with the array or simulate the array from multiple listening positions, and secondly, an inability to understand the acoustic effect of the room.

The comments suggest a need for an application that can simulate loudspeaker positioning for a novel array from multiple positions and that can simulate the acoustic space in which the array is within. The creation of this application allows for increased compositional access to novel loudspeaker arrays and would likely lead to increased satisfaction with the realisation of a piece in regards to one’s compositional intention. Additionally, this application would need to have minimal barriers of economic capital. The application would ultimately help to remove some barriers of economic, social, and symbolic capital to accessing novel spatial systems.

All in all, the application would need to:

- Be cheap or free
- Allow for a high channel number for custom channel based arrays
- Allow the user to change listening position within the array

- Be relatively easy to use
- Allow the user to simulate the reverb of an acoustic space (has an IR reverb)

4.6.2 Spatial Application Review

As addressed in Chapter Two, many spatial loudspeaker configurations require a lot of economic capital to setup. Wave field synthesis systems and high-density loudspeaker arrays can have from 20-100s of loudspeakers. Even for art and academic institutions, these systems can be costly. While octophonic and quadraphonic arrays are more affordable (as they require less loudspeakers and technical setup), they can still cost thousands of dollars and are often financially out of reach for the individual. Additionally, the individual not only has to be able to afford the array, but also have enough economic capital to afford a space big enough to house the system.

For this reason, various applications have been devised so that individuals can simulate various loudspeaker configurations in a stereo or binaural format so that they can be worked on at home. When in use, these applications allow composers to work primarily on their personal computer, simulating the intended listening space before an opportunity to work on the actual array when they can access one. In some cases however (like with *Multiple Monophony*), this situation of accessing the array prior to premiere may not present itself.

There are a variety of applications that have been devised to decode B-Format audio to stereo or binaural for some fixed configurations. These applications range in price and include *Harpex-X* (€298) (*Harpex-B* (version 1.6) 2011), ATK (free) (The Ambisonic Toolkit (version 1.0. beta 10) 2015), Soundfield by RØDE (free) (SoundField by RØDE (version 1.0.2) 2018), and *Envelop 4 Live* (free) (*Envelop 4 Live* (version 11.0.1) 2018). In addition to varying in price, these applications also vary in usage context, with *Envelop 4 Live* only being able to be used in Ableton Live. Similarly, the *ATK* suite can only be used in Reaper or SuperCollider.

The list of plugins here is also not exhaustive of B-Format decoders, but provides a range of price and usage contexts to provide an understanding of the field. In the case of all of these B-Format decoders, they only decode to a set of fixed arrays and only do so for a fixed listening position (the sweet spot). Unfortunately, these plugins would not be useful when trying to compose for an array outside of the arrays that these plugins support and as they are B-Format decoders, they would not be much assistance in channel based compositional approaches such as the ones the *Multichannel Monophonic Compositional Framework* is based on.

Looking beyond B-Format decoders, there are various applications that allow for more extended spatialization simulation. The following paragraphs look at a variety of spatial simulation applications, addressing their cost and function.

IEM Suite's *AllRADecoder* (*AllRADecoder* (version 1.13.0) 2018) is a free plugin that allows users to decode B-Format audio to any custom designed array. The user needs to enter the co-ordinates of the various loudspeakers within the novel array, and it will decode the B-Format audio. This plugin has no barrier of cost, however, it does not allow one to try channel based approaches and it centres the listening position around a sweet spot. It is somewhat easy to use, but does not allow for the simulation of the reverb of an acoustic space.

Spat Revolution (USD $399) and *Spat Revolution Ultimate* (USD $1,995) (*Spat Revolution* (version 20.12) 2019) allow for custom arrays for channel based, binaural, and ambisonic systems. The cheaper *Spat Revolution* allows for the simulation of 12 channel custom arrays, with *Spat Revolution Ultimate* allowing for the simulation of 64 channel custom arrays. With both applications, a user can vary the listening position. While *Ultimate* allows for creation of custom arrays with a large number of channels, it is relatively expensive. It is also challenging to use and does not allow for the simulation of the reverb of an acoustic space.

New Audio Technology's *Spatial Audio Designer* (€389) (*Spatial Audio Designer* (version 3.0) 2013) allows for custom arrays and channel based systems. The online and user documentation is limited, but it suggests one can use up to 330 outputs for custom systems but does not suggest you can simulate from multiple listening positions. With *Spatial Audio Designer*, there is a cost barrier and it doesn't allow for simulation from multiple listening positions.

It is also not relatively easy to use and does not allow for the simulation of the reverb of an acoustic space.

The *Spat MaxMSP Library* (free) (*Spat~* (version 5.x) 1990) is a library of MaxMSP externals designed specifically for spatialization use cases. The externals can be used in the creation of MaxMSP patches that can fulfil desired spatial use cases. Using them to create something to simulate a novel array from multiple listening positions would be possible, especially if used in conjunction with other MaxMSP external libraries such as the CICM HOA Library (*HoaLibrary* (version 2.2) 2012). These libraries allow for all the desired use cases except for being relatively easy to use. The libraries require a lot of cultural capital of knowledge of MaxMSP to create the patch to fulfil the desired use case.

In the applications reviewed, together, they tick all of the boxes desired within an application based on the criteria determined above. However, there is no application from the applications reviewed that allows one to tick all of those boxes. This demonstrates the need for the development of an application that does tick all of those boxes.

Table 1 - Comparison of spatial applications

	Cheap/free	**High channel number for custom channel based arrays**	**Change listening position within the array**	**Relatively easy to use**	**IR Reverb**
B-Format Decoders	Yes	No	No	Yes	No
AllRADecoder	Yes	Yes	No	Somewhat	No
Spat Revolution/ Ultimate	No	Yes	Yes	No	Unclear
Spatial Audio Designer	No	Yes	No	No	No
Spat MaxMSP library and other libraries	Yes	Yes	Yes	No	Yes

4.6.3 The Tool

The *Multichannel Monophonic Simulation Tool* has been developed to address all of the categories in the above table.

The tool developed (pictured below) was created using the Spat and CICM HOA MaxMSP external libraries (*HoaLibrary* (version 2.2) 2012; *Spat~* (version 5.x) 1990). It allows for the creation of custom channel based arrays for up to 64 loudspeakers, users can listen from multiple positions, it is relatively easy to use, and users can load an impulse response to simulate the reverb of an acoustic space. Additionally, there are Windows and MacOS versions of the application available for free download (https://www.jesseaustinstewart.com/software) (Austin-Stewart 2021a) as standalone applications (as opposed to MaxMSP patches) that can be used regardless of whether you have MaxMSP installed or not.

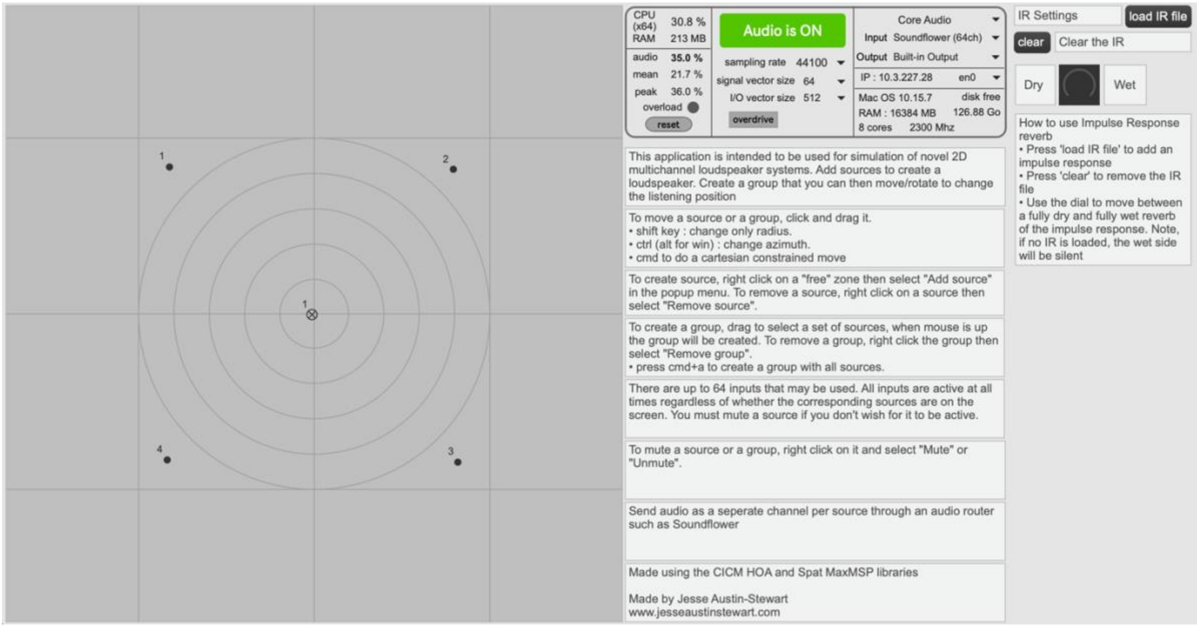

Figure 23 - Screengrab of the Multichannel Monophonic Simulation Tool

The application functions by using the GUI to add loudspeakers to create the 2D array that the user wishes to simulate. The loudspeakers are then numbered as to the speaker they correspond to.

To send audio to the loudspeakers, the user needs to use an audio routing application, such as *Soundflower*, as their DAW output device to send audio from their DAW to the application, with the output of the audio channel of their DAW corresponding with the loudspeaker number in the simulation tool. The listening position is the centre position of the GUI. Users can group the loudspeakers together and move the group around the GUI, in effect, changing the listening position. Users can also rotate the loudspeaker grouping to the direction the listener is facing from the listening position. In the top right corner, users have the ability to add an audio file with an impulse response to change the acoustic space that is simulated within the tool. By default, it does not simulate an acoustic space. The dry/wet of the IR reverb can also be adjusted.

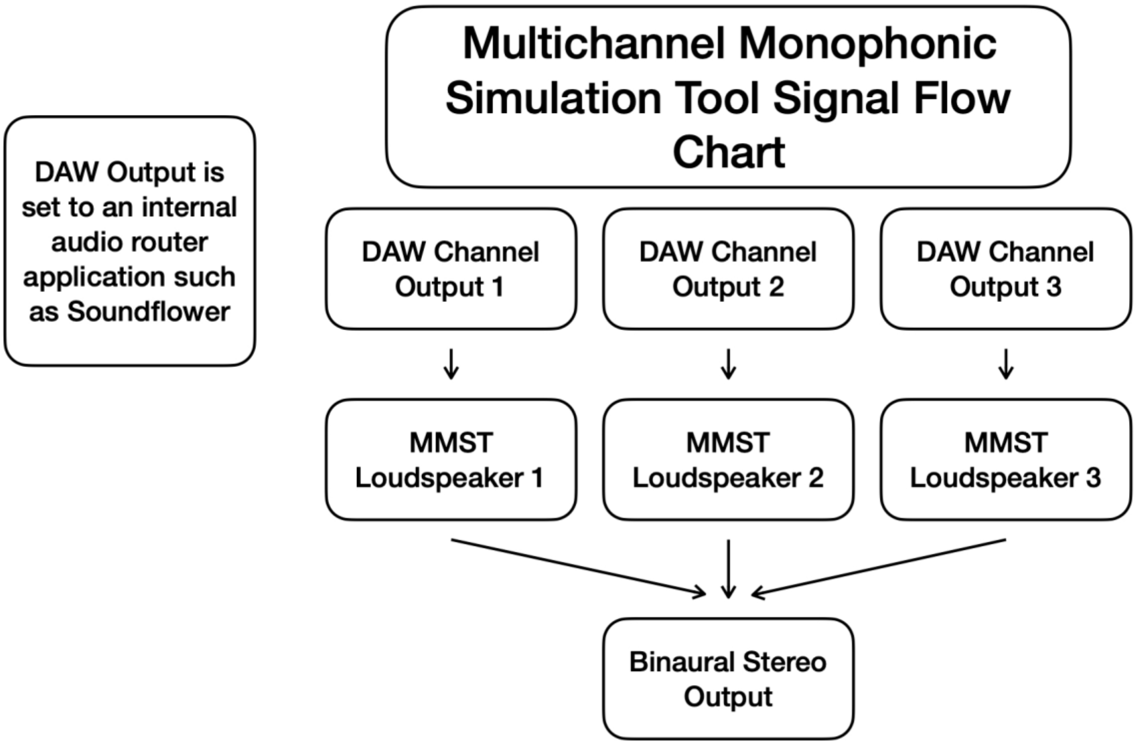

Figure 24 - Multichannel Monophonic Simulation Application Tool signal flow chart

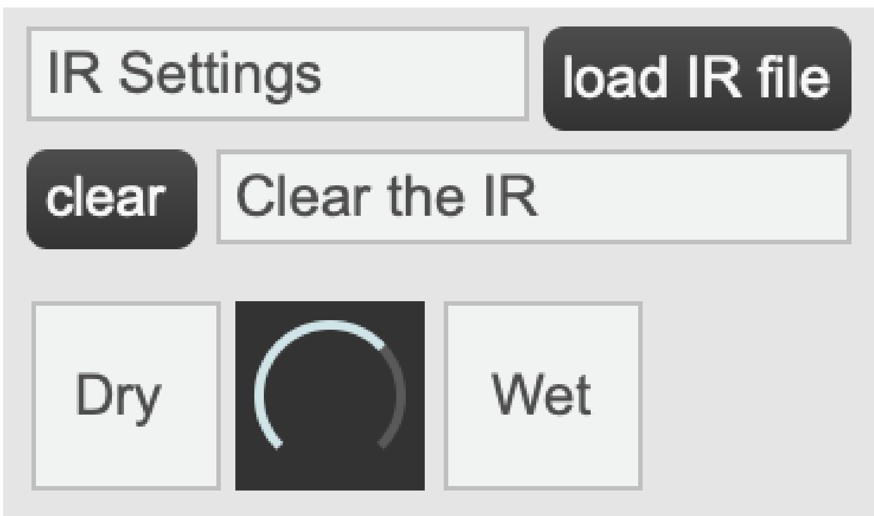

Figure 25 - screengrab of the impulse response section of the application

In regards to the tool's limitations, it doesn't allow you to specifically position the loudspeakers, but rather approximate their position by clicking and dragging them into position. What this feature loses in specificity makes up for in ease of use. The application also only allows binaural output. This is useful for simulating the novel systems created in a solo compositional context, but it doesn't allow the user to translate the simulation of the novel array devised within the tool to a standardised multichannel system.

4.6.4 Tool Summary

The development of the *Multichannel Monophonic Simulation Tool* removes barriers of economic, social, and symbolic capital for composers when writing for novel multichannel systems. Composers may find they have an inability to access a system prior to performance due to not having the finances to set up a system, not having the social connections to access a system, or not having the reputation to access a system. The tool allows composers to simulate any novel 2D array up to 64 loudspeakers, removing the barriers of capital associated with an inability to access a system.

4.7 Implementation of the Framework

4.7.1 24x multimono

Supporting files for this section can be found in the digital files folder. These include:

- The audio from the piece *24x multimono* (4.6.1. 24x multimono > Audio)
- Video documentation of the piece being played back (4.6.1. > Video)
- B-Format audio of the video documentation (4.6.1> Video)

24x multimono (Austin-Stewart 2020c) is a 24 track album released on all selected streaming platforms, including but not limited to Spotify, Apple Music, and Tidal, as well as being available for free download and streaming on Bandcamp. While presented as an album, it is actually one piece, where each track is a different channel. The varying channels have been composed in accordance with the *Multichannel Monophonic Compositional Framework*.

The intention is that a group of people can use their portable devices (phones, laptops, and other personal electronic devices) to play back a channel each. They place their devices in a position within in the space in which they are in (or they can move with their device) and begin playback of a different channel simultaneously. While there are 24 tracks, users can use as few tracks for playback as they like or a group could double up on the tracks if there are more than 24 devices being used.

The individual tracks have been designed in accordance with the framework but attention has been placed on making sure the variance between tracks isn't such that if a track or multiple tracks aren't played, elements of the piece are missing. This meant a focus on the creation of textural material and creating

Figure 26 -24x multimono album cover, image by Andy Hockey

spatial interest through subtle spatial movement through textural variance between the different tracks. This is in contrast with creating spatial interest through spatial movement between channels, in which case, if certain tracks weren't played, the piece may have quite a different musical result. The way that textural variance was explored in *24x multimono* is quite similar to the way it was explored in *Four Swinging Speakers*. By doing this, one can hypothesize that the listener survey results from *Four Swinging Speakers* may also apply to this usage case of the framework.

By using the framework in the composition of this work, it can be theorised that the work could be equivalently interesting from multiple listening positions, removing the associated barriers of capital.

By disseminating the piece through all popular streaming services and requiring playback from personal devices, the piece removes the need for complex loudspeaker systems and removes the need for the knowledge of how to run complex loudspeaker systems. In other words, the playback style of this piece removes barriers of economic and cultural capital to engage with spatial audio on top of also removing the sweet spot (which removes barriers of social, symbolic, and physical capital).

4.7.2 Some Swinging Speakers

Supporting files for this section can be found in the digital files folder. These include:

- B-format audio from *Some Swinging Speakers* (4.6.2. > Some Swinging Speakers B-format)
- Binaural render of B-format audio from *Some Swinging Speakers* (4.6.2. > Some Swinging Speakers Binaural)
- Video documentation of *Some Swinging Speakers* (4.6.2. > Some Swinging Speakers Video)

Note: Due to the particular location of the installation, the B-format and Binaural audio have intermittent wind noise.

Some Swinging Speakers was an iteration on *Four Swinging Speakers* for The Performance Arcade 2022, an art installation and performance series on Wellington's waterfront in February. The work is comprised of six hung bluetooth speakers playing back very similar material to *Four Swinging Speakers,* where listeners can engage with the work by swinging the speakers back and forth listening to the way that their agency changes the spatial composition.

This work removes barriers of capital through its removal of the sweet spot and use of the *Multichannel Monophonic Compositional Framework*. Additionally, its

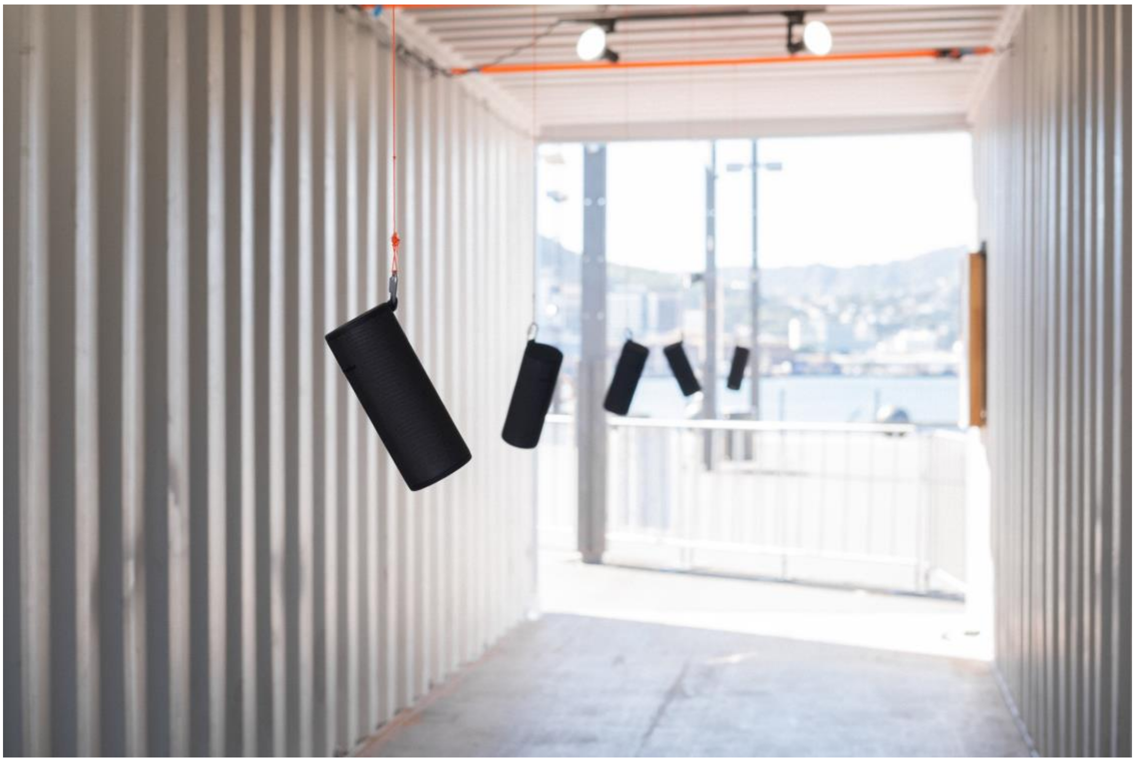

Figure 27 - Some Swinging Speakers installed at The Performance Arcade 2022, photo by Andy Hockey

installation outside minimizes potential cultural capital required to engage with the work as open air works are more attended by audiences of varying levels of cultural capital (Dimaggio and Useem 1978). The staging of the event in a public space where members of the public chance across it requires less cultural capital than a similar performance at art institutions such as Audio Foundation or The Engine Room (where *Four Swinging Speakers* and *Multiple Monophony* were held) and it being free on the waterfront minimises the economic capital needed to engage with the work.

4.7.3 Waterfront Monophony

Supporting files for this section can be found in the digital files folder. These include:

- The video of *Waterfront Monophony* (4.6.3. Waterfront Monophony)

Waterfront Monophony (Austin-Stewart 2021c) was a spatial performance that iterates on the Multichannel Monophonic Compositional Framework in its removal of the sweet spot. It expanded upon this work attempting to remove further barriers of capital than those associated with the sweet spot. The performance took place along the Wellington waterfront 4 December 2021 and 24 January 2022. It is a hybrid of *Multiple Monophony* and *Four Swinging Speakers* with 12 performers walking back and forth along the waterfront with a bluetooth loudspeaker each. Composers had written 12-channel works that were played back as the performers walked back and forth along the waterfront in a line, roughly two metres apart from one another. As listeners walked along the waterfront, the various channels blended into one another and the composed sound also blended into the sound of the environment (the water, other pedestrians, bicycles).

The composers were provided with the *Multichannel Monophonic Compositional Framework* to inform their work. The performance was funded primarily by the Ministry for Culture and Heritage. The Wellington waterfront was chosen as a space for performance, as it is an open air space (which can lead to a reduction in cultural capital to engage (Dimaggio and Useem 1978)), and is a space that is flat, does not require stairs, and very close to public parking (minimising the level of physical capital needed to engage with the work). The staging of the event in public space where any member of the public can stumble across it requires less cultural capital than a similar performance at Audio Foundation or The Engine Room and it being free on the waterfront requires no economic capital needed to engage with the work (other than relevant transport costs associated with getting to the performance space).

Figure 28 - Waterfront Monophony being performed, photo by Andy Hockey

Waterfront Monophony was performed twice and ran for 2 two hours at each event. Across the two events over 2900 people experienced the work by deliberately attending (the performance was promoted publicly) or by chancing upon it. This is in contrast with *Multiple Monophony*, where between 50-60 people attended. Both events had a similar level of marketing and promotion, with *Waterfront Monophony* involving fewer composers. While causation cannot

Figure 29 Waterfront Monophony being performed, photo by Andy Hockey

be determined, it is hard not to notice the significant differences in audience size when the location is made much more accessible from a cultural and physical capital perspective.

4.8 Future Work

There is much research to be done beyond what has been achieved within this chapter. There is further scope for more investigations with varying spatial audio systems to determine the efficacy of the *Multichannel Monophonic Compositional Framework*. There is room for further test cases with larger sample sizes. Additionally, there is room for further composer studies where composers evaluate their compositions in the room, as opposed to via recordings. There is also room for comparative surveys to be done where audiences compare both sweet spot and non-sweet spot arrays.

While the research has suggested removing the sweet spot can result in comparatively interesting spatial audio works (to sweet spot works), the current spatial audio culture remains heavily reliant on the sweet spot and heavily embraces it. Much of the work in this chapter (such as *24x multimono*, *Some Swinging Speakers*, and *Waterfront Monophony*) works towards changing this culture. While this is the case, the dominant culture within spatial audio is one that relies on the sweet spot and exclusion. There is much further work to be done both within the research and activist space to shift the culture of spatial audio towards works that don't require the sweet spot to move towards a field that requires less capital to engage.

There are further research opportunities in surveying the efficacy of removing the sweet spot while maintaining spatial interest for *24x multimono*, *Some Swinging Speakers*, and *Waterfront Monophony*. This research would be looked at alongside the audience survey results from *Multiple Monophony* and *Four Swinging Speakers*. There is also opportunity to further survey the work developed in this chapter with larger sample sizes.

There is room for research to further explore the efficacy of the *Multichannel Monophonic Simulation Tool*. Composer studies may be completed, where composers are asked to write a work using the tool. They would then review that work based off of a live performance listening context to compare their expected realization of the work with the actual realization.

4.9 Summaries of Abandoning the Sweet Spot

This chapter has seen various explorations in removing the sweet spot and reconstructing a new spatial listening experience. The development of the *Multichannel Monophonic Compositional Framework* has been instrumental in guiding these explorations.

The test cases of the framework of *Multiple Monophony* and *Four Swinging Speakers* led to two audio installations without a sweet spot where survey results suggested that the music was equally spatially interesting from multiple positions and in comparison to other spatial events they had attended. This suggested it had the effect of removing the barriers of capital associated with the sweet spot without losing spatial interest. The use of the framework also provides opportunity for spatial experiences without a sweet spot that require less economic and cultural capital than a WFS system, but more spatial opportunities than headphones.

Composer feedback led to the creation of the *Multichannel Monophonic Simulation Tool* in order to make multichannel monophonic composition more accessible for those who do not have access to the system for which they are composing (removing barriers of economic, social, and symbolic capital).

The framework has been used in removing further barriers of capital in addition to the barriers of the sweet spot in the works *24x multimono*, *Some Swinging Speakers*, and *Waterfront Monophony*.

While, in some cases in this chapter, the cultural capital required has been reduced, barriers of cultural capital have not been fully removed, and the methods used to remove barriers of cultural capital do not employ a Bourdieusian reflexivity. The issue of barriers of cultural capital in spatial audio are further explored in Chapter Six.

By successfully abandoning the sweet spot, one also abandons the issues discussed at the start of this chapter that composers had with taking the sweet spot listening position. By removing the sweet spot, the barriers of social, symbolic, and physical capital addressed by these composers are completely removed.

There are a variety of barriers of capital to spatial systems that use a sweet spot, including economic, social, symbolic, and physical capital related issues. Through abandoning the sweet spot, the associated barriers of economic, social, symbolic, and physical capital have been minimised leading to the potential for more engagement with spatial audio from more diverse audiences.

5 Hearing and Spatial Audio - Issues of Physical Capital

Not only can barriers of capital associated with the sweet spot restrict someone's engagement with spatial audio, but so can one's physical capital. Physical capital is the physical resource that one's body can provide them (Shilling 2004). In the case of spatial audio, the physical capital of full range amplitudinal and spectral hearing is required to fully engage with the field[12]. This chapter explores contexts through which spatial audio has excluded those who are hard of hearing and d/Deaf. It has used some of the research from the sweet spot chapter as a point of departure to develop new compositional strategies that allow those who are hard of hearing or d/Deaf to engage with spatial audio on more equal terms to those who are hearing.

[12] It is important to note that the hard of hearing and d/Deaf community do not look at their hearing as a disability, but rather a different type of hearing. It is integral to distinguish disability from physical capital. One's physical capital is completely context dependent (as is disability), but frames what one is able to do physically as a resource. In the case of spatial audio, someone who is d/Deaf will have less physical capital that someone who is hearing. Conversely, in a context where not being able to hear would be advantageous, someone who is d/Deaf would have more physical capital than someone who is hearing.

Some of the ideas explored in this chapter are discussed in a forthcoming book chapter *Do You Hear My Point: Addressing Accessibility Issues Within Spatial Audio* (Austin-Stewart 2022) which is currently in press.

5.1 Background

A variety of barriers of economic, cultural, social, and symbolic capital associated with the sweet spot have been removed through the research in Chapter Four. This chapter addresses issues with spatialization and localization beyond the inability to obtain a sweet spot listening position. For phantom imaging to produce accurate spatial localization, there is a reliance on the listener to have equal and full range spectral and amplitudinal hearing (where one can perceive a full range of frequencies and amplitude to decipher the spatial intentions)[13]. These requirements mean that not only are people outside the sweet spot excluded from the spatial intentions of the work, but so are those who are hard of hearing and those who are d/Deaf.

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[13] Individuals who are hard of hard hearing can have hearing that varies significantly from one another. In some cases, this can result in hearing a different range of frequencies in both ears and having limited and/or different amplitudinal hearing in both ears (Snapp and Ausili 2020; Victory 2020). There are a variety of spatialization methods that require listeners to be able to perceive a wide range of frequencies (Hartmann 1983; Rakerd and Hartmann 1986) and having equal amplitudinal hearing in both ears is required to accurately localize sound (Composer One 2020; Composer Two 2020; Kendall 2010).

Although the previous chapter demonstrates examples of successfully removing the sweet spot where audiences still perceive relatively equivalent spatial interest from multiple positions, the methodology and creative work did not consider the experiences of those who are hard of hearing or d/Deaf. So, while the research in the previous chapter *may* result in an experience where people who are hard of hearing feel they have an equivalent experience to those who are hearing, this has not been ascertained. Additionally, a d/Deaf audience will not have an equivalent experience in all the examples in the previous chapter to a hearing audience. The research presented in this chapter explores how barriers of physical capital in spatial audio, for those who are hard of hearing or d/Deaf, can be removed so that that those who are hearing, hard of hearing, and d/Deaf can have equivalent experiences.

5.2 Methodology

The methodology used to investigate ways of removing barriers of physical capital to spatial audio for individuals who are hard of hearing and d/Deaf is as follows.

Firstly, two composers who have experience with spatial audio who are also hard of hearing were interviewed about their experiences in the field. These interviews were used to gather a wider understanding of the hearing-related experiences they have faced within spatial audio. The composers interviewed have significant compositional, music technology, and spatial audio experience. The interviews informed new compositional strategies that were then developed and implemented into creative works. The creative works were then experienced by the two composers in a follow up interview to ascertain the work's spatial interest and determine if the composers perceive being able to participate equally to hearing individuals and whether barriers of physical capital

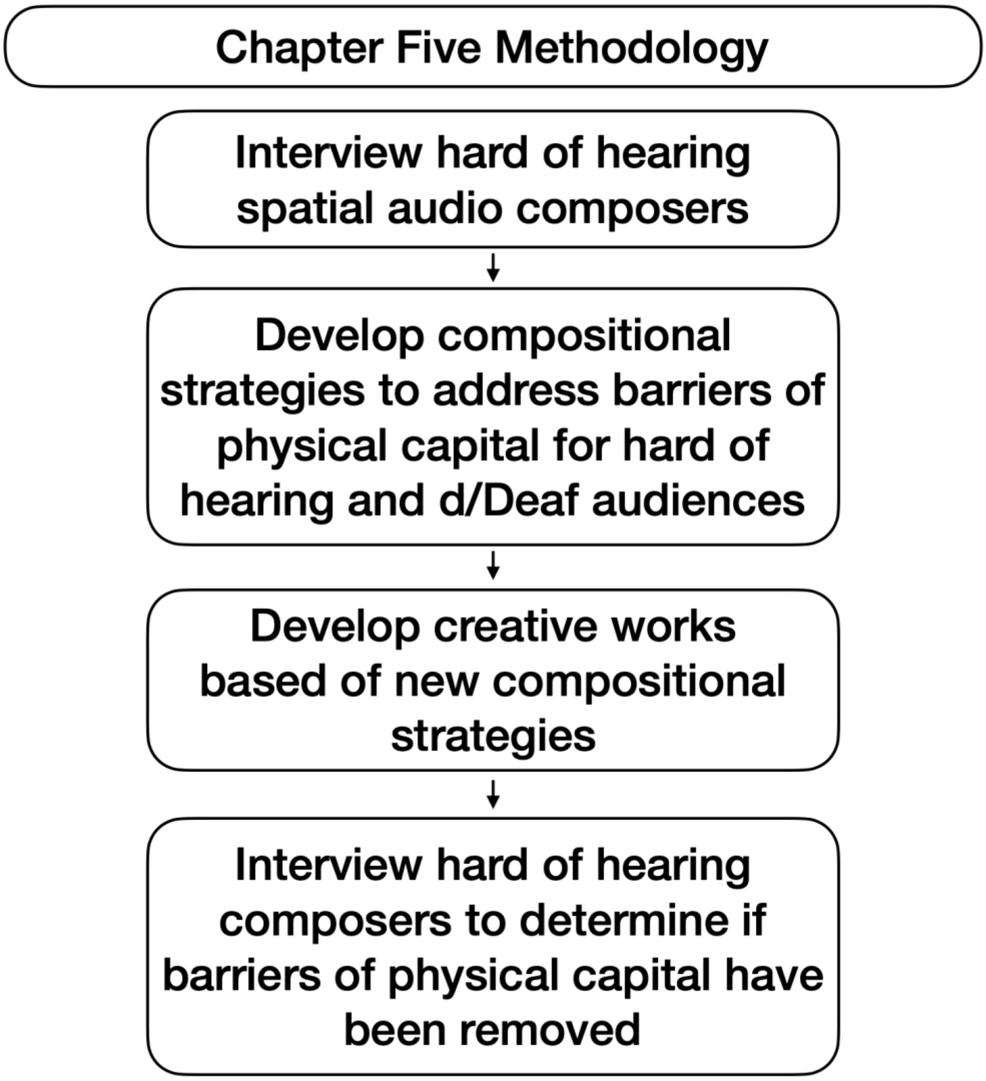

Figure 30 - Chapter Five methodology

have been removed.

In determining the efficacy of the compositional strategies, the creative works were experienced by the two composers simultaneously and they discussed their responses to interview questions simultaneously. In these interviews, they were asked the following questions:

- Did you feel you were able to engage spatially with the work?

- Did you feel you were able to engage spatially with the work equal to those who are not hard of hearing

- Did you feel your spatial experience of the work was hindered by your hearing?

- Did you feel that there was spatial interest to the work?

- How interesting did you perceive the work to be in regards to its ‘spatial aesthetic’ (meaning the effectiveness of how sounds interreact and move through the space during the work/s)?

- How spatially interesting did you find the work in comparison to works at other spatial concerts/installations/events you have attended?

5.3 Composer Interviews

In exploring barriers of physical capital to spatial audio, the author discussed experiences of the field with two composers who are hard of hearing [14]. The composers interviewed have significant compositional, music technology, and spatial audio experience. Both have master's degrees in music, having also completed undergraduate degrees in composition with specializations in sonic art and continue to practice within spatial audio. This background allows them to reflect on their experience in context of the wider field.

In discussing their being hard of hearing, the first composer described their hearing as experiencing unequal and partial range spectra and amplitude.

> *"My particular type of hearing is essentially localized to my left ear. … There is amplitudinal problems and there's spectral problems. … In terms of volume, in my left ear I hear things more quietly than in my right ear. … Spectrally speaking I have trouble hearing particularly low frequencies and particularly high frequencies."*
>
> - Composer One (Composer One 2020)

The partial range of spectra and amplitude that this composer experiences also causes significant barriers when participating in spatial audio as a listener and a composer/mixer.

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[14] The composers aren't named due to the anonymity required by the ethics agreement.

“I'm constantly having to visually look at metering… to figure out what I'm hearing. ... I'm having to make a bunch of decisions [from] what I'm seeing as opposed to what I'm hearing. … That means I'm often composing with mono materials, because then I can actually trust what I'm doing. … It [also] means a lot of the time… I make materials that are very left heavy, … because I just don't pick up on it until I start looking at it.”

- Composer One (Composer One 2020)

As a result of the barriers confronted when dealing with spatialized material, Composer One has come up with various strategies to compensate for the issues their hearing presents in this context. These strategies attempt to allow them to engage practically on a level of those who are hearing.

“[In] a surround environment… [I] have to compensate for it. I have to be thinking constantly about what is happening on the left side and compare to the right side. … If I'm in an environment where [I’m] working with loudspeakers, I'll just turn around so that my right ear is now hearing the left ear stuff and with headphones I'll just flip them around and see if it sounds imbalanced with everything reversed.”

- Composer One (Composer One 2020)

While these strategies often prove useful for Composer One, they still felt there were professional risks associated with their hearing.

“The methods that I use to overcome being hard of hearing take time. And in professional environments, the more time you use the more money you're costing your client, [so] there are reasons I would assume people don't want to employ people who are [hard of hearing], even if they're very good mixers because they take longer and they might not be as solid”

- Composer One

Their experience shows that they have to make creative accommodations to compensate for their difference in physical capital to create work that they perceive matches that of composers/mixers that aren’t hard of hearing or d/Deaf. The time this adds to their work results in a fear they may risk fewer professional opportunities because they perceive themselves as unable to work at a competitive pace to those who aren’t hard of hearing or d/Deaf. Their lack of physical capital in this context is a professional barrier for this individual. Additionally, it has led the composer to perceive themselves with a lack of symbolic capital in relation to composers/mixers who are hearing.

Composer Two’s hearing changed after an operation when they were young. They describe their particular type of hearing as being unable to understand what they hear in their right ear, but still knowing that they are hearing something.

“For ages I had, like, zero hearing [in my right ear], and then very slowly, in late teens, I started to develop some sense of

understanding sound. … I can tell that there is sound happening, but I can't, like, get it. Like, it's not in my brain. In computer science-y terms, it's like I have a sensor… and it's saying to the computer 'I have this information but I'm not going to tell you what it is'."

- Composer Two (Composer Two 2020)

As a result, Composer Two finds difficulty in localizing sound.

"I can kind of grasp where [sounds] are, vaguely. Especially when they are distanced. In a day-to-day being in the world, I can tell where a car is. I definitely can't pin-point it, but I can hear sound is happening in this quadrant… If I'm in a really loud environment, I struggle to identify where sounds are."

- Composer Two (Composer Two 2020)

While musically proficient (demonstrated by their master's degree), because of the nature of Composer Two's hearing, they felt unable to participate in spatial audio to the same extent as those who are hearing, discouraging them from engaging at all. This is caused by their lack of physical capital relevant to spatial audio.

"I acknowledged I was never going to [primarily] be a spatial audio composer. I had experienced larger channel works and I knew my experience of them wasn't optimum. I remember there being this one piece where there was a lot of motion through the space, and I

remember it being so confusing and not really understanding [it]. … My brain didn't compute it… The whole thing of space, and how to use space, fascinated me, but I felt that it probably wasn't going to be for me because the work that I would put in to achieve something might not be worth it… because I couldn't fully experience it."

- Composer Two (Composer Two 2020)

Composer Two still values spatial audio. They view space as an important element to their work and have engaged with it on their own terms.

"I have used spatial audio in my creative pursuits, but I use it in a way that I can access… In [one of my pieces], with drums and guitar, there is a quadraphonic audience recording at the beginning of the piece that I feel I can experience the same as those who aren't hard of hearing… because there's no need to be able to localize anything within that particular sound, so there's nothing gained or lost if you have or don't have the ability to localize."

- Composer Two (Composer Two 2020)

Composer Two's experiences show that the current perceived salient features of spatial audio both exclude and discourage those who lack the relevant physical capital from engaging with the field. Instead of devising strategies so they could comply with expected approaches within spatial audio (like Composer One), Composer Two explored space in a way that was accessible for them that they surmised was just as accessible to those who are hearing.

Both Composer One and Two's reflections illustrate that the current musical culture of spatial audio excludes those who are hard of hearing, and in turn, d/Deaf (those who don't have the physical capital). Both composers have been required to create novel approaches to engage with spatial audio. Composer One and Composer Two have approached their exclusion differently. Composer One has stayed within the field, while remaining concerned about professional risks. Composer Two has moved away from the field and engaged with spatial audio on their own terms. The perceived importance of specific sound localization to spatial audio has resulted in the exclusion of both composers and potentially many more from engaging with the field. This shows potential for increased engagement through minimizing and/or removing the barriers of physical capital presented.

5.4 Works that Engage with Issues of Hearing

Beyond spatial audio, there are various sound artists that have explored ideas of music for those who are hard of hearing or d/Deaf. These artists have engaged with sound through other senses beyond hearing.

Berlin-based Christine Sun Kim, a sound artist who is deaf, regularly engages with hearing in her works. Her installation *4x4* (Sun Kim, 2015) uses sound below human hearing range with the use of subwoofers to vibrate people's surroundings so that they either feel or see the effect of the low frequency sound. Her work *bounce house tokyo* (Sun Kim 2017) is a dance party with sounds below 20 Hz (below human hearing range), exploring the physical effect of inaudible sound. *fingertap quartet* (Sun Kim 2014) is a “work which consists of four sound files she created using an audio recorder, laptop, and transducers. During the performance she [communicates] the concept of each sound by typing in large projected text on the wall behind her for the audience to read and experience” (Sun Kim 2014). In this case, Sun Kim performs the sounds in an inaudible way to be interpreted visually by the audience rendering audience members’ hearing without purpose.

Darrin Martin is a California based artist who has hearing differences. His work *Ancestral Songs* (Martin 2020) is an installation video work that presents “large video projections of expansive pastoral scenes, while handheld viewers hang from the ceiling several feet above the projection wall. The images displayed in stereoscope through the viewers are interior spaces. In each set of imagery, hands enter the frame holding hearing aids left by the artist’s deceased relatives, which are cupped to initiate audible feedback. The silent large projections are closed captioned to describe all the environmental sounds the images once contained. Meanwhile, audio emanates from the stereoscopic viewers and bleeds through the installation. The work activates an inversion of assistive listening devices as they are used to derive sound in defiance to the ways in which those with deafness can become silent participants in a hearing world” (Martin 2020)

Myles de Bastion curated *Sound Beyond the Auditory Exhibition* (de Bastion 2016) where objects in the "exhibition are experiments in cymatics, the process of making sound visible and tactile. From mechanically simple to the electronically complex, each shares a different approach. The objects were composed and fabricated by members of CymaSpace, a Portland nonprofit founded by a collective of artists and technologists who are d/Deaf or hard of hearing. CymaSpace introduces d/Deaf and Hard of Hearing and Hearing communities to new sound experiences through cymatics, so that music can be savored and made by more people" (de Bastion 2016).

Deaf artist Liza Sylvestre's *Music from Christopher* (Sylvestre and Jones 2019) is a collection of drawings describing various musical interactions. While the work offers no description, it seems that collaborator Christopher Jones sent various videos of music on YouTube to Sylvestre, from which, Sylvestre responds to in the form of a drawing. The work of Sylvestre translates the sonic and visual of these YouTube videos into a hybrid of a description of the work and Sylvestre's deaf experience of the work through writing and drawn picture. In only viewing the drawing, the sound of the music is removed, leaving the viewer with only Sylvestre's linguistic and artistic impression.

While the scene *Hearing 4'33''* from the film *The Tuba Thieves* involves the use of sound, hard of hearing artist Alison O'Daniel speaks to the way in which she actively tried to have the camera movement act as a stand-in for the soundtrack (Cachia 2015). While, the work still involves music, O'Daniel shows great attempt at removing barriers of physical capital to engaging with the emotional material of the film through increased emotional direction of the camera movement. Though there are still barriers of physical capital, using music, the barriers have been removed via the attempt to convey the same ideas visually.

All of the works reviewed engage with sound from a d/Deaf and hard of hearing perspective and remove barriers of physical capital associated with sound art works. Their removal disregards the audience's ability to hear sound. While still explicitly engaging with sound, the audience engages with sound through other senses. The purpose of hearing sound is abandoned, but the sound itself is still embraced. These works act as forms of d/Deaf and hard of hearing activism, seeking to make experiences more inclusive of all types of hearing and allowing a more diverse audience. The examples discussed provide a strong precedent to explore ways in which spatial audio can be explored, seeking to remove barriers of physical capital for those who are d/Deaf or hard of hearing.

5.5 Compositional Reforms

The interviews with the two composers and the review of works suggest that there is scope for development within spatial audio to remove barriers of physical capital to allow individuals with all types of hearing the ability to engage equally to one another. Through the deconstruction of various features of spatial audio, the barriers of physical capital needed to engage with spatial audio are attempted to be removed through compositional reform. The following sections proposed three new compositional methods; *imagined localization*, *static spatialization*, and *haptic spatialization*.

The initial interviews with the two composers informed these methods. To evaluate the efficacy of these methods, Composers One and Two (from the initial interviews covered in this chapter) were interviewed again. This time they were presented with the newly developed works and asked as to the works' level of interest as spatial audio works and their efficacy at breaking down barriers of physical capital.

5.5.1 Imagined Localization

Supporting files for creative work in this section can be found in the digital files folder. These include:

- *Still Moving*, a video example of imagined localization (5.5.1. Still Moving)

As individuals, our ability to localize sound is strongly informed, not just by our ears, but also by what we see (Wallach 1940; Witkin, Wapner, and Leventhal 1952; Middlebrooks and Green 1991; Blauert 1996; Kumpik et al. 2019). As a result, visual cues can dictate audience's spatial perception. In the case of the composers surveyed, they both have amplitudinal hearing differences between their ears, meaning they have difficulty in localizing sound through aural means.

This research proposes an approach coined ‘imagined localization’. In imagined localization, all horizontal and vertical spatiality is removed by only using mono audio while sound spatialization is implied through visual cues. Using this technique, a new audio-visual headphone work was created entitled *Still Moving* (Austin-Stewart and Draper 2021). The use of headphones for the playback of audio ensures there are no reflections from the room that could determine a varying spatial perception based on different types of hearing.

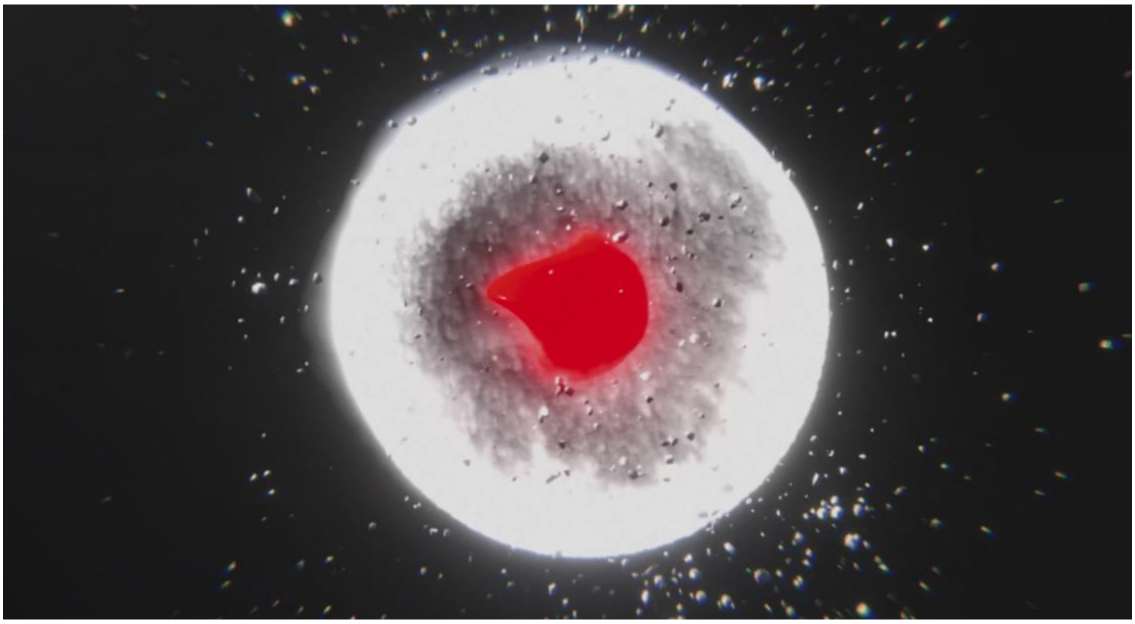

Figure 31 - Still Moving, image by Charley Draper

5.5.1.1 Composer Responses to Still Moving

In response to the work, the composers were surprised by their experience of the spatiality (Composer One and Composer Two 2021).

Composer One claimed “*there were moments when the red dot moved to the left… it felt like the spectral content changed a bit to suggest a spatial* *movement… I was perceiving a [horizontal] spatial change*…*The [flickery] stuff for me, it felt spatial. The [material that moved horizontally back and forth] at the start also felt spatial*". Additionally, Composer Two was surprised by the effect of the work "*If…there was [visual] movement, I would hear that movement projected into the work… At the beginning, I very strongly felt that something was panning… I felt as though it was moving [left to right]*".

Neither composer felt as if their spatial experience was hindered because of their hearing and both found the work to be spatially engaging, with Composer Two saying that the "*psychoacoustic thing going on was really interesting*."

The composers' responses illustrate that imagined localization allows for listeners who have a particular type of hearing to engage with spatial audio through means that don't feel obstructed by the format where listeners can perceive works as spatially interesting. The use of mono sound means that the perceived salient aspect of spatial audio of panning and physical spatial movement have been replaced by the psychoacoustic effect of perceived spatial movement through visual aid.

By creating spatial movement only through visual implication, and sticking with mono audio, barriers of physical capital have been removed for some individuals who are hard of hearing who have similar hearing to the composers surveyed.

5.5.2 Static Spatialization

Supporting files for creative work in this section can be found in the digital files folder. These include:

- A video example of static spatialization with accompanying B-Format audio (5.5.3. Static Spatialization)

The second newly developed compositional method is ‘static spatialization’. Accurate sound localization of spatial movement requires the listener to be in a fixed position with loudspeakers at the correct distance and angle and the amplitude of the sound varying between the loudspeakers to create a moving phantom image. As discussed, those who have amplitudinal and spectral differences in hearing between their ears are unable to accurately perceive changing spatial images. This presents a very clear barrier of physical capital. Static spatialization is a compositional approach devised to integrate those inter-aural amplitudinal and spectral differences.

In addition to the physical positioning of sound, our understanding and perception of space is also informed by the timbral characteristics of sound, where different types of sonic material (such as transient or sustained or low or high frequencies) are perceived differently spatially (Austin-Stewart and Zareei 2019; Barrett 2002; Rakerd and Hartmann 1986). Static spatialization is a compositional strategy designed for a multi-channel loudspeaker system that is void of a sweet spot where the different sonic materials with varying sonic characteristics are placed in one loudspeaker and do not move from loudspeaker to loudspeaker. Instead, the spatialization is caused by the listener moving throughout the room changing their position relative to the loudspeakers. This approach expands upon works in Chapter Four where listeners are given autonomy over the listening position. In static spatialization works, listeners are more specifically allowed to create novel spatializations through their own movement. It is through the combination of the removal of the sweet spot and the deliberate attempt to not spatialize material (through its movement between loudspeakers) that barriers of physical capital have been attempted to be removed.

5.5.2.1 Composer Responses to Static Spatialization

In answering questions regarding their experience with the work, both composers felt they were able to engage spatially with the work equally to those who are hearing.

> "*The interest that comes out of being able to hear things as they hit off the windows and walk through a zone where they reflect and then [don't]. There's a joy in that experience that [those who are hard of hearing and those who are hearing] would be able to experience fairly equally*," said Composer Two.

The composers also found the work interesting in the way that it gives agency to the listener. “*This felt really effective in democratizing spatial listening*,” said Composer One, with Composer Two adding:

> “*You’ve achieved a kind of democratization here… There is a lot more choice, you can experience it however you want. Being able to move around, being able to spend time in a certain place, being able to follow the sound in a way that you can't with traditional [spatial] sound works.*”

When asked how the work compared to other spatial audio works, Composer One said “*it’s hard to compare static spatialization to a quadraphonic or octophonic array because they are trying to achieve different things, but for what it is, I thought it was cool… I really enjoyed this spatially. I found it really effective*”.

From the composers’ responses, it can be suggested that static spatialization allows for an interesting spatial experience which gives more agency to the listener as to how they experience the work and, in turn, means there is no single intended spatial experience of the work. By allowing listeners to move around at their own pace and in whatever direction they wish, they are given the agency over the spatialization of the sound. The experiences of Composers One and Two illustrate that this can create interesting spatial experiences where audiences feel they can participate equally to those who are not hard of hearing or d/Deaf, in short, removing barriers of physical capital.

5.5.3 Haptic Spatialization

Supporting files for creative work in this section can be found in the digital files folder. These include:

- *Spatial Vibrations*, two documentation videos of an interface using haptic spatialization (5.5.5. Spatial Vibrations)

Imagined localization and static spatialization have both removed barriers of physical capital to spatial audio for some individuals who are hard of hearing. However, this is specific to the hearing experiences from the composers surveyed. Barriers of physical capital were not yet removed for those who are d/Deaf. Haptic spatialization is a newly devised spatial audio strategy that was developed in an attempt to specifically remove barriers for audience members who are d/Deaf.

Haptic spatialization is a spatial audio compositional method that employs physical feeling to communicate musical ideas drawing on the work done within musical haptics. In the case of this thesis, haptic spatialization has been explored using transducers to vibrate and audience's arm. Before discussing the resultant creative work, prior use of musical haptics has been investigated and the use of transducers as sound devices has been interrogated. The device entitled *Spatial Vibrations* is then introduced and composer responses are discussed.

5.5.3.1 *Musical Haptics*

There is a long history of the use of haptics in musical interfaces. Haptics involve a participant's engagement with an interface through touch in which the musical interface activates in some way. There has been a variety of research exploring musical haptics using vibrotactile feedback in the development of musical interfaces specifically for those who are d/Deaf and hard of hearing.

A common trajectory in haptic interfaces are vibrotactile chairs (Nanayakkara et al. 2009; Karam et al. 2009; Baijal et al. 2012; Jack, McPherson, and Stockman 2015). Nanayakkara et al's *Haptic Chair* causes vibrations through contact speakers attached to a custom chair. The researchers deemed the chair a success in enhancing the musical experience for d/Deaf individuals, however, they also note that the chair does not allow for any spatial variation. Karam et al, Baijal et al, and Jack, McPherson, and Stockman's various chairs differ from Nanayakkara et al's in that they allow spatial variation. The spatial variation is achieved by splitting incoming audio into various frequency bands to be felt in different positions on the body (e.g. high frequencies higher up the back, lower frequencies lower down the back).

There is also research that looks at the implementation of haptic music with media such as audio and visuals. Work by Danieau et al. (2013) and Petry et al. (2016) explore haptic music, but in multi-sensory applications. Hattwick et al. (2015) developed a wearable body suit with 30 vibrotactile actuators across the body that allow for spatial variance. This work has been in multi-sensory contexts, however, it could provide a singular haptic experience. Similarly, Elvitigala et al's (2019) wearable gloves provide spatial tactile stimulation to the fingers. They are intended to be used in tandem with other media, such as VR. Similar work has been explored by Mirzaei, Kán, and Kaufmann with *EarVR* (2020).

Søderberg et al. (2016) created a software interface that allows users to composer for a haptic device with a grid-based layout. The interface places an emphasis on pitch and melody. Its focus is on allowing d/Deaf and hard of hearing individuals to make music for hearing audiences and not themselves.

Currently works providing haptic experiences that afford equal inclusion of d/Deaf and hard of hearing audiences are limited. Development of interfaces that have more discrete spatial functionality than the vibrotactile chairs, provide musical experiences that aren't multi-modal, and view space as the salient feature of the work may address the issues of physical capital experienced by d/Deaf audiences.

5.5.3.2 Transducer Based Sound Art Works

Works that use transducers with no audible sound have a history within sound art practices. Blake Johnston's *Your Hearing Them* uses transducers in a headset designed to simulate (for the user) other people's perception of their own voice (Johnston et al. 2017). Natasha Barrett's *Crush-2* (2010) uses ultrasonic transducers to record the sound of rocks crushing which are later played back within an installation. Rebecca Kleinberger's *PHOX EARS* (Kleinberger 2015) is a helmet listening device that uses parabolic microphones and bone conduction transducers to direct the listener's attention to faraway sound sources. *Eidos (TJB 2013)* is a headset made of headphones, transducers, and directional microphones designed to cancel out ambient noise and allow the user to focus on speech more directly.

Figure 32 - Blake Johnston's your hearing them. Johnston, B. (2017). Your hearing them. Blake Johnston. [*https://www.blakejohnston.net/your-hearing-them*](https://www.blakejohnston.net/your-hearing-them) *[permission granted by copyright holder Blake Johnston]*

This collection of works demonstrates the established use of transducers in sound art contexts which could be further explored in combination with haptic spatialization for its potential to afford advances in removing barriers of physical capital for those who are d/Deaf.

5.5.3.3 Spatial Vibrations

Figure 33 - Spatial Vibrations, photo by Andy Hockey

Spatial Vibrations (Austin-Stewart 2021b) was devised to explore the potential of haptic spatialization to remove barriers of physical capital. It is an instrument made of four surface transducers that a person rests their arm on. The transducers vibrate distinctly from one another, where the participant feels the vibrations at various positions along their arm. A piece was devised for the interface that was played back for the composers.

Through the removal of audible sound, and its translation to physical vibration, haptic spatialization is an attempt to remove all barriers of physical capital present in traditional spatial audio.

5.5.3.4 Composer Responses to Spatial Vibrations

Both composers felt they were able to engage with the work spatially. They perceived their engagement to be equal to those who are not hard of hearing. They also said that their being hard of hearing had no hindrance to their spatial experience of the work (Composer One and Composer Two 2021).

Regarding the spatial aesthetic of the work, Composer One said "*It was interesting… I was drawn to the gestures. [The spatiality was found in] identify[ing] that one thing is going and then another thing is going as opposed to a spatial change*". Composer Two also found it interesting, saying that they "*think the idea of the confined spatial [space] is at least very conceptually interesting that I haven't experienced in other [sound] works*".

Figure 34 - Spatial Vibrations in use, photo by Andy Hockey

Summarizing the work, Composer One said "*I think this one is the most effective at overcoming my hearing difficulties because you've removed the difficulty entirely from people's experiences*"[15].

The interview responses from this work show that the use of haptic spatialization as a compositional method has led to the creation of a work that the composers did not feel was hindered by them being hard of hearing. They were able to engage with the work spatially and found it spatially interesting. They also found it effective to a degree that it removed all perceivable barriers of hearing that they have when engaging with spatial audio so that they could engage with it on equal terms to someone who is not hard of hearing. Through these responses, it can be theorized that those who are d/Deaf would have a similar response. This demonstrates that haptic spatialization is effective at removing barriers of physical capital to spatial audio while still maintaining spatial interest.

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[15] It is important to note the language used by this composer here. It doesn't align with language commonly used within public discourse surrounding hard of hearing and d/Deaf communities/individuals, however it does illustrate their experience within spatial audio. Their experience of being hard of hearing within spatial audio has been framed by the surrounding spatial audio culture as a physical capital barrier and as a difficulty that has needed to be overcome for them to participate equally to those who are hearing.

5.5.4 Summary of Compositional Reforms

Initial findings from these investigations into imagined localization, static spatialization, and haptic spatialization indicate that these compositional reforms have significant potential to remove barriers of physical capital for audience members who are d/Deaf or hard of hearing.

5.6 Future Work

There are lots of opportunities for future research in this field. More extensive studies with individuals with different types of hearing to the composers surveyed, as well as d/Deaf individuals, would allow continuation of this research trajectory.

Spatial Vibrations and its use of haptic spatialization creates a spatial audio work with no audible sound through engaging the audience's sense of touch using devices. The development of compositional methods for spatial audio works that engage with other senses (sight, smell, and taste), could also be explored in future research. Developments of works with these varying spatial compositional methods would act to further remove the physical capital needed to engage with spatial audio, removing barriers for those who are hard of hearing and d/Deaf.

There is also room for further surveys to be completed with larger sample sizes with more diversity of hearing to determine the comparative efficacy of the compositional methods developed.

5.7 Conclusion

This chapter engaged with the barriers of physical capital in spatial audio for those who are d/Deaf or hard of hearing. It identified barriers through interviews with two spatial audio composers who are hard of hearing. Reviews of other sound art works that have removed barriers of physical capital for those who are d/Deaf or hard of hearing outside of the context of spatial audio were completed. Three new compositional strategies were proposed and new works that address barriers of physical capital within spatial audio were created. The works created with the new strategies were reviewed by hard of hearing spatial audio composers who determined that the works presented spatial interest and that barriers of physical capital (particularly in the case of haptic spatialization) were removed. This research has illustrated that engaging spatial audio works can be created that don’t exclude based on someone’s level of physical capital, but rather create space for those individuals to take part in engaging with spatial audio to the same degree as those who are not hard of hearing or d/Deaf.

6 Gamification of Spatial Audio - Issues of Cultural Capital

6.1 Introduction

Academic and art institutions are the most common environments for music that prioritises space as the salient feature of the work. There can be entrance requirements to be educated in these academic institutions in spatial audio suggesting there is a required level of cultural capital to participate in the field.

This chapter addresses whether there is a relationship between one's level of spatial audio cultural capital and their engagement with the field. It also attempts to increase engagement with spatial audio for those with all levels of cultural capital, employing a Bourdieusian reflexivity through gamification and removing barriers of cultural capital.

Brändström (2000) illustrates a connection between generational economic wealth and the possibility to gain cultural capital. Not only is economic capital a barrier to exclusion based on the price of equipment, but it has been been theorised that those with more generational economic wealth have more potential to gain cultural capital. Additionally, work by Dimaggio and Useem

(1978) supports the idea that economic wealth is connected to participation in the 'high arts'.

The research presented in this chapter aims to explore the relationship between one's relevant cultural capital and their engagement with spatial audio. Strategies for the democratization and education of spatial audio to increase accessibility are presented. In creating the democratisation strategies a Bourdieusian reflexivity model was applied.

In the application of a Bourdieusian reflexivity, a radical rethinking of the field occurs where the codes [16] are changed so that formal or institutional education is not required. The level of cultural capital or habitus becomes less restrictive for inclusion in the field. While Södermain et al. (2015) call for a Bourdieusian reflexivity within music education, this is a novel approach to spatial audio.

6.2 Methodology

Firstly, a literature review on gamification and engagement was completed. Based off of this review, a method to measure engagement was developed. Thirdly, two studies were completed simultaneously; one to ascertain whether

[16] As discussed in Chapter Two, 'codes' are the knowledge required to understand the field. In the case of spatial audio, this would primarily consist of an understanding of the musical and aesthetic conventions of the field in regards to spatiality as well as an understanding of musical and aesthetic approaches in acousmatic music.

there is a relationship between relevant cultural capital and engagement with spatial audio and whether gamifying spatial audio increases engagement with the field. The results have been analyzed to determine if cultural capital is a barrier to engagement with spatial audio, and if gamifying spatial audio leads to increased engagement (and therefore removes barriers of cultural capital).

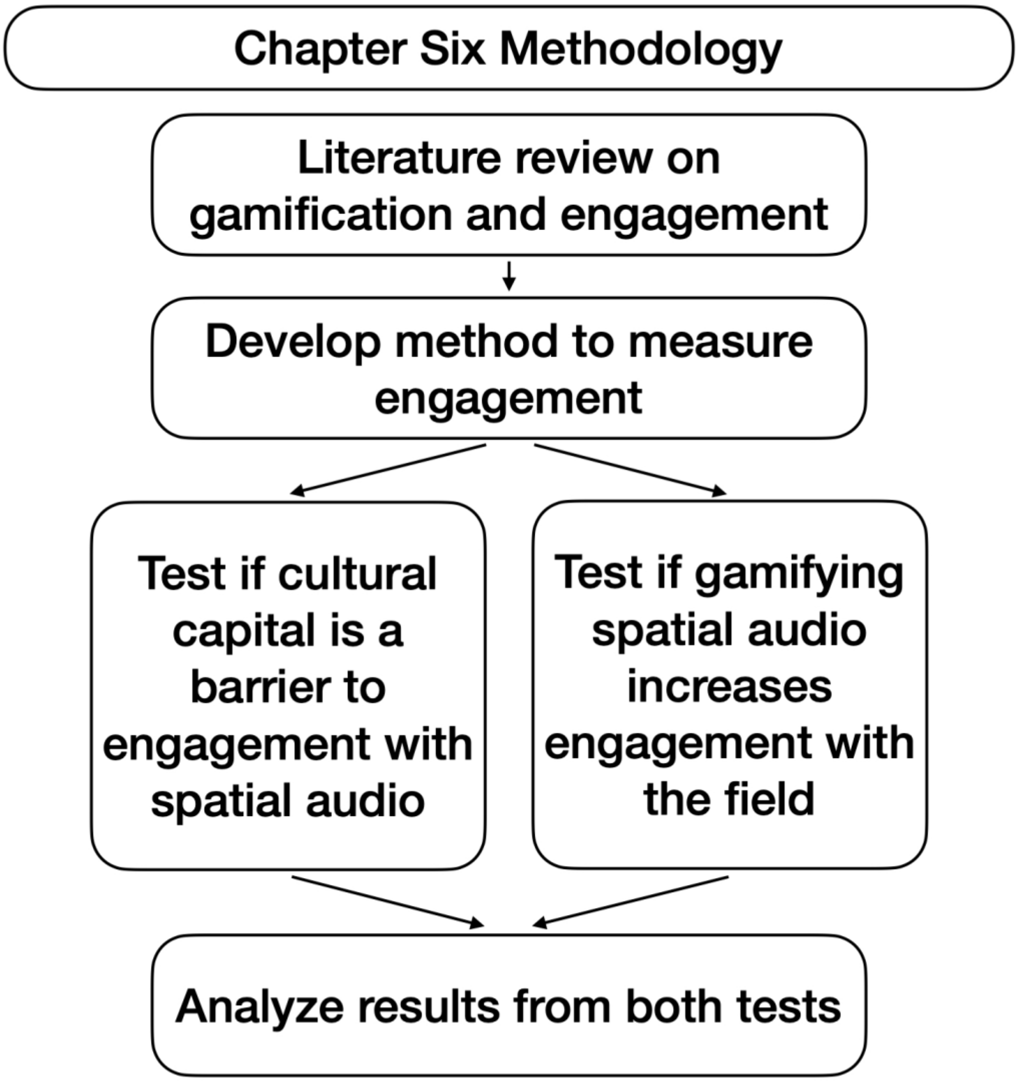

Figure 35 – Chapter Six methodology

6.3 Gamification Literature Review

6.3.1 Introduction

Gamification is commonly defined as the application or implementation of game features into non-game contexts, including both computer based games and non-computer based games (Stott and Neustaedter 2013; de Sousa Borges et al. 2014; Gomes, Figueiredo, and Bidarra 2014; Caponetto, Earp, and Ott 2014; Brigham 2015).

De Sousa Borges et al. make a clear distinction between gamification (“game developing techniques in non-game environments”) and *serious games* (“games designed for non-recreational environments and for educational purposes”), and *video games or digital games* (“systems in which users are engaged in resolving abstract conflicts and challenges, under predetermined rules”) (2014). This distinction shows that gamification is using game methods to communicate something that is already being achieved through another means; it is the process of implementing game features in a non-game context.

The overarching purpose of gamification is to increase motivation and/or engagement with a particular activity (de Sousa Borges et al. 2014; Brigham 2015; da Rocha Seixas, Gomes, and de Melo Filho 2016; Alsawaier 2018; Suh, Wagner, and Liu 2018). Gamification can also be used to increase fun or enjoyment for those who participate (Kankanhalli et al. 2012; da Rocha Seixas, Gomes, and de Melo Filho 2016). Definitions of engagement will be discussed within the section *6.3.4. Gamification for User Engagement*.

Gamification is implemented in a variety of use cases including in the context of “business, organizational management, in-service training, health, social policy, and education” (Caponetto, Earp, and Ott 2014). Within commercial use it is seen as a driver to “promote fundamental things like learning, employee performance, customer engagement, or even crowd sourcing initiatives” (Caponetto, Earp, and Ott 2014).

There is a large range of literature on the use of gamification as a tool within education to increase motivation and engagement. This literature has informed the gamification approaches in the research. In this research, gamification was used to communicate ideas of spatial audio to those without specialised education in order to remove barriers of cultural capital.

6.3.2 Gamification in Education

There is a wide variety of literature that looks at gamification within education including published literature reviews (Caponetto, Earp, and Ott 2014; Nah et al. 2014; de Sousa Borges et al. 2014).

Case studies suggest that gamifying courses, leads to an increase in student engagement (Stott and Neustaedter 2013). Certain underlying approaches are shown to be consistently successful within the literature reviewed; freedom to fail, rapid feedback, progression, storytelling.

Various strategies are implemented in the gamification of education. Nah et al. (2014) look at the effectiveness of strategies such as a points system, levels/stages, badges, leaderboards, prizes and rewards (all reward based gamifications), progress bars, storylines, and feedback with varying results for the strategies depending on context.

Within their review, Caponetto, Earp, and Ott conclude that the main driver for gamification is for “enhancement of motivation and engagement (Ott and Tavella 2009)… to make learning more attractive, captivating, and, ultimately, effective” (Caponetto, Earp, and Ott 2014).

Literature on the use of gamification more specifically within music education is limited, however, it shows similar results to the literature on education broadly. (Gomes, Figueiredo, and Bidarra 2014; Rovithis, Floros, and Kotsira 2018).

6.3.3 Gamification in Art and Museums

Much of the research within museum contexts looks at the use of gamification for motivation and communication of knowledge with similar purpose and/or results to gamification in education for intended/increased engagement (Ioannou and Kyza 2017; Kristianto, Dela, and Santoso 2018; Liu and Zaffwan Idris 2018; Jeon, Ryu, and Moon 2020; Tayara and Yilmaz 2020).

Further research explores utilization of gamification within art contexts. Romualdo (2013) poses that as funding decreases, art museums increasingly are required to compete for resources and support to financially survive. This leads some art museums to create gamified educational programmes “in order to involve visitors who may be ‘relatively uninterested in cultural activities’ ((De Freitas 2011) cited in (Romualdo 2013)).

Increased engagement with the visual arts can be seen through the gamification of street art through social media where participants are motivated to go to unfamiliar neighbourhoods and find street art (Ihamäki and Heljakka 2017; Foushée 2019). These examples show where location and social media based gamification have been used to increase engagement with visual art.

This section demonstrates ways in which gamification is used to increase engagement with the arts. These learnings have given context to support gamification in other arts areas such as spatial audio as a way to increase engagement.

6.3.4 Gamification for User Engagement

Much of the literature on gamification reviewed discusses how engagement may have increased, decreased, or stayed the same within particular education contexts. The literature on gamification for user engagement discusses how engagement manifests in particular contexts as well we how engagement is measured (Kankanhalli et al. 2012; Brigham 2015; da Rocha Seixas, Gomes, and de Melo Filho 2016; Alsawaier 2018; Suh, Wagner, and Liu 2018).

6.3.4.1 Tools to Measure User Engagement

Da Rocha Seixas, Gomes, and de Melo Filho look at the use of gamification in the classroom for the purpose of engaging students (2016). They measure gamification through a variety of indicators; autonomy, execution, social, delivery, participation, collaboration, cooperation, questioning, organization of the environment, and fun (da Rocha Seixas, Gomes, and de Melo Filho 2016). These criteria for engagement place a clear emphasis on the educational environment and are useful indicators to define and measure levels of engagement.

Elsewhere, Suh, Wagner, and Liu (2018), define and measure levels of engagement differently. Their paper proposes a theoretical model “which draws on cognitive evaluation theory to explain the effects of game dynamics on user engagement”. It says user engagement “must be characterized by a positive and fulfilling state of mind, such as vigor, dedication, and absorption. These three subdimensions represent the physical, emotional, and cognitive aspects of user engagement, respectively.” They define vigor as “the extent to which a user is willing to invest [their] persistent effort when engaging in a certain activity”; dedication as a ‘users’ sense of significance, enthusiasm, inspiration, pride, and challenge”; and absorption as “the extent to which a user is fully concentrated on and deeply engrossed in a particular activity, whereby time passes quickly without detachment from that activity” (Suh, Wagner, and Liu 2018). Overall, Suh, Wagner, and Liu suggest that gamification enhances user engagement when game dynamics satisfy their psychological needs.

In comparing the two examples, both use mixed methodologies to test the levels of engagement against their varying definitions of engagement. Bespoke models developed have proven successful in these two examples. The bespoke model used for gamification measurement within this research is further discussed in section *6.4.1. Gamification Method*.

6.3.5 Gamification in a Spatial Audio Research Context

Spatial audio has many musical conventions that are particular to the field itself. Engaging with musical works may be more difficult without knowledge of the field (without the relevant cultural capital). In gamifying spatial audio, the research goal was to determine whether it created a spatial audio experience that was more engaging than a traditional spatial audio experience for those who did not have the relevant cultural capital.

This literature review has looked at gamification with an emphasis on education and art and museums, and the effects of gamification on user engagement within these contexts. The results of this review has informed this research, suggesting that gamifying spatial audio may be successful at increasing engagement, and through related research, provides basis to develop a definition and methodology to measure engagement with spatial audio.

The next stage of this research sought to develop a model for spatial audio gamification, and a framework to measure engagement (informed by the relevant literature (da Rocha Seixas, Gomes, and de Melo Filho 2016; Suh, Wagner, and Liu 2018)).

6.3.6 Gamification Literature Review Conclusion

This literature review has looked at gamification with an emphasis on education and art and museums, and the effects of gamification on user engagement within these contexts. The results of this review have informed this research, suggesting that gamifying spatial audio may be successful at increasing engagement, and through related research, provided a basis to develop a definition and methodology to measure engagement with spatial audio.

The next stage of this research developed a model for spatial audio gamification, and developed a framework to measure engagement in this context (informed by the relevant literature (da Rocha Seixas, Gomes, and de Melo Filho 2016; Suh, Wagner, and Liu 2018)).

6.4 Gamification of Spatial Audio

The literature review from the previous section suggests that gamification can lead to increased engagement for those with lower cultural capital. If tthe hypothesis that there is a relationship between engagement with spatial audio and relevant cultural capital is correct, then gamification may be successful in removing barriers of cultural capital.

6.4.1 Gamification Method

A definition of ‘engagement’ was first developed based on relevant literature. A testing method was then created as to measure both engagement with gamified and non-gamified spatial audio.

This testing method was implemented on groups with varying levels of relevant cultural capital; a group of people with no tertiary degree (Group 1); a group with a non-music tertiary degree who have had minimal music engagement (Group 2); a group with a non-Sound Art degree in music or heavy music engagement (Group 3); a group with an undergraduate sound art degree (Group 4); a group with a masters or PhD in sound art (Group 5). Each group had an increasing amount of cultural capital relevant to sound art and spatial audio. By comparing the results from the studies of engagement of gamified and non-gamified spatial audio, differences and similarities between groups can be analyzed and the research questions can be investigated.

6.4.1.1 Model to Measure Engagement

Various definitions and measures have been used to determine level of engagement across connected research contexts (da Rocha Seixas, Gomes, and de Melo Filho 2016; Suh, Wagner, and Liu 2018). The examples cited developed definitions and measures of engagement that best suit their particular context. The model for defining and measuring engagement in this research is based off da Rocha Seixas et al's model. They provide a review of various ways authors define engagement and conclude "it is possible to observe there is a variety of engagement indicators of [participants]. They correspond to a measure that indicates the level of engagement" (da Rocha Seixas, Gomes, and de Melo Filho 2016). Da Rocha Seixas et al.'s indicators of engagement (autonomy, execution, social, delivery, participation, collaboration, cooperation, questioning, organization of the environment, and fun) are all relevant to the educational context they are investigating. This gives precedence to develop unique indicators of engagement that fit a spatial audio environment.

In an educational context, Fredericks et al. say that engagement can be split into three categories; behavioural engagement, emotional engagement, and cognitive engagement (2004). Behavioural engagement looks at participation in activities, draws on an individual's positive conduct, and looks at individuals displaying effort and persistence. Emotional engagement looks at an individual's affective reactions, including interest, boredom, happiness, and sadness. Cognitive engagement looks at an individual's psychological investment in a task and in mastering and comprehending new knowledge.

The way the Fredericks et al. define the three engagements can be appropriated to a spatial audio context. To ensure that the different types of engagement (behavioural, emotional, and cognitive) were evaluated, the indicators selected all fit within the definitions of those engagements.

Indicator	**Type of Engagement**	**Definition**
Autonomy	Behavioural	Did the participant want to continue the task/activity once it had completed and to what extent?
Feelings	Emotional	What emotions were felt by the participant when engaging with the activities?
Observations	Cognitive	What observations did the participant have about the spatiality of the activity?
Fun	Behavioural, Cognitive, Emotional	Did the participant enjoy the activity?

Table 2 - Engagement indicators, types, and definitions

These indicators of engagement are evaluated quantitatively and qualitatively through various Likert-type questions and written survey responses.

6.4.1.2 Survey Methods to Measure Engagement

The various types of engagement (behavioural, emotional, and cognitive) and their respective indicators (autonomy, feelings, observations, and fun) have been broken down below to determine the appropriate survey method to measure engagement.

To measure autonomy (behavioural engagement) a Likert-type question was used. To measure feelings (emotional engagement), participants were asked about the feelings they experienced while completing the activities. The results were then coded to compare the results. To measure observations (cognitive engagement), participants were asked what they noticed about the spatiality of the gamified and non-gamified versions of spatial audio. The results were then coded to compare the results. To measure fun (behavioural, cognitive, and emotional engagement) a Likert-type question was used.

The results across the various indicators of engagement were then compared across groups and activities.

6.4.1.3 Method to Test Hypothesis

In testing the hypothesis that there is a relationship between one's level of relevant cultural capital and engagement with spatial audio and to determine whether level of engagement increases when engaging with a gamified spatial audio, there are two studies. While outlined separately below, the studies occurred at the same time for survey participants.

6.4.1.3.1 Study One

The first study was testing the hypothesis. Participants were first played a spatial audio piece in a stereo headphone listening environment and then responded to a survey to determine engagement. The results were compared across the groups to determine if there is a relationship between relevant cultural capital and engagement with spatial audio.

6.4.1.3.2 Study Two

The second study examines whether gamifying spatial audio can result in increased engagement with the format. Participants were played a spatial audio piece in a stereo headphone listening environment and then responded to a survey to determine engagement. They also engaged with a gamified spatial audio activity, after which they were given the same survey to determine engagement. The results were compared to see if there are differences in levels of engagement between both activities.

6.4.1.4 The Activities

Supporting files for this section can be found in the digital files folder. These include:

- A short video illustrating how the game is played. The participant filmed was not one of the survey respondents and the example run time is shorter than the actual runtime of the game (6.4.1.4. Gamified Spatial Audio Activity)
- Audio files that were played back during the gamified spatial audio activity (6.4.1.4. Gamified Spatial Audio Activity)

6.4.1.4.1 Traditional Spatial Audio Activity

This was a listening activity in which the participants were given 13 minutes and 8 seconds of stereo spatial audio to listen to over headphones. Following this, they were given a survey to ascertain their levels of behavioural, emotional, and cognitive engagement.

Participants listened to Natasha Barrett's *Little Animals*. This work premiered in 1998 and was awarded first prize at the 25th Bourges International Electroacoustic Music Competition (France, 1998), received an Honorable Mention at the Prix Ars Electronica (Linz, Austria, 1998), and was a finalist at the 5th Prix International Noroit-Léonce Petitot (Arras, France, 1998). The piece was later re-released in 2017 on Barrett's album *Puzzle Wood*. The prizes *Little Animals* has received, along with the work's record label re-release, demonstrate it is a work that was deemed a successful spatial audio work upon release and also 19 years later upon re-release. These conditions also evidence that it is widely deemed as seminal to the field. Additionally, Barrett is someone who regularly has creative and written publications in the field of spatial audio. These factors suggest the work is appropriately representative of spatial audio conventions and traditions.

Survey responses based on *Little Animals* were reflective of listening to a spatial audio work widely deemed successful across decades by a composer who is heavily spatially engaged. This work was determined as canon and representative of a traditional spatial audio work that has its roots in acousmatic music.

6.4.1.4.2 Gamified Spatial Audio Activity

Participants played a game in which they were blindfolded and asked to attempt to tag a person who was moving around a room holding a bluetooth loudspeaker. This loudspeaker periodically played sounds utilizing spatial audio conventions (e.g. using a range of frequencies and using timbres that reflect timbres within acousmatic music). The activity was not unlike the water sport game Marco Polo and ran for 13 minutes and 8 seconds (the same length as *Little Animals*). The timbral aesthetic of the sounds were derivative of *Little Animals*, though were more gesturally static than active as to give the participants a more regular sound to follow.

Throughout the activity, the participants were incentivised by increasing level every two times they tagged the person with the loudspeaker. The levels were as follows: Beginner, Rookie, Amateur, Novice, Intermediate, Pro, Bronze, Silver, Gold, Platinum, Diamond, Crystal 1, Crystal 2, Crystal 3. The level of difficulty was varied by the person running the survey to keep it competitive for the participant. In practice, this looked like actively running around the room to avoid getting tagged, or slowly moving so that participants had an easier time finding the person. Participants were given a survey to ascertain their levels of behavioural, emotional, and cognitive engagement.

6.4.1.4.3 Activity Summary

Use of similar sonic material and same time length for both activities reduced the variables that could alter one's level of engagement. The main variables between activities were the format in which the musical material was delivered (as a musical piece or a musical game), and the spatiality. The spatiality is informed by the composer in the traditional spatial audio activity and by the game master in the gamified spatial audio activity – this is inherently part of the gamified format.

One could compare engagement between the activities, attributing any differences to the gamification and not to activity length or musical characteristic changes. The order of the activities was different for half of the participants, with half of the participants beginning with the gamified spatial audio activity and half begin with the traditional spatial audio activity to avoid any activity order bias.

6.4.1.5 Engagement Indicators

6.4.1.5.1 Autonomy

At the end of each activity, the participants were asked if they wanted to continue the activity and to what extent they wished to continue. This creates a hypothetical where if they were given autonomy to continue, whether (and to what extent) they would continue to engage with the activity. This adheres to Fredericks' et al. third definition of behavioural engagement, where behavioural engagements “draws on the idea of participation” evaluating the participants desire to continue in the task (Fredericks, Blumenfeld, and Paris 2004).

6.4.1.5.2 Feelings

Participants were surveyed as to their emotional response, being asked to provide a written response describing their feelings during the experience. This helped determine the emotional engagement of the participants, allowing the ability to survey their “affective reactions in the [activities] including interest, boredom, happiness, sadness” (Fredericks, Blumenfeld, and Paris 2004).

6.4.1.5.3 Observations

Participants were surveyed as to their cognitive response. They were asked to provide their observations of the spatiality of the music in the respective tasks. The responses were analyzed to determine what modes of listening the various participants engaged with.

Michel Chion’s *The Three Modes of Listening* describes three different ways people can listen; causal listening (what is the sound), semantic listening (what the sound means), and reduced listening (the qualities of the sound) (Chion 1994). When one listens, they may experience more than one of these modes of listening.

Using the modes of listening helped ascertain the ways participants engaged with the spatiality of the activities and provided an indication as to the "psychological investment [given] to comprehend and master knowledge and skills" (Wehlage and Smith 1992).

6.4.1.5.4 Fun

Some see the purpose of gamification to be increasing the fun for participants in order to increase motivation (Bisson and Luckner 1996; Prensky 2002; Shernoff et al. 2003; Kankanhalli et al. 2012; da Rocha Seixas, Gomes, and de Melo Filho 2016). Prensky sees fun as something that can lie between good and bad. " 'Fun' can connote both enjoyment and pleasure (good), and amusement and/or ridicule (bad)" (Prensky 2002). Defining fun points towards how fun connects to emotional engagement where people experience enjoyment, pleasure, amusement, and ridicule, defined as fun. Prensky splits these dichotomous definitions into their positive and negative senses saying 'fun in this positive sense can include real physical and mental exertion" (Prensky 2002). Prensky's definition of positive fun including physical and mental exertion illustrates cognitive engagement. "The enjoyment, pleasure or 'fun' we derive from… activities is the principal source of what makes us return to them again and again" (Prensky 2002). Returning to an activity and continuing to participate in it because it is as fun also demonstrates behavioural engagement. Prensky shows that a positive understanding of fun houses emotional, cognitive, and behavioural engagement within it.

Participants were asked how much they ‘enjoyed’ the activities on a Likert-type question. ‘Enjoy’ makes the definition of fun less ambiguous (abandoning the ‘negative’ fun that Prensky discusses).

6.4.1.6 Survey Questions

The following table provides each indicator and the relevant survey question(s) being used to ascertain engagement according to that indicator.

Indicator	**Question/s**
Autonomy	• Once the activity finished, did you have any interest in continuing the activity? • Please tick the circle most relevant to your interest in continuing/not continuing the activity once it finished. (They can choose from Not Interested, Mildly Interested, Moderately Interested Quite Interested, and Very Interested)
Feelings	• Please describe the feelings you had when participating in the activity
Observations	• Please describe any observations you had about the spatiality (the way the different sounds moved through space) during the activity.
Fun	• Please select the box that most accurately describes your level of enjoyment in the activity. (They can choose from No Enjoyment, Little Enjoyment, Some Enjoyment, Quite Enjoyable, and Very Enjoyable)

Table 3 - Engagement indicators and questions

6.4.2 Results

Supporting files for this section can be found in the digital files folder. These include: - A spreadsheet containing all participants answers to each question (6.4.2. Cultural Capital Survey Results)

This section examines the results for activities and groups based on the engagement indicators of autonomy, feelings, observations, and fun. The results of these indicators were looked at individually before being analyzed together.

While the results from this survey prove interesting, it is important to note their limitations. The results draw from a sample size of 21. Further research may later be done with a larger sample size and variations on gamified models. This research acts as a pilot study, showing preliminary results.

Note: In the tables within this section the traditional spatial audio activity may be referred to as the “Music” activity and the gamified spatial audio activity may be referred to as the “Game” activity.

6.4.2.1 Autonomy Results

Survey participants were asked two questions regarding their autonomy for both activities (they were the same questions for both). The questions are displayed below.

Once the activity finished, did you have any interest in continuing the activity? (Please circle an option) YES NO **Please tick the circle most relevant to your interest in continuing/not continuing the activity once it finished.** Not Interested O   Mildly Interested O   Moderately Interested O   Quite Interested O   Very Interested O

Table 4 - Autonomy questions

The responses from each group are displayed below. The question is outlined, followed by data of responses.

Question - Once the activity finished, did you have any interest in continuing the activity?

	Music Responses (Yes/No)	Game Responses (Yes/No)
Group 1	3/1	4/0
Group 2	2/3	5/0
Group 3	3/1	4/0
Group 4	4/0	3/1
Group 5	4/0	4/0

Table 5 - Yes/No responses to whether participants wanted to continue the game

Question - Please tick the circle most relevant to your interest in continuing/not continuing the activity once it finished.

	Music Mode	Music Median	Game Mode	Game Median
Group 1	Moderately Interested	Moderately Interested	Quite Interested	Quite Interested
Group 2	Mildly Interested	Mildly Interested	Quite Interested	Quite Interested
Group 3	Quite Interested	Quite Interested	Quite Interested	Quite Interested
Group 4	Moderately Interested	Moderately Interested and Quite Interested	Very Interested	Quite Interested and Very Interested
Group 5	Very Interested	Very Interested	Very Interested	Very Interested
All Participants	Moderately Interested	Quite Interested	Quite Interested	Quite Interested

Table 6 – Median and mode Likert-type responses as to whether participants wanted to continue the game

These results suggest that those with lower relevant cultural capital have less interest in continuing the traditional spatial audio task than those with higher relevant cultural capital. By the measure of autonomy, it is suggested that those with lower relevant cultural capital engage with spatial audio less than those with higher relevant cultural capital.

The results also suggest that those who have lower cultural capital (Groups 1 and 2) show increased willingness to continue to engage when spatial audio is gamified. There is also an increase from Group 4 and no change from Group 5. This suggests that not only may gamifying increase engagement based off the measure of autonomy for those with lower relevant cultural capital, but also that those with higher relevant cultural capital display increased engagement or no change. On average for all participants, the slight increase in desire to continue the activity demonstrates more behavioural engagement.

6.4.2.2 Feelings Results

Supporting files for this section can be found in the digital files folder. These include: - A spreadsheet containing quantified results from the coding of the qualitative responses of participants describing their feelings during the activities (6.4.2.2. Feelings Results)

Survey participants were asked a question regarding their feelings while completing both activities (the same questions were asked for both). This question is displayed below.

Please describe the feelings you had when participating in the activity

Table 7 - Feelings question

The participant's responses went through a double cycle coding process. The first cycle was inductive, seeking the themes that came through the different responses. Across both activities, the themes that emerged from participants' responses were the following: nervous/anxious, challenged/competitive, enjoyment/fun, frustration, boredom/losing attention, interested, satisfaction (including achievement), calm/comfort.

The second cycle of coding the responses was deductive, identifying how often the responses from the participants from each group fit the eight themes listed in the previous paragraph. The following tables show how many participants made observations about each feeling. The results that look at participants who reported multiple feelings are discussed briefly.

The coding of the results can be found in Appendix Three. An excel file can be found in the digital files folder for Chapter Six that shows the combinations of feelings participants reported (6.4.2.2. Feelings Results).

Traditional Spatial Audio Activity

	Nervous/ Anxious	**Challenged/Competitive**	**Enjoyment/Fun**	**Frustration**	**Boredom /Losing Attention**	**Interested**	**Satisfaction**	**Calm/Comfort**
Group 1	1/4	0/4	1/4	0/4	1/4	2/4	0/4	2/4
Group 2	3/5	0/5	1/5	0/5	1/5	2/5	0/5	2/5
Group 3	0/4	0/4	1/4	1/4	0/4	3/4	0/4	1/4
Group 4	2/4	0/4	1/4	0/4	3/4	2/4	0/4	1/4
Group 5	1/4	0/4	1/4	0/4	1/4	3/4	0/4	2/4
TOTAL	7/21	0/21	5/21	1/21	6/21	12/21	0/21	8/21

Table 8 - Feelings exhibited by participants during traditional spatial audio activity

Gamified Spatial Audio Activity

	Nervous/ Anxious	**Challenged/Competitive**	**Enjoyment/Fun**	**Frustration**	**Boredom /Losing Attention**	**Interested**	**Satisfaction**	**Calm/Comfort**
Group 1	3/4	3/4	1/4	1/4	0/4	0/4	1/4	0/4
Group 2	1/5	3/5	2/5	2/5	0/5	0/5	0/5	0/5
Group 3	1/4	3/4	3/4	0/4	0/4	2/4	0/4	0/4
Group 4	1/4	1/4	2/4	1/4	0/4	4/4	1/4	0/4
Group 5	3/4	1/4	4/4	1/4	0/4	0/4	1/4	2/4
TOTAL	9/21	11/21	12/21	5/21	0/21	6/21	3/21	2/21

Table 9 - Feelings exhibited by participants during gamified spatial audio activity

Many results such as “frustration” or “nervous/anxious” may perceived as negative emotional responses, but when analyzed in light of the game context and the other emotions expressed, it may be a response that shows engagement with the game.

This is illustrated in the following response which was coded as: enjoyment/fun, frustration, and satisfaction.

> “A little disorientated, sometimes frustrated with not knowing where to go. Happy when completed a level.’’

The feeling of frustration may traditionally be perceived as negative, but instead contributes to a complex emotional experience.

The activities differ in format and therefore bring out different feelings (emotional engagement) in participants. This means comparing the different feelings across activities do not allow for an effective measure of whether a group was “more” or “less” engaged. What can be said is that the traditional spatial audio activity saw more boredom/lost interest in Groups 1 and 2 (the groups with lower relevant cultural capital) than in the gamified spatial audio activity. This suggests emotional disengagement. Interestingly, there appears to be boredom/lost interest amongst Groups 4 and 5 (those with higher relevant cultural capital) in the traditional spatial audio activity as well. While one cannot compare the different emotions across groups and activities to determine level of engagement, boredom/lost interest may be considered as a measurement of emotional disengagement. This is seen through all groups (except Group 3) in the traditional spatial audio activity. Cultural capital doesn't seem to have an impact on emotional disengagement with traditional spatial audio, as most groups are similarly disengaged. Gamifying spatial audio appears to have led to a broader decrease in disengagement, with no participants expressing boredom/lost interest.

In addressing the research questions, there is not a considerable difference in boredom/lost interest when comparing Groups 1 and 2 with groups with higher relevant cultural capital. A lack of cultural capital, in the case of this survey, does not appear to correlate with a higher level of emotional disengagement. In examining the second research question, gamifying spatial audio, in the case of this survey, appears to have led to an decrease in the level of emotional disengagement during the activity.

6.4.2.3 Observations Results

Survey participants were asked a question regarding their spatial observations for both activities (they were asked the same question for both). The question is displayed below.

Please describe any observations you had about the spatiality (the way the different sounds moved through space) from the activity.

Table 10 - Observations question

The participants responses were read through and deductively coded according to the listening mode that the responses demonstrated (causal, semantic, or reduced). The results can be seen in the tables below. The coding of the responses can also be found in Appendix Four.

Key:

C = Causal Listening

S = Semantic Listening

R = Reduced Listening

Traditional Spatial Audio Activity

	Causal	**Semantic**	**Reduced**	**C & S**	**C & R**	**S & R**	**C, S, & R**
Group 1	1/4	2/4	0/4	0/4	0/4	0/4	0/4
Group 2	4/5	0/5	0/5	0/5	0/5	0/5	0/5
Group 3	1/4	0/4	4/4	0/4	1/4	0/4	0/4
Group 4	1/4	0/4	1/4	0/4	0/4	0/4	0/4
Group 5	1/4	0/4	3/4	0/4	1/4	0/4	0/4
TOTAL	8/21	2/21	7/21	0/21	2/21	0/21	0/21

Table 11 - Listening modes engaged with during traditional spatial audio activity

Gamified Spatial Audio Activity

	Causal	**Semantic**	**Reduced**	**C & S**	**C & R**	**S & R**	**C, S, & R**
Group 1	0/4	4/4	1/4	0/4	0/4	1/4	0/4
Group 2	0/5	5/5	2/5	0/5	0/5	2/5	0/5
Group 3	1/4	4/4	2/4	1/4	0/4	2/4	0/4
Group 4	0/4	3/4	4/4	0/4	0/4	3/4	0/4
Group 5	0/4	4/4	3/4	0/4	0/4	3/4	0/4
TOTAL	1/21	20/21	12/21	1/21	0/21	11/21	0/21

Table 12 - Listening modes engaged with during gamified spatial audio activity

In regards to observations and cognitive engagement, reduced listening is the listening mode that pays the most specific attention to the sonic characteristics of sound. In the traditional music activity, Groups 1 and 2 (the groups with the lowest relevant cultural capital) make no reduced listening observations. Conversely, the groups with high relevant cultural capital all do. It can be evidenced that the groups with higher relevant cultural capital had more cognitive engagement (through reduced listening) in their observations of the spatiality than those with lower relevant cultural capital.

Groups 1 and 2 both have increases in their response level of semantic listening and reduced listening when gamified. The groups with higher relevant cultural capital showed little change in reduced listening, though they show a significant increase in semantic listening. This increase in semantic listening may be attributed to participants attempting to use the sonic attributes of the sounds they heard to succeed in the game. Many participants' responses show a connection between participants' reduced listening and their semantic listening, identifying sonic characteristics of the sounds, and using them to understand how to play the game. This is in contrast to responses to the traditional spatial audio activity.

The responses to the traditional spatial audio activity show a much more causal response from the listeners. There are still some reduced listening responses though, once spatial audio has been gamified an increase in reduced and semantic listening responses can be seen, particularly within groups with lower relevant cultural capital. The observations made by participants suggests more cognitive engagement with the sonic characteristics (reduced listening) and what the various sounds mean (semantic listening) once spatial audio has been gamified.

6.4.2.4 Fun Results

Survey participants were asked a question regarding their level of enjoyment (fun) for both activities (they were asked the same question for both activities). This question is displayed below.

Please select the box that most accurately describes your level of enjoyment in the activity.				
No Enjoyment	Little Enjoyment	Some Enjoyment	Quite Enjoyable	Very Enjoyable
O	O	O	O	O

Table 13 - Fun questions

The responses from each group are displayed below. The question is outlined, followed by the average (mode and median) of responses for each activity and group.

Question - Please select the box that most accurately describes your level of enjoyment in the activity.

	Music Mode	Music Median	Game Mode	Game Median
Group 1	Quite Enjoyable	Some Enjoyment and Quite Enjoyable	Some Enjoyment	Some Enjoyment and Quite Enjoyable
Group 2	Some Enjoyment	Some Enjoyment	Very Enjoyable	Quite Enjoyable
Group 3	Very Enjoyable	Quite Enjoyable and Very Enjoyable	Very Enjoyable	Very Enjoyable
Group 4	Quite Enjoyable	Quite Enjoyable	Quite Enjoyable	Quite Enjoyable and Very Enjoyable
Group 5	Very Enjoyable	Very Enjoyable	Very Enjoyable	Very Enjoyable
All Participants	Quite Enjoyable	Quite Enjoyable	Very Enjoyable	Very Enjoyable

Table 14 - Median and mode Likert-type responses as to participant's level of enjoyment during the activities

It can be observed that the average enjoyment (fun) with the traditional spatial audio activity is lesser for groups with lower relevant cultural capital than those with higher relevant cultural capital. This supports the hypothesis that those with lower relevant cultural capital engage with spatial audio less than those with more.

Among Groups 2-4, there is an increase in average enjoyment when spatial audio has been gamified. Group 5 sees no change, but sees both of the activities as “very enjoyable”, the highest metric on the Likert-type response question. Group 1 sees a small decrease in average enjoyment. Those with lower relevant cultural capital (Groups 1 and 2) have varying levels of change in enjoyment (fun) between activities, so while individual claims for each group can be made, one cannot (with the participants surveyed) suggestively say whether gamifying spatial audio leads to a general increase, decrease, or no change in engagement (measured by fun) for those with lower relevant cultural capital. The difference in reported enjoyment for those groups is significant, however, with Group 2 moving from an average of “some enjoyment” for the traditional spatial audio activity to “quite” and “very enjoyable” for the gamified activity. In contrast, the decrease in average enjoyment for Group 1, once spatial audio has been gamified, is slim.

It can be observed that those with lower relevant cultural capital have lower engagement with spatial audio by the measure of fun than those with higher relevant cultural capital. It is also inconclusive as to whether gamifying spatial audio increases engagement by the measure of fun for those with lower relevant cultural capital, but when it does, it does so by a larger margin than when it decreases engagement. On average for all participants, gamifying spatial audio has led to an increase in fun from “quite enjoyable” to “very enjoyable”, further suggesting an increase in cognitive, emotional, and behavioural engagement.

6.4.2.5 *Results Summary*

When considered holistically, the results suggest a relationship between level of relevant cultural capital and engagement with spatial audio and that gamifying spatial audio increases engagement with the field.

In addressing the hypothesis of there being a relationship between relevant cultural capital and spatial audio engagement, some initial observations can be made. The groups with lower relevant cultural capital appeared to show more interest in continuing the activity than those with more. This suggests that participants had less behavioural engagement if they had lower relevant cultural capital. Groups with all levels of cultural capital also showed similar levels of emotional disengagement in regards to “boredom/lost interest”. The results don’t suggest that cultural capital informs one’s emotional disengagement. Groups with lower cultural capital showed less reduced listening, exhibiting less cognitive engagement with the sonic characteristics of the sounds. Groups with lower relevant cultural capital also showed less enjoyment than groups with higher levels of cultural capital in the traditional spatial audio activity.

Based off the indicators or autonomy, feelings, observations, and fun, those with lower relevant cultural capital, on the whole, showed less engagement (by the measures of behavioural, emotional, and cognitive engagement) with traditional spatial audio than those with higher relevant cultural capital. This suggests a relationship between relevant cultural capital and spatial audio engagement.

All groups either increased or had no change to their level of wanting to continue the activity once spatial audio had been gamified, suggesting more behavioural engagement. Participants showed a decrease in disengagement (boredom/lost interest) once spatial audio had been gamified, suggesting an increase in emotional engagement. There was an overall increase in semantic listening and reduced listening among listeners for the gamified activity. This suggests an increase in cognitive engagement. There was a general increase in enjoyment with the gamified activity (though staying relatively neutral amongst those with lower relevant cultural capital).

From these results, it can be observed that participants showed more engagement with gamified spatial audio than with traditional spatial audio. Additionally, amongst the groups with lower relevant cultural capital, increased behavioural, emotional, and cognitive engagement can be seen through the indicators of autonomy, feelings, and observations. The groups with higher relevant cultural capital also showed more engagement across all indicators

The results suggest that there is a relationship between relevant cultural capital and engagement with traditional spatial audio and that gamifying spatial audio may lead to an increase in engagement.

6.5 Further Research

There are limitations with this preliminary research that invite opportunity for further work. Firstly, the sample size of 21 is small so invites further research with larger sample sizes. Secondly, variations of the gamified spatial audio activity could be developed to test the efficacy of gamifying the format to increase engagement. There is also space to complete a causal analysis study on the relationship between level of relevant cultural capital and engagement with spatial audio to determine whether there is causation.

Furthermore, the pilot study within this chapter and proposed future research only serve to produce results that investigate the research questions of this chapter. This research would not, however, serve to change the culture within the field. This invites opportunity for practice-based research and public implementation of gamified spatial audio with the intention of decreasing the level of relevant cultural capital needed to engage with the field.

6.6 Conclusion

This chapter has investigated the connection between cultural capital and engagement, exploring two research questions. Firstly, is there a relationship between relevant cultural capital and engagement with spatial audio? Secondly, does gamifying spatial audio allow for increased engagement with the practice?

The survey results suggested that, by a variety of measures of engagement, those with lower relevant cultural capital engaged with traditional spatial audio less that those with higher relevant cultural capital. The survey results also suggested that gamifying spatial audio leads to higher engagement for those with *lower* relevant cultural capital and also those with *higher* relevant cultural capital. This suggests that gamifying spatial audio can remove barriers of cultural capital to engagement with spatial audio.

This chapter has established a connection between engagement and cultural capital, and addressed this through gamification of spatial audio. There is much room for further practice-led and practice-based research to further understand the relationship between gamification of spatial audio and cultural capital, and to actively change the culture of spatial audio to one that is more inclusive of audiences’ level of cultural capital.

7 Conclusion

This research addressed whether barriers of capital can be removed in the field of spatial audio. It explored issues of economic, social, symbolic, cultural, and physical capital and the barriers they present to the field. Creative-practice mixed-methodology research mitigating barriers to spatial audio was presented and their successes measure through quantitative and qualitative surveys. These responses suggest barriers of capital to spatial audio can be removed, allowing for increased engagement with audiences as well as composers.

The capital and spatial audio review from Chapter Two contributed a contextual understanding of the field and provided a lens of capital with which to analyze the field. Subsequent chapters examined barriers of capital identified within Chapter Two and other barriers identified through participant interviews and surveys. These identified barriers were then addressed through novel creative works in an attempt to reduce or remove apparent barriers of capital and their efficacy was analyzed through survey and interview responses.

7.1 Novel Contributions

This research has led to a variety of novel contributions to the field. Firstly, it has implemented Bourdieu's notion of capital as a lens to critique existing artistic systems and practices. This lens of capital has also been used to increase accessibility for audiences and practitioners. This has been exemplified through the removal of barriers of capital in the creation of new artistic works. New spatial audio works have been created in the form of pieces, installations, and games. Novel hardware and software has also been developed to remove barriers of capital from the field. New compositional frameworks and methods have also been developed to aid practitioners in the creation of spatial audio works that remove barriers of capital. A new compositional framework has been developed in order to assist composers in writing for novel non sweet spot arrays. In doing so, it provides composers a resource to write for a system with fewer barriers of capital than sweet spot systems. Compositional methods to include those who are hard of hearing and d/Deaf were also developed that were, in some cases, suggested to have removed all barriers of physical capital initially present for participants. Methods used to gamify spatial audio resulted in increased engagement compared to traditional spatial audio for those who aren’t educated in the field, resulting in a removal of barriers of cultural capital.

7.2 Future Research

The novel research throughout this thesis has presented a range of initial findings concerning the relationship between capital and spatial audio and ways to mitigate issues of access. However, there is scope for additional research opportunities

Future research could develop both the conceptual understanding of issues around access, and further test how Bourdieu’s capital model translates in a broader range of cultural and social settings:

There is need for future research in the intersection between gender, capital, and spatial audio in both the industry and education. Born and Devine (2015) identify how there is a significant gender divide in tertiary music technology courses, where music technology courses are predominantly made up by men. Similarly, Hoad and Wilson (2020) identify that a greater proportion of women and gender diverse individuals see themselves having barriers to music education. This research has suggested that there is a relationship between engagement with spatial audio and cultural capital. When looked at in conjunction with the work by Born, Devine, Hoad, and Wilson, it can be hypothesized that there are capital-associated issues within spatial audio based on gender as well. There is much need for these issues to be further investigated. Pearson and Wilkinson find (2017) lower educational attainment for men with same sex-sexuality who don’t attend college and for women with same-sex sexuality in general within the United States. With the research in this thesis suggesting a relationship between cultural capital and engagement with spatial audio, there is a need for further investigation in regards to engagement with spatial audio and sexuality.

The way spatial audio is situated within a post-colonial context has not been addressed. The impact of capital-associated issues on indigenous communities on their engagement with spatial audio and beyond would provide a new research trajectory. In Aotearoa New Zealand, Māori are identified as having lower net worth (economic capital) (“Wealth Patterns Across Ethnic Groups in New Zealand” 2016), lower educational outcomes (cultural capital) (“Education Outcomes Improving for Māori and Pacific Peoples” 2020), and higher disability rates (physical capital) (“Disability Survey: 2013” 2014). As demonstrated within this thesis, lower economic, cultural, and physical capital are seen to be significant barriers to engagement with the field. Further investigations are needed addressing Aotearoa New Zealand and global-oriented post-colonial issues within spatial audio and beyond.

Various technical tools and strategies have been developed within this thesis to mitigate issues of capital. The tools themselves could be further developed to continue to address issues of capital, and in effect, social issues.

The approach in Chapter Four focused on the sweet spot. While the research has suggested removing the sweet spot can result in comparatively interesting spatial audio works, the current spatial audio culture remains heavily reliant on the sweet spot. There is much further work both within the research and activist space to shift the culture of spatial audio towards works that don’t require the sweet spot to reduce the required capital to engage with the field.

The investigations of Chapter Five show there are opportunities to further research utilizing imagined localization, static spatialization, and haptic spatialization techniques. Works utilizing these strategies would aid removing barriers of physical capital by creating a larger body of work that audiences of all types of hearing can engage with. The ideas within haptic spatialization can be further extended in practice led and practice based research towards new spatial audio strategies that engage with other senses than touch (sight, smell, taste) and works informed by those strategies.

There also opportunities for further research in relation to removing barriers of cultural capital from spatial audio. The investigations into gamification have suggested that gamification appears to be effective in removing barriers of cultural capital to spatial audio to increase engagement for those with lesser relevant cultural capital. While this investigation showed promising results, there is room to develop a more public-facing gamified spatial audio broadly engaging both research communities and the general public. This public gamified spatial audio could then use quantitative and qualitative approaches testing the results presented here in Chapter Six. This could in turn, inform further research in the gamifying of spatial audio, potentially with commercial outcomes given games global popularity.

7.3 Towards an Inclusive Future

This thesis has illustrated ways in which spatial audio has excluded people, thus prohibiting them from engaging in certain areas of the arts. These issues of engagement with spatial audio help to demonstrate the impact of the unequal distribution of capital within society.

By understanding capital in spatial audio, it sheds light on the fundamental power structures that underpin Western art. Similar issues of capital may be found throughout Western art traditions. As Western art is often publicly funded, it becomes an issue of public justice, where many audiences are excluded as they do not have the required capital to engage. Other researchers address the inequities and inequalities within the arts through policy and activism and there is further work to be done in reforming artistic practice. The continued funding of these Western art practices and institutions serves to uphold classist notions of power, preserving the capital of the dominant class, while restricting the opportunities for those with less capital.

These institutions of power present themselves as removing barriers of engagement to appease the public and funders, though, in reality, their actions maintain power and capital. They must undergo radical transformation to transform their art in a way that empowers all people.

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9 Appendices

9.1 Appendix One: Multichannel Monophonic Compositional Framework

Introduction

A multichannel monophonic spatial system is a multichannel loudspeaker system where loudspeakers are addressed individually through monophonic spatio-compositional strategies. The purpose of this system is to allow for the creation of spatial audio experiences that are equally intended experiences regardless of where you are positioned in relation to the array. A monophonic system is one in which the channels are addressed discretely of one another, and sound does not move from speaker to speaker through phantom imaging.

Multichannel Monophonic Spatio-Compositional Methods

The spatial compositional strategies in the following sections attempt to give the composer ways to approach a multichannel monophonic spatial system to create spatial works that may provide equally intended spatial listening experiences without knowing the listening position. These methods are devised so that they may be effective regardless of the number of loudspeakers, those loudspeakers' positioning, or the direction in which they are facing.

Spatial Allusion

One may create a spatial allusion with this type of system. A spatial allusion is where another space is described, but not realistically spatially portrayed to the listener. An example would be if the listener were to hear wind, they would imagine themselves outside, but the sonic spatial image created may not be wholly representative of what being in that space would sound like. This would allude to that sound, rather than be a spatial illusion (where it does sound like you are within that space) (Barrett 2002).

Spatial Movement

Unlike stereophonic systems, you cannot pan sounds around a multichannel monophonic system. You are able to use other methods to spatialize, however. One may change the location of sounds by changing which speaker they are sent to randomly (or not randomly) (Baalman 2010). One could also use panning methods to move sounds between loudspeakers. This would mean that the composer would not be able to be certain of which positions the sounds were moving between, but it would provide interesting spatial results/opportunities.

Timbre Spatialization

One may split the various frequencies of a sound and send those to different loudspeakers. This may using basic EQ or multiband compressor plugins (or more complicated means) to break a sound up into different frequency groups. These separate groups may then be sent to different loudspeakers to spatialise the sound (Normandeau 2009).

Temporal Nature of Space

As people, we have a strong sonic spatial memory. With the multichannel monophonic system, composers can use this memory, by implementing particular spatial ideas over the course of a piece, that may return (with the audience being familiar with those spatial ideas upon their return) as a way to construct a spatial form (Barrett 2002; Wishart 1985).

Localization Characteristics of Varying Types of Sonic Material

Sounds with quick attack are much easier to localize than sounds with slow attack and steady-state sine tones or similar types of sound do not provide useful localization information unless they have an initial attack (Rakerd and Hartmann 1986). It is also impossible to localize a steady low frequency sine tone in a room and the localization of steady noise can be degraded by increasing reverberation (Hartmann 1983). Higher frequencies and texturally varying material can also be more easily located than lower frequencies and static material (Barrett 2002; Blauert 1996). The types of sonic material used may be varied throughout a work to change the listener’s perception of the space in which they are in and to add spatial variance.

Loudspeaker System Design and System Selection

When composing a work, if you are also designing the positioning of the loudspeakers, it is important to consider how their placement can enhance your work spatially and the work's compositional intentions. If selecting an already devised system, one must consider the compositional implications of that system (Austin-Stewart and Johnson 2021).

Compositional Suggestions

It is recommended that these compositional methods are integrated with one another for spatial interest. Through test sketches, the author found that there is a tendency, when used solely by themselves, for these different compositional methods to be spatially uninteresting. This suggestion does not mean that they always need to be integrated, but the integration and lack of integration must be something that is thought about when considering the spatial form of the work.

9.2 Appendix Two: Multiple Monophony Composer Survey Responses

Note: Composers 1-5 provided written responses to questions. These responses are below exactly as submitted. Composers 6 and 7 had oral interviews where their responses have been summarised in their responses below.

Listening Questions

1. **After listening to the various recordings of your work, how representative were the recordings of your spatial intentions?**

Composer 1: Overall, I think the recordings are a good fulfilment of my spatial intentions, which were to create a dynamic, active soundscape with sound objects which travel quickly over large distances and act in a random, semi-chaotic way. I can hear in the recordings (some more than others) than this has been achieved.

Composer 2: The recordings represent the spatial intentions well apart from that I expected the audience to move through the space and had considered their movement as part of the spatial aspect of the piece.

Composer 3: They seemed very representative - I could hear the spatialization of the voices around the room, and given the reverberant nature of the gallery I felt that they blended as intended.

Composer 4: [unanswered]

Composer 5: The movements were less accurate, as being played in a bigger space the sound got more “washed out” than I had intended. Everything else was pretty accurate.

Composer 6: A lot of the recordings were really different. I used a percussive medium and melodic medium and in some of the recordings you’d get a lot of the transients and in others you’d get a lot of the drone material. Some of the recordings were more accurate of my spatial intentions than others.

Composer 7: They weren’t super representative. For some of the spatial concepts I was trying to explore, they felt lost in the in the realisation of the work. Not necessarily lost in the recording itself, but lost in the space of the work. The room played a large part in the piece not sounding as I had planned.

2. **Did you find the spatial aesthetic (meaning the effectiveness of how sounds interreact and move through the space during the work/s) of the various recordings ‘interesting’?**

Composer 1: In short, yes. The “interesting” factor was how the spatial aesthetic changed between recordings, and noting how these changes affected my judgement of the work’s success and whether the arrangement of channels was “optimal” or not.

Composer 2: Yes but perhaps it could have been more interesting in more unconventional spaces.

Composer 3: Absolutely! I’m a huge fan of how spatialised composition interacts with the environments they’re presented in too.

Composer 4: I think my approach to multichannel stuff up until now has been interested in specific patterns. A big block around this project I experienced was the abdication of a certain level of control over how they would play out in space.

The piece I hear is much easier to engage with as a new listener as a result, which itself is ‘interesting’

Composer 5: Yep. Obviously, it was not as effective as in person but the recordings from the different points in the room allowed the different parts of the piece to be explored.
Composer 6: Some of the recordings appeared ‘uninteresting’. Some felt flatter relative to the other recordings.

Composer 7: Somewhat. I don’t think I was successful in realising what I wanted to achieve with the work spatially. While this is the case, there was still spatial interest.

3. **Did you feel that a particular recording was more representative of your spatial intentions or were they equally representative?**

Composer 1: I particularly liked 01, as I felt that the recording position gave a really even balance of sounds – loud and delicate, high and low frequencies. Because I know the level of detail present at each point in the work, it was nice to be able to hear them all clearly – though perhaps other people wouldn’t really notice a difference! In 03, the recorder is placed very close to the “pedal point” track which only contains a sustained bass line. Hearing this so clearly in some parts was a little annoying and took away from its purpose, which was to support and punctuate other sounds, rather than take centre stage. Another interesting outcome of the spatialization – we’ve found a position which doesn’t seem “optimal” to me; some of the sound objects still have optimal trajectories/distances from others, despite the intent for this to be random. I also really enjoy 06, as I get a sense of a larger space and sounds travelling over a larger area. I like the sense of gravity and impact that this creates as the sounds fly through space.
Composer 2: Equally representative. The spatial intentions were based on the brief to write a piece with no intended sweet spot.
Composer 3: I believe so - with this composition, it would have been cool to contrast a POV recording with someone getting up close to the speaker too, but in general it seemed representative. I really enjoyed hearing the composed reverb in the piece versus the real-world acoustic.
Composer 4: All felt the same
Composer 5: In each recording certain parts of the piece are more noticeable. This was the nature of my piece as it was disjointed with a lot of different materials, which the different recordings exemplify. The parts towards the end in which all speakers are involved are as I intended in all the recordings, so I would say there were equally represented.

Composer 6: The fourth one stood out to me. I found it 'moved' more. It had a lot more of the original image that I intended when composing.

Composer 7: I didn't form a strong preference for any of them. I found that there were different things that came out of the different recordings, however, there wasn't one that stood out above the others.

4. Did you feel as if the spatial aesthetic was more interesting in some recordings or as if they were somewhat equally interesting to one another?

Composer 1: It certainly sounds like sound objects tend to be placed further apart in some recordings. It may be that I didn't distribute sounds randomly/evenly across the tracks, and favoured a discourse between a group of three or four channels which happened to be placed closely together in one of the recordings. I don't think this is necessarily telling of the system itself, and more of composer fallibility! I'll be more careful next time (lol) or compose in a different way.

Composer 2: Equally interesting. This is personal taste. To me the spatial aesthetic in any listening position is equally interesting because my interest is peaked mainly by the process of discovery.

Composer 3: It definitely felt like each recording had its own tonal variation, which was curious and surprising but on the whole, felt expected. All interesting!

Composer 4: Instances where perhaps a microphone was positioned closer to one speaker or another, giving different platform or base of focus for instances of the piece

Composer 5: As stated above, each recording exemplified different parts of the piece, so each recording had a different take on the spatial interest of the piece (but equally as interesting).

Composer 6: I found some recordings more interesting than some others.

Composer 7: I didn’t form a strong preference for any of them. I found that there were different things that came out of the different recordings, however, there wasn’t one that stood out above the others.

5. **In what ways is the result of the work what you intended and in what ways does it differ?**

Composer 1: The work seems to be as immersive as it possibly could be in this space. I am really pleased with this outcome, especially since I was unsure whether the measures I took to thicken the texture of certain points would be successful. I also knew that the spatialization would be random, which meant I had to keep an open mind about where sounds would end up. In that way, the system has fulfilled my expectations, giving many different configurations which all have their own character.

Composer 2: I had expected the speakers to be dispersed randomly throughout the room facing random directions. My online implementation of the work is closer to what I had pictured in that sense.

Composer 3: I am unfamiliar of the acoustic of the exhibition space. Usually when I write a spatially composed piece, I will mix it to be site-specific so knowing only that it was a moderate to large space with high walls and large flat reflective surfaces felt very weird as the composer! But in another way it reminded me of how early medieval Christian choral works are composed - each voice occupies a specific space in church and the composer only has limited amount of control exerted on the acoustic of the space and how the colours of the sounds will blend. It is simultaneously freeing, but also as someone who is usually so involved in the process on the tech side, it takes some getting used to the change in process! Sonically-speaking, it is largely what I anticipated from a very reverberant vocal-based piece.

Composer 4: I think I’ve pointed towards it already but I derive patterns from specific output numbers. Meaning that when speakers are positioned differently, the pattern could be scrambled or refracted in some way.

Composer 5: The ambient recordings sounded much more immersive than I thought as it was hard to imagine that effect from within the DAW. I intended for the gestures towards the beginning of the piece to be more jarring. They still played with the different locations as I expected but over a bigger space the effect was a bit more “washed out”, which was also due to the reverb I was using. Some of the smaller gestures were much more noticeable when played in the space which was cool because there was some stuff in there I wanted, but at times also distracted from the overall effect I was wanting. I feel as if the spatial allusions I had tried to create were better than I was expecting.

Composer 6: I did not foresee how the sound of the room would affect the end result of my work. I pictured it being more dry and events more clear to localize, but instead, it was rather a cacophony of sound.

Composer 7: The reverb of the room greatly effected the end result in comparison to my intentions. The inability to work on my piece within the space made it difficult to execute the spatial ideas I wanted to achieve as I was unable to understand the effect the room would have on the end result

6. **Were there spatial aspects evident within the recording that you did not expect when composing (if any)?**

Composer 1: I didn't expect the room to be so responsive to the sounds in the work – from the recordings, it seems like I could have kept my sounds completely dry of reverb and let the room colour them as it will. I did try to plan for this a little bit by reducing my use of reverb across the work and instead focusing on creating a sense of "envelopment" through repetition of the same sustained sounds across multiple speakers, but next time I think it would be good for me (if possible) to test out sounds in the space, get an idea of its response, and then compose the sounds accordingly. Of course, that is not in the spirit of this experiment though…

Composer 2: I was expecting the unexpected and so therefore none.

Composer 3: I wasn't sure about how obvious the noises listeners made in the space would impact the piece. Occasionally when I heard noise from people in the space through the recordings, it surprised me how present they were in the recording, and got me wondering about the acoustic of the space, how much space people absorbed before the sound became dry. I was extremely surprised not to hear any wind or environmental sound from outside, being that it was a gallery in Wellington! There was an unusual hum in the last recording which sounded like the resonant frequency of the gallery, or perhaps air conditioning?

Composer 4: The room itself! Naturally that would happen, but I had no idea what the space would sound like. Also people moving through the space, or other organic sonic events taking place during the recording

Composer 5: The one thing I noticed most was the hight [sic] created by the higher frequencies. This was something I would have played with more if I had realised it when composing. It wasn't super evident in the recordings but very effective in person.

Composer 6: The sound of the room. Reverb of the room tones down the transients.

Composer 7: How significant the effect of the sound of the room would be.

Compositional Questions

1. **How many works have you created previously where spatiality was an integral aspect of the work?**

Composer 1: Many of my previous works involve space as an integral creative decision, however not often in a "large diffusion" environment. My works tend to occupy the monophonic and stereophonic space, and experiment with the significance of spatial characteristics in these "small diffusion" works.

Composer 2: 5-10

Composer 3: It is a core part of my sonic arts practice, I've lost count! A lot.

Composer 4: few - mainly for university work in the past

Composer 5: I have only completed two other major works which were spatial, one of which was binaural.

Composer 6: I've only done 5.1 and 7.1 works at uni. One was a soundtrack for a movie and the other was sort of a spatial illusion/allusion of a scene for 5.1.

Composer 7: 15. A lot of my works, space plays a pretty important role or the medium that the work is for, makes space a pretty important role. About 5 works space plays an important conceptual role. I've done a couple of octophonic works and live electronic works

2. **When composing your work, how did the multichannel monophonic framework inform your compositional process?**

Composer 1: I decided to compose the work in stereo first to get an idea of how I wanted sounds to move, then "up-mix" to the 12 monophonic channels. I could easily have begun by composing in the 12 monophonic channels, but because stereo composition is my most comfortable space, I thought it would be more authentic for me to realise a piece in stereo, *then* decide how to best appropriate it for the multichannel monophonic framework. The intended end-point of the piece impacted on the treatment of the sound material – while in the initial composing stages, I was constantly imagining how these sounds would be heard in the more open space. The ease of moving each sound object or phrase into the monophonic framework also informed what I included in the piece (asking question like "will this be easy to transfer into the 12 monophonic channels? If I compose this phrase like so, will it have a similar impact once I transfer it?")

Composer 2: It was one of two central focuses of the piece. The other one being the live coded sound materials. Once I had the materials ready, the piece essentially became a panner in Max/MSP that was built to realise the 'problem' of panning sounds without knowing the speaker positions.

Composer 3: It made me think about the role of each specific sound very carefully - I felt there was a reasonable amount of restriction in timbral composition because typically when I write for multi-channel works, I could take a sound and move it around a speaker array, so in that sense I felt myself thinking reasonably ‘statically’. However, it put the focus back on sounds and harmonies themselves that would lend themselves to movement in the music themselves. It re-framed how I approached gestural composition in a big way.

Composer 4: felt like a very different seed to begin creating a work from - explicitly considering movement through space, as opposed to timbre, or harmony

Composer 5: I decided on the materials I was going to use and composed some ideas before even using the framework. As it went on, I used the ideas within the framework to create a form within my piece, using the timbre spatialization and spatial allusion to create the fuller parts of my piece. I then went back and edited a lot of what I had done with more of a focus on the framework.

Composer 6: I really liked the framework. I took almost all of the ideas and tried to incorporate them within my work. I found it confusing differentiating between spatial illusion/allusion.

Composer 7: It informed the work a lot conceptually. I found that the framework restricts you in many ways. Given that my own practice is very much rooted in the audience’s perception, I found this quite frustrating. That forced me to think “what is interesting about this?” and how will I work with the speakers without being able to pan things between speakers. I had maybe 4 or 5 ideas that could be explored through the framework and chose the one I thought would be the most coherent. As I didn’t know where the speakers would be, it made me revert to more fundamental spatial ideas, such as spatial density or spatial flux, rather than specific movement of sounds. I also used the framework as priming for my compositional ideas

3. **When composing your work, how did you (or didn't you) approach the issue of not being able to recreate the listening environment that the piece would be in (e.g. did you pan your different stems to hear them in different positions? Did you leave everything in mono throughout the process? Etc)?**

Composer 1: Once I had composed the piece, I distributed my sounds across the 12 monophonic channels. This was something I thought about a lot and simply had to imagine. I tried to re-create the many chaotic sound trajectories in my work by using manual panning (i.e., sounds fading out in volume in one channel, then increasing the volume of the sound in another channel to create a spatial trajectory). Obviously, I didn't know which channel would be situated where – which luckily worked very well with my particular piece – so I imagined how it would sound to have objects pinging randomly all over the space. Where I wanted sounds to be smoother, more enveloping, I copied them across multiple (or all) channels – imagining that this would result in an enveloping sensation for the listener.

Composer 2: I routed all sounds through my Max/MSP panner and then sent them to reaper where the mono sources were assigned positions in a binaural sound space.

Composer 3: I panned everything very hard on headphones and left all the stems on mono so I could get a sense of the individual 'voices' in the mix.

Composer 4: mono stems - that part felt particularly difficult to navigate, I panned things around various parts of the stereo field but ultimately yielded significantly different results from where speakers were placed in the space

Composer 5: This was one of the parts of the process I found the most challenging. I mostly panned the stems into different positions to hear them in different ways. I composed the piece on x number of tracks and then compressed them down into 12 tracks. I left everything in mono in the process because I didn't want to compress down from stereo and lose certain spatial aspects in the process. I spent time listening to each track individually so I could realize how they held their own, as well as in the context of the mix. I also tried to listen to them through speakers so I could see how they would sound in a space.

Composer 6: At the very start, I attempted to use split panning (panning of left and right of a stereo track) and pan each of the 12 channels of the left/right of both of those sides. I eventually gave up on that idea and approached it from a mono stance. I wrote my material and assigned it to the speakers aftrewards and listened to each individual speaker as I was going.

Composer 7: As I don't have any access to a multichannel system, I had to use headphones or speakers. As I was dealing with beat frequencies, I had to be aware they sound quite different when in mono, so I panned them hard left/right to get a better idea of how they'd sound. I did do some general panning of the sounds that would have more spatial flux to get a rough idea of how they'd sound. I worked in a way I would normally work, but I had to keep reminding myself that there was a big realisation difference form what I was hearing and what the work would be.

4. **Describe your process of taking ideas from the compositional framework and using them in your compositional process.**

Composer 1: I particularly liked the idea of spatial allusion – however, rather than inspiring me to allude to a real-world space, I decided to subvert this idea and allude to non-realistic spaces to evoke interesting landscape images in the mind of the listener.

Composer 2: This was mainly the case when I creating the panning system in Max/MSP. I largely created it based on drawings and diagrams of how I could manage sound panning between a randomised multi-channel speaker setup.

Composer 3: I think Timbre Spatialization was the most successful aspect of the framework included in my contribution, by providing each speaker a 'voice' in the fray against a backdrop of ambient colour. As I wasn't working directly with the technology it really changed how I approached the re-working of a song.

Composer 4: interested in making patterns that moved through space at different rates and in different ways

Composer 5: I use a lot of field recordings in my work and I initially struggled when having to put them into mono, which is where I tried to create a spatial illusion by splitting them into different frequencies. To add form in the piece I simply increase/decreased the number of speakers I was sending to at different points. The sounds I was using in the first half of the piece were all sounds which had quick attacks and sharp gestures, allowing them to be easily localized and lead the listener around the room.

Composer 6: I used the ideas of Spatial Movement, moving sine tones around the speaker and moving percussive sounds. I then listened to my final stems by themselves and then together and if it didn't sound terrible, I thought it would work. I also explored timbre spatialization and localization characteristics of different sonic material in my work as well.

Composer 7: Some of the ideas, such as spatial allusion, were less applicable to my concept than others. I focused more on the timbre spatialization, localization of various sonic material, and spatial movement sections. When I was reading through the framework, I thought about what I find most interesting in spatial works myself. I used the framework to identify what I could do with the new system, as I knew there were things I wouldn't be able to achieve that I was able to with my previous spatial works. A bunch of the ideas sparked a bunch of ideas for me of how to realise the piece. It had a bit of an effect on the conceptual part of the piece, but had a big effect on my realisation of the piece.

5. **Having now heard the recordings, what (if anything) would you change about the compositional experience?**

Composer 1: Yes.

- make sure that sound objects contain value outside of their spatial trajectory – in case I am not satisfied with how short/far the sound object has to travel.

- Get a better idea (through correspondence, binaural recordings or visits) of how the final performance space reacts to sound, and adjust your spatial effects accordingly. I.e. dry space? Room for more reverb creativity. Wet space? Keep the sounds dry, perhaps exploit the relationship between sound and space by using short, sharp sounds, etc.

Composer 2: I would like to add more variety to my panner and spend time tweaking it according to different sound sources. I think I could have created more interesting textures by breaking down the sounds further and assigning more individual panning trajectories to different parts of the sounds.

Composer 3: I found it extremely challenging to just imagine the sounds in the space, and usually try to compose on the speaker arrays I work with. In future, I would absolutely love to have an opportunity before opening to work with the speaker array to try out my ideas and see if they actually translate outside of headphone. It was a little bit like feeling around in the dark for me!

Composer 4: it would be much more compelling if I knew the placement of the speakers in the space to guide the piece into the space itself rather than seemingly stochastic patterning around the room

Composer 5: I would have tried to create a more immersive piece, focusing on the composition as a whole rather than trying to fit the technical details of the brief (easier said now knowing how it sounds on the system). The immersive parts of the piece ended up being quite effective, and moments where I was utilizing most of the speakers make the piece sound more complete.

Composer 6: I would love to try the same thing knowing where the speakers are or using a plugin that simulates the experience of working with that speaker configuration.

Composer 7: Being in the space would have helped. Also using the particular speakers. In the computer you get all of the constructive interference that you don’t get within the space.

6. What (if anything) did you enjoy about the compositional process and working with the framework?

Composer 1: I enjoyed the great deal of imagining that was involved. It was a fun compositional challenge to compose for a framework I'd never seen before, and create a piece which could fit in to whichever configuration the curator decided (whether that be symmetrical, asymmetrical, etc.).

Composer 2: I think the process echoes my own contempt for sweet spot listening and so I really enjoyed this framework and as you know even made an online listening space for my piece.

Composer 3: It was really lovely to be given some context of the techniques you were using for your draft pieces and what might be helpful! I really enjoyed reading about your work drafts and then exploring your ideas of spatialization in this project on my own terms.

Composer 4: good to use technologies that I haven't used in a while. Great way to think about engaging in the compositional process generally

Composer 5: I always find that within having a set of boundaries it allows me to be more creative because you have to really utilize what you have. Since we did not know what the speakers would be set out like it took a lot of imagination to try and realize what the piece would turn out like. It was a very different way of approaching this sort of composition and since I am relatively new to composing spatially, I found it quite challenging, however I was happy with the result I managed to produce.

Composer 6: I think I would have been more or less lost without the examples given. It was a strange new way for me working with music that I found really interesting.

Composer 7: The restrictions that the framework place on you are quite difficult, but they made me think in new ways of how to deal with the space and they provoke new compositional techniques. It was interesting to approach space through a conceptual approach, rather than a perceptual one.

Framework Questions

1. **In what ways did you find the framework helpful/unhelpful in regards to the compositional task that you were set?**

Composer 1: I found it to be a good springboard for ways to approach this monophonic system. The examples given were extremely useful, in particular – even if they did not really manifest in my work.

Composer 2: For me the limitations were great and I felt that I was able to draw many compositional ideas just from the framework itself.

Composer 3: I don't typically approach spatial composition with a set of techniques, but rather a melodic/ harmonic frame work that I contextualise for the spatial framework. Although I think it was a really lovely move to include the framework, for me personally I really felt like I missed out on having a listen to an edit before it was shown.

Composer 4: felt similar to oblique strategies **-** a couple of things to think about or consider in terms of how you might approach the piece but ultimately the creative process went where it went

Composer 5: It was helpful in the sense that it gave the technical tools needed in order to work within the system. The different techniques gave rise to the ways which would effectively spatialize the material, which I would have struggled to do so otherwise within the mono system. It also gave me a much more critical view when thinking about sound in a space.

Composer 6: It gave me techniques to use in approaching my piece. It might help to give audio examples of the techniques? It also might be helpful to have more visual examples of the ideas

Composer 7: The strategies are very helpful. I didn't find them unhelpful. They didn't seem to exclude me from exploring ideas that I wanted to explore.

2. **In what ways did you find it difficult/easy to translate the ideas from the framework to your composition?**

Composer 1: I feel I didn't really attempt to include ideas such as timbre spatialization or realistic allusion as such, but topics like spatial movement were really helpful and easy to translate – especially the suggestion of using volume as a way to pan sound objects randomly across speakers. I really ran with this concept and used "manual panning" in this way to make my sounds highly spatialized.

Composer 2: This task fitted well with the way I have approached previous work by allowing the work to come out of a technical limitation or problem. I love this kind of thing.

Composer 3: Due to the way in which I compose, which is usually a testing and writing with the technological framework that I'm working with, the framework seemed largely abstracted from the creative process and I had a hard time integrating ideas from the framework in the composition. I found myself relying a bit on previous knowledge of monophonic composition - I think I would have had a really hard time coming up with anything compositionally if I hadn't worked on a system like this before.

Composer 4: given how I was making the sound

Composer 5: At first, I was skeptical about adding some of the ideas into my composition (e.g. Splitting up the field recordings into different timbres) as I thought it would degrade the sound. It was hard to imagine how it would sound in the context of the array, so I wasn't sure which techniques to use in order to achieve certain things. However, once I understood the framework better it made it much easier to create a form in the piece that would suit the array.

Composer 6: Using spatial movement was difficult to use in imagining what the end result would sound like, as that was essentially impossible to do.

Composer 7: Not difficult

3. **To what extent do you think that the framework gives composers ways to create spatial experiences that are interesting from multiple positions?**

Composer 1: I think it is a good starting point for those who might be feeling overwhelmed by the idea of composing for this system. It certainly gives suggestions of what may or may not work on the system.

Composer 2: [unanswered]

Composer 3: It provides composers with some very real options and ideas about how to approach space outside of their usual toolbox, and challenged my compositional process on what was possible using the Multiple Monophony system.

Composer 4: to a great extent, lots of provocations or limitations to focus on

Composer 5: It forces you to think about all possibilities of how the materials will sound as there is so guarantee of where they will be in the space. This made me really think about exactly what was in the materials and for what function within the composition they could be utilized best. I think it gives the tools to really think about how different types of sounds are displayed within space, which is the top thing to consider when doing any type of spatial composition.

Composer 6: To a great extent. I felt that the examples given were as much as you could give. I couldn't think of anything else that could be said.

Composer 7: I think it is quite effective at proving/curating/forcing composers to create works that are more intended for that type of spatial experience through limiting certain elements and providing strategies for dealing with those limitations.

4. What would you change about the framework?

Composer 1: Perhaps a little more discussion of what is ineffective for the framework, or even a disclaimer that traditional spatialization methods may be used but to keep an open mind to their final effect – be open to creating something which sounds entirely different to what you envisioned? Encourage the composer to play with its random nature?

Composer 2: I would randomise the speaker channels for each playback & have a more varied speaker layout.

Composer 3: It was awesome to read what you found worked and didn't work. It make the framework feel like a moving, growing beast which was evolving. I think as long as you are including further research as a way to build upon the literature of the possibilities of spatial composition, it's a bloody good job well done.

Composer 4: Different cultural approaches to sound of movement through space, different ways of approaching the idea of space and sound, through different mediums and not exclusively the written word

Composer 5: I wouldn't change anything, but maybe add a bit more about how to realize the composition without being able to hear exactly how it will sound?

Composer 6: Include diagrams. Include audio. Different non-text based learning mediums. This may vary if you are trying to lead composers to particular ideas or have them come up with their own stuff.

Composer 7: I would want to know what the space is and the speaker layout. I think the framework is successful in that it provoked me to come up with a new working method

5. **What would help make the framework more understandable and easier to compose with?**

Composer 1: I think it is good. Maybe add in a few dot-point-y list things showing techniques the composer can use to implement these concepts. I found it useful though, coming from an acousmatic background and already being familiar with these concepts (at least on a shallow level).

Composer 2: If someone would make some sort of virtual version where you can just plug your mono files in and experience the space and how movement in the space changes the piece that would be great. http://multimono.space =D

Composer 3: Provide audio examples or diagrams of the way sound moves in the space perhaps alongside your definitions could really help to illustrate the nuances of each definition for people who come from a variety of disciplines.

Composer 4: Perhaps aural examples, visual cues or demonstrations, ways to include other types of learning styles other than read/write

Composer 5: Maybe some more examples into what each technique would sound like in the space? Or an example of how the speakers could potentially be placed? Just to give a bit more of an idea of what it could be like.

Composer 6: Include diagrams. Include audio. Different non-text based learning mediums. This may vary if you are trying to lead composers to particular ideas or have them come up with their own stuff.

Composer 7: It may be a little jargon-y? I was comfortable understand it, but others might not be.

General Comments

Composer 1: This whole project was a lot of fun, and extremely valuable for me as a space-focused acousmatic composer. It allowed me to create what I'd describe as a "large diffusion" piece more easily than if I'd had to interact with the set-up before the concert. A great, more accessible way to get people creating large and potentially enveloping works. Yay!

Composer 2: I loved working on this and being able to come along and hear how everyone else approached their work. Would love to do more stuff like this in the future.

Composer 3: I really enjoyed the opportunity to work with Jesse's Multiple Monophony system. It deeply challenged assumptions I had about the ways in which I compose spatial composition and I feel like it has a rich future for exploration. I hope to try it out again some day and see if I can enter a musical space where I can get comfortable not using the multi-channel rig. But I also hope to have a go on composing for it in real life too!

Composer 4: Unique experience,

Composer 5: I really enjoyed listening to the other pieces when I came and saw the exhibit. Having the ability to “walk through” someone’s piece and hear it from different points of view is a much more immersive experience and allows for all the materials to really be explored which I really liked.

Composer 6: “very epic”

Composer 7: [unanswered]

9.3 Appendix Three: Cultural Capital Coding of Feelings Responses

Emergent Themes

Nervous, challenged, disoriented, frustrated, satisfied, focused, engaged, enjoyable/fun, stimulated, achievement, concentration, boredom/losing attention, calm, spooked, anxiety, interest

Of the 21 participants, I identified 8 different emotional themes amongst the participants.

Although asked to identify emotions, many participants described their experience rather than specifying a particular emotions.

Codes

Nervous/Anxious Challenged/Competitive Enjoyment/Fun Frustration Boredom/Losing Attention Interested Satisfaction (includes achievement) Calm/Comfort

Table Summary

Gamified Spatial Audio Activity

	Nervous/Anxious	Challenged/Competitive	Enjoyment/Fun	Frustration	Boredom/Losing Attention	Interested	Satisfaction	Calm/Comfort
Group 1	3/4	3/4	1/4	1/4	0/4	0/4	1/4	0/4
Group 2	1/5	3/5	2/5	2/5	0/5	0/5	0/5	0/5
Group 3	1/4	3/4	3/4	0/4	0/4	2/4	0/4	0/4
Group 4	1/4	1/4	2/4	1/4	0/4	4/4	1/4	0/4
Group 5	3/4	1/4	4/4	1/4	0/4	0/4	1/4	2/4
TOTAL	9/21	11/21	12/21	5/21	0/21	6/21	3/21	2/21

Traditional Spatial Audio Activity

	Nervous/Anxious	Challenged/Competitive	Enjoyment/Fun	Frustration	Boredom/Losing Attention	Interested	Satisfaction	Calm/Comfort
Group 1	1/4	0/4	1/4	0/4	1/4	2/4	0/4	2/4
Group 2	3/5	0/5	1/5	0/5	1/5	2/5	0/5	2/5
Group 3	0/4	0/4	1/4	1/4	0/4	3/4	0/4	1/4
Group 4	2/4	0/4	1/4	0/4	3/4	2/4	0/4	1/4
Group 5	1/4	0/4	1/4	0/4	1/4	3/4	0/4	2/4
TOTAL	7/21	0/21	5/21	1/21	6/21	12/21	0/21	8/21

Gamified Spatial Audio Activity

GROUP 1

Participant 8 - “Nervous I might run into a wall/chair/window. Tired after halfway through or so but encouraged to keep going based off how well I thought I was doing.” **Nervous/Anxious** **Challenged/Competitive**

Participant 9 - “Eager to catch the sound holder. Felt worried about having no vision. Felt challenged to see how high I could get with the "level setup"” **Nervous/Anxious** **Challenged/Competitive**

Participant 11 - “Nervous and disoriented. Competitive and challenging.” **Nervous/Anxious** **Challenged/Competitive**

Participant 21 - “A little disorientated, sometimes frustrated with not knowing where to go. Happy when completed a level.” **Enjoyment/Fun** **Frustration** **Satisfaction**

GROUP 2

Participant 6 - “Fucking want to win bc of levels/ Where the fuck is he. I thought I was real close a lot but it took me a while to find - like knowing something is happening but you're just on the outskirts” **Challenged/Competitive** **Frustration**

Participant 7 - “Energy, focus engaged”

Participant 10 - “At first was very reluctant/scared I would smoke myself. As it went on I felt more comfortable. Did touch something which slowed me down a bit again. It was enjoyable but I was nervous also running into something the whole time. Also got frustrated if one took too long.” **Nervous/Anxious** **Enjoyment/Fun** **Frustration**

Participant 13 - “Wanted to win, uncertain, silly” **Challenged/Competitive**

Participant 14 - “Excitement, challenge, self-concious, enjoyment” **Challenged/Competitive** **Enjoyment/Fun**

GROUP 3

Participant 1 - “trying to find the sound and tag Jesse was actually super fun! The use of levels (for skills) made me feel invested and challenged” **Challenged/Competitive** **Enjoyment/Fun**

Participant 2 - “I really enjoyed this activity, it was cool to completely rely on my ears to navigate around. I also enjoyed the variety of the pieces used in the activity. It felt sort of weird at first but I feel as if my ears adjusted as the activity continued.” **Enjoyment/Fun** **Interested**

Participant 5 - "I mostly felt competitive. I think there was the ideas I was being played with, but that I could also try and counter that with my own sharpness of movement. It was definitely disorienting, but I felt like wherever the sound was, I could get to confidently. The variety of sound/trying to work out how each one resonated was really great." **Challenged/Competitive** **Interested**

Participant 20 - "Excitement for the overall activity and the challenge - especially in reaching one of the described levels. Also a bewilderment by the sounds themselves and their textures. Occasional fear of walking into things." **Nervous/Anxious** **Challenged/Competitive** **Enjoyment/Fun**

GROUP 4

Participant 4 - "Moments of frustration followed by a surprising degree of satisfaction when I caught the target. Puffed as! Momentary thoughts on the content, strategizing based on the sonic content (e.g. sounds are sparse = wait and listen, sounds are high and focussed = ATTACK!" **Enjoyment/Fun** **Frustration** **Interested** **Satisfaction**

Participant 15 - "Was more physically engaging than I'd expected - element of competitiveness?? Would opt to go slower in a different setting (would allow me to spend more time with the work)." **Challenged/Competitive** **Interested**

Participant 16 - "Stimulated?!?! It was interesting to be put in a situation where I really had to trust my ears. While you need to trust in many audio fields, you always have a visual to back it up and control over the sound itself. Without that, I feel like I had to rely on my hearing in a way I never really have before!”

Interested

Participant 16 - “At first I felt very disoriented and spooked, but as the test went on, it became a very fun game. It was interesting to only use aural sense to move around, but after a few minutes it became much easier to just be able to locate the sounds. By the end I felt very immersed in the game.”

Nervous/Anxious Enjoyment/Fun Interested

GROUP 5

Participant 3 - “Mostly excited about finished the task. I felt more and more comfortable as the game progressed.” **Enjoyment/Fun Calm/Comfort**

Participant 12 - “Super fun but a bit scary. It felt like a nightmare at Berghan.”

Nervous/Anxious Enjoyment/Fun

Participant 17 - “Nervous, frustration, excitement, achievement, alertness, attentiveness, enjoyment, tension, concentration, hesitation.”

Nervous/Anxious Challenged/Competitive Enjoyment/Fun Frustration Satisfaction

Participant 19 - “In the beginning, it took a while to feel confident moving around the space confidently. Eventually I came to trust that I wasn't going to run into something, so was able to engage with the spatial bodily elements a lot more. Overall, good clean fun." **Nervous/Anxious** **Enjoyment/Fun** **Calm/Comfort**

Traditional Spatial Audio Activity

GROUP 1

Participant 8 - "Initially, I anticipated that it would be less 'sounds' and have more 'beat' or 'rhythm' involved but as it progressed I lost interest." **Boredom/Losing Attention**

Participant 9 - "Didn't know whether to feel spooked or intrigued by the sounds. I felt my brain creating an almost visual image of what I was hearing" **Nervous/Anxious** **Interested**

Participant 11 - "At times it was peaceful, but it was also interesting identifying sounds and figuring out what they were" **Interested** **Calm/Comfort**

Participant 21 - "Strange like the music was passing through my brain, calm, confused, happy" **Enjoyment/Fun** **Calm/Comfort**

GROUP 2

Participant 6 - “Like I was listening to the lifetime of a bunny or a deer or something - there was a woodlandsy feel and also safety and danger, warm and cool - like the seasons of life.” **Nervous/Anxious** **Calm/Comfort**

Participant 7 - “Relaxed, calm, spaced” **Calm/Comfort**

Participant 10 - “Found it was more interesting than I was expecting (though 13 minutes was enough). The first 6 minutes felt like a horror film. It was goosebumps material. Lost attention a bit when it got quieter. Found myself waiting to hear where it would go next. Enjoyed the build up.” **Nervous/Anxious** **Enjoyment/Fun** **Interested**

Participant 13 - “anxious, ominous, immersed” **Nervous/Anxious**

Participant 14 - “interest, tired, weird” **Boredom/Losing Attention** **Interested**

GROUP 3

Participant 1 - “Very Calm, curious to hear all the different sounds that were in the piece. After about 5~ minutes I felt I could have fallen asleep. It was very relaxing. Felt like meditation.” **Interested** **Calm/Comfort**

Participant 2 - “I really liked how unpredictable the piece was and I felt a bit more immersed in the experience that I would a more standard piece of music. I felt a little bit frustrated? (unsure if this is the best term) when there'd be a sound or combination of sounds that I really enjoyed and they usually stopped pretty quick/weren't repeated - but this also meant I didn't get tired of the piece.” **Enjoyment/Fun** **Frustration**

Participant 5 - “Intrigue, I was definitely pulled in by the sound design and wanted to know how it had been achieved. It took me a while to feel like there was intention though, and that there was some kind of narrative - not just a collection of disconnected sounds. In hindsight though I can also see the value and relevance of an arrangement completely lacking in direction (I think I was trying to work out if there was one).” **Interested**

Participant 20 - “Intrigue for the individual sounds” **Interested**

GROUP 4

Participant 4 - “Nostalgia for my time at uni - I have not been particularly engaged with spatial audio since this time. The piece felt quite narrative and was inspiring. Obviously very eerie - at times to the point of fear, though never quite. I found myself thinking "I wonder how that did *that*" from time to time. Moments of boredom.” **Nervous/Anxious** **Boredom/Losing Attention** **Interested**

Participant 15 - “Enjoyable at first, drifted considerably during the middle 6 mins (approx.). Having studied/created work like this, I can't help but analyse it/hear the processing/guess the field recording sources.” **Enjoyment/Fun** **Boredom/Losing Attention**

Participant 16 - “In comparison to the game before it, the piece felt a lot less interactive, like something was being dictated to me. And it was an interesting and cool piece! But I was also going into "technological listening" mode a lot more! It felt less engaging and (especially at 13 mins long) I noticed my attention waning.” **Boredom/Losing Attention** **Interested**

Participant 18 - “The piece was very suspenseful. The movement of gestures from being close up to very far away created a lot of depth, and allowed me to really be immersed in the piece. I felt like I was able to get into an almost meditative state, and just focus on the sound world.” **Nervous/Anxious** **Calm/Comfort**

GROUP 5

Participant 3 - “As the piece progressed I started forgetting about my environment inside the "3D" sound made me feel like I was in a different place. I then, listening to the sounds that resemble living things moving around, was feeling a bit vulnerable and scared expecting the next sound that could make me jump off the seat.” **Nervous/Anxious**

Participant 12 - “It is a lovely piece of music. I find it very calming but also interesting and that is a difficult combination.” **Interested** **Calm/Comfort**

Participant 17 - “Attentiveness, calm, inspiration, deconstruction, analysis, enjoyment.” **Enjoyment/Fun** **Interested** **Calm/Comfort**

Participant 19 - “For me, the experience was very steeped in my previous engagement with acousmatic music. The work feels very traditional of that genre. I found it to be very well executed with some interesting and convincing spatial behaviours and spectromorphologies. I did find it to not be very emotive. At times it held my attention deeply, especially with dry, water drop sounds, but at other points, it lost my attention” **Boredom/Losing Attention** **Interested**

9.4 Appendix Four: Cultural Capital Coding of Observations Responses

Table Summary

Gamified Spatial Audio Activity

	Causal	Semantic	Reduced	C & S	C & R	S & R	C, S, & R
Group 1	0/4	4/4	1/4	0/4	0/4	1/4	0/4
Group 2	0/5	5/5	2/5	0/5	0/5	2/5	0/5
Group 3	1/4	4/4	2/4	1/4	0/4	2/4	0/4
Group 4	0/4	3/4	4/4	0/4	0/4	3/4	0/4
Group 5	0/4	4/4	3/4	0/4	0/4	3/4	0/4
TOTAL	1/21	20/21	12/21	1/21	0/21	11/21	0/21

Traditional Spatial Audio Activity

	Causal	**Semantic**	**Reduced**	**C & S**	**C & R**	**S & R**	**C, S, & R**
Group 1	1/4	2/4	0/4	0/4	0/4	0/4	0/4
Group 2	4/5	0/5	0/5	0/5	0/5	0/5	0/5
Group 3	1/4	0/4	4/4	0/4	1/4	0/4	0/4
Group 4	1/4	0/4	1/4	0/4	0/4	0/4	0/4
Group 5	1/4	0/4	3/4	0/4	1/4	0/4	0/4
TOTAL	8/21	2/21	7/21	0/21	2/21	0/21	0/21

Gamified Spatial Audio Activity

GROUP 1

Participant 8 - "With the sounds that had breaks, I struggled to close in on the sound quickly" **SEMANTIC**

Participant 9 - "Some were easy to pin point. Others felt harder to audibly lock onto. Some of the sounds could be jarring at times. Some sounds confused me regarding how far away they were. It was hard to decide whether they were close or far." **SEMANTIC**

Participant 11 - "It was difficult to identify where the sounds were coming from. They varied with being close and far away. It was challenging to identify where the sound was coming from and move through a dark space." **SEMANTIC**

Participant 21 - "Louder sounds were easier to detect and clear, binging noises made it harder to distinguish a clear spot to move to. Noises that stopped and started were harder to detect." **SEMANTIC REDUCED**

GROUP 2

Participant 6 - "Far out[,] some of them were all over the place and some of them I think I knew where I was in relation like I grew in confidence as I went on but I couldn't pick a pattern in the sound to judge and if it stopped[,] so did I because I had literally nothing to go on." **SEMANTIC**

Participant 7 - "The different tones and sounds some of them would flow around the room as you moved. Others jumped so trying to track with no sight was hard when it was jumping around." **SEMANTIC**

Participant 10 - "Constant sounds were very easy. Sporadic sounds and sounds where the pitch changed where hard. For one of the higher pitches I struggled to know which direction it was coming from." **SEMANTIC REDUCED**

Participant 13 - “Some sounds were harder to locate than others. Quieter sounds meant I had to rely on the sound of footsteps rather than the speaker.” **SEMANTIC**

Participant 14 - “Same sounds were above, some were everywhere. Some were easy to pinpoint.” **SEMANTIC REDUCED**

GROUP 3

Participant 1 - “I found the higher pitched sounds harder to locate in the space in comparison to the lower pitched ones - and the audio clips that stopped and started were a bit disorienting. The more frequencies that the piece had, the easier I found it to locate as well.” **SEMANTIC REDUCED**

Participant 2 - “I definitely noticed the difference in difficulty from the first level to the second. Pieces with more silent parts were harder to figure out and the louder pieces were easier. I enjoyed the physical link between the spatiality of the pieces and actually shifting around the room.” **SEMANTIC**

Participant 5 - “The sharper sounds were easier to locate, and obviously ones that were more consistent/constant. The hardest sounds to locate were the sparse ones and the more ambient pad sounds. The ambient sounds felt more enveloping and vague. I didn't notice much difference in the pitch, bass and treble were equal, and just dependent on the other two factors. [participant inserted arrow pointing at sentence talking about it being hard to locate sparse sounds] The other sound I used a lot were the footsteps, but there were two sets of these which made it a bit harder." **SEMANTIC REDUCED**

Participant 20 - "The whole thing almost felt like a VR video game. I found it interesting how it was often easy to tell which direction the sound was coming from, but difficult to tell the distance." **CAUSAL SEMANTIC**

GROUP 4

Participant 4 - "Some sounds felt that they already had spatial aspects? bit of verb? that was hard.. The sine sweep thing was weird - much harder to detect than low freq. Anything with hard transience [sic] was a blessing - particularly glitch sounds. Anything sporadic was weird. Sometimes easier b/c of transiences [sic]. It would undo progress of finding you! Also, aware of speaker moving independent of person/target." **SEMANTIC REDUCED**

Participant 15 - "Height differences - as I was taller than the Sensei [indistinguishable word], I experienced a lot of sounds that were perhaps lower to the ground - occasional sounds that were at head height were surprising/confronting" **REDUCED**

Participant 16 - "This is complicated and I have lots of thoughts! Impulses and short sounds were more directional and easier to judge distance with. The drone (sine wave thingy) confused me when it was a little further away because it melted into the room a bit. Interestingly, the long white noise was easier than the tonal drone. The "percussive" sounds with lots of space between were easy to perceive in space and distance, but hard in the game! I was also listening to the sound of both of you shuffling in between sounds which helped in predicting where the next sound would be." **SEMANTIC REDUCED**

Participant 18 - "The sounds that were more solid (say, the long sawtooth sounds) were easier to move towards from afar, but much harder to locate when up close, as opposed to the more grainey, gesturay sounds, which were easier to locate when up close. When the sounds were louder, they became much harder to pinpoint in the space as it seemed to cover more space than the object they were coming from. In a sense, the sounds became their own objects, and were bigger/smaller depending on the type of sound." **SEMANTIC REDUCED**

GROUP 5

Participant 3 - "Some of the sounds were easier to follow due to the higher overtones however, short sounds were sometimes confusing as echo sometimes could be heard coming from another direction." **SEMANTIC REDUCED**

Participant 12 - "The very high pitched sound was extremely hard to locate. Sometimes I "cheated" and developed a hunch of where you were based on the sound of your footsteps. Some sounds were trickier than others but nothing like the waffling high pitched one." **SEMANTIC**

Participant 17 - “I had to figure out if sounds had patterns/gestures of just random movements. Constant hf [high frequency] sounds are easier to locate vs periodic LF (low frequency) sounds. Sounds had wide range of movement. Up/down - side to side - near/close to the body. Was interesting to try and determine whether there was fluctuation in volume in samples or just movement creating variation in amplitude.” **SEMANTIC REDUCED**

Participant 19 - “The types of sounds played a large role for me. The initial sound was a confusing sine texture that I struggled to locate. More iterative, pulsed sounds were much easier. I became quite aware of how my head movements were effecting my ability to localise the sound.” **SEMANTIC REDUCED**

Traditional Spatial Audio Activity

GROUP 1

Participant 8 - “At first, the start of the song reminded me of the movie 'Avatar' in how detailed it was and how intricate it is, like the song.” **SEMANTIC**

Participant 9 - “Audibly, the sounds felt 3 dimensional. Instead of feeling like I was hearing 2D sound from a macbook, the sounds felt more environmental I guess? As if they were occupying the room with me.”

Participant 11 - “I noticed the breaks and transitions. I noticed there would have been a sort of 'storyline' being told/used. I don't feel like I have the background in music to really appreciate the artist.”

Participant 21 - “The water drops echoed through space whilst the buzzing was sharp and distinct. Soft noises eased through the air travelling around me.” **CAUSAL**

GROUP 2

Participant 6 - “Made me think of this bit in a twilight movie where you're speeding through the surroundings but remain v focussed on the subject? like it was an awareness of time and a near and far focus - somethings were close and v clear sounding and vice versa but also there was a mix of the two."

CAUSAL

Participant 7 - "After the energy of the first activity I kind of zoned out as the [unsure] moved around while listening to it."

Participant 10 - "Felt like quite the journey. Some of the sounds felt very real and you could hear them all around me. The sounds worked surprisingly well together and I could appreciate the time it would have taken to make." **CAUSAL**

Participant 13 - "It felt like I could hear the same way you would underwater."

CAUSAL

Participant 14 - "Sounded like nature, trees, bugs, birds, water etc. Like walking in a forest - or in a museum that has some sound." **CAUSAL**

GROUP 3

Participant 1 - "I liked how the different sounds moved around from L to R and back - it felt like they were moving through me." **REDUCED**

Participant 2 - "The spatiality was really evident throughout the piece, I enjoyed especially how weird it felt when a lot of the soundscape seemed like it was coming from behind me. While the sounds moved around heaps is wasn't enough to become irritating, which I appreciated." **REDUCED**

Participant 5 - “There were some really great moments where amplitude and panning were used to make a spirally effect, that was awesome. This plus general panning (overlapping at times) and pitch/texture did really make it feel like you were moving forward through a space, through a surrealist scene. The way this was achieved with quite dry/direct sounds was pretty cool.” **CAUSAL REDUCED**

Participant 20 - “The sound design was impressive, with intense use of stereo field sometimes giving each sound a "3D" feeling. I tended to react to faster moving and louder sounds more - whereas slower ones I felt I lost interest in” **REDUCED**

GROUP 4

Participant 4 - “As I said, it felt quite narrative. I started at the mouth of a cave with hail lashing down. Space felt longer than it was wide. The odd sound would 'ruin' this space, only for it to be re-established. The faster the movement, the more sci-fi-esque, star-wars-race it felt. Mostly, I was thinking of real things. Centipedes, insects for the really present stuff. Falling rocks for others. The space felt real. The stretching sounds broke this space.” **CAUSAL**

Participant 15 - “A lot of movement, generally smooth (active but not overbearing so). Spectral processing, granular synthesis, "whoosh-drops" very immersive - perhaps why I was able to 'drift'?” **REDUCED**

Participant 16 - “Aside from the obvious limitations with binaural, like the head tracking issue (i.e. space rolling with my head rolling), there was a more clearly defined "centre" to the space: the "inside" of my head. The sounds that were sorta "behind me" or "in front" felt a lot less immediate (?) that the other task. This experience felt a lot more focussed on the sides and the "width" of the field rather than the front and back, like the previous task. One reason is, with the headphones, there's a feeling like you're always static and the space changes around you. With the other task, the space stays static, but your movement within it changes your experience of it.”

Participant 18 - “There was a lot of micro-gestures in the piece, which moved around the space, and felt very close and focussed. There were also moments in the piece where the space opened up and there were wide, less definable sounds, that made the piece seem to expand into the room. There was also a sense of front and back depth to the sounds, as well as movement within the stereo field, a credit to the wonderful sound design of the composer.”

GROUP 5

Participant 3 - “The spatiality made the sounds feel as if they were natural sounds. Even when many of them were clearly synthesis, their movement around the "virtual world" made them feel like real objects that, as they move, evolve and change as physical gestures change the shapes of natural bodies. For instance, when we see a lioness hiding in the grass, then running to catch an animal, we see two completely different shapes. I think when the sounds were dynamically moving in space, my perception was that they were changing. They had more of a "goal" and I expected a specific direction or evolution. When they were static I couldn't predict how they would change so they didn't feel like "objects"" **CAUSAL** **REDUCED**

Participant 12 - "I appreciated the forward/backward panning in the piece and the way that the particular sound had particular spatial movements." **REDUCED**

Participant 17 - "Lots of movement and types of movement from each of the discrete sounds. Each sound had a differing 'space' and way it moved and occupied space. Spatiality of the piece was a composed binaural space rather than a 'real world' space. Very complex spatializations and layering of sounds to make each sound distinct."

Participant 19 - "There was a lot of precise spatial behaviours and the work's teleology and organisation was heavily based on these relationships. There were some really nice sounds where textures would move around the head, and some other moments where there was a wide stereo spread. Definitely for me, the most interesting part of the piece." **REDUCED**

9.5 Appendix Five: Compositional Considerations

Four Swinging Speakers

The role the author's creative practice played in the composition

As a sound artist, the author engages primarily with sound installations and audio-visual works as medium. The use of an installation format expands upon previous works by the author. The work was first installed at the Audio Foundation in Auckland. The work was commissioned as the curator had seen previous installation works by the author. The author primarily engages with the medium of spatial audio, often utilizing multichannel systems.

As a person with a disability, the author's work often seeks give power to the audience to determine the way that they engage with a work.

Timbrally aesthetically, the author's work tends to engage with the acousmatic tradition and noise music and the intersection of these two musics.

How the author's practice contributed to answering the research question

The author uses their creative practice in their engagement with installation work and disability and hearing discourse to explore the question of how to remove barriers of capital from spatial audio within the work *Four Swinging Speakers*.

The use of affordable technology is used to remove barriers of economic capital. $20 mobile phones and relatively inexpensive bluetooth loudspeakers were used in this work. The use of this technology reduces the cost relative to a system that requires a computer, loudspeakers, and audio interface etc.

The loudspeakers were hung from the roof in a non-linear fashion. This removed the possibility of a sweet spot. The removal of the sweet spot removes some barriers for those who are hard of hearing who have certain types of hearing, as it makes localization less important and more individualized, removing barriers of physical capital. The lack of a sweet spot also removes other sweet spot associated barriers of capital.

Details regarding sound production methodologies, & timbre compositional intent.

Four Swinging Speakers uses a variety of pitch related strategies and speaker placement to explore space. The work is comprised of a variety of frequency content that varies over the course of the work. The beginning of the work utilizes rumbling low frequency material and higher frequencies are slowly filtered in. As the spatial perception of sound varies based on the frequency of the sonic material (i.e. lower frequencies are more difficult to localize than higher frequencies), this informed the structural form of the work. As the work progresses, more high frequency material enters creating contrast with the beginning of the work. Aesthetically, this work is very textural and guided by simple gestures and draws from acousmatic and noise music traditions.

Four loudspeakers were hung from the roof of the exhibition space from non-specific positions. While they were hung in fixed positions, audience members were able to swing the loudspeakers in any manner that they wished. In doing this, they were able to engage with how the moving sound changed as the speaker moved and if their spatial perception shifted when the frequency material also shifted.

Aesthetically, this work is very textural and draws from acousmatic and noise music traditions.

24x multimono

The role the author's creative practice played in the composition

As a sound artist, the author engages primarily with sound installations and audio-visual works as medium, but also with fixed acousmatic work, with a particular focus on multichannel spatial audio. Within this space the author's work's timbral aesthetic tends to engage with the acousmatic tradition and noise music and the intersection of these two musics. The author primarily engages with the medium of spatial audio, often utilizing multichannel systems.

As a person with a disability, the author's work often seeks give power to the audience to determine the way that they engage with a work.

How the author's practice contributed to answering the research question

The author uses their creative practice in their engagement with acousmatic work and disability and hearing discourse to explore the question of how to remove barriers of capital from spatial audio within the work *24x multimono*.

In *24x multimono*, the audience uses their personal playback devices (phones, computers), to play back individual channels of a multichannel work. In using personal electronic devices, barriers of economic and cultural capital have been removed for audiences, as they do not require expensive and complex multichannel systems. Similarly, they also may use cheap consumer technology for playback, or technology that is already/commonly owned.

As the system doesn't require a sweet spot, a variety of sweet spot associated barriers of capital have also been removed through the speaker placement.

Details regarding sound production methodologies, & timbre compositional intent.

24x multimono uses a variety of pitch related strategies and speaker placement to explore space. The work is comprised of a variety of frequency content that varies over the course of the work, and in turn, varies the spatiality (i.e. lower frequencies are more difficult to localize than higher frequencies). The beginning of the work utilizes rumbling low frequency material and higher frequencies are slowly filtered in. As the spatial perception of sound varies based on the frequency of the sonic material, this informed the structural form of the work. As the work progresses, more high frequency material enters creating contrast with the beginning of the work. Aesthetically, this work is very textural and guided by simple gestures and draws from acousmatic and noise music traditions.

The work is designed to be played back from people's personal electronic devices and audiences have agency over how many devices are used and also where the devices are placed.

Aesthetically, this work is very textural and draws from acousmatic and noise music traditions.

Some Swinging Speakers

The role the author's creative practice played in the composition

As a sound artist, the author engages primarily with sound installations and audio-visual works as medium. The use of an installation format expands upon previous works by the author. The author primarily engages with the medium of spatial audio, often utilizing multichannel systems.

As a person with a disability, the author's work often seeks give power to the audience to determine the way that they engage with a work.

Timbrally aesthetically, the author’s work tends to engage with the acousmatic tradition and noise music and the intersection of these two musics.

How the author’s practice contributed to answering the research question

The author uses their creative practice in their engagement with installation work and disability and hearing discourse to explore the question of how to remove barriers of capital from spatial audio within the work *Some Swinging Speakers*.

The use of affordable technology is used to remove barriers of economic capital. $20 mobile phones and relatively inexpensive bluetooth loudspeakers were used in this work. The use of this technology reduces the cost relative to a system that requires a computer, loudspeakers, and audio interface etc.

The loudspeakers were hung from the roof in a straight line fashion. This removed the possibility of a sweet spot. The removal of the sweet spot removes some barriers for those who are hard of hearing who have certain types of hearing, as it makes localization less important and more individualized, removing barriers of physical capital. The lack of a sweet spot also removes other sweet spot associated barriers of capital.

Details regarding sound production methodologies, & timbre compositional intent.

Some Swinging Speakers uses a variety of pitch related strategies and speaker placement to explore space. The work is comprised of a variety of frequency content that varies over the course of the work. The beginning of the work utilizes rumbling low frequency material and higher frequencies are slowly filtered in. As the spatial perception of sound varies based on the frequency of the sonic material (i.e. lower frequencies are more difficult to localize than higher frequencies), this informed the structural form of the work. As the work progresses, more high frequency material enters creating contrast with the beginning of the work. Aesthetically, this work is very textural and guided by simple gestures and draws from acousmatic and noise music traditions.

Six loudspeakers were hung from the roof of the exhibition space. While they were hung in fixed positions, audience members were able to swing the loudspeakers in any manner that they wished. In doing this, they were able to engage with how the moving sound changed as the speaker moved and if their spatial perception shifted when the frequency material also shifted.

Aesthetically, this work is very textural and draws from acousmatic and noise music traditions.

Waterfront Monophony

<u>The role the author's creative practice played in the composition</u>

As a sound artist, the author engages primarily with sound installations and audio-visual works as medium. The use of an installation/performance format expands upon previous works by the author. The author also engages in curation practices within their work, often commission artists and devising compositional scenarios. The author primarily engages with the medium of spatial audio, often utilizing multichannel systems.

As a person with a disability, the author's work often seeks give power to the audience to determine the way that they engage with a work.

Timbrally aesthetically, the author's work tends to engage with the acousmatic tradition and noise music and the intersection of these two musics.

<u>How the author's practice contributed to answering the research question</u>

The author uses their creative practice in their engagement with installation/performacne work. curation, and disability and hearing discourse to explore the question of how to remove barriers of capital from spatial audio within the work *Waterfront Monophony*.

The use of affordable technology is used to remove barriers of economic capital. $20 mobile phones and relatively inexpensive bluetooth loudspeakers were used in this work. The use of this technology reduces the cost relative to a system that requires a computer, loudspeakers, and audio interface etc.

The loudspeakers were held by performers who walked back and forth in a straight line. This removed the possibility of a sweet spot. The removal of the sweet spot removes some barriers for those who are hard of hearing who have certain types of hearing, as it makes localization less important and more individualized, removing barriers of physical capital. The lack of a sweet spot also removes other sweet spot associated barriers of capital.

Giving audiences more autonomy over their listening experience also removes further barriers of physical capital.

Details regarding sound production methodologies, & timbre compositional intent.

The work the author wrote for *Waterfront Monophony* uses a variety of pitch related strategies and speaker placement to explore space. The work is comprised of a variety of frequency content that varies over the course of the work. The beginning of the work utilizes rumbling low frequency material and higher frequencies are slowly filtered in. As the spatial perception of sound varies based on the frequency of the sonic material (i.e. lower frequencies are more difficult to localize than higher frequencies), this informed the structural form of the work. As the work progresses, more high frequency material enters creating contrast with the beginning of the work. Aesthetically, this work is very textural and guided by simple gestures and draws from acousmatic and noise music traditions.

12 loudspeakers were held by 12 performers who walked in a line, back and forth across a 20-30 metre stretch of Wellington's waterfront. The 20-30 metre stretch created a wide spatial field that could be experienced by staying in one position relative to the speakers or moving back and forth across the line. The performers had an amount of agency over the spatialization of the material, as they were able to choose the pace that they walked at, effecting the spatial result.

Still Moving

<u>The role the author's creative practice played in the composition</u>

As a sound artist, the author engages primarily with sound installations and audio-visual works as medium. The use of an audio-visual medium to explore this work expands upon previous works by the author. It also develops previous collaborative relationships, working alongside visual artist Charley Draper in the development of the visual material in this work.

As a person with a disability, the author’s work often seeks to engage with ideas around disability and hearing and how our body can often change the way one can engage or access art.

Timbrally aesthetically, the author’s work tends to engage with the acousmatic tradition and noise music and the intersection of these two musics.

How the author’s practice contributed to answering the research question

The author uses their creative practice in their engagement with audio-visual works and engagement with disability and hearing discourse to explore the question of how to remove barriers of capital from spatial audio within the work *Still Moving*.

This work explores the use of visual material to change the spatial perception of sound so that hearing audiences and hard of hearing audiences with certain types of hearing can engage with the spatiality of the work in a similar fashion. Through the use of visual material and mono audio, this work seeks to remove barriers of physical capital, so that more people can engage with the work and have a similar experience to one another.

The use of mono audio makes the work able to be played back through most personal electronic devices that can play video and removes any barriers of capital traditionally associated with accessing sound art. The lack of a sweet spot also removes associated barriers of capital. The lack of auditory spatialization removes barriers of physical capital.

<u>Details regarding sound production methodologies, & timbre compositional intent.</u>

Still Moving uses a variety of pitch and reverb related spatial compositional strategies. The work plays with the relationship between dry and reverberant material throughout, varying the mix of reverb on elements of the track to vary the perception of the size of the space. The work begins with a pulsing mid-frequency tone, and after a while, some flickering high frequency material enters. This is mimicked by flickering visual material that moves back and forth across the screen. The work itself uses mono sound attempts to create the perception of spatialized sound using moving visuals. In this case, the high frequency material is used, as it is easier to localize than lower frequency material, and it is hoped by the composer that this will aid the perception that the sound is moving. Aesthetically, this work is very textural and guided by simple gestures and draws from acousmatic and noise music traditions.

Static Spatialization Example

<u>The role the author's creative practice played in the composition</u>

As a sound artist, the author engages primarily with sound installations and audio-visual works as medium. The use of an installation format expands upon previous works by the author. The author primarily engages with the medium of spatial audio, often utilizing multichannel systems.

As a person with a disability, the author's work often seeks to engage with ideas around disability and hearing and how our body can often change the way one can engage or access art.

Timbrally aesthetically, the author's work tends to engage with the acousmatic tradition and noise music and the intersection of these two musics.

How the author's practice contributed to answering the research question

The author uses their creative practice in their engagement with installation and multichannel works and engagement with disability and hearing discourse to explore the question of how to remove barriers of capital from spatial audio within the example of static spatialization (a technique developed in the thesis by the author).

A system that explores static spatialization doesn't utilize a sweet spot. The removal of the sweet spot removes some barriers for those who are hard of hearing who have certain types of hearing, as it makes localization less important and more individualized, removing barriers of physical capital. The lack of a sweet spot also removes other sweet spot associated barriers of capital.

The autonomy that is given to listeners in regards to their listening position also serves to remove barriers of physical capital.

Details regarding sound production methodologies, & timbre compositional intent.

The example of static spatialization used in this thesis is not a piece, but rather a compilation of five sketches exploring the strategy. The sketches utilize gesture/texture, various frequencies, and loudspeaker placement as compositional strategies. Each sketch takes a different approach regarding how gestural versus textural the material is. In each sketch, a variety of frequency material was placed in each loudspeaker so that as the listener moves around the space, they physical become closer/further away from one sound as they become closer/further away from another.

The loudspeakers were set up in an unconventional array, with loudspeakers pointing into the room, against the wall, and angled from the ground up to the wall. Listeners are given agency as to the spatialization of the work, as they can decide how to move around the space.

The various sketches explore timbral aesthetic characteristics of acousmatic music and noise music and utilize modular synthesis systems.

Spatial Vibrations Piece

<u>The role the author's creative practice played in the composition</u>

As a sound artist, the author engages primarily with sound installations and audio-visual works as medium. As an extension of this, the author often builds audio interfaces to explore novel musical ideas. The author primarily engages with the medium of spatial audio, often utilizing multichannel systems.

As a person with a disability, the author's work often seeks to engage with ideas around disability and hearing and how our body can often change the way one can engage or access art.

Timbrally aesthetically, the author's work tends to engage with the acousmatic tradition and noise music and the intersection of these two musics.

<u>How the author's practice contributed to answering the research question</u>

The author uses their creative practice in their engagement with audio interfaces and multichannel works and engagement with disability and hearing discourse to explore the question of how to remove barriers of capital from spatial audio.

Using vibrating transducers, the author removes the need for hearing to engage with the work. Through this removal, barriers of physical capital have been removed. D/deaf and hard of hearing survey responders suggested that it removed all barriers of physical capital for them.

Details regarding sound production methodologies, & timbre compositional intent.

The work devised for *Spatial Vibrations* uses strategies around spatial movement and dynamic. The work begins by using all four transducers at the same time. This introduces the vibration to the audience. After a period, the transducers begin to vibrate separately, with the audience becoming aware of the spatial separation between the transducers. As the piece progresses, a variety of spatial patterns emerge, performed by the transducers. The dynamic of the vibration also begins to vary halfway through the work. Before this point, the vibrations had been on/off. The introduction of dynamic adds to the spatial interest.

As intensity and spatiality of the vibration are the only variables that can be controlled, timbre is not explored within this work.

Gamified Spatial Audio

The role the author's creative practice played in the composition

As a sound artist, the author engages primarily with sound installations and audio-visual works as medium, as well as acousmatic music. The author also works as a tertiary educator within the field of music.

Timbrally aesthetically, the author's work tends to engage with the acousmatic tradition and noise music and the intersection of these two musics.

How the author's practice contributed to answering the research question

The author uses their creative practice in their engagement with acousmatic music and experience as a tertiary educator to explore the question of how to remove barriers of capital from spatial audio.

The hypothesis of the author was that those who have less relevant cultural capital in spatial audio would engage with it less. It was also the hypothesis that if the work was gamified, it would lead to increased engagement – particularly for those with less relevant cultural capital.

The experience of the author as a tertiary educator informed to approaches to the development of the gamified spatial audio. the results suggested that engagement increased for peoples of all levels of cultural capital, suggesting the removal of barriers of cultural capital for those who don’t have the relevant cultural capital.

<u>Details regarding sound production methodologies, & timbre compositional intent.</u>

The sketches used in the Gamified Spatial Audio use frequency and reverb related spatial compositional strategies. Aesthetically, the sketches were modelled after the timbral aesthetic of Natasha Barrett’s *Little Animals*. The various sketches use a range of frequency material and a mix of dry/reverberant material as an attempt to make them easier/more difficult to localize for those playing the game. The sounds were categorized into easy, medium, and hard categories for the game master to use to vary to difficulty for the participants. Sounds were placed in those categories according to what spatial strategies they engaged with and, based on those strategies, how difficult the sounds should be to localize. Some sounds also contained prolong periods of silence.

The variation of localization of difficulty here was used to try help vary the level of engagement for participants so that it either didn’t become too easy, or become too difficult, and was determined by the game master during the game. This strategy was implemented as a part of investigating whether gamifying spatial audio increases capital, and in turn, removes barriers of cultural capital for those without education in spatial audio.

9.6 Appendix Six: Ethics Permissions

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

Ethics Application

Application ID :	4000021891
Application Title :	A review of the initial multichannel monophonic framework
Date of Submission :	29/10/2019
Primary Investigator :	Jesse Austin-Stewart Austin-Stewart (Applicant)
Other Personnel :	

1. Risk Assessment

Project Detail

Human Ethics Application Risk Assessment Form

Does your research fall within the scope of the Code? The scope includes:

a. All research involving either the participation of human or where the research impacts on individuals, groups or communities. This includes consultancies, contract research, staff research and supervised student research.
b. Any teaching which involves the participation of students for the demonstration of procedures or phenomena that have a potential for harm.
c. Any evaluation of university services, organisational practices or teaching programmes where information of a personal nature may be collected, where participants may be identified, or where the performance of staff may be commented on. This does not include routine organisational quality improvement activities, e.g. academic programme evaluations or service delivery projects but does include activities which have a research component and may lead to publications.

- **NB: Where research involves a Massey staff researcher using their own students as participants please refer to the Decision Chart in Section 2 of the Code.**

Applicant Information- PEER REVIEW

Prior to submitting your application for approval, there is an option for you to have your application peer reviewed. (This could be a supervisor if you are a student, or a colleague in the case of academic research). The process is as follows:

- Click on the Action Tab
- Click on the 'Send for peer review' action
- Follow the instructions given.

Note: This process will send an email to your peer reviewer which contains a pdf of the application.
The peer reviewer comments by email outside of the RIMS process.
This **IS NOT** part of the approval process.
Following comment (if any) from your peer reviewer, you must **STILL** submit the final application through the action tab.

1 **Project Title**
*Please limit this to a maximum of 25 words**

A review of the initial multichannel monophonic framework

2 **Recruitment / Data collection start date.**
This date must be in the future.
*Data collection /recruitment cannot begin until notification of submission has been received.**

26/10/2019

3 **Projected end of project date.***

31/03/2020

4 **Project Type ***

- ○ Academic Staff Research
- ○ General Staff Research
- ◉ Postgraduate Student Research
- ○ Undergraduate Student Research
- ○ Evaluation
- ○ Teaching
- ○ Other

5 **Project Summary**
*Please outline in no more than 2000 characters in lay language**

The project is a Spatial Composition User Study. My thesis explores ways to make spatial audio experiences and systems more accessible. Part of this work has seen me devise a new spatial audio system that aims to allow more listeners to have an equally intended listening experience, regardless of where they are positioned in relation to the system. In tandem with the creation of this system, I am creating a framework from which people can respond to to create their own work for this system. To deem the success of this system and its initial framework, I will be asking 6-10 people to write musical works for the system. Upon completion, I will ask them to complete a survey regarding their perceived success of the framework in regards to the outcome of their piece. I also intend to conduct a listener survey to deem the success of the multichannel monophonic system itself.

6 **Describe the peer review process that has been used to discuss and analyse the ethical issues present in this project.**
(maximum of 4000 characters)*

Discussions with my supervisor have taken place in which we have unpacked the ethical issues surrounding the project in regards to the people surveyed and how they are surveyed.

7 **List the ethical issues considered and explain how each has been addressed**
(maximum of 2000 characters)*

This application is considered low risk, as the ethical concerns are limited. Prior to participation in the project, composers will be asked to sign a consent form, agreeing to have their work publicly displayed, to partake in a survey that will ask questions regarding their experience of the system and the created framework or the system, and also agreeing to have their anonymous answers contribute towards my PhD research and potential academic papers.. They will be asked to complete a survey where they will be asked questions as to their experience of working with the system and what they think in regards to the framework's success. This will involve questions such as "Would you deem your work spatially interesting from multiple positions?" and "How would you describe the spatial interest of the system and why?". The composers will be sent these questions via a Google Form. They will not be asked for any identifiable details, as to keep their answers and identities separate.

Listeners who did not compose for the system will also be asked to complete a survey of their listening experience of the system. They will be asked to sign a consent form agreeing to partake in the survey, to be asked questions regarding to their listening experience of the system, and have their anonymous answers contribute towards my PhD research and potential academic papers. The people asked to do the survey will be handpicked by the applicant (based on their musical background and experience), however, the survey will not require identifiable details to keep their identity anonymous. They will be asked questions like "Did you have equally interesting spatial experience from multiple positions within the space?", and "What did you think was ineffective about this spatial experience?".

Data will be stored privately on a password protected Google Drive account. This information will only be shared with the co-applicants Bridget Johnson and Oli Wilson.

8 **With whom did you peer review your research?**
(maximum of 2000 characters)*

Bridget Johnson (supervisor) - B.D.Johnson@massey.ac.nz

Applicant

1 Applicant Department*

School of Music and Creative Media Production

2 Ethics Category Hidden*

Human

Campus of Chief Applicant
*(or Campus of Supervisor for Student)**

- ○ Manawatu
- ◉ Wellington
- ○ Albany

3 Personnel
You can add any additional team members here. Click on 'More criteria' below to access the advanced search function.

1	Surname	Austin-Stewart
	Given Name	Jesse
	Full Name	Jesse Austin-Stewart Austin-Stewart
	Position	Applicant
	Primary?	Yes
	Work Number	
	Email Address	J.Austin-Stewart.1@uni.massey.ac.nz
	Department	
	College	

Please add name of co researchers if unable to locate above

Bridget Johnson, Oli Wilson

Risk Assessment

1 **Is Health and Disability Ethics Committee review required for this study?***

- ◉ No
- ○ Yes

[Link to Standard Operating Procedures for HDECs]

[Link to HDEC scope of review form]

2 **Does your research include:**

a **Situations where the researcher may be at risk of harm***

- (●) No
- ( ) Yes

b **Use of a questionnaire or interview, whether or not it is anonymous, which might reasonably be expected to cause discomfort, embarrassment or psychological or spiritual harm to the participants. ***

- (●) No
- ( ) Yes

c **Processes that are potentially disadvantageous to a person or group, such as the collection of information which may expose a person / group to discrimination.***

- (●) No
- ( ) Yes

d **Collection of information of illegal behavior(s) gained during the research which could place the participants at risk of criminal or civil liability or be damaging to their financial standing, employability, professional or personal relationships.***

- (●) No
- ( ) Yes

e **Collection of blood, body fluid, tissue samples or other samples.***

- (●) No
- ( ) Yes

f **Any form of exercise regime, or deprivation. (e.g. sleep or dietary)***

- (●) No
- ( ) Yes

g **Any form of physical examination (e.g. physical, radiation, ultrasound).***

- (●) No
- ( ) Yes

h **The administration of any form of drug, medicine (other than in the course of standard medical procedure), or placebo. ***

- (●) No
- ( ) Yes

i **Physical pain, beyond mild discomfort.***

- (●) No
- ( ) Yes

j **Any Massey University teaching which involves the participation of Massey University students for a demonstration of procedures or phenomena which have potential for harm.***

- (●) No
- ( ) Yes

k **Participants whose identities are known to the researcher giving oral consent rather than written consent, other than for cultural reasons .***

- (●) No
- ( ) Yes

l **Participants who are unable to give informed consent.***

- (●) No
- ( ) Yes

m **Research on your own students / pupils. For Massey Staff - refer to the Decision Chart in section 2 of the Code.**
Code of Ethical Conduct - Decision Chart*

- (●) No
- ( ) Yes

n **The participation of children (seven (7) years old or younger).***

- (●) No
- ( ) Yes

o **The participation of children under sixteen (16) years old where active parental consent is not being sought.***

- (●) No
- ( ) Yes

p **Participants who are in a dependant situation, such as nursing home or prison, or patients highly dependent on medical care.***

- (●) No
- ( ) Yes

q **Participants who are vulnerable.***

◉ No
○ Yes

r **The use of previously collected identifiable personal information or research data for which there was no explicit consent for this research.***

◉ No
○ Yes

s **The use of previously collected biological samples for which there was no explicit consent for this research.***

◉ No
○ Yes

t **Any evaluation of organisational services or practices where information of a personal nature may be collected and where participants or the organisation may be identified.***

◉ No
○ Yes

u **Deception of the participants, including concealment or covert observations.***

◉ No
○ Yes

v **Conflict of interest situation for the researcher.**
Code of Ethical Conduct- Special Relationships
e.g. Is the project funded or supported in any way that might result in a conflict of interest, do any of the researchers have a financial interest in the outcome, or is there a professional or other relationship between the researcher and the participants? *

◉ No
○ Yes

w **Payments or other financial inducements (other than reasonable reimbursement of travel expenses or time) to participants.***

◉ No
○ Yes

x **A requirement by an outside organisation (e.g. a funding organisation or a journal in which you wish to publish) for Massey University Human Ethics Committee approval.***

◉ No
○ Yes

y **I wish to submit a full application for Training / Education purposes***

◉ No
○ Yes

2. Sign off

Applicant Sign Off

To submit this application please select the check box below, then using the Actions Tab click on the Submit action.

As Chief Applicant;

- I have read the Code of Ethical Conduct for Research, Teaching and Evaluation involving Human Participants.
- I understand my obligations and the rights of the participants.
- My Head of Unit knows that I am undertaking this research. (for academic staff research)
- I understand that Low Risk Notifications are audited by the Ethics Office and that breaches in complying with Low Risk conditions will be followed up.
- I agree to undertake the research as set out in the Code.

Are there any co-researchers?*

○ No
◉ Yes

- I have confirmed that all co-researchers have read the Code and I have obtained their approval for the content of this application.

- The information in this application is to the very best of my knowledge accurate and not misleading.

*
☑ I have read and understood the above statements

Date: 22 October 2019

Dear Jesse Austin-Stewart Austin-Stewart

Re: Ethics Notification - **4000021891** - **A review of the initial multichannel monophonic framework**

Thank you for your notification which you have assessed as Low Risk.

Your project has been recorded in our system which is reported in the Annual Report of the Massey University Human Ethics Committee.

The low risk notification for this project is valid for a maximum of three years.

If situations subsequently occur which cause you to reconsider your ethical analysis, please contact a Research Ethics Administrator.

Please note that travel undertaken by students must be approved by the supervisor and the relevant Pro Vice-Chancellor and be in accordance with the Policy and Procedures for Course-Related Student Travel Overseas. In addition, the supervisor must advise the University's Insurance Officer.

A reminder to include the following statement on all public documents:

"This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named in this document are responsible for the ethical conduct of this research.

If you have any concerns about the conduct of this research that you want to raise with someone other than the researcher(s), please contact Professor Craig Johnson, Director - Ethics, telephone 06 3569099 ext 85271, email humanethics@massey.ac.nz."

Please note, if a sponsoring organisation, funding authority or a journal in which you wish to publish requires evidence of committee approval (with an approval number), you will have to complete the application form again, answering "yes" to the publication question to provide more information for one of the University's Human Ethics Committees. You should also note that such an approval can only be provided prior to the commencement of the research.

Yours sincerely

Research Ethics Office, Research and Enterprise
Massey University, Private Bag 11 222, Palmerston North, 4442, New Zealand **T** 06 350 5573; 06 350 5575 **F** 06 355 7973
E humanethics@massey.ac.nz **W** http://humanethics.massey.ac.nz

Ethics Application

Application ID :	4000022933
Application Title :	A review of the multichannel monophonic framework
Date of Submission :	02/07/2020
Primary Investigator :	Jesse Austin-Stewart Austin-Stewart (Applicant)
Other Personnel :	

1. Risk Assessment

Project Detail

Human Ethics Application Risk Assessment Form

Does your research fall within the scope of the Code? The scope includes:

a. All research involving either the participation of human or where the research impacts on individuals, groups or communities. This includes consultancies, contract research, staff research and supervised student research.
b. Any teaching which involves the participation of students for the demonstration of procedures or phenomena that have a potential for harm.
c. Any evaluation of university services, organisational practices or teaching programmes where information of a personal nature may be collected, where participants may be identified, or where the performance of staff may be commented on. This does not include routine organisational quality improvement activities, e.g. academic programme evaluations or service delivery projects but does include activities which have a research component and may lead to publications.

- **NB: Where research involves a Massey staff researcher using their own students as participants please refer to the Decision Chart in Section 2 of the Code.**

Applicant Information- PEER REVIEW

Prior to submitting your application for approval, there is an option for you to have your application peer reviewed. (This could be a supervisor if you are a student, or a colleague in the case of academic research). The process is as follows:

- Click on the Action Tab
- Click on the 'Send for peer review' action
- Follow the instructions given.

Note: This process will send an email to your peer reviewer which contains a pdf of the application.
The peer reviewer comments by email outside of the RIMS process.
This **IS NOT** part of the approval process.
Following comment (if any) from your peer reviewer, you must **STILL** submit the final application through the action tab.

1 **Project Title**
*Please limit this to a maximum of 25 words**

A review of the multichannel monophonic framework

2 **Recruitment / Data collection start date.**
This date must be in the future.
*Data collection /recruitment cannot begin until notification of submission has been received.**

03/07/2020

3 **Projected end of project date.***

31/05/2022

4 **Project Type ***

- ○ Academic Staff Research
- ○ General Staff Research
- ◉ Postgraduate Student Research
- ○ Undergraduate Student Research
- ○ Evaluation
- ○ Teaching
- ○ Other

5 **Project Summary**
*Please outline in no more than 2000 characters in lay language**

The project is a Spatial Composition User Study. My thesis explores ways to make spatial audio experiences and systems more accessible. Part of this work has seen me devise a new spatial audio system that aims to allow more listeners to have an equally intended listening experience, regardless of where they are positioned in relation to the system. In tandem with the creation of this system, I am creating a framework from which people can respond to to create their own work for this system. To deem the success of this system and its initial framework, I will be asking 6-10 people to write musical works for the system. Upon completion, I will ask them to complete a survey regarding their perceived success of the framework in regards to the outcome of their piece. I also intend to conduct a listener survey to deem the success of the multichannel monophonic system itself.

6 **Describe the peer review process that has been used to discuss and analyse the ethical issues present in this project.**
(maximum of 4000 characters)*

Discussions with my supervisor have taken place in which we have unpacked the ethical issues surrounding the project in regards to the people surveyed and how they are surveyed.

7 **List the ethical issues considered and explain how each has been addressed**
(maximum of 2000 characters)*

This application is considered low risk, as the ethical concerns are limited. Prior to participation in the project, composers will be asked to sign a consent form, agreeing to have their work publicly displayed, to partake in a survey that will ask questions regarding their experience of the system and the created framework or the system, and also agreeing to have their anonymous answers contribute towards my PhD research and potential academic papers.. They will be asked to complete a survey where they will be asked questions as to their experience of working with the system and what they think in regards to the framework's success. This will involve questions such as "Would you deem your work spatially interesting from multiple positions?" and "How would you describe the spatial interest of the system and why?". The composers will be sent these questions via a Google Form. They will not be asked for any identifiable details, as to keep their answers and identities separate.

Listeners who did not compose for the system will also be asked to complete a survey of their listening experience of the system. They will be asked to sign a consent form agreeing to partake in the survey, to be asked questions regarding to their listening experience of the system, and have their anonymous answers contribute towards my PhD research and potential academic papers. The people asked to do the survey will be handpicked by the applicant (based on their musical background and experience), however, the survey will not require identifiable details to keep their identity anonymous. They will be asked questions like "Did you have equally interesting spatial experience from multiple positions within the space?", and "What did you think was ineffective about this spatial experience?".

Data will be stored privately on a password protected Google Drive account. This information will only be shared with the co-applicants Bridget Johnson and Oli Wilson.

8 **With whom did you peer review your research?**
(maximum of 2000 characters)*

Bridget Johnson (supervisor) - B.D.Johnson@massey.ac.nz

Applicant

1 Applicant Department*

School of Music and Creative Media Production

2 Ethics Category Hidden*

Human

Campus of Chief Applicant
*(or Campus of Supervisor for Student)**

- ○ Manawatu
- ◉ Wellington
- ○ Albany

3 Personnel
You can add any additional team members here. Click on 'More criteria' below to access the advanced search function.

1	Surname	Austin-Stewart
	Given Name	Jesse
	Full Name	Jesse Austin-Stewart Austin-Stewart
	Position	Applicant
	Primary?	Yes
	Work Number	
	Email Address	J.Austin-Stewart.1@uni.massey.ac.nz
	Department	
	College	

Please add name of co researchers if unable to locate above

This question is not answered.

Risk Assessment

1 **Is Health and Disability Ethics Committee review required for this study?***

- ◉ No
- ○ Yes

[Link to Standard Operating Procedures for HDECs]

[Link to HDEC scope of review form]

2 **Does your research include:**

a **Situations where the researcher may be at risk of harm***

- (•) No
- ( ) Yes

b **Use of a questionnaire or interview, whether or not it is anonymous, which might reasonably be expected to cause discomfort, embarrassment or psychological or spiritual harm to the participants. ***

- (•) No
- ( ) Yes

c **Processes that are potentially disadvantageous to a person or group, such as the collection of information which may expose a person / group to discrimination.***

- (•) No
- ( ) Yes

d **Collection of information of illegal behavior(s) gained during the research which could place the participants at risk of criminal or civil liability or be damaging to their financial standing, employability, professional or personal relationships.***

- (•) No
- ( ) Yes

e **Collection of blood, body fluid, tissue samples or other samples.***

- (•) No
- ( ) Yes

f **Any form of exercise regime, or deprivation. (e.g. sleep or dietary)***

- (•) No
- ( ) Yes

g **Any form of physical examination (e.g. physical, radiation, ultrasound).***

- (•) No
- ( ) Yes

h **The administration of any form of drug, medicine (other than in the course of standard medical procedure), or placebo. ***

- (•) No
- ( ) Yes

i **Physical pain, beyond mild discomfort.***

- (•) No
- ( ) Yes

j **Any Massey University teaching which involves the participation of Massey University students for a demonstration of procedures or phenomena which have potential for harm.***

- (•) No
- ( ) Yes

k **Participants whose identities are known to the researcher giving oral consent rather than written consent, other than for cultural reasons .***

- (•) No
- ( ) Yes

l **Participants who are unable to give informed consent.***

- (•) No
- ( ) Yes

m **Research on your own students / pupils. For Massey Staff - refer to the Decision Chart in section 2 of the Code.**
Code of Ethical Conduct - Decision Chart*

- (•) No
- ( ) Yes

n **The participation of children (seven (7) years old or younger).***

- (•) No
- ( ) Yes

o **The participation of children under sixteen (16) years old where active parental consent is not being sought.***

- (•) No
- ( ) Yes

p **Participants who are in a dependant situation, such as nursing home or prison, or patients highly dependent on medical care.***

- (•) No
- ( ) Yes

q **Participants who are vulnerable.***

- (x) No
- ( ) Yes

r **The use of previously collected identifiable personal information or research data for which there was no explicit consent for this research.***

- (x) No
- ( ) Yes

s **The use of previously collected biological samples for which there was no explicit consent for this research.***

- (x) No
- ( ) Yes

t **Any evaluation of organisational services or practices where information of a personal nature may be collected and where participants or the organisation may be identified.***

- (x) No
- ( ) Yes

u **Deception of the participants, including concealment or covert observations.***

- (x) No
- ( ) Yes

v **Conflict of interest situation for the researcher.**
Code of Ethical Conduct- Special Relationships
e.g. Is the project funded or supported in any way that might result in a conflict of interest, do any of the researchers have a financial interest in the outcome, or is there a professional or other relationship between the researcher and the participants? *

- (x) No
- ( ) Yes

w **Payments or other financial inducements (other than reasonable reimbursement of travel expenses or time) to participants.***

- (x) No
- ( ) Yes

x **A requirement by an outside organisation (e.g. a funding organisation or a journal in which you wish to publish) for Massey University Human Ethics Committee approval.***

- (x) No
- ( ) Yes

y **I wish to submit a full application for Training / Education purposes***

- (x) No
- ( ) Yes

2. Sign off

Applicant Sign Off

To submit this application please select the check box below, then using the Actions Tab click on the Submit action.

As Chief Applicant;

- I have read the Code of Ethical Conduct for Research, Teaching and Evaluation involving Human Participants.
- I understand my obligations and the rights of the participants.
- My Head of Unit knows that I am undertaking this research. (for academic staff research)
- I understand that Low Risk Notifications are audited by the Ethics Office and that breaches in complying with Low Risk conditions will be followed up.
- I agree to undertake the research as set out in the Code.

Are there any co-researchers?*

- ( ) No
- (x) Yes

- I have confirmed that all co-researchers have read the Code and I have obtained their approval for the content of this application.

- The information in this application is to the very best of my knowledge accurate and not misleading.

*

- [x] I have read and understood the above statements

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

24/02/2022

Dear: Jesse Austin-Stewart Austin-Stewart

Re: Low Risk Notification - 4000022933 - A review of the multichannel monophonic framework

Thank you for your notification which you have assessed as Low Risk.

Your project has been recorded in our database for inclusion in the Annual Report of the Massey University Human Ethics Committee.

The low risk notification for this project is valid for a maximum of three years.

If situations subsequently occur which cause you to reconsider your ethical analysis, please contact a Research Ethics Administrator.

Please note that travel undertaken by students must be approved by the supervisor and the relevant Pro Vice-Chancellor and be in accordance with the Policy and Procedures for Course-Related Student Travel Overseas. In addition, the supervisor must advise the University's Insurance Officer.

A reminder to include the following statement on all public documents:

"This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named in this document are responsible for the ethical conduct of this research.

If you have any concerns about the conduct of this research that you want to raise with someone other than the researcher(s), please contact Professor Craig Johnson, Director - Ethics, telephone 06 3569099 ext 85271, email humanethics@massey.ac.nz."

Please note, if a sponsoring organisation, funding authority or a journal in which you wish to publish requires evidence of committee approval (with an approval number), you will have to complete the application form again, answering "yes" to the publication question to provide more information for one of the University's Human Ethics Committees. You should also note that such an approval can only be provided prior to the commencement of the research.

Yours sincerely

Professor Craig Johnson
Chair, Human Ethics Chairs' Committee and Director (Research Ethics)

Research Ethics Office, Research and Enterprise
Massey University, Private Bag 11 222, Palmerston North, 4442, New Zealand T 06 951 6841; 06 95106840
E humanethics@massey.ac.nz; animalethics@massey.ac.nz; gtc@massey.ac.nz

Ethics Application

Application ID :	4000022934
Application Title :	Interviews with hearing impaired individuals as to their experiences within the field of spatial audio
Date of Submission :	14/07/2020
Primary Investigator :	Jesse Austin-Stewart Austin-Stewart (Applicant)
Other Personnel :	

1. Risk Assessment

Project Detail

Human Ethics Application Risk Assessment Form

Does your research fall within the scope of the Code? The scope includes:

a. All research involving either the participation of human or where the research impacts on individuals, groups or communities. This includes consultancies, contract research, staff research and supervised student research.
b. Any teaching which involves the participation of students for the demonstration of procedures or phenomena that have a potential for harm.
c. Any evaluation of university services, organisational practices or teaching programmes where information of a personal nature may be collected, where participants may be identified, or where the performance of staff may be commented on. This does not include routine organisational quality improvement activities, e.g. academic programme evaluations or service delivery projects but does include activities which have a research component and may lead to publications.

- **NB: Where research involves a Massey staff researcher using their own students as participants please refer to the Decision Chart in Section 2 of the Code.**

Applicant Information- PEER REVIEW

Prior to submitting your application for approval, there is an option for you to have your application peer reviewed. (This could be a supervisor if you are a student, or a colleague in the case of academic research). The process is as follows:

- Click on the Action Tab
- Click on the 'Send for peer review' action
- Follow the instructions given.

Note: This process will send an email to your peer reviewer which contains a pdf of the application.
The peer reviewer comments by email outside of the RIMS process.
This **IS NOT** part of the approval process.
Following comment (if any) from your peer reviewer, you must **STILL** submit the final application through the action tab.

1 **Project Title**
*Please limit this to a maximum of 25 words**

Interviews with hearing impaired individuals as to their experiences within the field of spatial audio

2 **Recruitment / Data collection start date.**
This date must be in the future.
*Data collection /recruitment cannot begin until notification of submission has been received.**

15/07/2020

3 **Projected end of project date.***

31/05/2022

4 **Project Type ***

- ○ Academic Staff Research
- ○ General Staff Research
- ◉ Postgraduate Student Research
- ○ Undergraduate Student Research
- ○ Evaluation
- ○ Teaching
- ○ Other

5 **Project Summary**
*Please outline in no more than 2000 characters in lay language**

This project will involve interviewing hearing impaired individuals as to their experiences working within the field of spatial audio. My thesis explores ways to make spatial audio experiences and systems more accessible. Part of this work will be investigating how to create works for hearing impaired individuals. I wish to speak with 2 individuals who are hearing impaired and have experience within spatial audio (they have been identified within the community and are personally known to the researcher) as to their experiences of how both of those things have interacted with each other. They will also be invited to review the solutions (created by the researcher) to any issues they describe.

6 **Describe the peer review process that has been used to discuss and analyse the ethical issues present in this project.**
(maximum of 4000 characters)*

Discussions with my supervisor have taken place in which we have unpacked the ethical issues surrounding the project in regards to how they are surveyed.

7 **List the ethical issues considered and explain how each has been addressed**
(maximum of 2000 characters)*

This application is considered low risk, as the ethical concerns are limited. Prior to participation in the project, interviewees will be required to sign a consent for, agreeing to be interviewed, to have the interview audio recorded, to answer questions in regards to their experience of having a hearing impairment and working within spatial audio, and to have their responses contribute towards my PhD research and potential academic publication. Interviewees are personally known to the researcher and will be approached by email requesting participation. The email will say that they have a choice to not participate. They will be given the option to meet in a private or public space to conduct the interview. Questions will be asked around how their hearing impairment has impacted their engagement with spatial audio. The responses will inform artistic works that will be created to resolve any issues they may have experienced. They will then be invited to review the works and their effectiveness at solving their issues. There may be accessibility issues around the conversational format of the interview. The researcher's past engagement with them suggests this won't be an issue, however they will still be given the option to select other means of interviewing (e.g. video call, written response etc). The interviews will all be audio recorded and follow the same protocol.. The interviewees will be asked these questions and have their responses audio recorded. The interviewees identities will be kept anonymous and be referred to as 'Person A' and 'Person B'. These recordings will be stored on a laptop and two external hard drives. The file will then be deleted from the recorder. The two external hard drives will be kept secure behind locked doors and the laptop will be password protected. The audio will also be backed up to Google Drive which will be password protected. This information will only be shared with the co-applicants Bridget Johnson and Oli Wilson.

8 **With whom did you peer review your research?**
(maximum of 2000 characters)*

Bridget Johnson (supervisor) - B.D.Johnson@massey.ac.nz

Applicant

1 Applicant Department*

School of Music and Creative Media Production

2 Ethics Category Hidden*

Human

Campus of Chief Applicant
*(or Campus of Supervisor for Student)**

- ○ Manawatu
- ◉ Wellington
- ○ Albany

3 Personnel
You can add any additional team members here. Click on 'More criteria' below to access the advanced search function.

1	Surname	Austin-Stewart
	Given Name	Jesse
	Full Name	Jesse Austin-Stewart Austin-Stewart
	Position	Applicant
	Primary?	Yes
	Work Number	
	Email Address	J.Austin-Stewart.1@uni.massey.ac.nz
	Department	
	College	

Please add name of co researchers if unable to locate above

Bridget Johnson, Oli Wilson

Risk Assessment

1 **Is Health and Disability Ethics Committee review required for this study?***

- ◉ No
- ○ Yes

Link to Standard Operating Procedures for HDECs

Link to HDEC scope of review form

2 **Does your research include:**

a **Situations where the researcher may be at risk of harm***

◉ No
○ Yes

b **Use of a questionnaire or interview, whether or not it is anonymous, which might reasonably be expected to cause discomfort, embarrassment or psychological or spiritual harm to the participants. ***
◉ No
○ Yes

c **Processes that are potentially disadvantageous to a person or group, such as the collection of information which may expose a person / group to discrimination.***
◉ No
○ Yes

d **Collection of information of illegal behavior(s) gained during the research which could place the participants at risk of criminal or civil liability or be damaging to their financial standing, employability, professional or personal relationships.***
◉ No
○ Yes

e **Collection of blood, body fluid, tissue samples or other samples.***
◉ No
○ Yes

f **Any form of exercise regime, or deprivation. (e.g. sleep or dietary)***
◉ No
○ Yes

g **Any form of physical examination (e.g. physical, radiation, ultrasound).***
◉ No
○ Yes

h **The administration of any form of drug, medicine (other than in the course of standard medical procedure), or placebo. ***
◉ No
○ Yes

i **Physical pain, beyond mild discomfort.***
◉ No
○ Yes

j **Any Massey University teaching which involves the participation of Massey University students for a demonstration of procedures or phenomena which have potential for harm.***
◉ No
○ Yes

k **Participants whose identities are known to the researcher giving oral consent rather than written consent, other than for cultural reasons .***
◉ No
○ Yes

l **Participants who are unable to give informed consent.***
◉ No
○ Yes

m **Research on your own students / pupils. For Massey Staff - refer to the Decision Chart in section 2 of the Code.**
Code of Ethical Conduct - Decision Chart*
◉ No
○ Yes

n **The participation of children (seven (7) years old or younger).***
◉ No
○ Yes

o **The participation of children under sixteen (16) years old where active parental consent is not being sought.***
◉ No
○ Yes

p **Participants who are in a dependant situation, such as nursing home or prison, or patients highly dependent on medical care.***
◉ No
○ Yes

q **Participants who are vulnerable.***

- ◉ No
- ○ Yes

r **The use of previously collected identifiable personal information or research data for which there was no explicit consent for this research.***

- ◉ No
- ○ Yes

s **The use of previously collected biological samples for which there was no explicit consent for this research.***

- ◉ No
- ○ Yes

t **Any evaluation of organisational services or practices where information of a personal nature may be collected and where participants or the organisation may be identified.***

- ◉ No
- ○ Yes

u **Deception of the participants, including concealment or covert observations.***

- ◉ No
- ○ Yes

v **Conflict of interest situation for the researcher.**
Code of Ethical Conduct- Special Relationships
e.g. Is the project funded or supported in any way that might result in a conflict of interest, do any of the researchers have a financial interest in the outcome, or is there a professional or other relationship between the researcher and the participants? *

- ◉ No
- ○ Yes

w **Payments or other financial inducements (other than reasonable reimbursement of travel expenses or time) to participants.***

- ◉ No
- ○ Yes

x **A requirement by an outside organisation (e.g. a funding organisation or a journal in which you wish to publish) for Massey University Human Ethics Committee approval.***

- ◉ No
- ○ Yes

y **I wish to submit a full application for Training / Education purposes***

- ◉ No
- ○ Yes

2. Sign off

Applicant Sign Off

To submit this application please select the check box below, then using the Actions Tab click on the Submit action.

As Chief Applicant;

- I have read the Code of Ethical Conduct for Research, Teaching and Evaluation involving Human Participants.
- I understand my obligations and the rights of the participants.
- My Head of Unit knows that I am undertaking this research. (for academic staff research)
- I understand that Low Risk Notifications are audited by the Ethics Office and that breaches in complying with Low Risk conditions will be followed up.
- I agree to undertake the research as set out in the Code.

Are there any co-researchers?*

- ○ No
- ◉ Yes

- I have confirmed that all co-researchers have read the Code and I have obtained their approval for the content of this application.

- The information in this application is to the very best of my knowledge accurate and not misleading.

*

☑ I have read and understood the above statements

Date: 02 July 2020

Dear Jesse Austin-Stewart Austin-Stewart

Re: Ethics Notification - **4000022934** - **Interviews with hearing impaired individuals as to their experiences within the field of spatial audio**

Thank you for your notification which you have assessed as Low Risk.

Your project has been recorded in our system which is reported in the Annual Report of the Massey University Human Ethics Committee.

The low risk notification for this project is valid for a maximum of three years.

If situations subsequently occur which cause you to reconsider your ethical analysis, please contact a Research Ethics Administrator.

Please note that travel undertaken by students must be approved by the supervisor and the relevant Pro Vice-Chancellor and be in accordance with the Policy and Procedures for Course-Related Student Travel Overseas. In addition, the supervisor must advise the University's Insurance Officer.

A reminder to include the following statement on all public documents:
"This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named in this document are responsible for the ethical conduct of this research.

If you have any concerns about the conduct of this research that you want to raise with someone other than the researcher(s), please contact Professor Craig Johnson, Director - Ethics, telephone 06 3569099 ext 85271, email humanethics@massey.ac.nz."

Please note, if a sponsoring organisation, funding authority or a journal in which you wish to publish requires evidence of committee approval (with an approval number), you will have to complete the application form again, answering "yes" to the publication question to provide more information for one of the University's Human Ethics Committees. You should also note that such an approval can only be provided prior to the commencement of the research.

Yours sincerely

Research Ethics Office, Research and Enterprise
Massey University, Private Bag 11 222, Palmerston North, 4442, New Zealand **T** 06 350 5573; 06 350 5575 **F** 06 355 7973
E humanethics@massey.ac.nz **W** http://humanethics.massey.ac.nz

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

Ethics Application

Application ID :	4000024794
Application Title :	Gamification of Spatial Audio Surveys
Date of Submission :	28/07/2021
Primary Investigator :	Jesse Austin-Stewart Austin-Stewart (Applicant)
Other Personnel :	

1. Risk Assessment

Project Detail

Human Ethics Application Risk Assessment Form

Does your research fall within the scope of the Code? The scope includes:

a. All research involving either the participation of human or where the research impacts on individuals, groups or communities. This includes consultancies, contract research, staff research and supervised student research.
b. Any teaching which involves the participation of students for the demonstration of procedures or phenomena that have a potential for harm.
c. Any evaluation of university services, organisational practices or teaching programmes where information of a personal nature may be collected, where participants may be identified, or where the performance of staff may be commented on. This does not include routine organisational quality improvement activities, e.g. academic programme evaluations or service delivery projects but does include activities which have a research component and may lead to publications.

- **NB: Where research involves a Massey staff researcher using their own students as participants please refer to the Decision Chart in Section 2 of the Code.**

Applicant Information- PEER REVIEW

Prior to submitting your application for approval, there is an option for you to have your application peer reviewed. (This could be a supervisor if you are a student, or a colleague in the case of academic research). The process is as follows:

- Click on the Action Tab
- Click on the 'Send for peer review' action
- Follow the instructions given.

Note: This process will send an email to your peer reviewer which contains a pdf of the application.
The peer reviewer comments by email outside of the RIMS process.
This **IS NOT** part of the approval process.
Following comment (if any) from your peer reviewer, you must **STILL** submit the final application through the action tab.

1 **Project Title**
*Please limit this to a maximum of 25 words**

Gamification of Spatial Audio Surveys

2 **Recruitment / Data collection start date.**
This date must be in the future.
*Data collection /recruitment cannot begin until notification of submission has been received.**

29/07/2021

3 **Projected end of project date.***

31/05/2022

4 **Project Type ***

- ○ Academic Staff Research
- ○ General Staff Research
- ◉ Postgraduate Student Research
- ○ Undergraduate Student Research
- ○ Evaluation
- ○ Teaching
- ○ Other

5 **Project Summary**
*Please outline in no more than 2000 characters in lay language**

Participants are invited to take part in two 10-minute musical activities, one of which will be a listening activity with the other being a game. After each activity, the participants will be asked to complete a short survey as to their experience of the activity. For one of the activities you will be blindfolded. There will be an independent observer in the room during this time.

6 **Describe the peer review process that has been used to discuss and analyse the ethical issues present in this project.**
(maximum of 4000 characters)*

The peer review process involved reviewing the survey and consent form with Dr Oli Wilson and Dr Bridget Johnson. Participants are asked for demographical data about themselves (gender, age, ethnicity), however are asked to only respond if comfortable. There is an activity where they will be blindfolded, for which, and independent observer will be present. The particpants are allowed to stop participation at any point during the activities.

7 **List the ethical issues considered and explain how each has been addressed**
(maximum of 2000 characters)*

This application is considered low risk, as the ethical concerns are limited. Prior to participation in the project, participants will be required to sign a consent for, agreeing to be surveyed. Participants are asked for demographical data about themselves (gender, age, ethnicity), however are asked to only respond if comfortable. There is an activity where they will be blindfolded, for which, and independent observer will be present. The particpants are allowed to stop participation at any point during the activities. The participants identities will be kept anonymous. These surveys will be stored on a paper copy in a locked room and a spreadsheet of the results will be stored on a locked computer and uploaded to a password protected Goole Drive account. This information will only be shared with the co-applicants Bridget Johnson and Oli Wilson.

8 **With whom did you peer review your research?**
(maximum of 2000 characters)*

Dr Bridget Johnson and Dr Oli Wilson

Applicant

1 Applicant Department*

School of Music and Creative Media Production

2 Ethics Category Hidden*

Human

Campus of Chief Applicant
*(or Campus of Supervisor for Student)**

- ○ Manawatu
- ◉ Wellington
- ○ Albany

3 Personnel
You can add any additional team members here. Click on 'More criteria' below to access the advanced search function.

1	Surname	Austin-Stewart
	Given Name	Jesse
	Full Name	Jesse Austin-Stewart Austin-Stewart
	Position	Applicant
	Primary?	Yes
	Work Number	
	Email Address	J.Austin-Stewart.1@uni.massey.ac.nz
	Department	
	College	

Please add name of co researchers if unable to locate above

Bridget Johnson, Oli Wilson

Risk Assessment

1 **Is Health and Disability Ethics Committee review required for this study?***

- ◉ No
- ○ Yes

Link to Standard Operating Procedures for HDECs

Link to HDEC scope of review form

2 **Does your research include:**

a **Situations where the researcher may be at risk of harm***

- ◉ No
- ○ Yes

b **Use of a questionnaire or interview, whether or not it is anonymous, which might reasonably be expected to cause discomfort, embarrassment or psychological or spiritual harm to the participants. ***

◉ No
○ Yes

c Processes that are potentially disadvantageous to a person or group, such as the collection of information which may expose a person / group to discrimination.*

◉ No
○ Yes

d Collection of information of illegal behavior(s) gained during the research which could place the participants at risk of criminal or civil liability or be damaging to their financial standing, employability, professional or personal relationships.*

◉ No
○ Yes

e Collection of blood, body fluid, tissue samples or other samples.*

◉ No
○ Yes

f Any form of exercise regime, or deprivation. (e.g. sleep or dietary)*

◉ No
○ Yes

g Any form of physical examination (e.g. physical, radiation, ultrasound).*

◉ No
○ Yes

h The administration of any form of drug, medicine (other than in the course of standard medical procedure), or placebo. *

◉ No
○ Yes

i Physical pain, beyond mild discomfort.*

◉ No
○ Yes

j Any Massey University teaching which involves the participation of Massey University students for a demonstration of procedures or phenomena which have potential for harm.*

◉ No
○ Yes

k Participants whose identities are known to the researcher giving oral consent rather than written consent, other than for cultural reasons .*

◉ No
○ Yes

l Participants who are unable to give informed consent.*

◉ No
○ Yes

m Research on your own students / pupils. For Massey Staff - refer to the Decision Chart in section 2 of the Code.
Code of Ethical Conduct - Decision Chart*

◉ No
○ Yes

n The participation of children (seven (7) years old or younger).*

◉ No
○ Yes

o The participation of children under sixteen (16) years old where active parental consent is not being sought.*

◉ No
○ Yes

p Participants who are in a dependant situation, such as nursing home or prison, or patients highly dependent on medical care.*

◉ No
○ Yes

q Participants who are vulnerable.*

◉ No
○ Yes

r The use of previously collected identifiable personal information or research data for which there was no explicit consent for this research.*

- (x) No
- ( ) Yes

s **The use of previously collected biological samples for which there was no explicit consent for this research.***

- (x) No
- ( ) Yes

t **Any evaluation of organisational services or practices where information of a personal nature may be collected and where participants or the organisation may be identified.***

- (x) No
- ( ) Yes

u **Deception of the participants, including concealment or covert observations.***

- (x) No
- ( ) Yes

v **Conflict of interest situation for the researcher.**
Code of Ethical Conduct- Special Relationships
e.g. Is the project funded or supported in any way that might result in a conflict of interest, do any of the researchers have a financial interest in the outcome, or is there a professional or other relationship between the researcher and the participants? *

- (x) No
- ( ) Yes

w **Payments or other financial inducements (other than reasonable reimbursement of travel expenses or time) to participants.***

- (x) No
- ( ) Yes

x **A requirement by an outside organisation (e.g. a funding organisation or a journal in which you wish to publish) for Massey University Human Ethics Committee approval.***

- (x) No
- ( ) Yes

y **I wish to submit a full application for Training / Education purposes***

- (x) No
- ( ) Yes

2. Sign off

Applicant Sign Off

To submit this application please select the check box below, then using the Actions Tab click on the Submit action.

As Chief Applicant;

- I have read the Code of Ethical Conduct for Research, Teaching and Evaluation involving Human Participants.
- I understand my obligations and the rights of the participants.
- My Head of Unit knows that I am undertaking this research. (for academic staff research)
- I understand that Low Risk Notifications are audited by the Ethics Office and that breaches in complying with Low Risk conditions will be followed up.
- I agree to undertake the research as set out in the Code.

Are there any co-researchers?*

- ( ) No
- (x) Yes

- I have confirmed that all co-researchers have read the Code and I have obtained their approval for the content of this application.

- The information in this application is to the very best of my knowledge accurate and not misleading.

*
- [x] I have read and understood the above statements

Date: 28 July 2021

Dear Jesse Austin-Stewart Austin-Stewart

Re: Ethics Notification - **4000024794** - **Gamification of Spatial Audio Surveys**

Thank you for your notification which you have assessed as Low Risk.

Your project has been recorded in our system which is reported in the Annual Report of the Massey University Human Ethics Committee.

The low risk notification for this project is valid for a maximum of three years.

If situations subsequently occur which cause you to reconsider your ethical analysis, please contact a Research Ethics Administrator.

Please note that travel undertaken by students must be approved by the supervisor and the relevant Pro Vice-Chancellor and be in accordance with the Policy and Procedures for Course-Related Student Travel Overseas. In addition, the supervisor must advise the University's Insurance Officer.

A reminder to include the following statement on all public documents:
"This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named in this document are responsible for the ethical conduct of this research.

If you have any concerns about the conduct of this research that you want to raise with someone other than the researcher(s), please contact Professor Craig Johnson, Director - Ethics, telephone 06 3569099 ext 85271, email humanethics@massey.ac.nz."

Please note, if a sponsoring organisation, funding authority or a journal in which you wish to publish requires evidence of committee approval (with an approval number), you will have to complete the application form again, answering "yes" to the publication question to provide more information for one of the University's Human Ethics Committees. You should also note that such an approval can only be provided prior to the commencement of the research.

Yours sincerely

C Johnson

Research Ethics Office, Research and Enterprise
Massey University, Private Bag 11 222, Palmerston North, 4442, New Zealand **T** 06 350 5573; 06 350 5575 **F** 06 355 7973
E humanethics@massey.ac.nz **W** http://humanethics.massey.ac.nz

Ethics Application

Application ID :	4000025459
Application Title :	Documentation of Installations
Date of Submission :	02/02/2022
Primary Investigator :	Jesse Austin-Stewart Austin-Stewart (Applicant)
Other Personnel :	A/Pro Oli Wilson (Applicant)

Initial Assessment

Project Detail

Human Ethics Application Risk Assessment Form

Does your research fall within the scope of the Code? The scope includes:

a. All research involving either the participation of human or where the research impacts on individuals, groups or communities. This includes consultancies, contract research, staff research and supervised student research.
b. Any teaching which involves the participation of students for the demonstration of procedures or phenomena that have a potential for harm.
c. Any evaluation of university services, organisational practices or teaching programmes where information of a personal nature may be collected, where participants may be identified, or where the performance of staff may be commented on. This does not include routine organisational quality improvement activities, e.g. academic programme evaluations or service delivery projects but does include activities which have a research component and may lead to publications.

NB: Where research involves a Massey staff researcher using their own students as participants please refer to the Decision Chart in Section 2 of the Code.

Applicant Information- PEER REVIEW

If your application is deemed to be high risk after the risk assessment questions have been answered, there will be an option for you to have your full application peer reviewed, prior to submitting it for approval. (This could be a supervisor if you are a student, or a colleague in the case of academic research). The process is as follows:

- Click on the 'Send for peer review' action.
- Follow the instructions given.

Note:
This process will send an email to your peer reviewer which contains a pdf of the application.
The peer reviewer comments by email outside of the RIMS process.
This **IS NOT** part of the approval process.
Following comment (if any) from your peer reviewer, you must **STILL** submit the final application by clicking on the "Submit" action.

1 Project Title:
(*Please limit this to a maximum of 25 words*)*

Documentation of Installations

2 **Recruitment / Data collection start date:**
This date must be in the future.
*Data collection /recruitment cannot begin until notification of submission has been received.**

03/02/2022

3 What date do you expect data collection and analysis activities to be completed by?
*Note: this must be done within 3 years of ethics approval.**

30/04/2022

4 **Project Type:** *

- ○ Academic Staff Research
- ○ Professional Staff Research
- ◉ Postgraduate Student Research
- ○ Undergraduate Student Research
- ○ Evaluation
- ○ Teaching

5 **Aim of the project:***

Document installation works for PhD Thesis

6 **Project Summary:**
*Please outline in no more than 2000 characters in lay language (What you're doing, how you're doing it, who you're doing it with)**

This will involve the video documentation of various art works from the applicant's PhD thesis. As a part of this, members of the public will be asked to be in the video documentation to illustrate how the works would be experienced. This video documentation will then be used in the context of a digital files folder within the PhD Thesis and within conference presentations.

7 **Describe the peer review process that has been used to discuss and analyse the ethical issues present in this project:**
*(maximum of 4000 characters)**

The peer review process involved the applicant and the applicant's supervisor discussing the ethical issues and methods to mitigate those issues. The issues present are that those involved in the documentation do not have agency over their image and the use of the footage.

8 Summarise the ethical issues considered and explain how each has been addressed:
(*maximum of 2000 characters*)*

In regards to the people in the documentation not having agency over their image and the use of the footage, they applicants will be given a consent form to sign that will outline the use cases of the footage (digital files folder for PhD thesis and conference presentations) asking for permission to use their image in those contexts. Participants will also be granted the right to remove themselves from the project at any time.

9 **With whom did you peer review the ethical aspects of your research?**
(*maximum of 2000 characters*)*

Oli Wilson

Applicant

1 Applicant Department:*

School of Music and Creative Media Production

2 Ethics Category:*

Human

3 **Campus of Chief Applicant:**
(or Campus of Supervisor for Student)

- ○ Manawatu
- ◉ Wellington
- ○ Albany

4 Internal Personnel:
Please add any additional team members here. For student applicants, please also add your supervisor(s) here.

1	Surname	Austin-Stewart
	Given Name	Jesse Austin-Stewart
	Full Name	Jesse Austin-Stewart Austin-Stewart
	Position	Applicant
	Primary?	Yes
	Work Number	
	Email Address	J.Austin-Stewart.1@uni.massey.ac.nz
	Department	
	College	
2	Surname	Wilson
	Given Name	Oli
	Full Name	A/Pro Oli Wilson
	Position	Applicant
	Primary?	
	Work Number	
	Email Address	O.Wilson@massey.ac.nz
	Department	PVC's Office-College of Creative Arts
	College	College of Creative Arts

5 External Personnel:
Please add name of co researchers if unable to locate above

This question is not answered.

Health and Disability Ethics Committee

Is Health and Disability Ethics Committee (HDEC) review required for this study?

- ◉ No
- ○ Yes

If you are unclear about whether approval from HDEC is required, please click on the links below.

Operating Procedures for HDECs (NZ Government Health and Disability Ethics Committees website)

Find out if your study requires HDEC review (NZ Government Health and Disability Ethics Committees website)

Please click on 'Save' to continue, then click on the blue button that says "Next Page: Risk Assessment Questions".

Risk Assessment Questions

Does your research include:
Note: all of the risk assessment questions are mandatory

a) **Situations where the researcher may be at risk of harm.***
- (•) No
- ( ) Yes

b) **Use of a questionnaire or interview, whether or not it is anonymous, which might reasonably be expected to cause discomfort, embarrassment or psychological or spiritual harm to the participants.***
- (•) No
- ( ) Yes

c) **Processes that are potentially disadvantageous to a person or group, such as the collection of information which may expose a person / group to discrimination.***
- (•) No
- ( ) Yes

d) **Collection of information of illegal behavior(s) gained during the research which could place the participants at risk of criminal or civil liability or be damaging to their financial standing, employability, professional or personal relationships.***
- (•) No
- ( ) Yes

e) **Collection of blood, body fluid, tissue samples or other samples.***
- (•) No
- ( ) Yes

f) **Any form of exercise regime or manipulation (e.g. sleep pattern or dietary).***
- (•) No
- ( ) Yes

g) **Any form of physical examination (e.g. physical, radiation, ultrasound).***
- (•) No
- ( ) Yes

h) **The administration of any form of drug (including alcohol), medicine (other than in the course of standard medical procedure), or placebo.***
- (•) No
- ( ) Yes

i) **Physical pain, beyond mild discomfort.***
- (•) No
- ( ) Yes

j) **Any Massey University teaching which involves the participation of Massey University students for a demonstration of procedures or phenomena which have potential for harm.***
- (•) No
- ( ) Yes

k) **Participants whose identities are known to the researcher giving oral consent, rather than written consent, other than for cultural reasons.***
- (•) No
- ( ) Yes

l) **Participants who are unable to give informed consent.***
- (•) No
- ( ) Yes

m) **Research on your own students / pupils. For Massey Staff - refer to the Decision Chart in section 2 of the Code.**
Code of Ethical Conduct - Decision Chart*
- (•) No
- ( ) Yes

n) **The participation of children (seven (7) years old or younger).***

- (•) No
- ( ) Yes

o) **The participation of children under sixteen (16) years old where active parental consent is not being sought.***
- (•) No
- ( ) Yes

p) **Participants who are in a dependent situation, such as nursing home or prison, or patients highly dependent on medical care.***
- (•) No
- ( ) Yes

q) **Participants who are vulnerable.***
- (•) No
- ( ) Yes

r) **The use of previously collected identifiable personal information or research data for which there was no explicit consent for this research.***
- (•) No
- ( ) Yes

s) **The use of previously collected biological samples for which there was no explicit consent for this research.***
- (•) No
- ( ) Yes

t) **Any evaluation of organisational services or practices where information of a personal nature may be collected and where participants or the organisation may be identified.***
- (•) No
- ( ) Yes

u) **Deception of the participants, including concealment or covert observations.***
- (•) No
- ( ) Yes

v) **Conflict of interest situation.**
Code of Ethical Conduct - Special Relationships
e.g. Is the project funded or supported in any way that might result in a conflict of interest, do any of the researchers have a financial interest in the outcome, or is there a professional or other relationship between the researcher and the participants? *
- (•) No
- ( ) Yes

w) **Payments or other financial inducements (other than reasonable reimbursement of travel expenses or time) to participants.***
- (•) No
- ( ) Yes

x) **A requirement by an outside organisation (e.g. a funding organisation or a journal in which you wish to publish) for Massey University Human Ethics Committee approval.***
- (•) No
- ( ) Yes

y) **I wish to submit a full application for Training / Education purposes.***
- (•) No
- ( ) Yes

Risk Level

Risk Assessment

Due to your responses to the risk assessment questions, your application has been categorized as Low Risk.

If you click on Submit, you will have access to the sign off section and submit the application for review (if applicable) in the Low Risk category. Note that you will not be able to change the Risk Assessment during that stage.

If you want to change this, please review and update the Risk Assessment section to re-evaluate the risk level.

Please click on 'Yes' to confirm and submit to continue*

◉ Yes
○ No

Sign off

Applicant Sign Off

To submit this application please select the check box below, then click on the Submit action on the right hand side of this page.

As Chief Applicant;

- I have read the Code of Ethical Conduct for Research, Teaching and Evaluation involving Human Participants.
- I understand my obligations and the rights of the participants.
- My Head of Unit knows that I am undertaking this research. (for academic staff research)
- I understand that Low Risk Notifications are audited by the Ethics Office and that breaches in complying with Low Risk conditions will be followed up.
- I agree to undertake the research as set out in the Code.

Are there any co-researchers?*

○ No
◉ Yes

- I have confirmed that all co-researchers have read the Code and I have obtained their approval for the content of this application.

- The information in this application is to the very best of my knowledge accurate and not misleading.

*

☑ I have read and understood the above statements

Your supervisor will have to approve this application before it can be processed.
Click on the Review Group button in the toolbar on the right. Search for your supervisor by searching for their surname only. Click on the entry that has a six digit ID code, as this is their staff ID rather than their student ID.

Approver Signoff

Comments for researcher.

This question is not answered.

Once you have completed the comments section you must submit the form. To do this click on the Submit button on the right hand side.

- I have read the Code of Ethical Conduct for Research, Teaching and Evaluation involving Human Participants.
- I understand my obligations and the rights of the participants.
- I understand that Low Risk Notifications are audited by the Ethics Office and that breaches in complying with Low Risk conditions will be followed up.
- I agree to undertake the research as set out in the Code.

2/02/2022

Dear: Jesse Austin-Stewart Austin-Stewart

Re: Low Risk Notification - 4000025459 - Documentation of Installations

Thank you for your notification which you have assessed as Low Risk.

Your project has been recorded in our database for inclusion in the Annual Report of the Massey University Human Ethics Committee.

The low risk notification for this project is valid for a maximum of three years.

If situations subsequently occur which cause you to reconsider your ethical analysis, please contact a Research Ethics Administrator.

Please note that travel undertaken by students must be approved by the supervisor and the relevant Pro Vice-Chancellor and be in accordance with the Policy and Procedures for Course-Related Student Travel Overseas. In addition, the supervisor must advise the University's Insurance Officer.

A reminder to include the following statement on all public documents:

"This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named in this document are responsible for the ethical conduct of this research.

If you have any concerns about the conduct of this research that you want to raise with someone other than the researcher(s), please contact Professor Craig Johnson, Director - Ethics, telephone 06 3569099 ext 85271, email humanethics@massey.ac.nz."

Please note, if a sponsoring organisation, funding authority or a journal in which you wish to publish requires evidence of committee approval (with an approval number), you will have to complete the application form again, answering "yes" to the publication question to provide more information for one of the University's Human Ethics Committees. You should also note that such an approval can only be provided prior to the commencement of the research.

Yours sincerely

Professor Craig Johnson
Chair, Human Ethics Chairs' Committee and Director (Research Ethics)

Research Ethics Office, Research and Enterprise
Massey University, Private Bag 11 222, Palmerston North, 4442, New Zealand T 06 951 6841; 06 95106840
E humanethics@massey.ac.nz; animalethics@massey.ac.nz; gtc@massey.ac.nz

9.7 Appendix Seven: Image Copyright Permissions

COPYRIGHT PERMISSIONS LETTER

Dear Blake Johnston

My name is Jesse Austin-Stewart. I am a Doctoral student at Massey University, New Zealand, and am writing a thesis on spatial audio for my PhD. A print copy of this thesis when completed will be deposited in the University Library, and a digital copy will also be made available online via the University's digital repository. This is a not-for-profit research repository for scholarly work which is intended to make research undertaken in the University available to as wide an audience as possible.

I am writing to request permission for the following work, for which I believe you hold the copyright, to be included in my thesis:

Picture of *your hearing them* (Johnston, 2017)

Johnston, B. (2017). *Your hearing them*. Blake Johnston.

https://www.blakejohnston.net/your-hearing-them

I am seeking from you a non-exclusive licence for an indefinite period to include these materials in the print and electronic copies of my thesis. The materials will be fully and correctly referenced.

If you agree, I should be very grateful if you would sign the form below and return a copy to me. If you do not agree, or if you do not hold the copyright in this work, would you please notify me of this. I can most quickly be reached by email at [redacted].

Thank you for your assistance. I look forward to hearing from you.

Yours sincerely,
Jesse Austin-Stewart

I Blake Johnston agree to grant you a non-exclusive licence for an indefinite period to include the above materials, for which I am the copyright owner, in the print and digital copies of your thesis.

Signature:

Date: 8/2/2022

COPYRIGHT PERMISSIONS LETTER

Dear Darrin Martin,

My name is Jesse Austin-Stewart. I am a Doctoral student at Massey University, New Zealand, and am writing a thesis on spatial audio for my PhD. A print copy of this thesis when completed will be deposited in the University Library, and a digital copy will also be made available online via the University's digital repository. This is a not-for-profit research repository for scholarly work which is intended to make research undertaken in the University available to as wide an audience as possible.

I am writing to request permission for the following work, for which I believe you hold the copyright, to be included in my thesis:

Image of *Ancestral Songs* (Martin, 2020)

Martin, D. (2020). *Ancestral Songs*. https://darrinmartin.myportfolio.com/ancestral-songs

I am seeking from you a non-exclusive licence for an indefinite period to include these materials in the print and electronic copies of my thesis. The materials will be fully and correctly referenced.

If you agree, I should be very grateful if you would sign the form below and return a copy to me. If you do not agree, or if you do not hold the copyright in this work, would you please notify me of this. I can most quickly be reached by email at [redacted].

Thank you for your assistance. I look forward to hearing from you.

Yours sincerely,
Jesse Austin-Stewart

I ________Darrin Martin___________ agree to grant you a non-exclusive licence for an indefinite period to include the above materials, for which I am the copyright owner, in the print and digital copies of your thesis.

Signature: __________________

Date: __2/9/2022________

Gmail **Jesse Austin-Stewart <[redacted]>**

Re: Webform submission from: EMPAC Contact

shannon johnson <johnss3@rpi.edu> Tue, Feb 8, 2022 at 4:43 PM
To: [redacted]
Cc: empacboxoffice@rpi.edu

hi jesse.
thanks for asking.

for academic use ONLY you can use the photo with the following credit/captions:

"High-Resolution Modular Loudspeaker Array for Wave Field Synthesis installed in Studio 1—Goodman in 2016 at EMPAC, The Curtis R. Priem Experimental Media and Performing Arts Center at Rensselaer Polytechnic Institute. Photo courtesy EMPAC/Rensselaer."

very best,

--
shannon johnson / pronouns: shannon/shannon's
web manager, EMPAC
http://empac.rpi.edu
johnss3@rpi.edu / 518.527.9803

On 7 Feb 2022, at 16:03, Webforms wrote:

> Submitted on Mon, 02/07/2022 - 19:03
>
> Submitted values are:
>
> **First name**
> Jesse
>
> **Last name**
> Austin-Stewart
>
> **Email**
> [redacted]
>
> **Message**
> Hey there,
> I am currently completing my PhD in spatial audio and as a part of it, there is some discussion on wave field synthesis. I am interested in including an image used by EMPAC at the below link and wondered if you could point me in the right direction of the copyright holder so I could obtain permissions? :)
>
> https://artsandculture.google.com/story/HgVRGR7JB1pnAg
>
> The relevant image can also be found at this link - https://easternbloc.ca/en/lab/workshops/wave-field-synthesis

COPYRIGHT PERMISSIONS LETTER

Dear Scott Wilson,

My name is Jesse Austin-Stewart. I am a Doctoral student at Massey University, New Zealand, and am writing a thesis on spatial audio for my PhD. A print copy of this thesis when completed will be deposited in the University Library, and a digital copy will also be made available online via the University's digital repository. This is a not-for-profit research repository for scholarly work which is intended to make research undertaken in the University available to as wide an audience as possible.

I am writing to request permission for the following work, for which I believe you hold the copyright, to be included in my thesis:

Image of BEAST (Deruty, 2012)

Deruty, E. (2012, January). *Loudspeaker Orchestras*. Sound on Sound.

https://www.soundonsound.com/techniques/loudspeaker-orchestras

I am seeking from you a non-exclusive licence for an indefinite period to include these materials in the print and electronic copies of my thesis. The materials will be fully and correctly referenced.

If you agree, I should be very grateful if you would sign the form below and return a copy to me. If you do not agree, or if you do not hold the copyright in this work, would you please notify me of this. I can most quickly be reached by email at [redacted].

Thank you for your assistance. I look forward to hearing from you.

Yours sincerely,
Jesse Austin-Stewart

I Scott Wilson agree to grant you a non-exclusive licence for an indefinite period to include the above materials, for which I am the copyright owner, in the print and digital copies of your thesis.

Signature:

Date: 10/2/22