Moving air -
a portfolio of sounding sculpture

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Abstract

This portfolio and commentary document the realisation of a series of sound art works which seek to explore aspects of the physical materiality of sounding objects. The portfolio consists of seven acoustic sound sculpture installations which were exhibited in both indoor and outdoor site-specific settings. The following commentary outlines the motivating principles behind the work as well as its position within key art culture and research contexts before discussing my praxis methods and approach to each work in detail with reference to related theory and existing artworks.

Established theories of sound reproduction and acousmatic sound practices are examined in order to frame and contextualise the importance of the local, acoustic encounter with the work and new terminology is proposed to account for this distinct characteristic. My media archaeological method and use of existing sounding objects as stimuli is discussed as well as my approach to the development of materials, compositional intentionality, documentation methods and the audience encounter.

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Portfolio Works Information

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Exhibited as part of the Noises of Art conference, Aberystwyth University, September 2013.
Primary documentation recorded in the Ramshorn Theatre, Glasgow, August 2013.
Eigenfunction_dev documentation filmed in Glasgow in the months prior.

When Bells Are Ringing (But There Aren't Any Bells)
Exhibited at the Hunterian Art Gallery as part of the Hunterian Associates Programme, Glasgow, October 2013.
Primary documentation recorded in the Hunterian Art Gallery, Glasgow, October 2013.
WhenBellsAreRinging_dev documentation filmed in Glasgow in the months prior.

Shishi Odoshi / Scare the Deer
Exhibited at Sonorities Festival, Queens University Belfast, April 2018 and at Leith Theatre, Edinburgh as part of Hidden Door Festival, May-June 2018.
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Shelter In Place
Exhibited at open studio event at David Dale Gallery, Glasgow, February 2020.
Primary documentation recorded at David Dale Gallery, Glasgow, February 2020.
ShelterInPlace_dev documentation filmed in Glasgow in the months prior.

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1. Introduction

This text and accompanying portfolio documents a series of sound sculptures; electro-mechanically actuated physical objects and assemblages that produce acoustic sound. They were each exhibited unamplified as continuous installations across a range of contexts. The following commentary provides discussion and contextualisation of these artworks and my practice more generally which has evolved from my masters research into musical applications of physical computing technologies. My doctoral project expands on this previous research, aiming to develop a consistent approach over a number of works as well as widening my focus from an explicitly musical one to a concern with sound and vibration more generally.

In Chapter 2 the research context and foundational principles of the work are outlined. Specifically, established critical theories of sound reproduction are explored in order to highlight the importance of the local, acoustic encounter and the term *sound qualia* is proposed to account for this distinct aspect of the work. My work is contrasted with the acousmatic paradigm and recorded sound more generally in order to define a key characteristic; it utilises technologies of sound reproduction as 'acoustical motors' which produce sound rather than as transparent media which carry it.

A central method in the development of the portfolio has been the recreation of existing sounding objects as stimulus for my creative process. This media archaeological approach seeks to explore aspects of the historical through a creative reengagement with objects. Chapter 3 provides discussion of this aspect alongside other 'praxis methods'; my approach to working with physical materials, developing sounding behaviours, decision making, selecting and arranging behaviours as well as my documentation methods are explored.

In Chapter 4 each portfolio work is discussed in the chronological order of their conception. The development process, choice of stimulus objects, technical considerations and the audience encounter are each examined with reference to key theory and existing artworks. The portfolio consists of video documentation of seven artworks; three indoor sound sculpture installations, a

suite of three outdoor sound sculpture installations and an installation designed for both indoor and outdoor spaces.

At its broadest level my practice is grounded by a concern with the relationship between sound and physical materials. I trace this concern to my background as an instrumental musician and specifically to my experience as a drummer; the foundational musical lens which has shaped my approach to music and sound. This 'drummer's sensibility' has been a useful precept in framing my creative approach, manifesting as an intimate, tactile understanding of interrelations between the body, physical objects and sound. A key motivating factor in my artistic decision making has been a search for musical immediacy born out of this sensibility which I trace to my background as a drummer.

Artistic territory and terminology

The work inhabits territory which intersects a number of distinct art culture histories, each with unique perspectives, priorities and expectations of the artwork and its reception. Throughout the text, reference is made to artworks and scholarship from the fields of experimental music, sound installation, visual art, instrument design and environmental art amongst others.

Historically, the term 'sound sculpture' has been used to describe a range of practices which involve sound and physical objects or structures. John Grayson's 1975 essay collection bearing the name features contributions 'from senior artists active in the field of sound sculpture' (Grayson, 1975, v) such as Bernard and Francois Baschett, Harry Bertoia and Harry Partch. These artists built sounding apparatus which were intended to be played manually and were classified as 'sound sculpture' in order to set them apart from existing musical instruments. Further historical precedent for this practice can be found in Luigi Russolo's *Intonarumori* (or 'noise players') which consisted of a series of acoustic noise-instruments built in fulfilment of the proposals in his 1913 Art of Noises manifesto. Citing existing musical instruments' diminishing power to inspire, the *Intonarumori* were built as a 'futurist orchestra' in order to 'break out of this limited circle of sound and conquer the infinite variety of noise-sounds' (Russolo, 2004, p. 6). Although my artworks are not played manually like these instrument-sculptures, they share a foundational principle; they are

physical apparatus developed in search of sonic possibilities beyond those afforded by existing musical instruments.

In fact, a distinct characteristic of my work is the seemingly autonomous sounding of apparatus without a human performer. This aspect has a spectacular quality which connects my work with the history of sounding automata and mechanical music. Automatophonic instruments such as the player piano and the barrel organ adapted existing instruments to be played by an automated mechanical process. These instruments were developed as an early means of mechanical reproduction and, as David Toop states, predated and foreshadowed the coming revolution of recorded sound: 'A technology that allowed music to be perfectly and repeatedly reproduced until the mechanism broke, mechanical music also anticipated the phonograph' (Toop, 2002, p. 119).

These early examples of mechanical music find contemporary relevance in the work of artists such as Frederic Le Junter whose makeshift musical machines provide mechanically automated accompaniment to his performances and Trimpin, whose ambitious autonomous sound sculptures have been a consistent inspiration throughout this project. Indeed, Trimpin, who studied under Conlon Nancarrow has produced a body of work which is explicitly influenced by mechanical music, having stated that 'his interest in peculiar, automatic methods of making sound originated in the cuckoo clocks and ornate motorized music boxes of his Bavarian childhood' (Follett, 2009).

As previously disparate disciplines of visual and sound arts have expanded and blurred, contemporary sound artists have proposed alternative terminology for broadly similar practices. Ethan Rose's term 'object based sound installations' refers to '[works] that engage an audience by actuating a visibly present object' (Rose, 2013, p. 65) and Mo H. Zareei offers the term 'audiovisual materialism' to describe a 'corporeal materiality within the audiovisual domain' (Zareei, 2020, p. 369). Jon Pigott's 'electromechanical perspective of sound art and electronic music' defines artworks whose 'technologies […] combine and transduce between mechanical and electrical energy' (Pigott, 2017, p.276). The artworks presented in the accompanying portfolio could justifiably be described with each of these terms since they emphasise discrete and important aspects of

the work. Furthermore, sharing a common methodological impulse with the instrument-sculptures discussed earlier as well as with the automatophonic quality and the spectacle of mechanical music, the following discussion will have relevance both to the theorisation and deeper understanding of these practices and to the wider field.

2. Research Context

The following discourse sets out the contextual framework in which I position my practice and the key principles which define the work. Firstly, a media archaeological reading of sound reproduction technologies is employed to demonstrate and explore the unique aspects of the direct local encounter with sounding objects which are central to my practice. An examination of critiques of sound reproduction is then used to frame the concept of 'sound qualia' which is proposed to account for this experiential quality of the local encounter and its significance to my practice before the broader post-digital context is discussed.

In addition to the contextual discussion below, a dynamic exists throughout my praxis in which competing notions of production and reproduction are at play. This (re)production duality is situated across three areas which are explored further in Chapter 3: the use of electromagnetic sound reproduction technologies in the production of acoustic sound, the media archaeological exploration of stimulus objects and the performative mediated encounter at play in my video documentation.

Sound reproduction - a media archaeological perspective

Sound reproduction technologies are generally understood to concern the detection of air pressure waves (sound) using microphones, storing those waves on mechanical, electronic or digital media and then converting them back into air pressure waves using loudspeakers. It is notable however that the use of the word 'reproduction' in describing these technologies leads us into a particular conceptual trap when thinking about recorded sound. We tend to think in terms of an original sound being 'captured', 'stored' and then 'recreated' or 'reproduced' and these notions are underscored by the often-touted ambition of sound reproduction technologies towards faithfulness and transparency (Sterne, 2003, p. 256). James Lastra characterises this aspiration towards faithfulness as a key distinguishing feature between two general models of sound reproduction. Whereas a *telephonic* model values intelligibility over other factors the *phonographic* model 'sets as its goal the perfectly faithful reproduction of a spatiotemporally specific [sound]' (Lastra, 2021, p. 248). Although the promise of 'lossless' reproduction concedes that a loss of fidelity existed in previous

technologies (e.g., through compression or other media specific factors) this goal of perfect reproduction is central to current notions of 'losslessness' in the audio industry.

The experience of listening to recorded sound underscores this way of thinking, as Damrosch (1935, p. 93) describes:

> The listener who hears a symphony or string quartet through his loud-speaker loses little that is essential. His impression of the work is nearly, if not quite, as vivid and complete as if he were seated in the concert hall.

However from a media archaeological perspective the original sound and the 'reproduced' sound are entirely different in their material conditions. Although the impression one has is of a sound 'captured' and 'reproduced', in reality when listening to a recording it might be more accurate to say that we are listening to the media itself - we are listening to microphones, storage media (whether mechanical, electronic or digital) and loudspeakers. Van Eck (2017, p. 42) states:

> When listening to one of Bach's Six Suites for Unaccompanied Violoncello through loudspeakers, most people would probably regard what they are hearing as the music performed by a violoncello, and not by a piece of cardboard, moving forwards and backwards to produce sound waves.

In the above example would it be more accurate to say we are listening to a cello or to vibrating cardboard? Rather than recreation or reproduction, perhaps a better terminology would be that of translation. Sterne (2003, p. 34) alludes to this interpretation when he defines sound reproduction by the use of transducers, which turn sound into 'something else' and vice versa:

> Every apparatus of sound reproduction has a tympanic function at precisely the point where it turns sound into something else – usually electric current – and when it turns something else into sound. Microphones and speakers are transducers; they turn sound into other things, and they turn other things into sound.

Roelof Vermeulen's description of microphones and loudspeakers as 'acoustical motors' (1937, cited in van Eck 2017, p. 33) is also helpful in reframing these technologies as primarily concerned with the transformation of electrical energy into mechanical energy (and vice versa). Wolfgang Ernst extends this thinking further by referring to the reproduction of sound as a 'transubstantiation':

> When physically propagated sound is being technically transduced, this is not simply a linear translation but it changes its essence from sound to signal. Within a telephone line or when stored as magnetic charges on a tape, a media epistemological transubstantiation of sound has happened. (Faculty of Arts, Aarhus Universitet, 2016, 00:34:37)

Conceptualising these technologies as reproducing original sounds, then, ignores the role the reproducing media has in the process. As Stanyek and Piekut (2012, p. 320) state: 'Media is not merely a connective technology between agencies, but is itself an effective agent'. Indeed, the agency of sound reproduction media is apparent in technologically led pop music genres, from motown to hip hop, where media specifics have had a foundational role in the development of music cultures. Thinking of sound reproduction as transformation, translation or even transubstantiation, speaks to the agency of the media involved, the mechanical aspect of these 'acoustical motors' and allows us to think beyond terminologically restrictive ideas of 'capturing' and 'reproducing' original sounds.

Sound and source

An exploration of the sounding potential of electromagnetic media (including loudspeakers) has been a recurring theme in my sound practice which, as previously discussed, seeks to engage with the physical nature of sound. In contrast to the use of these technologies in their intended transparent operation, a key defining characteristic of my practice has been the production (rather than reproduction) of sound acoustically where the sounds heard are physically linked to their apparent sources.

In electroacoustic music studies, consideration of the significance of the separation of sounds from their physical sources (as in sound reproduction) has

been conceptualised as either emancipatory or reductive (or both) and focus has centred around the seemingly divergent theories of acousmatic composers (following Pierre Schaeffer) and acoustic ecologists (following R. Murray Schafer). Pierre Schaeffer equated the experience of listening to recorded sound to that of Pythagoras' students hearing him teach from behind a curtain and introduced the term *reduced listening* to describe the resulting experience of heightened concentration. Van Eck traces this privileging of the sonic above all other senses to the emergence of musical forms such as the Konzertreform in the late 19th Century when 'it had [...] become common to think of sound as being the only desirable component of a musical performance' (van Eck 2017, p. 30). Schaeffer's term objet sonore conceptualises the separating of sounds from their physical sources as an emancipatory act, later described by Stockhausen (2004, p. 371) as a desire to free music of the 'dictatorship of the material'.

Acoustic ecologists have taken an altogether different view of the new sonic environments afforded by recording technologies, framing the separation of sounds from their physical sources as unnatural and even disordered. The Canadian composer and acoustic ecologist R. Murray Schafer introduced the term *schizophonia* in The New Soundscape (1969, p. 46) to describe the 'cutting free of sound from its natural origins' as an 'aberration'. His view has been criticised as idealistic by acousmatic composers such as Francisco López (1997), since it assumes an impossible wholeness of 'natural' sonic environments where sounds and their sources are not just interconnected but ontologically identical. Sterne (2003, pp. 20-21) argues:

> Acousmatic or schizophonic definitions of sound reproduction carry with them a questionable set of prior assumptions about the fundamental nature of sound, communication, and experience. Most important, they hold human experience and the human body to be categories outside history.

Stanyek and Piekut (2012, p. 309) expand on the idea of the schizophonic with their neologism *rhizophonia* in an attempt to sidestep the oppositional approaches outlined above, critiquing the idea of the primacy of interpersonal immediacy of the acoustic ecologists while acknowledging the material nature of sound:

> Schizophonia describes sound itself. All sounds are severed from their sources - that's what makes sound sound. Rhizophonia is our term for taking account both of sound's extensity and the impossibility of a perfect identity between sound and source.

This extensity (or spatiality) has also been a defining issue separating philosophical theories of sound perception. A key feature of these theories is their concern with the location of sounds, conceived variously as situated in the sounding object (distal theories), the listener (proximal theories) or in the space between listener and object (medial theories). From a media archaeological perspective the location and identity of the sounding object in recorded sound is even less clear. *Rhizophonia* acknowledges this ambiguity around the 'where' of recorded sound and instead suggests a multiplicity of locations; 'where sounds and bodies are constantly dislocated, relocated, and co-located in temporary aural configurations' (Stanyek & Piekut, 2012, p. 309).

The aura of unmediated experience

Despite the above criticism of schizophonic theory, its motivating idea — that there is a quality in the direct experience of acoustic sound that is altered through its reproduction or transmission — is sharply relevant to my work as a sound artist since this unique unmediated quality is a key aspect of my practice. Indeed for some, the character of work such as mine is defined by its distinctiveness from the acousmatic. In *Loudspeakers Optional: A history of non-loudspeaker-based electroacoustic music* Long, Murphy, Carnegie and Kapur (2017, p. 195) chart a number of reasons artists have adopted a 'non-loudspeaker-based' sound practice including: 'the omnidirectional and complex nature of sound diffusion by way of real-world acoustic sound objects', 'the intricacy of the interactions between sounding bodies and their actuators as imbuing the music with an organic element often not found in sample-based music' and that 'the process of actuating sounds in physical space affords an observable cause-and-effect relationship that provides audiences with a more meaningful experience, not present in purely acousmatic music'.

Walter Benjamin (1999, p. 447) described the particular character of unmediated phenomena as its 'aura', referring specifically to spatial

characteristics in his definition: 'aura [is] the distance of the gaze that awakens in the object looked at'.

> Even the most perfect reproduction of a work of art is lacking in one element: its presence in time and space, its unique existence at the place where it happens to be. (Benjamin, 1969, p. 220)

Although Benjamin made almost no reference to aura as it relates to sound reproduction, his contemporary Theodor Adorno referred to the loss of sound's aura and its transformation when separated from its physical source through broadcast media. As applied to sound, Benjamin's aura could be defined as a quality of the direct experience of sound in physical space and time, which is lost by reproduction (or broadcast). Although he disagreed with Benjamin's privileging of the material uniqueness of unmediated experience, Adorno did argue that sound reproduction brought with it a loss or reduction of some aspects of direct experience; that 'authenticity, or aura [was] vanishing in music because of mechanical reproduction' (Adorno, 2009, p. 90). Goodman (2009, pp. 42-43) writes:

> Adorno argued that radio transformed music as well as disseminated it and that the experience of listening to radio music was profoundly different from the experience of listening in the concert hall. To this extent, Adorno agreed with Benjamin that there was an aura about the live concert performance that was lost when people listened at home - but he lamented the loss.

Taking an absolutist position Dutch multimedia artist and theorist Dick Raaijmakers characterises this loss of aura through sound reproduction bluntly as a 'reduction of three-dimensional, spatial music to a narrow, one-dimensional, electric current' (van Eck, p. 33). Raaijmakers (2008, p. 256) states:

> Music causes vibrations in the air. Microphones are designed to pick up these vibrations from the air and [... obtain] an electric equivalent of the music. However, that electrical equivalent is not spatial, as music is, but one-dimensional. The music is reduced to a thin electric current, which flows through the one- dimensional, equally thin and pointed wire of the coil. Only through this reduction from space to point it becomes possible to disconnect the sound from the sound source. [...] The sound no longer possesses a substantial quality.

This framing of reproduction as a purely negative loss of aura fails to recognise that reproduction and its media can be said to possess auratic qualities themselves. Mark Katz argues that reproduced sound does not lose its aura entirely, rather its aura is expanded to include aspects which stem from its reproduction: 'Benjamin was certainly right about the increased accessibility of mass-reproduced art, yet he was wrong about the emancipation from ritual. Reproductions, no longer bound to the circumstances of their creation, generate new experiences, traditions, and indeed rituals, wherever they happen to be' (2004, pp.17–18). Furthermore Michael Bull argues that reproduction 're-auratizes' the original experience of the direct encounter: 'I suggest that experience is now re-auratized precisely through forms of mechanical reproduction [...] The reproduction is the real for contemporary subjects' (Bull, 2000, p. 132).

The preceding discussion of sound and source and of aura are included here to provide some positioning concepts through which I frame my practice. Since they are designed to be experienced directly and acoustically my artworks and their documentation fit a paradigm of 'originals' and 'reproductions'. The originals are specifically conceptualised in opposition to the idea of sound reproduction – they cannot be reproduced (or in some cases even repeated) without fundamentally altering them. Whilst significant care has been made to translate much of the auratic qualities of the originals into the documentation, and whilst the documentation itself creates its own aura, these reproductions represent an altogether different experience of the artwork. The significant 'substantial quality' which is part of a bodily encounter with sounding objects in acoustic space is a central feature of the 'original' work.

Sound, qualia and the local encounter

Central to the framing of my artistic practice the term *sound qualia* is proposed to describe this 'substantial quality'; the spatial, experiential aura which is unique to the local encounter with my work. The philosophical concept of qualia (borrowed from psychologist William James) refers to the idea that our experiences have subjective, qualitative aspects to them that are distinct from the properties of objects. In his essay *The Mental and the Physical* (1967)

Herbert Feigl used the term *raw feels* to describe this idea of perception in-and-of-itself and *cooked feels* to describe perception seen as existing in terms of its effects. Definitions of qualia often cite perception of musical sound as key examples. Haynes (2009, p. 75) describes 'the 'qualia' or 'raw feels' of sensory experience such as the redness of red, the *timbre of an instrument* [emphasis added], or the scent of a specific flower [as] the most vivid aspects of consciousness.'

In performance studies these terms have been used by Whalley & Miller (2017, p. 91) to describe the intersubjective encounter between performers and audiences:

> The uncertain space in between the performance and the audience can be framed as a qualic exchange. [...] We consider the qualic exchange as a process which embraces the strangeness of an encounter that is not fully real, while allowing the potential for affect to emerge. [...] The qualic exchange is an attempt to give value to the experiential in spectatorial practices.

The acceptance of qualia as a useful concept has been questioned by some philosophers. Central to this, Daniel Dennett (1987, 1991, 2020) has been consistently sceptical of its merits. Dennett acknowledges qualia only as 'intentional objects of many of the reflective or introspective beliefs that one may have about one's own mental states' (Dennett, 2020, p. 7) but argues that this does not make them 'real'. Dennett's primary criticism is related to the 'where' of qualia, arguing against treating experiences as if *they themselves* have intrinsic qualic properties and 'projecting' special qualities of sensations onto things in the world:

> I am not denying the existence of the perceptual properties of things in the world […] These are real things in the world, as real as real can be, and they are not properties *of* mental events but properties *represented* by mental events. (Dennett, 2020, p. 9)

Proponents of the usefulness of qualia account for Dennett's stance as stemming from a 'reductionist' framework based on a particularly restrictive definition of qualia as intrinsic, ineffable properties of objects. Koch & Crick

(2001, p. 2600) state: 'the subjective content associated with a conscious sensation—what philosophers refer to as 'qualia'—does exist and has its physical basis in the brain. To what extent qualia and all other subjective aspects of consciousness can or cannot be explained within a reductionist framework remains highly controversial'. A more widely accepted definition (given as the primary definition by Tye (2021) for example) is broader: that of qualia as 'phenomenal character' and my use of the term in relation to my practice is in this broadest sense.

Several scholars have applied the concept in this way to the study of sound and music. Presenting his morphological notation system for interactive electroacoustic music Kevin Patton (2007, p. 123) uses the term as an 'intellectual mechanism by which we can talk about the character or constitution of a sound object outside of its motion behaviour' and proposes the three qualic aspects of any sound object to be 'duration (time), register (pitch), and spectra (timbre)' (Patton, 2007, p. 124).

The qualia of timbre has been studied through a number of open-ended description based studies (Huron (2006), Arthur (2016), Reymore & Huron (2020)). According to Reymore & Huron, these studies 'suggest that musical components can elicit relatively stable qualia' (Reymore & Huron, 2020, p. 4). In contrast to established multidimensional scaling approaches to timbre studies (Plomp (1970), Wessel (1973), Grey (1977)) Reymore & Huron's 2020 study of timbre uses a language based model which traces 'inter-subjectively reliable descriptors' of timbre qualia dimensions. These studies are based on a broad definition of qualia as outlined above. Reymore & Huron state:

> Our approach aims to go beyond timbre as a purely perceptual phenomenon to include the broader concept of qualia, that is, of the phenomenological experience of sound that may extend beyond acoustical and perceptual correlates to include cognitive, affective, cultural, and other facets. (Reymore & Huron, 2020, p. 6)

Although there is relatively little scholarship on sound or music qualia academic study of timbre is well established. If we accept these as overlapping fields (as Patton does, since timbre is a qualic aspect of the sonic) then

scholarship on timbre is highly relevant to the study of sound qualia. Indeed, even when not explicitly linked, descriptions of the nature of timbre bear striking similarities to those of qualia as it relates to sound. For example, Isabella Van Elferen writes that:

> Timbre undeniably has material as well as immaterial components [...]. Its paradoxical im/materiality engenders a sublime aesthetic experience that can be described as the aporia of being drawn into a void which appears to be real but which—the closer you get to it—flickers in and out of earshot and comprehension. (Van Elferen, 2017, p. 616)

I propose that like Benjamin's aura, *sound qualia* is a unique aspect of our subjective experience of sound in acoustic space that is fundamentally changed through its technological mediation (reproduction and broadcast). Extending the sound qualia concept further I propose the term *raw sound* to refer to this unmediated, direct and spatial experience of acoustic sound, which is a defining characteristic of my artistic practice. My sound practice involves the creation of electronically actuated physical objects and assemblages that produce *raw sound*. It stands in contrast to acousmatic sound work since it uses the technologies of sound reproduction as acoustical motors which produce sound rather than as transparent media which carry it. It involves the sounding of objects and materials in acoustic space and concerns itself with 'opening the acousmatic curtain' (to paraphrase van Eck, p. 37) by using the technologies of sound reproduction (electromagnets, speakers etc.) in order to create sound installations which exist in temporally and spatially localised instances. A crucial characteristic of my work is its ability to produce the *raw feels* of sound qualia in a local audience through the experience of unmediated acoustic sound.

Post-digital context

The preceding discussion of sound qualia and (re)production can be considered part of a wider post-digital context within which I locate my practice more broadly. The 'post-digital' was first defined in 2000 by American composer Kim Cascone (Cascone, 2000, p. 12) and Australian media artist Ian Andrews (Andrews, 2000) separately, each using the term in opposition to what they saw as a cultural obsession with digital purity and progress. Florian Cramer has since defined it as 'the messy state of media, arts and design after their digitization'

(Cramer, 2015, p. 19) and as 'a media aesthetics which opposes [...] digital high-tech and high-fidelity cleanness' (p. 16).

Allen & Gauthier (2014, p. 18) describe the post-digital as a 'media archaeology of the present', which reveals, 'that which is left after and behind the digital'. The post-digital then, addresses the perceived deficiencies of digital media and of the digital age more generally. Aden Evens' criticism of digital sound media rests on its inability to adequately represent the 'fuzzy and 'imprecise' nature of acoustic sound: 'the digital operates by establishing thresholds in the qualitative continuum of the actual. These thresholds mark an absolute distinction, transforming the actual world of continuously varying qualities into the digital world of discrete and exact quantities' (Evens, 2005, p. 69). Sterne argues that this criticism, of reducing the 'actual' to something 'less real' could be equally applied to analog sound reproduction, pointing to the discontinuous arrangement of ferric oxide particles in analog tape recordings: 'we cannot say that the segmentation of digital media renders them fundamentally different from analogue media, and we cannot say that their segmentation renders the experience of digital media inherently less full or substantial than the experience of analogue media' (Sterne, 2006, p. 341).

Rather than addressing a debate between analog and digital sound reproduction, a post-digital approach to sound addresses the continuum of the real and its representation and reproduction (whether analog or digital) more generally. By defining my artistic practice as distinct from digitally mediated **or** reproduced sound I see my work as having a post-digital aesthetic focus on elements that are lost or diminished in digital sound media: the qualic *raw feels* of the direct experience of sounding objects.

A defining feature for many proponents of the post-digital is a return to the tactility of pre-digital media and the combination of old and new (which can be taken to mean analog and digital) technologies. Cramer (2015, pp. 20-21) states: '"Post-digital" eradicates the distinction between "old" and "new" media, in theory as well as in practice [...] the term "post-digital" usefully describes "new media"- cultural approaches to working with so-called "old media"'. My approach to the development of physical materials aligns with this paradigm and

could be said to enact Filipe Pais' concept of 'media displacement' where analog processes are approached from an implicitly digital standpoint. Although I have a background of physical instrumental musicianship it is the computer that has been the central instrument in my development as a composer and artist and as such, whilst the encounter with my artworks in physical space is decidedly analog, every other aspect of my practice, from my compositional approach to my research and documentation methods, is enacted through or informed by digital processes.

In his paper for the 19th International Symposium on Electronic Art, Ian Andrews revisits and expands his exposition of post-digital aesthetics from a decade previously. He identifies two discreet approaches to the post-digital in the sound arts: firstly a 'process based model' which exhibits a shift towards non-intentionality and foregrounds digital media itself through disruptive acts (i.e. glitch); secondly a 'neo-modernist reductivism that adheres to a sound-in-itself ideology'. My practice spans aspects of each of these modalities. The media archaeological methods I have used have led to a relaxing of compositional determinacy over the course of the portfolio. Additionally, the importance placed on the direct local experience of the sounding source—whilst standing in contrast with a Schaefferian reduced listening—aligns with aspects of a 'sound in itself' tendency which Andrews describes as 'foregrounding [...] the immediacy of sense perception and sound as a form for its own sake' (Andrews, 2013, p. 1).

3. Praxis Methods

This section outlines the broad parameters guiding my research and the key recurrent methods I have used. I will discuss the generation of lines of enquiry via stimulus objects, my approach to the development of materials, the design and organisation of sounding behaviours and my approach to documentation.

As discussed in the previous chapter a central feature of my work is the unmediated experience of acoustic sound. This principle has helped mark out the scope of the praxis and identify some foundational features of the work. Specifically, the artworks are physical assemblages which produce sound by resonating physical objects in local aural proximity to an audience.

In order to maintain this proximal, local connection to the acoustic source I have avoided the use of microphones and loudspeakers (in their normal 'transparent' application) in both the production and exhibition of the work. Extending Ethan Rose's term 'object-based sound installation' (Rose, 2013), Mo H. Zareei proposes the term 'audiovisual materialism' to describe this 'corporeal materiality within the audiovisual domain' (Zareei, 2020, p. 369) which is key to the qualic encounter discussed earlier.

Stimulus based method

A recurring strategy I have employed has been the use of stimulus objects as a focus for experimentation. These have been helpful both in providing a conceptual basis for individual works as well as in guiding the initial stages of their practical development. The stimuli on which the works are based include historical objects and structures, existing sounding objects and scientific instruments or demonstration apparatus. They have primarily been identified at an early stage and used as a catalyst for physical experimentation. Where they have been identified later in the process, after a period of experimentation, they have operated as focal points in order to draw together developing ideas and research.

A key method has been the physical recreation of these stimuli, once identified, in order to gain an experiential understanding of the object and its

original application before adapting it in service of a broader set of artistic concerns. My approach to the stimulus is media archaeological, in so far as it centres around knowledge gained through direct physical engagement with past media. Wolfgang Ernst (2016, pp. 91-92) describes this process as important because it uncovers latent historical knowledge: 'media-archaeological experimentation (simulation as opposed to historiographic historicism) gives access to the invariant elements of knowledge in time … The best method for understanding a medium is through re-engineering and functional (re-)enactment'.

The experiential knowledge gained through this process of 'functional (re-)enactment' is key to my engagement with these objects and central to the artworks' development; the act of recreating the object reveals a multitude of possible adjustments and alternative iterations which fuels my process of creative imagination. Whilst developing *Eigenfunction* for example, I began by recreating Franz Melde's vibrating needle demonstration apparatus as faithfully as possible before undertaking a period of wide-ranging experimentation based on this stimulus; experimenting with the scale and orientation of the apparatus and the materials used (replacing the vibrating needle with loudspeakers). Whilst the final work maintains a clear link with Melde's apparatus, it is the process of first building then deconstructing, adapting and reworking the stimulus which is of central importance and transforms the process of reengineering into an artistic one.

In the publication which followed the *After the Act* exhibition which she curated in 2005 and involved the restaging of performance art documentation Barbara Clausen describes such an artistic process based on the recreation of past media as a 'dialog between the originals and their artistic appropriation' (Clausen, 2007, p. 8). Further, that this involves 'a mutual process of appropriation' (Clausen, 2007, pp. 13-14) through which both the original and the 'appropriator' are changed. This mutual dialog is key to my interest in stimulus based re-enactments as a central artistic method. The process creates a reciprocal relationship where the physical reality of a 'functional (re-)enactment' concretises many aspects of an original object which could otherwise only be imagined.

The relationship between the stimulus object and the final work varies across the portfolio. A balance is continually struck between maintaining clear links to the stimulus with the need to follow avenues of creative possibility as they emerge. Whereas in the above example the physical form of Melde's experiment is still recognisable in the finished work, in others the aspects of the stimuli which are carried forward from the rebuilding process into the artwork are more abstract. For example in *Shishi-odoshi / Scare the Deer* discrete aspects of two stimulus objects are combined; the water propelled tipping mechanism of the *shishi-odoshi* and the complex, transposing effect of the sound of the *suikinkutsu*. Drawing out, developing and presenting these characteristics in combination was the primary motivating force in the artwork's development. Without an immediately recognisable link to the stimuli the result is an artwork which retains some of the character or insight gained from the process of rebuilding them whilst simultaneously exploring separate concerns.

Beginner's mind, naivety and the 'neutral gear of knowing'

The practices outlined above are characterised by a tension between following a pre-planned approach (of recreating an object accurately) and the intuitive, improvisatory creative activity of exploring independent avenues of experimentation. Both are important in order to develop the work in a deliberate way whilst retaining a sense of creative freedom. Environmental artist Andy Goldsworthy identifies the tension between these competing approaches as key to his work: 'A tension develops between what I want and what is emerging. This tension is important to the feeling of the piece' (Goldsworthy, 2004, p. 8). This tension mirrors a broader dynamic which is negotiated throughout my development process; the relationship between research and practice, or the balance between thinking and doing. Recognising that these are not separate, binary approaches in practice research such as mine, but rather ways of framing the continuum of research practice activities, there is nonetheless a shifting emphasis between these framings which must be negotiated.

Sarat Maharaj characterises the territory of artistic research as residing in the space between the approaches outlined above stating that 'visual art as

knowledge production is about engaging with 'difference and the unknown''
(Maharaj, 2004, p. 45). Maharaj cites artists' 'lack of knowledge' as a defining
characteristic of artistic research, a 'neutral gear of knowing' which can
generate knowledge by cutting across existing academic modalities: 'It is a
scene of maceration– a mixing of scraps of percept, feeling and concept,
subjectivity, affect and object, without knowing what might happen [...] a
detournement of the 3 D academic corpus' (Maharaj, 2004, p. 42).

The navigation of this 'neutral gear of knowing' through the integration of
deliberate and exploratory approaches is a feature of my stimulus based
method; the reengineering of stimuli gives the work an initial focus whilst the
following period of open experimentation provides opportunities for unplanned
or 'unknown' aspects to emerge and evolve requiring an intuitive, flexible
approach to developing the artwork. The work's development is driven by a
continual balancing of these two approaches in a cyclical, reflective process of
action and evaluation.

Throughout the early experimentation phase outlined above my primary
guiding principle has been the development of a satisfying range of sounding
behaviours. The palette of sound materials is developed with their eventual
combination and organisation as an unknown abstract objective and as such, at
this stage, consideration of the visual aesthetic dimension remains secondary.
Having had no formal visual arts training I approach the realisation of the visual
aesthetic dimension to my work with caution and an awareness of my own
naivety. To paraphrase Dubuffet this naivety can free the work from assimilation
and result in a visual aesthetic which is not explicitly indebted to gallery
culture.

My intention is that this approach will lead the audience to ask: what has the
artist done, or spent time crafting? What concerns them? Of course the visual
semiotics must be considered in a purposeful manner during the development
process and beyond but they are not my primary focus. Since the motivating
principle in my practice revolves around sound a simplicity has developed in the
visual aspect of the work which reflects its secondary significance. This
audiovisual hierarchy manifests variously throughout the portfolio and reflects

the privileging of sound in my process, giving the audience some insight into my motivation as an artist and the aspects that concern me most.

The naivety discussed above in reference to the visual aesthetic dimension of the work is also a feature of my approach to the manual task of recreating stimulus objects. Due to the varied physical materials involved a recurring feature in my development process has been the adoption of new techniques for each project. My craft and engineering skills are rudimentary and self taught, however rather than presenting a frustrating limitation I find this naivety to be a source of motivation; where a trained engineer may be uninspired by a familiar mechanism or arrangement of components, the untrained observer retains a sense of fascination or awe. This positive conception of naivety which mirrors Maharaj's 'neutral gear' is known in zen buddhism as *shoshin* or 'beginner's mind' and reflects a state of openness to possibilities akin to that of a novice.

A recurring approach I have used when working with new materials or sounding objects has been the manual manipulation of materials to first find the range of sounds and behaviours that are possible before setting up physical relationships between objects and actuating mechanisms which can then operate independently. This practice of haptic exchange with a sounding object draws upon an internalised intuitive approach to working with sound and touch which stems from my experience in instrumental musicianship.

As musicians we are accustomed to applying a wealth of hard won experience to our craft, however an approach which I have returned to repeatedly is the imposition of limitations or unfamiliarity into musical processes to help engender an elemental approach to creativity akin to beginner's mind. Environmental sound artist Cheryl E. Leonard has documented this dynamic when working with groups of trained musicians who were asked to play unfamiliar instruments: 'Phillip Greenlief, who performed Meltwater with me, was struck by the way that control is taken away from the musicians when working with natural-object instruments, inspiring humility and a "beginner's mind"' (Leonard, 2016, p. 57).

My approach to working with a new material mirrors that of Leonard's musicians experiencing beginner's mind; although the materials may be

unfamiliar I approach them with a musician's instincts, drawing on an internalised knowledge of the relationship between the body, touch, sensitivity and the kinetic energy of sounding objects (or instruments) which is key to the 'drummer's sensibility' discussed earlier.

Selecting and arranging behaviours, intentionality and compositional control

Having developed a palette of possible sounding behaviours a process of decision making is necessary in order to narrow the focus of the work's development. Behaviours are selected, combined and organised through an orchestration process, where elements are arranged in temporal and sounding relation to each other. The identification of an exhibition context (whether confirmed or hypothetical) helps to lead this process. In all but one instance (which was timed to coincide with the appearance of bats at dusk) the works were presented as continuous installations without a perceivable beginning or end. This embedded a degree of nonlinearity into the work from the outset since the length of the encounter with the work (and therefore the range of behaviour witnessed) was determined by each audience member. An awareness of the subjective, audience led context in which the work would be received led me to incorporate this aspect into my approach to the work's orchestration; mirroring my previous discussion of the development of sounding behaviours, the arrangement or orchestration of these behaviours involves a balance between predetermined elements and opportunities for chance or unpredictable elements.

In his Indeterminacy lecture Cage outlines the ways in which incorporating indeterminacy into various elements of a composition leads to 'a unique morphology of the continuity, a unique expressive content, for each performance' (Cage, 1961, p. 35). Cage identifies four compositional elements which can contain aspects of indeterminacy: *structure* ('the division of the whole into parts'), *method* ('the note-to-note procedure'), *material* ('the sounds and silences of the composition'), and *form* ('the expressive content, the morphology of the continuity' (p. 36)). My approach to compositional control has been enacted variously over the course of the portfolio, the balance of determinacy shifting between each of Cage's compositional elements.

Quentin Meillassoux characterises this artistic approach, to allow elements of chance within certain restraints as a 'lawful randomness' (Hecker, Meillassoux & Mackay, 2010, p. 2). Further, he suggests that an exploration of chance in sounding art is particularly bound by laws due to the biological nature of sound perception, 'because if it is going to be an experience, you need continuity for experience' (Hecker, Meillassoux & Mackay, 2010, p. 5). Meillassoux presents in his concept of *hyperchaos* the idea of *absolute contingency*, that laws (including biological laws) are themselves contingent. *Hyperchaos* when applied to explorations of chance or indeterminacy in artistic practice could be characterised as a layered disorder, where the laws which govern random operations are also subject to a higher level of disorder or randomness.

My approach to these issues has been to maintain a balance of 'laws' and 'contingencies' weighted variously across the portfolio. Although the first three artworks exhibit a temporal structure which is predetermined by software, within this the behaviour of the apparatus and the progression through this structure is more fluid. *Eigenfunction* and *When Bells are Ringing (But There Aren't Any Bells)* both have a structure whose sequence and duration is fixed. Although the fundamental pitches of the sounds produced were also predetermined (by the choice of physical materials), chance operations in the software are used at points to select and combine these pitches. In Cagean terms it is the method or 'note to note procedure' which is indeterminate. In contrast, although the overall structure of *Shishi-odoshi / Scare the Deer* was predetermined, the temporal progression of the composition through this structure was led by the unpredictable behaviour of the apparatus. In the *Listening Cave* suite no predetermined temporal structure was imposed. Instead, environmental factors such as rainwater levels, sunlight and the behaviour of wildlife had a direct bearing on both the character and temporal arrangement of the works' sounding behaviour.

Documentation

As discussed previously, a crucial aspect of my sound practice is the sound qualia associated with an unmediated encounter with sounding objects in physical space. This raises a number of issues when considering how to document my work. How can the spatial, durational and qualic aspects of the work be adequately represented? Should an attempt be made to translate these elements in the documentation through specific media techniques or should the documents be treated as entirely separate experiences, releasing them from the necessity to faithfully represent an in-person encounter with the physical artworks?

Claire Bishop argues that the characteristics of activated spectatorship and decentring, fundamental to the altered relationship between audience and artwork in installation and site-specific art are undermined by fixed perspective documentation (Bishop, 2005, p. 11). It could be argued that linear documentation of subjectively navigated installation art collapses these key characteristics and recentres the encounter through the fixed viewpoint of the document.

Indeed the idea of 'documenting' (i.e. faithfully representing or accurately recreating) work such as mine suggests a role for the document which it is unable to fulfil. As discussed in chapter two, the material conditions of 'original' sounds and their reproductions are entirely different and I contend that it is the qualic aspects of the in-person encounter with my work which are particularly vulnerable to recession through documentary representation. However, to judge artwork documentation by its representational faithfulness is to misunderstand its function as Mitchell Akiyama states:

> There is a self-avowed, utopian striving implicit in this understanding of mediation. The recording does not capture and contain a given time and place; it is a non-space shot through with ontological uncertainty. [...] The separation of sound from source does not degrade some presumably integral and pure original; rather, it creates new experiences and affects that can remake the field itself. (Akiyama, 2019, p. 124-125)

The relationship between in-person and mediatised encounters with the work can instead be thought of as a fruitful tension. Barbara Clausen describes this as 'an ongoing process of an interdependent relationship between event, medialization, and reception' (Clausen, 2007, p. 7). Rather than flattening the artwork's qualic, auratic aspects, I contend that artwork documents and their media-technologies produce qualic aspects themselves which are separate but interrelated with those of the in-person encounter, creating alternative perspectives through which to experience the work.

The approach I have taken to the documentation of the portfolio has been to create video documents in which an encounter with the work is performed from the point of view of an imagined audience member. This approach has been used in order to create a sense of the experiential encounter with the work in physical space whilst acknowledging that these documents cannot recreate such an encounter and exist as an alternative rendering of the work.

Philip Auslander (2006, p. 1) describes this performative approach as theatrical (in contrast with documentary) documentation; the performance is constructed for the benefit of the document and no other audience. The extent of the document's theatricality varies across the portfolio; some are constructed from multiple recordings and benefit from postproduction whereas others have been shot with multiple cameras in a single take. Alongside these theatrical videos which are presented as the primary documentation of the artworks I have included additional documentary material in the form of video and photography of early experiments, test installations and audience encounters.

4. Portfolio Works

4.1 Eigenfunction

Stimulus

Eigenfunction is a durational sound sculpture which explores the materiality of sound as vibration through the use of extended techniques for loudspeakers. The initial concept for the work was drawn from the historical development of wave theory - specifically French physicist Louis De Broglie's 'wave particle duality' theory, which formed the basis of wave mechanics and proposed that all matter has wave properties. This wave-like nature of all matter was also theorised by the philosopher Henri Bergson (1991, p. 208) who wrote:

> Matter thus resolves itself into numberless vibrations, all linked together in uninterrupted continuity, all bound up with each other, and traveling in every direction like shivers through an immense body.

Since sound is itself a wave phenomenon theories concerning the vibrational nature of matter can be viewed in metaphorical alignment with the material nature of sound; indeed they could be said to argue the sound-like nature of matter. Wolfgang Ernst uses the term 'implicit sonicity' to account for inaudible phenomena which are structurally similar to sound, describing them as exhibiting 'temporal processuality'. Ernst contrasts this implicit sonicity with 'explicit sound' which he describes as 'sound unfolding in time' (Ernst, 2016, p. 22). De Broglie's wave theory could therefore be said to account for an implicit sonicity (or sound-like nature) within all matter.

A popular demonstration of wavelength theory was developed by the German physicist Franz Melde involving the exhibition of longitudinal waves on a weighted string via a vibrating needle. I based my initial experiments around this demonstration apparatus, replacing the needle with motors and then speakers in order to set up an audiovisual relationship driven from the same source of vibration. Eigenfunction then, could be seen as an attempt to reverse engineer Melde's experiment through media archaeological (re)production and make the implicit sonicity of his apparatus (and the phenomena it demonstrates) explicit.

Artistic process, technical explanation

I began by glueing a trailing piece of string to a speaker cone and using the haptic, sensoaesthetic method discussed previously, experimented with manipulating it with my hands. I found that when a constant tone was played through the speaker I could achieve a variety of effects in the string by holding it under tension and slowly letting out more string. This manual 'playing' of the material gave me a sense of what was possible with these materials and the effect that slight changes in tension and length could produce.

Having experimented with using a variety of tones to vibrate the speaker cone I decided to apply different tones to each end of the string, first by setting up pairs of identical speakers in horizontal tension and then by hanging small speakers from the larger speakers in a vertical configuration. By offsetting or dividing the frequencies of the two speakers I found a more complex range of behaviours could be achieved. I also found that in the vertical configuration the weight of the smaller speaker distorted the cone of the larger speaker just enough to create a papery distortion that could be manipulated through adjustment of the volume of the top speaker. This gave the sound of the work a more percussive texture and emphasised the vibrational, rather than purely tonal nature of the sounds heard.

The exhibited apparatus comprises six small loudspeakers suspended from six larger loudspeakers via differing lengths of string. Each speaker is vibrated independently via pure sine and triangle waves in order to create standing waves and related effects in the strings. The effect for an audience is that the sounds heard are visually represented by the shape of the vibrating strings. The sound produced is directly related to the physical apparatus, as the tones are based on the first fundamental frequency of each string (dictated by its length and the weight of the lower speaker). (For the arrangement in my primary documentation these were 29.2 Hz, 30.2 Hz, 33.6 Hz, 39 Hz, 45.6 Hz and 48.4 Hz.) These fundamentals are then multiplied, layered and abstracted in order to create multiple nodes and effects such as pulsing and distortion.

This approach, of tuning the source-of-vibration material to resonant characteristics of physical materials mirrors techniques that David Tudor used in the development of his Rainforest series (1968-73), works which employed audio transducers attached to a variety of physical objects to create 'sculptural loudspeakers'. Contributing to the 2001 Getty Institute symposium *The Art of David Tudor: Indeterminacy and Performance in Postwar Culture,* John Driscoll writes:

> The source material created is motivated by the unique set of resonant characteristics that each sculptural speaker presents. After investigation, the composer creates material which will tease the resonant nodes into strong vibration creating responses that are highly non-linear. It is the equivalent of tickling someone – a little input at just the right spot creates great output. (Driscoll & Rogalsky, 2001, p. 7)

The arrangement of the strings in close proximity to each other was chosen after some experimentation with a more dispersed approach in which an audience member might navigate between and through them. In contrast with the 'informal social environment' of Tudor's Rainforest IV 'where visitors are encouraged to wander around and physically interact with the work' (Driscoll & Rogalsky, 2001, p. 6), my decision to group the strings together was made to create a stronger sense of objecthood and distance whilst still allowing the audience a degree of spectatorial freedom through their position and proximity to the work.

Figure 1. Still from Eigenfunction video documentation, Ramshorn Theatre, Glasgow, August 2013.

The audio which drives the work is controlled via software (a Max patch) that outputs audio to each of the twelve speakers separately. This software loops every seven minutes with a large amount of variability built in to the composition. Both the individual frequencies and the order in which they appear, as well as the order and timing of each section is randomly varied each time the composition loops. The work is designed for a gallery context and to be installed for an extended period with each audience member able to dictate the length of their encounter with the work by their physical presence. When exhibited I have presented it in 'black box' spaces with accent lighting on the strings. Whilst not hiding the wiring, frame and other supporting apparatus, this was intended to guide the audience by foregrounding the vibrating materials. My aim was to simplify the visual aspect of the work by imposing a visual hierarchy, leading the gaze of audience to the strings whilst allowing the other parts to still be seen.

Key works

A number of existing artworks involving sounding strings have been useful as reference points during the development of this work. In particular the manual playing of vibrating strings described above brings to mind Terry Fox's piano string performances (starting from 1976). Alvin Lucier's renowned *Music on a*

Long Thin Wire (1977) employs similar elements; magnets are used to vibrate a suspended string which is then amplified via contact microphones and loudspeakers. Tony Conrad's 2008 *Quartet* features a wooden bench which is suspended by amplified wires. Audience members are invited to sit on the bench and play the wires. The work playfully demonstrates the effect of tension (or weight) on the sound of the strings. Whereas each of these works uses loudspeakers to amplify the sound of vibrating string my work reverses this technique by using the loudspeaker as an actuating source of vibration.

Extended techniques

The attaching of objects to loudspeakers can be compared to the use of extended and prepared techniques for musical instruments where, for example, objects are placed on the strings of the piano in order to disrupt its normal operation and (it could be argued) to reveal something about the character of the instrument itself. Seen this way Eigenfunction could be said to instrumentalise the loudspeaker through extended techniques. Indeed, Moore (1980, p. 214) stated: 'the true instrument of our age is not the lute or guitar or piano or drum or organ or even the electronic synthesiser – it is the loudspeaker'. Instrumentalising, according to Keep (2009, p. 113) 'seeks to discover the performability, intrinsic sonic palette and possibilities for sonic manipulation of objects' through their 'creative abuse' which is characterized as any action on a sounding object other than its intended function. Likewise, Patteson (2015, p. 83) uses the term 'media instruments' to describe the optical sound film experiments of composers in the 1920s which 'treated media not as a means of capturing performances but rather as a novel instrument capable of uniquely technogenic effects'. By extending and preparing the media of sound reproduction, disrupting their normally transparent operation through creative abuse, Eigenfunction could be seen as a 'media instrument' which instrumentalises the loudspeaker and draws attention to its mechanical nature.

Similarly, Dutch artist Dick Raaijmakers' sound works included the use of extended techniques that could be said to instrumentalise sound reproduction media. In his piece for microphones, *Intona* (1992) the performer destroys a number of microphones by subjecting them to a variety of increasingly violent actions. His *Ideofoon* installation series (1971) involved arrays of prepared

loudspeakers with various objects such as tubes containing ballbearings and sheet metal suspended by wire attached to their surfaces. In discussing Raaijmakers' sound works van Eck references Pythagoras' curtain (and by extension the Schaefferian acousmatic veil of recorded sound) suggesting that the use of extended techniques such as those in *Eigenfunction* is akin to 'opening the curtain': 'Raaijmakers opens the curtain, which in stereophony hides the loudspeakers. By opening this curtain he searches for their true nature' (van Eck 2017, p. 37). John Pigott (2011, p. 86) characterises the use of these techniques as addressing a historical tendency in sound practices involving speakers to focus on the content of sound rather than the mechanical nature of reproduction media:

> An aesthetic and musical focus on electromechanical technology may therefore usefully be aligned to a notion of media archaeology [...] the prepared loudspeaker and other extended electromechanical interfaces seek to redress the balance of creative focus between electrical and mechanical energy in music and music technologies, and in doing so they reassert their power as the final gatekeeper in the signal chain of the electronic music system.

By opening the acousmatic curtain through extended techniques for sound reproduction media, Eigenfunction draws attention to this balance between the electrical and the mechanical nature of the loudspeaker and its dual role as an instrument of (re)production.

4.2 When Bells Are Ringing (But There Aren't Any Bells)

> It happens. You awaken in the night, then lie reviewing the sounds around you. Breathing. Curtains rustling in a breeze. The rattle of cans while a cat does a garbage inventory. A radio playing somewhere. A jet far overhead. Then, for some of us, there's that other sound in the quiet of the night. Some describe it as the noise a cicada makes, an ocean's roar, a sizzle, or like a transformer's hum. For others it's more like the ringing of bells, and that's where the name for this condition comes. This "other" sound is called tinnitus, from the Latin tinnire, which means to ring or tinkle like a bell. (Modeland, 1989, p. 9)

Stimulus

When Bells are Ringing (But There Aren't Any Bells) is a durational sound sculpture, developed during a research associateship with Glasgow University's Hunterian Museum. Having based my previous portfolio work on a piece of scientific demonstration apparatus, I wanted to explore this approach further by using acoustics objects from the museum's collections as a source of stimulus. Specifically, the work is presented as a creative response to Rudolph Koenig's electrically maintained tuning fork from the Hunterian's Scientific Instruments collection. Koenig manufactured a number of these tuning forks in the late 19th century for use in the emerging field of acoustic physics. They were used in the early development of wave mechanics by Franz Melde in his wavelength demonstration as well as by Herman Von Helmholtz in experiments for his treatise on auditory perception, *On the sensations of tone* (1863).

Koenig's apparatus is comprised of a single tuning fork, a brass resonator (fabricated to amplify the same pitch as the fork) and an electromagnet positioned around the tuning fork tines. The electromagnet would typically have been wired in a 'make and break' circuit attached to the tines of the tuning fork, resulting in the continuous vibration of the fork. *When Bells Are Ringing* simulates the materiality of this apparatus (the generation of vibration through electrically controlled magnets) whilst exploring boundaries in the aural and visual perception of vibration.

Artistic process, technical explanation

As with the previous work, I based my initial experiments around recreating a version of the stimulus object. I experimented with winding my own electromagnets using bolts and copper wire, and explored various methods of recreating a 'make and break' mechanism, a kind of feedback loop where the vibration of the sounding material is used to rapidly switch an electromagnet on and off in order to further excite the vibrating material. As my experimentation developed I found a balance had to be struck between maintaining a close link with the stimulus object and developing the work separately based on my own artistic sensibility and aesthetic instincts. Although I initially used tuning forks from the museum's collection as the sounding material, I found that a wider range of timbres could be created by using the electromagnets to vibrate other metal objects. I also found that by varying the speed of electromagnetic switching, a number of overtones could be found and volume could be controlled by applying various speeds around the range of the desired frequency.

The rusty visual aesthetic of the metal sheets stems from a happy accident. Following an unplanned break, I had to leave an unfinished prototype in my studio for several months. When I returned, the metal sheet I had been working on had developed an elaborate (and quite beautiful) patina. I then used a hydrogen peroxide solution to recreate a similar rust effect on the remaining sheets.

Figure 2. Photograph of When Bells are Ringing (But There Aren't Any Bells) during audio recording. Hunterian Art Gallery, Glasgow, October 2013.

The exhibited work is comprised of a series of pieces of sheet metal, suspended centrally from below. These are each brought into sounding vibration through the operation of an electromagnet underneath. The electromagnets are switched rapidly via an Arduino microcontroller and a Max patch at speeds based on the fundamental frequencies of the metal sheets.

The encounter

The work was exhibited in the Hunterian Art Gallery alongside Koenig's tuning fork in a glass case. It was presented in a plinth-like white box with the electromagnets and electronics hidden from view underneath.

Throughout the portfolio I have taken an exploratory approach to designing the audience encounter with my artworks, from the physical locations or exhibition contexts to the use of signage and other visual cues which shape audience expectations. While the implications of these decisions have been carefully considered they have often been reached through a process of practical

negotiation between competing factors; tailoring the encounter in sympathy with the specific traits of each artwork, practical necessities of available exhibition space and materials used as well as a somewhat performative 'acting out' of different approaches. This 'acting out' is at its most explicit in the presentation of this work where the plinth and accompanying artwork label were chosen to emulate tropes of the gallery arts.

I made the decision to hide all but the sounding parts of the apparatus primarily out of a concern to minimise the visual semiotic elements and to focus attention towards the sound and the vibrating materials. Although this could be interpreted as something of a theatrical gesture I felt that showing the mechanics (the electronics and hardware) any more than necessary would have ultimately distracted from the primary focus of the work - the sound. Of course, this approach carries its own semiotic implications - a valid response to the artwork might be to wonder what is hidden or how the apparatus works. Rather than a distracting element however, this response may contribute to the sense of disbelief, mystery or unease that has emerged organically from working with the materials themselves.

The acousmatic veil

In exploring the above techniques and behaviours I was led primarily by a desire to find a varied and satisfying palette of sounding behaviours which could then be arranged and organised over time. However I found that in selecting behaviours based purely on the resulting sound material, an unintended audiovisual complexity was emerging. At times a clear visual link between a sound and a movement could be perceived and at other times the sound and movement seemed to be operating quite separately. There was often a distinct separation between the sounds heard and the visually recognisable movement of the metal sheets, with either inaudible movements occurring or, more commonly, sounds coming and going with no noticeable visual shift. This behaviour disrupts the effect of *synchresis* which Michel Chion describes as 'a spontaneous and reflexive psychophysiological phenomenon, contingent on our nervous and muscular responses, and that consists in perceiving as a single and same phenomenon that manifests itself both visually and acoustically [...]

starting from the instant that these two are produced simultaneously' (Chion, 2015, p. 154).

The decoupling of sound and movement described above brings the vibratory nature of sound into sharp focus. Shelley Trower traces the historical importance of an understanding of sound as vibration (through the work of acousticians such as Helmholtz) as key to understanding, and crucially experiencing, the vibratory nature of other phenomena. She writes, 'sound […] became a way of making manifest for the senses those vibrations that exist beyond the limits of sensitivity […] sound is the experience through which the conceptualization of vibration more generally is made possible' (Trower, 2012, p. 4). Although the apparent separation of sound and source outlined above may bring attention to the vibrational nature of sound, the breakdown of *synchresis* and the resulting loss of this experiential link produces an uneasiness and ambiguity.

This ambiguity around sound and source is of course directly relevant to the earlier discussion concerning *schizophonia* and *sound qualia*. Whereas I have framed the previous work around the notion of instrumentalising the loudspeaker and interrogating its intended function as an acousmatic veil, the current work could be seen as an exploration of the perceptual mechanisms at play in the pythagorean veil analogy – i.e., the effects of perceiving sound and visual source together and apart. As previously discussed R. Murray Schafer (1969, p. 46) coined the term *schizophonia* to describe an uneasiness associated with perceiving a sound without visual evidence of its source. If we were to expand this notion somewhat we could also attribute such an uneasiness to the perception of visual movement without perceivable sound. The work explores the uneasiness of this expanded definition of *schizophonia* by shifting between perceived synchresis and unknown sound sources and vibration.

In retrospect, the work could be seen to be exploring one of the central notions which now frames my portfolio - direct acoustic experience of sound (*sound qualia*) and the discomfort associated with an unstable sense of the acoustic source (broady, *schizophonia*). The work plays with the perception of the sound source and draws attention to the unmediated presence of vibrating, sounding materials and to limitations in our audiovisual perception.

Phantom sound, tinnitus and the heard/imagined, key works

In arranging the previously developed sound palette and behaviours over time, I wanted to reinforce the sense of uneasiness and ambiguity which had emerged from working with the materials. To create a layered sense of movement I combined slow shifts in tones and harmonics, giving a (false) sense of stasis with faster shifts which could be perceived more immediately. In combination with the schizophonic effects discussed earlier and a background 'bed' of noise caused by operating multiple electromagnets simultaneously, the overall effect was complex and disorientating. Whist working on the arrangement I found myself 'tuning in' to certain frequencies and textures, often unsure as to whether a particular sound had reached my consciousness through a shift in the work or in my own attention. This could be described according to Kubovy and Van Valkenburg's theory of auditory objects as a blurring between figure and ground segregation. Key to this theory is the idea that attention to a particular 'object' renders it a 'figure' or 'perceptual object' and 'relegates all other information to ground' (Kubovy & Van Valkenburg, 2001, p. 102).

Furthermore Clarke (2005) cites the role of attention as a key distinguishing factor between his proposed listening modalities, describing shifts between autonomous and concentrated listening as primarily a shift in attention. Clarke refers to the unique 'scale of focus' of our attention and the 'disturbing and disruptive' effect that shifts in focus can elicit (Clarke, 2005, p. 188). Could the ambiguity I felt as auditory objects seemed to appear and dissolve in real time as I listened to the emerging artwork simply be attributed to a shifting scale of focus in my attention? Or perhaps I was hearing imaginary objects that were not really there. I found this ambiguity around attention, listening and the imagination to be surprising and compelling. Exploring the experience of listening as a play between both objective, external and subjective, internal processes became a central focus shaping the final arrangement of the sounding behaviours in the work.

This intersection between subjective and objective listening is at the heart of the ambiguity that surrounds the diagnosis of tinnitus and related disorders

within audiology and psychoacoustics. Tinnitus (or phantom sound) is the 'sensation of hearing in the absence of external sounds' (Møller, 2003, p. 249) and can be subdivided into objective tinnitus (where the sounds heard emanate from the body) or subjective tinnitus (where there is no detectable sound present). Objective tinnitus, also known as 'otoacoustic emissions' has been observed by Zurek (1981) and according to Moore (2008, p. 37) 'indicates that there is a source of energy within the cochlea that is capable of generating sounds'.

Subjective tinnitus involving meaningful sounds, music or speech is known as auditory hallucination. The popular understanding that tinnitus is caused by exposure to loud noise (although true in some cases) doesn't give a complete picture. Enduring and persistent tinnitus can arise spontaneously with no clear cause and can be linked to stress, fatigue, mental ill health or psychotic episodes involving other hallucinations. Many sufferers report a link between the severity of their tinnitus and the attention they pay to it. In the most severe cases it is dramatically debilitating and can trigger other stress related disorders. Notably, tinnitus and auditory hallucinations occupy a domain at the intersection between physical and mental health where (over)attention and (hyper)subjectivity can have a compounding effect. According to Mac Hagood (2019, pp. 54-55):

> today clinicians mostly agree on treating tinnital suffering as a problem in which cognition profoundly affects psychoacoustics. In short, researchers consider problematic tinnitus to be more a problem of listening than a problem of hearing […] the meaning, suffering, treatment, and even the sound of tinnitus are enacted differently in different practices of listening and mediation.

During his pivotal experience in Harvard's anechoic chamber, built to absorb all reverberation and exclude all outside environmental sound, John Cage briefly experienced phantom sound:

> …in that silent room, I heard two sounds, one high and one low. Afterward I asked the engineer in charge why, if the room was so silent, I had heard two sounds… He said, 'The high one was your nervous system

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in operation. The low one was your blood in circulation. (Cage, 1961, p. 8)

Kyle Gann casts doubt on the engineer's explanation since the nervous system is thought to be completely silent: 'It is possible that Cage had tinnitus, which many musicians develop and which often remains masked until the afflicted person is in an extremely quiet environment' (Gann, 2011, pp. 163-164).

The idea that extreme quiet may have a triggering effect is also key to the 'release theory' of auditory hallucinations outlined by Diana Deutsch. She states that 'ongoing activity in the sensory areas of the brain is usually inhibited by input from the ears rather than from higher centers. When such input isn't received, this brain activity is released from inhibition, so giving rise to hallucinations. It's also believed that damage to sensory pathways can produce release from inhibition, which is why brain injury and drugs can give rise to hallucinations' (Deutsch, 2019, p. 138).

In any case, this experience led to a key insight, convincing Cage that absolute silence was an impossibility: 'Try as we might to make silence, we cannot… Until I die there will be sounds. And they will continue following my death. One need not fear about the future of music' (Cage, 1961, p. 8).

Feedback

Following Cage, consideration of the tinnital experience has provided a useful framework for the development of the conceptual focus of this work, in particular the ambiguity surrounding the subjectivity of listening and the role of attention in the perception of real and imagined sound. Mirroring the make-and-break mechanism in the stimulus object, the idea of the feedback loop has become a recurring concept across the work in both the development of the physical apparatus and sounding behaviours and in the consideration of the works relationship to the tinnital experience. Hagood has described the compounding effect of the 'feedback loop' between attention and severity of tinnital symptoms:

'In the process of externalizing their experience for others to hear, people with tinnitus can make their own perception of the sound grow stronger. They may also generate anxiety in others, encouraging them to notice and problematize their own, previously benign tinnitus'. (Hagood, 2012)

Likewise, in discussing his 2007 installation *Hearing Loss,* John Wynne describes this mental feedback loop in relation to his own childhood tinnitus:

…when I was younger I suffered from tinnitus, and I had lots of hearing tests and brain scans which revealed nothing wrong, physiologically. Then I read Cage's account of his experience in the anechoic chamber and realized that at least part of my problem was that there was a feedback loop between listening to the sounds of my own body and worrying about what I was hearing – the more I worried, the louder it got. (Everyday Listening, 2014)

The mental feedback between attention, listening, the heard and the imagined described above resonates with my own experience of ambiguity when listening to the work in development which I found to be so compelling and distils the conceptual focus of the work which fundamentally concerns the subjectivity of listening.

Summary

Borrowing its title from Vern Modelands 1989 Tinnitus case study, When Bells Are Ringing (But There Aren't Any Bells) resynthesises and extends Rudolph Koenigs electrically maintained tuning fork apparatus and explores the psychophysiology of listening as it relates to attention and auditory hallucination by shifting between seen and unseen vibration, causing an unstable perception of the acoustic source.

4.3 Shishi Odoshi / Scare the Deer

Shishi-odoshi / Scare the Deer is a durational sound sculpture based on two Japanese sounding objects; the *suikinkutsu* and the *shishi-odoshi*. The work engages with these examples of traditional sonic engineering through a process of media archaeological resynthesis, and explores the acoustic potential of water as a sculptural material. The work is driven by a combination of electronic and physical forces – a dripping mechanism which drives the movement of the sculpture is controlled electronically and the position of its levers is monitored via sensors. This creates a basic feedback mechanism on the macro level whilst allowing for fine differences in movements (and their related sonic results) to occur by chance.

Stimulus

The development of this work followed a somewhat different path to those previous. Although it is inspired by stimulus objects, these were found once development was underway. I initially set out to explore the possibilities of using water to create a palette of sound materials, both as an actuating medium on other sounding objects and as a sounding medium itself. An emerging aspect of the previous works was the extent to which the behaviour of the physical apparatus was not entirely controllable. This was particularly apparent in the previous work which under certain conditions could exhibit a potentially destructive unpredictability; it had the potential to produce forces which would pull it apart. I was attracted to using water as a starting point for experimentation as I felt it would introduce an unpredictability in the physical apparatus of the work which would build on this developing characteristic.

Of course the use of water to produce sonic variability is not a novel idea. Douglas Kahn's excellent historical summary in Noise, Water, Meat (2001, pp. 242-288) traces the use of water from a tradition of 'extramusical' experimentation in western art music to its role in the new 'fluidity' emerging in the art of the 1960s stemming from the work of Jackson Pollock and John Cage over the previous decades. Cage (and later Fluxus artists such as George Brecht) explored indeterminacy through the use of water as a source of variability or chance. I see this desire to explore unpredictability as related to my 'drummer's

sensibility' discussed earlier. Indeed Kahn makes an explicit link between Cage's use of water and the existing characteristics of fluidity and variability in percussion: 'Water produced a variability within percussion that, as Cage understood in retrospect, was already characterised by variability' (Kahn, 2001, p. 250).

In exploring simple ways of controlling the movement of water my research led me to focus on two traditional Japanese sounding objects; the *suikinkutsu* (*tr. water koto cave*) and *shishi-odoshi* (*tr. scare the deer*).

Suikinkutsu

The *sukinkutsu* (*tr. water koto cave*) is a sounding object found in parks and at the entrance to temple gardens and tea rooms throughout Japan. Its development can be traced to the elaborate tea ceremonies of 17th century Japan where it became a feature of the *temizu* purification ritual. During the ritual water that is used to rinse the mouth and hands overflows into an arrangement of stones and then drains into a hidden upturned ceramic pot creating a sound akin to a koto (or zither). In his provocation for the 2012 *Sound Art and Music: historical continuum and mimetic fissures* colloquium at the London College of Communication, Allen S. Weiss describes its original significance as intertwined with the complex aesthetics of the tea ceremony. Weiss (2016, pp. 10-12) emphasises the effect of the unseen, acousmatic sound of the *sukinkutsu* on the listener as an 'occult surprise' emanating from the earth below:

> This aleatory 'music', as if of liquified earth, variously serves as purification of body and soul, as an anticipation of the pleasures of the tea ceremony, and as a prefiguration of the rare sounds that punctuate the stillness of the tea hut during the tea ceremony (cha-no-yu): hot water for tea. And yet this sound can not be named, situated or classified.

I was drawn to the *sukinkutsu* in particular because it seemed to embody some of the emerging themes at play in the previous works - the seen and the unseen and the heard and the imagined. A number of notable sound works have been made based on the *sukinkutsu* including Jem Finer's *Score for a Hole in*

the Ground (2006) which is actuated by rainwater, Ungenda's *American Suikinkutsu* (2010) where the sounding chamber of the suikinkutsu is foregrounded and made visible and Nelo Akamatsu's *Chijikinkutsu* (2013) which is modified according to the geomagnetism of the earth. All three are concerned with the significance of unseen forces and a connection with nature. Discussing *Score for a Hole in the Ground* Jem Finer states:

> I like the idea of the underground, you know, that under the surface there's this whole, you know, heaving life going on […] not the deathliness of down in the earth but the life, the hidden life down in the earth […] the creaking of geology, you know, geological sound, the creaking of tectonic plates as they grind past each other. (Finer, 2012)

Shishi-odoshi

The second stimulus object, the *shishi-odoshi (tr. scare the deer)* is a traditional Japanese sounding object originally designed for use in ornamental gardens to discourage animals from grazing on the plants. It is actuated by running water entering a length of suspended bamboo which then slowly fills until a tipping point is reached. The bamboo then overbalances, tipping out the accumulated water and returning to its original position with a loud clap. As with the *suikinkutsu* its cultural value has become detached from its original function (as deer are less common and other control methods are used) and it is instead now appreciated as a primarily aesthetic object. Anthropologist Rupert Cox (2013, p. 45) links the auditory delay of the *shishi-odoshi* to the Zen concept of *ma* which alludes to 'an in-determinate but instantaneously appreciable interval in time or space, that is a "space between" or "empty space"'.

I have a strong memory of encountering a *shishi-odoshi* in the winter gardens in Aberdeen's Duthie Park as a child. I remember first hearing its periodic clap echoing around the hushed otherworldly environment of the cactus house without knowing the source of the sound, then once the apparatus was in view the sense of anticipation as I waited for the apparently spontaneous tipping action as the water filled the bamboo. In both of these observations I found something potent in the unseen aspect of the encounter, first in hearing the sound without seeing its source but then in seeing the source of sound but not the rising water level within the apparatus. Stated as questions; 'What is that

sound?' and 'How does that work?' I contend that these unseen aspects of the encounter create an imaginative 'empty space' for the listener akin to Cox's *ma* of temporal space. Creating conditions for these notions to be explored has been of consistent relevance in my practice and (as previously discussed) in my decision making about the 'theatre' of the encounter and I see the creation of works and encounters which raise these questions as important because they activate an imaginative 'empty space' in the listener. My intention is that by designing ambiguous or unresolved aspects into the work (such as uncertainty around sound sources or a mechanism's operating principles) the audience will be led to fill the 'empty space' with subjective imagined possibilities.

Artistic process, technical explanation, key works

I began by recreating the two objects using a variety of materials and approaches before combining elements of each into a hybrid sculpture. There were a number of elements which I wanted to retain from the stimulus objects; the sense of anticipation that is felt whilst waiting for the *shishi-odoshi* to tip and the idea of the mechanism being 'reset' afterwards, the harmonic complexity of the *suikinkutsu* and the transposing effect of the vessel slowly filling with water. I experimented with a number of ways of controlling the flow of water, from simple mechanisms which fill and reset to speed controlled water pumps and solenoid water valves. The system that I settled on involves a series of servo controlled irrigation valves which can be adjusted to control the speed of dripping water. The drippers are positioned above eight metal paint kettles which produce a pinging sound full of complex harmonics when struck. As the water fills each vessel the pitch of the sound decreases, a characteristic shared by many instruments which are referred to by Douglas Kahn as 'wet percussion' (Kahn, 2001, p. 250). The vessels are balanced in pairs across four wooden levers which tip according to the weight of water in each vessel. The position of these levers is monitored via tilt switches and the vessels are emptied with winch servos if they have remained in the bottom position for a set time. A four gallon water tank above head height provides gravity based water pressure. The tank is fitted with water level sensors which refill the tank by triggering a water pump in a separate reservoir. The sound of the work is one of contrasts: the delicate pinging sound of the water drips as they slowly increase in pitch is characterised by their rhythmic 'fluidity', their timing dictated by specifics of the apparatus

(such as changing pressure in the tubing) which are outwith the control of the system. This fluid, delicate sound world is periodically interrupted by the mechanical, harsh sound of the emptying mechanism.

Figure 3. Scare the Deer installation at Hidden Door festival, Edinburgh, May 2018.

The work bears comparison to Trimpin's *Liquid Percussion* (1991) and Godfried-Willem Raes' *Dripper* (2002), both of which feature programmable water valve systems which produce sound compositions through dripping water. Trimpin describes *Liquid Percussion* as being 'activated by "rainfall"' (Trimpin. & Focke, 2011, p. 48) and 'demonstrating the natural acoustical sounds of falling water'. Both are designed to be as controllable as possible so that the intention of the performer or programmer can be precisely realised. My approach sits somewhere between the 'dry' precision of these systems and the fluidity associated with the compositional indeterminacy of Cage and the Fluxus movement. The noisy, chaotic nature of water is allowed space to act while a degree of control is maintained over the structure and behaviour of the apparatus.

The system is controlled via a Max patch and an Arduino MEGA microcontroller. The software triggers a series of sections (or states) in a looped sequence and each of these has a large degree of unpredictability. This is partly due to the inherently chaotic nature of the medium (water) but is also caused by idiosyncrasies in the apparatus. This inherent unpredictability led me to use a compositional method more akin to *guiding* the behaviour of the system within certain parameters, rather than dictating exact behaviours.

This approach was then designed into the software where, for example, the behaviour of the dripping mechanism is directly linked to the current (changing) position of the lever armature and the progress of the work from section to section is triggered by a series of conditions which are met differently every time the cycle loops. This created a work which (from my perspective) had a life of its own in a way that contrasted with my previous work. The work can be chaotic and noisy but also sparse and delicate. It can flit from state to state quickly, disrupting the listening experience but can also produce uninterrupted periods of cross rhythm which are at times reminiscent of meditative techno music. This range of behaviour can manifest over a prolonged period and undoubtedly requires a greater patience for an audience to appreciate. This more durational approach to the temporal organisation of behaviours arose naturally once the relationships and conditionalities above were set up. However I found myself leaning into this aspect of the work during the course of its

installation by adjusting the set points in the software to stretch the space within and between sections. Whilst I wasn't explicitly aware of it at the time this instinct to uncover the 'space between' reflects back to my stimulus, to *ma*.

The finished work is a resynthesis of the two stimulus objects built upon the mechanical apparatus of the *shishi-odoshi* and the sound of the *suikinkutsu*. Moreover, it aims to engage the with the 'empty space' or 'space between' which is central to the aesthetics of these objects, in order to activate the imagination of the audience.

Aesthetic finishing, form and function and useless objects

The work has been installed in both indoor gallery settings and outdoors as part of a multi-arts festival. In both, the valves and water tank were on display but separated from the rest of the apparatus. Having hidden the mechanics of the previous work completely I wanted to experiment with a different approach, allowing the mechanics to be seen but separating (rather than obscuring) them as a way of framing the visual aesthetic. Audiences were confronted with two separate but linked assemblages, with the mechanics in view but not foregrounded; the separation between public and 'backstage' space left intentionally ambiguous. In contrast to the clean, minimalist appearance of the previous work, the visual aesthetic of *Scare the Deer/ Shishi Odoshi* is raw. The timber is unfinished and screw heads are visible on the basic butt joints.

The decision to leave this raw finish, whilst standing in contrast with the previous work, reflects my developing approach to the visual aesthetic dimension of my work discussed earlier. Both the instinct towards visual simplicity in the previous works and the raw, unrefined aesthetic of the currently discussed work reflect the audiovisual hierarchy in my development processes and give audiences insight into my artistic priorities.

The approach outlined above resonates with the guiding principle of the Arts and Crafts movement that 'form follows function', a point of view which privileges of the functional aspect of an object in its design. It could be said that my artworks are objects whose form is considered as secondary to their sounding 'function'. Indeed, the question of the functionality of my artworks is one which

often arises in discussion with audiences. *Shishi Odoshi* in particular presents as a *potentially* functional object with parts and mechanisms audiences may equate with an irrigation system. Common audience questions are 'what does it do?, 'what is it for?' or 'why does it do that?'. While these questions may seem confounding to some, I would argue that this focus on *practical* functionality provides an opportunity to consider a fundamental truth behind the artwork; leading audiences to an understanding of the works *artistic, sounding* function and ultimately provide some insight into the process beyond or behind the artwork's form.

Discussing his *Devices for Progress* (2009), a series of photographs of 'makeshift machines' without any practical function, David Penny suggests this focus on the usefulness (or otherwise) of art objects challenges the audience to think about the assumptions we attach to technology and its relationship to art:

> The failure of the devices to 'do' anything - their practical uselessness as anything but an element in the creative and creative/critical process - is perhaps allegorical of the intrinsic, ensuing failure of all technology. (www.culturemachine.net, 2010)

There is an intimacy in this *looking behind* or *beyond* the artwork which I became particularly aware of through discussion with audiences during the exhibition of *Shishi Odoshi*. The ambiguity between public and private space in the works presentation and the questions raised by its appearance as a potentially functional object foregrounded the process and motivation behind the work and seemed to lead audiences to a closer understanding of my priorities and sensibilities.

4.4 Listening Cave Suite

Introduction and approach

Listening Cave is a series of outdoor sound sculpture works which were developed during an artist residency at RSPB Baron's Haugh, a wetland nature reserve near Motherwell, Scotland. I anticipated that the residency would necessitate a shift in my approach in a number of ways and build upon my existing research practice, extending it by applying the creative media archaeological methods I had developed thus far to site specific work. My intention was that this disruption would facilitate reflection on my established methodologies and help draw out key principles which I value, usefully informing the research moving forward.

RSPB Baron's Haugh occupies part of what was once the estate and gardens of Dalzell House, the family seat of the Barons Hamilton. The site consists of a managed wetland habitat as well as woodlands and a number of historical features including a mausoleum, a summerhouse, a curling pond and a Japanese garden.

I approached the project with an open mind, thinking about how my developing praxis could be enacted in new contexts across the site. Whereas the previous works were based on stimulus *objects* my initial focus for this project was to engage with the *site* as stimulus. Gillian McIver characterises this site-responsive approach as intrinsically historical, stating: 'The past is always there in the present. Artists working site-responsively are working with […] traces or "ghosts" as raw material, aware that whatever we put into a place will be mingled with whatever was there before' (McIver, 2004).

My initial visit to the site was indeed shaped by an awareness of some of its history. I had conducted some initial research into past residents of Dalzell House and was able to trace the development of the house and grounds through map data which also revealed that part of the site had been used as farmland and later as the site of a colliery. As I explored I found myself piecing together imagined historical narratives based on these insights. In particular, the remaining architectural features in the grounds painted an otherworldly picture

of a seemingly idyllic lifestyle of past residents. As I walked I listened to the environmental sound in the present whilst imagining how the site might have sounded in the past.

My sound survey revealed an array of human and non-human actors: I heard the constant drone from a nearby motorway, ducks calling on the haugh, children shouting, a blackbird singing in the wood, a squirrel rustling through leaves, an aeroplane passing overhead, dogs barking, trees rustling in the wind, a distant chainsaw, babbling water in the burn. Resisting the urge to label human sources of sound as automatically problematic, I found the mixture of human and non-human sources in the soundscape to be illustrative of our current post-nature epoch. First proposed in *The End of Nature* (McKibben, 1990) and now gaining widespread traction through the writings of Timothy Morton amongst others, this represents a shift in perspective, moving from utopian ideas of saving or preserving nature towards a post-nature perspective that acknowledges the age of the anthropocene in which we can no longer think of ourselves as separate to nature having already impacted its development. The soundscape at Baron's Haugh confronts the listener with this hybridity. The human impact on the soundscape is twofold, both as a direct source in real time and as a factor which has shaped the development of the site.

The managed status of the site also raises questions about the relationship between humans and the natural environment. Much of the work of the reserve's wardens involves maintaining a particular set of environmental conditions which are beneficial to visiting wildfowl. Indeed, I came to discover that the wetland area of the reserve which the RSPB now manages was formed in part due to human activity, having become susceptible to flooding after its use as grazing land. Although the impression one has when visiting the reserve is of a semi wild environment in a 'natural' state, beneath the surface lie a multitude of human influences and entanglements.

Although enacted in a different context, my dual listening approach (of listening in the present while imagining historical sounding and listening) connects with the exploration of *ma* and of the heard and the imagined in previous works. To search for sonic 'ghosts' lost to the passage of time is to

engage with an absence or negative space akin to *ma*. Again I was drawn towards this idea and the exploration of sites of historical or hidden sounding and listening became a central focus. An architectural feature called the Listening Cave which I found in the grounds of Dalzell House seemed to draw together some of these developing themes.

The Listening Cave

The Listening Cave is a brick parabola located on the south bank of the Dalzell Burn which was built in 1765 by Archibald Hamilton, the 4th Laird (1694-1774). It is thought to have been built as a gift for his wife Lady Marion Hamilton (1713-1779) and is designed to amplify the sound of the Dalziel Burn and the waterfall below.

Figure 4. The Listening Cave, Dalzell Estate, Motherwell, July 2019.

The structure brings to mind the concrete acoustic mirrors which were built on Britain's coasts during wartime as a kind of early radar, some of which survive at RSPB Dungeness. These structures were an early method for focussing the listening experience, of in some way controlling or mediating the aural

environment. As such they provide a tantalising insight into listening practices of the past and pose questions about our changing relationship to our sound environment.

The Listening Cave for me distills the dual listening approach outlined above; the cave provides a physically focussed listening experience in the present whilst engaging our sonic imagination of past listening and listeners. This approach—of connecting with the past experience of others through an active engagement with objects—enacts Vivian Sobchak's concept of historical re-presencing. Sobchak argues that a central feature of media archaeology is 'the desire for presence', linking this to Walter Benjamin's aura:

> For those media archaeologists to whom the presence of the past emerges (in part) in the here and now through actual engagement with a historical "original" (if never with an "origin"), presence is numinous or auratic much in the manner of Walter Benjamin's description of "aura" as the numinosity attached to one's existential encounter with the singularity of a work of art. (Sobchak, 2011, p. 326)

The *sonic* re-presencing taking place from within the Listening Cave is a key feature of Wolfgang Ernst's concept of the sonic time machine which he describes as 'an operative medium … for tunnelling … cultural-historical distances' (Ernst, 2016, p. 90). Describing the Pythagorean monochord as one such example, Jussi Parikka (2013, p. 145) states:

> They short-circuit from their time to ours, establishing an operational link. Whenever we listen to or play the monochord, we also share at least a bit of that past world that is actually not past but non-linearly 'here'. This could be seen as a sort of a re-presencing of the past, as Vivian Sobchak has argued.

I contend that there is a similar 'operational link' taking place in the Listening Cave. When listening from within the cave I think about Lady Hamilton (for whom it was built), the sounds she might have heard and how the sound environment of the site might have changed since her time. The Listening Cave operates as a sonic time machine enabling a re-presencing of past listening, connecting the listener with past listeners and activating a historical sonic imagination. Although the casual visitor may be unaware of the history or

function of the cave an experiential link with past listening nevertheless exists. The cave's position on the site, at the dead end of a path overlooking the Dalzell Burn and its structure and shape which compel the visitor to enter and turn to face outwards engender a mode of reflection and attentiveness in the visitor. The sense of numinosity which this creates stems from, in part, the thought of the imagined other – the intimacy of shared experience across temporal distance – where the visitor is connected to the imagined other through the shared experience triggered by the physical assemblage of the Listening Cave. As Gerald Fiebig states: 'the sound of a place enters the listeners body just like breath, which creates a compelling symbol for the listeners connection to a place and the bodily presence of others that were there before her' (Fiebig, 2015, p. 15).

The Listening Cave became a central stimulus for the project as I found it to be emblematic of a number of key themes which emerged during the residency; engagement with sonic 'ghosts' and the re-presencing of hidden or historical sounding and listening. It amplifies and focusses attention towards environmental sound and elicits reflection on urbanization and the changing soundscape. More generally the Listening Cave for me represents an attentive 'listening' in the broadest sense and the installations I have made attempt to fulfil a similar function; to draw out or bring attention to an aspect of the site which was previously hidden.

Listening and sounding on site

In conversation with the reserve's wardens and volunteers I came to understand the important role that listening plays in the ongoing management of the site. Regular surveys are carried out, documenting wildlife activity and identification of birds from the sound of their calls alone is common. Thinking about making work which produces sound on the reserve raised a number of ethical considerations about sounding responsibly and sympathetically. Would my work be likely to disrupt wildlife? How does one sound responsibly whilst respecting the importance of sound to both wildlife and humans on the reserve? The approach taken relates to the extent to which the artist sees themselves as a part of or apart from nature. Land artist Andy Goldsworthy, known for his sympathetic approach to site specific work states:

I am part of nature, I don't see myself as being in opposition, and I think it's a strange idea to see us as separate from nature. Our lives and what we do affect nature so closely that we cannot be separate from it ... It is the way of nature to be used, worked and touched ... This is a good thing if it's done well, with respect. (Goldsworthy et al., 2004, p. 164)

Extending this idea of sounding sympathetically I wanted to explore ways in which my artworks could respond to or resonate with natural processes on the site. Many environmental processes, from tiny cellular oscillations to the cycles of the earth and the seasons, exhibit a 'sound-like' nature. Indeed one could think about environmental oscillation as implicitly sonic in the same way as Louis de Broglie's vibrating needle. As the artworks developed, the linking of apparatus directly to cyclical or oscillating processes on the site became a key operative principle in order to embed in them a structural sympathetic resonance with their environment.

The idea of artworks as systems linked to or dependant on a wider environmental system draws upon notions of ecological cybernetics, a field which translates aspects of cybernetics theory such as information fluxes and control systems to the complexity of the biosphere. The influence of systems theory on the work of artists is well documented, particularly in Shanken (2015) and Sommerer and Mignonneau (2023) and whilst Maturana and Varela (1980) proposed the machinic nature of biological forms, highlighting the *autopoiesis* or 'self-making' characteristic of living systems, artists such as Alan Sonfist reversed this comparison, conceptualising their artworks as 'ecological systems' (Glueck, 1970, p. D26). Central to the work of such artists is a dual conception of the environment as both pertaining to nature and ecology and to cybernetic systems. Thought of in terms of Maturana and Varela's 'living machines', my works could be said to comprise systems or machines which are responsive to the larger machine-system of the environment.

Artistic process, technical considerations

The outdoor, off-grid setting of the reserve necessitated a shift in my approach to technical aspects of the work: the artworks would need to be weatherproof and function without mains electricity. Rather than use a generator or large battery in order to employ familiar computing and

microcontroller technologies the challenges of the setting were embraced as an opportunity to explore new technical methods. This exploratory approach raised a number of questions since the use of computing and physical computing technologies had been a foundational methodology in my practice. Would it be possible to create sufficiently satisfying work without these tools and to what extent would there be commonality with the other portfolio artworks?

The approach taken was to use analog circuits which respond to environmental oscillation (via sensors or transducers) and trigger low-power actuators running on battery or solar power. This configuration was used as an experiment in transposition of my technical methods as it mirrors the basic architecture of computing whist using simple analog circuitry in place of a microprocessor. As such its value is as a simplification of my existing methods, testing them through limitation and distilling their essential elements in order to inform my praxis moving forward.

Listening Cave: Flow

Of the three works in the series *Flow* followed my established stimulus-based methodology most closely. The initial stimulus for the work was Roger W. Eddy's Audubon Bird Call, a simple mechanical device made from zinc and pewter which can be manipulated to create a surprisingly diverse range of bird-like sounds. I was drawn to this object because it has a musicality about it (it is 'played' like a musical instrument) and it connects with some key themes; humanity's relationship with wildlife, historical narratives as stimuli and listening and sounding in nature.

The sound is made through the friction of wood against metal and can be varied through slight adjustments in speed and pressure. Based on the acoustic lures used by Italian wild bird hunters, it became a ubiquitous birding accessory in the USA following its manufacture in 1947. It is now seen primarily as a novelty historical device and is used to engender a general interest in ornithology.

The aspect of the bird call I wanted to explore was of a sounding behaviour based on friction and pressure. I first recreated a version of the bird call itself

and then experimented with different materials and apparatus which could be driven by a motor. I found that by bringing the sounding surfaces together under a constant pressure and with the addition of powdered rosin, a range of sounds could be created by varying only the speed of the motor.

Figure 5. Listening Cave: Flow test installation. RSPB Baron's Haugh, Motherwell, October 2019.

The finished work consisted of a series of sounding objects installed on a stretch of the Dalzell Burn which were animated by small variations in the movement of its water. It comprised six independent apparatus, each of which followed a similar design. A fishing float in the burn was attached to a spring loaded potentiometer which controlled the speed of a motor via a 555 Timer IC-based circuit. Low inertia solar motors (with a starting current of 30mA) were used to actuate suspended cymbals and geared motors (which provide torque at low power) were used to actuate stainless steel parabolas.

Although the name of the work, *Flow*, reflects the action of the burn, the dominant force influencing the sounding mechanism is tension. Indeed there is a juxtaposition between the resistance of the sounding material under tension and the flow of the water which impels the apparatus. In common with the strings of Eigenfunction there is a delicate relationship between the tension of the apparatus and the sounding behaviour produced. In contrast with the previous

work, *Flow* employs the characteristic variability of water discussed earlier to actuate an otherwise carefully regulated mechanism.

Listening Cave: Cycles

The next work in the suite, *Cycles* consisted of a series of mechanical 'bells' which were activated by accumulated solar energy. Their design was based on BEAMbots (Biology, Electronics, Aesthetics and Mechanics) which are simple analog robots with circuitry designed to mimic basic biological processes. Specifically a Miller Solar Engine circuit was used; a solar panel charged a supercapacitor which then discharged into a motor when a predefined voltage was detected. Low inertia solar motors were used to animate a spinning beater mechanism which struck the 'bell' repeatedly until the supercapacitor discharged fully before repeating the cycle. The length and intensity of the discharge action and the delay between each burst of activity was dependant on the realtime intensity of the sun. The ranges of these parameters could be manipulated through selection of differently rated capacitors and voltage detectors.

The bells were suspended from long branches gathered from the surrounding woodland and were dispersed across a 100m area of grassland near the site of the Dalzell and Broomside Colliery. On approach, a visitor might hear a distant ringing before seeing the sound source clearly. Although there was a pathway through the area the arrangement of the bells allowed for a highly subjective self guided encounter. Over the course of a short encounter with the work, the bells typically exhibited a range of behaviour as their rhythm and intensity changed with the light level. However a longer scale variation would become evident to patient or frequent visitors as the sculptures' behaviour changed over the course of a day and in response to varying weather patterns.

Figure 6. Photograph of Listening Cave: Cycles installation. RSPB Baron's Haugh, Motherwell, September 2019.

The sound of the work evokes the bells of mountain livestock and connects with the earlier discussion concerning humanity's relationship to nature by referencing the site's history as grazing land; it is thought that the current wetland habitat of the haugh exists in part because grazing cows had made the land susceptible to flooding. So the sound of the cowbells makes me think about the history of the site, how human activity has shaped it and the extent to which we think of the current site as its 'natural' state to be maintained.

Listening Cave: Echo

Echo, the final work in the series, created an immersive audiovisual experience on the Clyde Walkway at dusk with lights and bells triggered by the live echolocation calls of bats. These calls are used primarily for navigation and are outwith the range of normal human hearing. As such they connect with the exploration of *ma* and sonic ghosts above since they represent a sounding and listening which is ordinarily beyond our experience.

Heterodyne detectors are commonly used to transpose the frequency of bat calls into the human hearing range. The resulting sound is a dynamic series of chirps which occur as the bat's highly directional calls come in and out of range. The calls produce a range of staccato patterns and complex cross rhythms and

each species has a unique call pattern, producing distinct hunting, feeding and social calls. Whilst the raw output from the bat detectors was compelling it is limited by its fixed perspective. I decided to develop a system for realtime, multi nodal spatialised sonification of the bat calls across a given area using physical sound objects and lights to transmit the dynamic nature of the calls. The work consisted of eight individual apparatus, each of which captured ultrasonic sound using a directional bat detector. The audio output of the detector was used to drive an LED light and a low inertia motor which struck a bell with a beater. An adjustable audio amplifier based on an LM386 IC was used to fine tune the apparatus.

Figure 7. Photograph of Listening Cave: Echo installation. RSPB Baron's Haugh, Motherwell, September 2019.

The result was an immersive installation where the movement of bats was sonified and dispersed across an area of the Clyde Walkway. Sonic structure and movement was created as the bats moved in and out of range and fed on the water. The arrangement of the individual apparatus across the site remained fluid in order to adapt to the dynamic behaviour of the bats and as I became familiar with their nightly flight patterns. At times multiple apparatus responded to distant calls or reflections simultaneously whilst at other times individual bats could be tracked across the area as the apparatus each responded in turn. There is significant scope to develop the work on a larger scale with many more

multiples across a bigger area or the varied character of mammalian echolocation calls in different species could be explored.

This work further develops my approach to compositional intentionality and control over the behaviour of the sounding material discussed in Chapter 3. In *Echo, both* the temporal composition of the work as well as the individual sonic gestures were determined entirely by the behaviour of the bats. It could be said that the bats were unwitting performers and I their instrument builder. This approach bears comparison with the work of Céleste Boursier-Mougenot whose installation series *from here to ear* (1999) featured prepared piano wires (and later, amplified electric guitars) which were brought into sounding vibration by the inadvertent action of a flock of zebra finches, resident in the gallery space during the exhibition. Contrasting this animal actuated approach with Cagean indeterminacy James Trainor (2002) writes:

> Whereas Cage's practice was imitative of chance operations found in nature, Boursier-Mougenot's method lies primarily in the transliteration of natural structures, revealing to the ear certain realities that remain invisible to the eye. The artist acts as the 'first cause', putting certain laws and systems in motion which he then allows to exist and evolve autonomously, rather than merely using chaos and dissonance as compositional models.

This framing, of transliteration of natural processes, resonates strongly with my approach to the whole suite. Each work has significant compositional or temporal elements which are directly responsive to a natural process. Whilst I have built and tuned the apparatus carefully to achieve a certain range of potential behaviours it is the action of these natural processes which animate the work and dictate much of the final result. This continues my approach to the temporal organisation of behaviours which has become increasingly extended over longer periods as the portfolio has developed. In the *Listening Cave Suite*, there is a temporal layering at play since each work responds to a combination of realtime and longer environmental processes. The calls of the bats, the movement of water in the burn and the action of the sun on the solar bells all have an immediate 'live' effect, however the bats behaviour is affected by environmental factors, the action of the burn is affected by accumulated rainfall and soil health and the solar bells are affected by longer term climate.

There are of course ethical implications to an art practice which relies upon human intervention in natural systems. In particular artists such as Boursier-Mougenot and Alan Sonfist whose artwork requires the participation of animals must consider not only the welfare of the animals involved but also the implicit ecological hierarchy such work communicates. Sonfist's *Army Ants: Patterns & Structures* (1972), heavily influenced by ecological cybernetics, involved the collection and relocation of a colony of *Eciton hamatum* ants into a New York gallery. This work was criticised as 'implicitly celebrating human mastery of and separation from the natural world in the very process of transforming natural objects and processes into works of art' (Benson, 2014, p. 17) and led to a shift in Sonfist's work towards a less interventionist, site-specific approach to working with natural systems.

Similarly my approach to working at Baron's Haugh and to working with bats in *Echo* in particular was to tread carefully. Although it is known that roosting bats can be disrupted by light pollution and I was ill equipped to measure any effect my interventions may have had I judged that the scale and temporary nature of the work posed little risk.

The encounter, space and documentation

The works in the suite mark a change in my approach to space: all three works consisted of multiples of singular apparatus which were dispersed over the site. Although the works are site-responsive they are not necessarily site-specific since each work has potential to be redeployed or adapted to a different site and could (with greater resources) be scaled up many times over to cover a wider area.

I pursued this approach in order to introduce a level of complexity and variation within the technical limitations outlined above. By offsetting and multiplying simple singular apparatus I was able to create works with a spatialised complexity which could be altered by physically navigating the site, marking a fundamental shift in the relationship of the audience to the artwork. Although my earlier discussion around the case for *sound qualia* foregrounds the experiential subjective encounter, the previous works and their exhibition

contexts maintained an objecthood and distance which contrasts with the current work. The Listening Cave works were exhibited with no physical textual explanation or guidance and could be approached from multiple directions. As such the duration and physical perspective of the encounter was left open, allowing the audience to frame and reframe the work as they traversed the site.

In addition, a guided walk was held on the site during which RSPB wardens led visitors through the reserve to encounter the artworks. My presence in the role of artist-curator (as previously discussed) introduced a performative element to the encounter and facilitated dialog between artist and audience. In contrast with the previous works this event gave the audience encounter a distinct social dimension which resulted in more meaningful exchanges and discussion with the audience.

The dispersed, subjectively navigated aspect of the work outlined above presented a particular challenge when deciding how to document the artworks. The durational aspect to the temporal organisation of behaviours and the range of environmentally dependant states necessitated a flexible approach since their behaviour couldn't be accurately predicted. The documentation methods used consisted of a combination of unedited ambisonic 360 degree video as well as the 'theatrical' video method I have used previously which documented an imagined encounter over a particular period (a day for Cycles and an evening for Echo). The ambisonic 360 degree video (whilst still separating the audience from the qualic experiential encounter) was used to give the viewer a more immersive experience and to more successfully document the spatial aspect of the encounter which was particularly significant in these works. The ambisonic audio provides a spatial depth (albeit from a fixed point) and the 360 video allows the viewer to control the point of view in three axes, giving a virtual simulation of an audience led encounter in order to mirror this feature of the physical work.

4.5 Shelter In Place

Overview

The final work in the portfolio, *Shelter In Place* is based on a series of practical explorations on the theme of 'moving air'. Connecting with previous portfolio works (and *Eigenfunction* in particular) that have been concerned with a grounded, tangible connection with the materiality of sound, this theme could be said to engage with the *medium* in which sound performs. From a fundamental physical perspective sound is a pressure wave which travels through air (or another medium) causing the air to move. The medial theory of sound perception discussed earlier locates sound in the space between the listener and the sounding object. Manipulation of this 'space between' the listener and sounding object formed the initial conceptual basis for practical experimentation.

Having developed several distinct threads based on this overall theme the form of the work was taking shape when its development was cut short due to the national Covid-19 lockdown in the UK in March 2020. The work has been subsequently finished through the creation of a 'documentation collage' composed from recordings taken at an open studio event in February 2020.

My initial practical experimentation based on the general theme of 'moving air' was wide ranging and included a number of disparate avenues. An important part of my process throughout the portfolio has been to allow time and space for equivalent early experiments to develop before making decisions based on their artistic or aesthetic value. The act of selecting and developing certain threads whilst discarding others is a process of reduction which produces and defines 'the work'. Until this occurs the work remains 'open' in Ecoean terms; it consists of a number of constituent parts, developed separately, which could be arranged and deployed in any number of configurations or contexts. It is the act of selecting and developing these threads for a specific exhibition context which 'completes' the work.

In this work, uniquely, the documentation is the primary exhibition context (since no other context was possible in lockdown) and the reduction process

above has been performed through the construction of its documentation. The relationship of the work to its documentation stands in contrast to the other portfolio works. The approach taken has been to adopt a *theatrical* approach (Auslander, 2006, p. 1) where instead of documenting an existing 'finished' work in real time the work has been composed through the documentation, concretising its form and 'completing' the work.

The interruption of my established development process and the subsequent completion of the work through documentation collage affords an opportunity to present it in a more open form and reflect on the process of false starts, loose ends and seemingly disparate experimentation which form a key method in the early development of my works. I have included discussion of these developmental threads (as well as supplementary video documentation) as a way of presenting this important but as yet unexplored aspect of my research process.

Thread 1 - controlling low velocity airflow, actuating lightweight materials
The initial idea for this thread stemmed from observing the way in which a sheet of paper hanging in my studio responded to a nearby air conditioning unit. As the unit switched on and off the paper moved rhythmically (and sounded very quietly), as if it were breathing very slowly. I found the subtle and surprising quality of 'lightness' which this chance arrangement of materials exhibited compelling and began experimenting with actuating very lightweight materials with controlled airflow. I developed a mechanism based around a computer fan whose speed and direction could be controlled via a pair of servos and experimented with actuating a variety of lightweight materials including paper and polystyrene balls. The polystyrene balls formed unpredictable eddies and movement patterns in response to the fan and exhibited increasingly wild behaviour at higher velocities. The expanded definition of *schizophonia* proposed earlier applied here also: since the lightweight balls made almost no sound when they moved there was a disconnect between their movement and the sound heard. Finally, the behaviour of the carefully controlled actuating mechanism contrasted with the wild movement of the polystyrene balls. This juxtaposition of 'wildness' with other elements is a characteristic which would recur and develop further as the work progressed.

Thread 2 - Wolfgang von Kempelen's speaking machine,

This thread was based around Hungarian inventor Wolfgang von Kempelen's 1769 'speaking machine' or 'speech synthesiser' as an initial stimulus object. This instrument was based on the human vocal tract and was capable of creating crude speech through manual manipulation. As with previous stimuli, I set out to recreate the object; I created a number of foam 'vocal tracts' which produced vowel sounds and experimented with various sources of sound such as bagpipe reeds, simple whistles and white noise. Although I found the idea of producing speech sounds compelling the project presented a number of technical challenges and this thread stalled before a fully working model was made.

Thread 3 - Breathing machines

Inspired by the breath-like characteristic of the paper in the example above, I set out to make a number of assemblages which could exhibit breathing behaviours. This led me to research early medical technologies for assisted breathing such as the iron lung machines which were mass produced during the polio epidemic of the mid 20th Century. These consisted of a closed 'cabinet respirator' which provided the lungs with alternating positive and negative pressure via an attached mechanical ventilator. In keeping with my stimulus based approach I decided to make a version of such a ventilator. I purchased a vintage East Radcliffe ventilator and after deconstructing it, found it to be driven by a geared brushless motor and a bellows. I proceeded to create a number of apparatus based on this simple design. I built a simple airflow regulator from two extractor fans and some ducting which could be controlled via a servo mechanism and used this to actuate a series of large polyethylene 'lungs' which quietly rustled and crinkled as they inflated and deflated over the course of many minutes.

Thread 4 - Wind

Having developed the above threads previously, this thread was developed following the completion of my work on the Listening Cave. I wanted to continue to explore some of the approaches and concerns raised during the Listening Cave project and connect these with the developing threads above. Applying the technique of environmental transliteration to the theme of moving air, I set out

to make an apparatus which could capture and respond to the movement of wind. I built a series of 'flags' attached to weighted armatures whose position could be monitored via a coupled potentiometer. I found that positioning multiple armatures in separate axes created a nuanced live mapping of the wind in two dimensional space. I initially connected this sensor data to a set of sine wave oscillators but planned to experiment with actuating other sound sources and incorporating elements from the other threads.
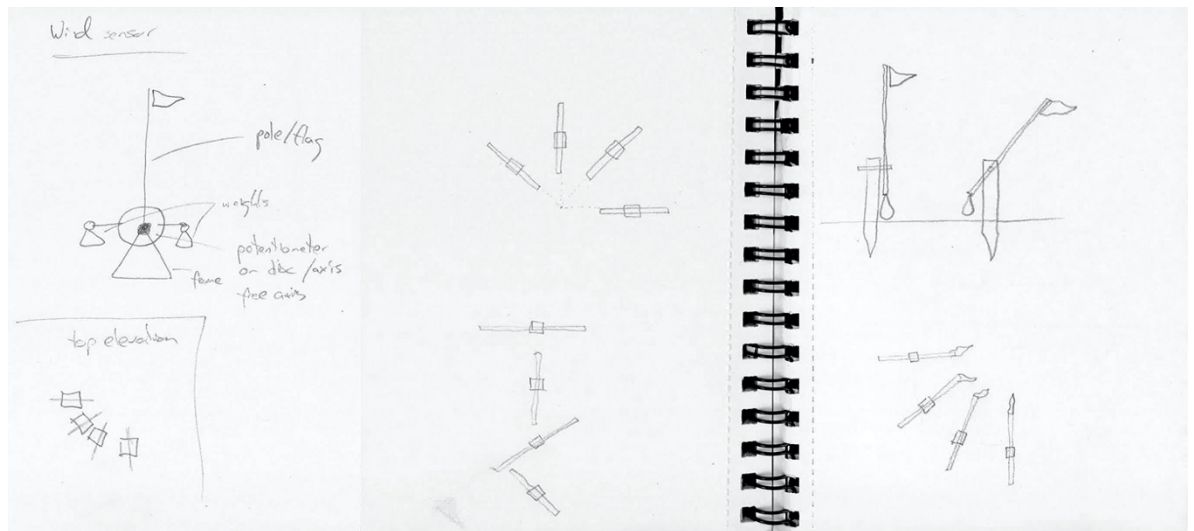
Figure 8. Sketches of flag armatures, 2019.

Thread 5 - Additional indoor elements

This thread was developed with the idea of coupling to the flag armatures described above in mind. I wanted to create a contrast with the outdoor elements and as such was drawn towards creating mechanisms with slow, subtle movements. A series of carefully balanced wooden rods, actuated by slow moving geared motors were set to strike suspended chimes. This created a momentum which built and dissipated very slowly as the rods turned resulting in an erratic striking behaviour.

Documentation, planned installation context

The documentation collage video I have created combines and overlays elements from the above threads with an imagined physical exhibition context in mind. In reference to his *Familiehuis/ Halte-2 (*2013) installation Krien Clevis describes this kind of documentation, of 'what might have been rather than what was' as 'virtual performativity', arguing that 'artistic research is a form of

thinking-through-media … in the end it is irrelevant, from an artistic angle, whether or not the [artwork] is real at all' (Clevis, 2017, p. 36). Although my previous documentation exhibited the kind of virtual performativity outlined above by simulating an imagined encounter, it was based on experiential knowledge of an existing artwork. My documentation collage approach extends this concept further into the virtual (since it is based on an imagined exhibition context), mirroring Clevis' definition of artistic research by 'composing-through-media'.

My initial intention was for the installation to be exhibited across both indoor and outdoor spaces which share lines of sight. The feeling I wanted to capture with this work was a sense akin to looking out at a storm, where wild, natural outdoor environmental elements are viewed from a place of indoor safety or sanctuary, drawing attention to human vulnerability and extending some of the thinking developed during my Listening Cave work around human-nature relationships.

Max Eastley's *Aeolian Circles* (2013) at the Berlin Reservoir and *Aeolian Harp and Sculptures* (2018) at Perrott's Folly in Birmingham each operated across a similar combination of indoor and outdoor spaces. Each featured a series of indoor sound sculptures combined with acousmatic sound from an aeolian harp situated on the roof of the exhibition space. In Eastley's installations the audience is connected with the wild, environmental elements of the outdoor space through the projected sound of the aeolian harp. By contrast, in my proposed installation context the audience's encounter with the outdoor sculptures would primarily be visual, assuming there would be sound separation between the indoor and outdoor spaces. This again connects with the expanded definition of *schizophonia* explored in previous works, where visual movement is perceived without any clear synchresis.

Parallel themes, loose ends, open questions

In addition to the overarching theme of moving air, a number of parallel themes have emerged in the development process outlined above which connect with previous portfolio artworks and point to areas for further development.

The concept of balance runs through many of the threads above. The weighted flag armatures whose carefully chosen pivot points determine their sensitivity to the wind are based on the practical work undertaken whilst exploring the shishi-odoshi mechanism for *Scare the Deer*. The exploration of breathing behaviours above relied upon the creation of balanced systems of airflow and the spinning rods were finely balanced so that wild, erratic behaviours were exhibited in response to the slow movement of the motor.

In his *Walking* lecture Thoreau famously stated that 'In Wildness is the preservation of the World' (Thoreau, 1862). Concepts of wildness connect many of the above threads together as well as with aspects of previous portfolio works. Wildness manifests in the unpredictable behaviours I am drawn towards: in the eddies of the polystyrene balls and movement of the flag armatures described above, in the 'destructive unpredictability' of *When Bells Are Ringing* and the fluidity discussed in relation to *Scare the Deer*. Dana J. Graef connects Thoreau's wildness (distinct from wilderness) with an attitude towards humanity's relationship to nature which finds modern relevance in the emergence of the Anthropocene stating that 'wildness is not dependent on the fiction of untouched spaces, devoid of human history ... Conceptually, wildness can transgress borders between human and not human, nature and culture' (Graef, 2020, p. 524).

As described previously, the contrast between senses of wildness and safety became a central concept in the imagined work and exhibition context across indoor and outdoor spaces. This idea connects with the stimulus object in the previous work, the Listening Cave in which the subject is separated from but attendant to the natural environment. Unexpectedly, these ideas of indoor sanctuary, safety and remote connections between environments take on new significance under the current pandemic as does my focus on ventilators and lungs in the developmental threads. Even the name Shelter in Place which was chosen to represent a generalised feeling of sanctuary or dwelling has become synonymous with Covid-19 as it is used in the USA as an equivalent to the UK's 'stay at home' order during lockdown.

Summary

Although this work was unable to be exhibited in a physical exhibition context due to ongoing uncertainties following the Covid19 pandemic, it is presented here in 'documentary collage' form alongside a more detailed explanation of my development processes, giving the reader insight into the disparate avenues of practical experimentation and thematic development which form an important part of my practice.

Figure 9. Shelter in Place flag armatures, David Dale Gallery, Glasgow, February 2020

5. Closing thoughts and future research

This text and the practices to which it relates detail an approach to thinking about and conducting practice based sound art research which contribute to the understanding of related practices and beyond. Some key foundational principles have guided the development of the work within methodological and conceptual boundaries; the works produce acoustic sound, they are non-linear installations, they are based upon physical stimuli, they operate independently from a human performer etc., whereas other aspects such as my approach to visual aesthetics, compositional intentionality and site specificity have evolved over the course of the project.

The primary contextual framing I have outlined, contrasting the importance of the local experiential encounter in work such as mine with critical theories of sound reproduction, contributes scholarship to the understanding of sound installation practices involving mechanically actuated physical objects. There remains more research to be undertaken as regards other sound artists whose work fits this paradigm. The work of Pe Lang, Mike Blow, John Wynne, Trimpin and Max Eastley particularly (who share similar affinities and concerns) has proved invaluable as an anchoring point throughout the project and gaps remain in the scholarship which addresses this specific area of artistic practice directly. I have proposed new terminology, based on the experiential philosophy of Herbert Feigl, in order to navigate and illuminate unique aspects of this practice. These may be usefully applied to wider fields and practices which share similar concerns.

The ways in which I have characterised my research practice and the scholarship to which I have referred in the above text are presented as a singular reading of my practice. There are undoubtedly several equally authentic ways to frame the work and some areas have not been covered in significant depth in order to maintain clarity. Accordingly, the research has given rise to a number of avenues which warrant further enquiry.

There is more research to be done on mechanisation as it relates to the digital and post-digital age. Some of the above discussion, particularly that

around the post-digital has relied upon an assumed distinction between analog and digital domains. A creative media archaeological investigation into objects like the mechanical computer could provide an avenue for future enquiry, both in techno-philosophy and artistic experimentation, into the role of the mechanical as a bridge between digital and analog domains.

There is significant scope to apply the methods I have developed to historically important sounding apparatus such as Ctesibius' hydraulis, the sounding automata of the Banu Musa or the mechanical instruments of Athanasius Kircher's Musurgia Universalis. A sonic re-presencing of these historical apparatus could lead to new insights and provide alternative kinds of knowledge about these objects and their place in history. Following Derek de Solla Price's 1964 work on automata as epistemic models for mechanistic philosophies, Brian Cantwell Smith's *Origin of Objects* (1998) and Reza Negarestani's 2015 reading of Turing's Intelligent Machinery as a 'computationalist-functionalist' theory of mind, a practice based enquiry could also explore relationships between mechanical or computational approaches to sound and mechanistic conceptions of the self.

Lastly, the portfolio works have been realised with limited resources and on a relatively small scale. As such there is significant potential to revisit specific works and the themes explored more generally in order to enact them on a greater magnitude. The interdisciplinary nature of the work and the combination of my media archaeological stimulus method with the immediacy of the artworks make it well suited to educational or museum settings. This aspect could enable future research to reach wider communities and give the work greater cultural and social impact.

Bibliography

Adorno, T. (2009). Radio physiognomics. In R. Hullot-Kentor (Ed.), *Adorno: Current of music* (pp. 41-132). Polity. (Original work published 1939)

Akamatsu, N. (2013). *Chijikinkutsu* [Installation]. NTT InterCommunication Center, Tokyo.

Akiyama, M. (2019). Nothing Connects Us but Imagined Sound. In: M. Droumeva & R. Jordan (Eds), *Sound, Media, Ecology. Palgrave Studies in Audio-Visual Culture.* Palgrave Macmillan.

Allen, J., & Gauthier, D. (2014). Critical infrastructure. *Post-digital Research* 3(1), 18.

Andrews, I. (2000). Post-digital aesthetics and the return to modernism. Ian Andrews. http://www.ian-andrews.org/texts/postdig.html

Andrews, I. (2013). Post-digital aesthetics and the function of process. In K. Cleland, L. Fisher, & R. Harley (Eds.), *Proceedings of the 19th International Symposium on Electronic Art* (pp. 1-3). International Symposium on Electronic Art.

Arthur, C. (2016). *When the leading tone doesn't lead: Musical qualia in context* [Doctoral dissertation, The Ohio State University]. OhioLINK repository. http://rave.ohiolink.edu/etdc/view?acc_num=osu1461254823

Auslander, P. (2006). The performativity of performance documentation. *PAJ: A Journal of Performance and Art,* 28(3), 1-10.

Benjamin, W. (1969). The work of art in the age of mechanical reproduction. In H. Arendt (Ed.), *Illuminations* (pp. 217-251). Schocken.

Benjamin, W. (1999). *The arcades project*. (H. Eiland & K. McLaughlin, Trans.). Harvard University Press. (Original work published 1982)

Benson, E. (2014). Environment between System and Nature: Alan Sonfist and the Art of the Cybernetic Environment. In *communication +1*: 3(1).

Bergson, H. (1991). *Matter and memory (*N. M. Paul & W. Scott Palmer, Trans.). Zone Books.

Bishop, C. (2005). *Installation art: A critical history*. Routledge.

Boursier-Mougenot, C. (1999). *from here to ear* [Installation]. Paula Cooper Gallery, New York.

Bull, M. (2000). *Sounding out the city: Personal stereos and the management of Everyday Life*. Berg.

Buren, D. (1991). *The square of the flags*. Helsinki Museum of Contemporary Art.

Cage, J. (1961). *Silence: Lectures and writings*. Wesleyan University Press.

Cascone, K. (2000). The aesthetics of failure: "Post-digital" tendencies in contemporary computer music. *Computer Music Journal*, 24, 12–18.

Chion, M. (2015). *Sound: an ecological treatise*. Duke University Press.

Clausen, B. (2007). *After the act: the (re)presentation of performance art*. Mumok Wien.

Clevis, K. (2013). *Familiehuis/ Halte-2* [Installation]. Oude UB, Leiden.

Clevis, K. (2017). Time/place/memory. Artistic research as a form of thinking-through-media. In B. Herzogenrath (Ed.), Sonic thinking: A media philosophical approach (pp. 23-40). Bloomsbury Academic.

Conrad, T. (2008) *Quartet* [Installation]. Sonic Youth etc.: Sensational Fix., Malmö Konsthall, Malmö.

Cox, R. (2013). Kill the inner voice: Zen and the self-conscious anthropologist. In A. Carlyle & C. Lane (Eds.), *On listening* (pp. 45-47). Uniformbooks.

Cramer, F. (2015). What is 'post-digital'? In D. M. Berry & M. Dieter (Eds.), *Postdigital aesthetics: Art, computation and design*. Palgrave Macmillan.

Damrosch, W. (1935). Music and the radio. *Annals of the American Academy of Political and Social Science*, 177, 91–93. https://doi.org/10.1177/000271623517700113

Dennett, D. C. (1987). *The intentional stance*. The MIT Press.

Dennett, D. (1990). Quining Qualia. In W. Lycan (ed.), *Mind and Cognition*. Oxford: Blackwell, 519–548.

Dennett, D. C. (2020). A history of qualia. *Topoi, 39*(1), 5-12.

de Solla Price, D. J. (1964). Automata and the Origins of Mechanism and Mechanistic Philosophy. *Technology and Culture*, 5(1), 9–23.

Deutsch, D. (2019). *Musical Illusions and phantom words: How music and speech Unlock mysteries of the brain*. Oxford University Press.

Driscoll, J., & Rogalsky, M. (2001). David Tudor's Rainforest: An Evolving Exploration of Resonance. In *The Art of David Tudor*. Los Angeles, California.

Eastley, M. (2013). *Aeolian Circles* [Installation]. Berlin Reservoir, Berlin.

Eastley, M. (2018). *Aeolian Harp and Sculptures* [Installation]. Perrott's Folly, Birmingham, UK.

Ernst, W. (2016). *Sonic time machines: Explicit sound, sirenic voices, and implicit sonicity*. Amsterdam University Press.

Evens, A. (2005). *Sound ideas music, machines, and experience*. University of Minnesota Press.

Everyday Listening. (2014). *Five Sound Questions to John Wynne*. http://www.everydaylistening.com/articles/2014/6/2/five-sound-questions-to-john-wynne.html

Faculty of Arts, Aarhus Universitet. (2016, October 11). *Wolfgang Ernst - listening to sonic expressions with media-archaeological ears* [Video]. YouTube. https://www.youtube.com/watch?v=B2m9ouzlYHc

Feigl, H. (1967). *The mental and the physical*. University of Minnesota Press.

Fiebig, G. (2015). The Sonic Witness: On the Political Potential of Field Recordings in Acoustic Art. *Leonardo Music Journal*, 25, 14–16.

Finer, J. (2006). *Score for a Hole in the Ground* [Installation]. Kingswood Forest, Kent, UK.

Finer, J. (2012, March 25). Score for a hole in the ground—A documentary by Nora Meyer [Video]. Vimeo. https://vimeo.com/39175641

Follett, K. (2009, May 8). *Trimpin: Review of 'The sound of invention', Peter Esmonde, USA 2009*. Not Coming To A Theater Near You. http://www.notcoming.com/reviews/trimpin

Fox, T. (1976). 552 Steps Through 11 Pairs of Strings [Performance]. San Francisco, CA.

Gann, K. (2011). *No such thing as silence*. Yale University Press.

Glueck, G. (1970, November 15). Auction Where the Action Is. *New York Times*, p. D26.

Goldsworthy, A. (2004). *Passage*. Harry N. Abrams.

Goldsworthy, A., Friedman, T., & Adams, C. (2004). *Hand to earth: Andy Goldsworthy sculpture, 1976-1990* (Pbk. Ed.). Harry N. Abrams.

Goodman, D. (2009). Distracted listening: On not making sound choices in the 1930s. In D. Suisman & S. Strasser (Eds.), *Sound in the era of mechanical reproduction* (pp. 15-46). University of Pennsylvania Press.

Graef, D. (2020). Wildness. In C. Howe & A. Pandian (Eds.), *Anthropocene unseen: A lexicon* (pp. 523-527). Punctum Books. https://doi.org/10.2307/j.ctv11hptbw.88

Grayson, J. (1975). Foreword. In J. Grayson (Ed.), *Sound sculpture: A collection of essays by artists surveying the techniques, applications, and future directions of sound sculpture (v)*. A.R.C. Publications.

Grey, J. M. (1977). Multidimensional perceptual scaling of musical timbres. In *The Journal of the Acoustical Society of America, 61*(5), 1270–1277.

Hagood, M. (2012, July 16). Listening to tinnitus: Roles of media when hearing breaks down. Sounding Out! https://soundstudiesblog.com/2012/07/16/listening-to-tinnitus-roles-of-media-when-hearing-breaks-down/

Hagood, M. (2019). *Hush: Media and sonic self-control*. Duke University Press.

Haynes, J.-D. (2009). The Neural Basis of Perceptual Awareness. In W. P. Banks (Ed.), *Encyclopedia of consciousness* (pp. 75–86). Academic Press.

Hecker, F., Meillassoux, Q. & Mackay, R. (2010). *Speculative Solution: Quentin Meillassoux and Florian Hecker Talk Hyperchaos,* Urbanomic Document UFD001. https://www.urbanomic.com/wp-content/uploads/2015/06/Urbanomic_Document_UFD001.pdf

Huron, D. (2006). Sweet anticipation: music and the psychology of expectation. Cam- bridge, Mass: MIT Press.

Kahn, D. (2001). *Noise, water, meat: A history of sound in the arts*. MIT Press.

Katz, M. (2010). *Capturing Sound: How Technology Has Changed Music*. University of California Press.

Keep, A. (2009). Instrumentalizing: Approaches to improvising with sounding objects in experimental music. In J. Saunders (Ed.), *The Ashgate Research Companion to Experimental Music* (pp. 113-130). Routledge.

Koch, C., & Crick, F. (2001). Neural Basis of Consciousness. In N. J. Smelser & P. B. Baltes (Eds.), *International Encyclopedia of the Social & Behavioral Sciences* (pp. 2600–2604). Elsevier.

Kubovy, M. & Van Valkenburg, D., 2001. Auditory and visual objects. *Cognition, 80*(1-2), pp. 97-126.

Lastra, J. (2012). Fidelity Versus Intelligibility. In J. Sterne (Ed.), *The sound studies reader* (pp. 248–253). Routledge.

Leonard, C. E. (2016). Meltwater. In F. Bianchi & V. J. Manzo (Eds.), *Environmental sound artists: In their own words* (pp. 49-57). Oxford University Press.

Long, J., Murphy, J., Carnegie, D., & Kapur, A. (2017). Loudspeakers Optional: A history of non-loudspeaker-based electroacoustic music. *Organised Sound, 22*(2), 195-205.

López, F. (1997, January). *Schizophonia vs. l'objet sonore: Soundscapes and artistic freedom*. The Official Francisco López Website. http://www.franciscolopez.net/pdf/schizo.pdf

Lucier, A. (1977) *Music on a Long Thin Wire* [Installation/Performance] Albuquerque, NM.

Maharaj, S. (2004). Unfinishable sketch of 'an unknown object in 4 D': scenes of artistic research. In *Artistic Research*. Leiden, The Netherlands. Brill.

Maturana, H. R., & Varela, F. J. (1980). *Autopoiesis and cognition: The realization of the living*. D. Reidel.

McIver, G. (2004). *Art/site/context*. Site Specific Art. http://sitespecificart.org.uk/art-as-site-response

McKibben, B. (1990). *The end of nature*. Viking.

Modeland, V. (1989). When bells are ringing (but there aren't any bells). *FDA Consumer*, 23(3), 9-12.

Møller, A. R. (2003). Pathophysiology of tinnitus. *Otolaryngologic Clinics of North America*, 36(2), 249–266. https://doi.org/10.1016/s0030-6665(02)00170-6

Moore, F. R. (1980). The futures of music. *Perspectives of New Music*, 19(1/2), 212–226.

Moore, B. J. (2008). *An introduction to the psychology of hearing*. Emerald.

Negarestani, R. (2015). Revolution Backwards: Functional Realization and Computational Implementation. In M. Pasquinelli (Ed.), *Alleys of your mind: Augmented intelligence and its Traumas* (pp. 139–154). Meson Press, Leuphana University of Lüneburg.

Ohlenschläger, K., Weibel, P., & Weidinger, A. (Eds.). (2023). *The Artwork as a Living System: Christa Sommerer and Laurent Mignonneau 1991-2022*. MIT Press.

Parikka, J. (2013). Part III. Introduction. In W. Ernst, *Digital memory and the archive* (pp. 141-146). University of Minnesota Press.

Patteson, T. (2015). *Instruments for new music: Sound, technology, and modernism*. University of California Press.

Patton, K. (2007). Morphological notation for interactive electroacoustic music. *Organised Sound, 12*(2), 123–128.

Penny, D. (2009). *Devices for Progress* [Photography Series]. https://culturemachine.net/creative-media/

Penny, D. (2010). Devices for progress. *CULTURE MACHINE*, 11, 102-106.

Pigott, J. (2017). Across fields: Sound, art and technology from an electromechanical perspective. *Organised Sound*, 22(2), 276–285. https://doi.org/10.1017/S1355771817000188

Pigott, J. (2011). Vibration, volts and sonic art: A practice and theory of electromechanical sound. In, *Proceedings of the International Conference on New Interfaces for Musical Expression* (pp. 84-87). International Conference on New Interfaces for Musical Expression. http://doi.org/10.5281/zenodo.1178133

Plomp, R. (1970) Timbre as a multidimensional attribute of complex tones. In R. Plomp, & G. F. Smoorenburg (Eds.), *Frequency analysis and periodicity detection in hearing*. Sijthoff, Leiden, 397–410.

Raaijmakers, D. (1971). *Ideofoon* [Installation/Sculpture]. Stedelijk Museum, Amsterdam.

Raaijmakers, D. (1992) *Intona* [Performance]. 's-Hertogenbosch, Netherlands.

Raaijmakers, D. (2008). *Raaijmakers, a monograph*. V2_Institute for Unstable Media.

Raes, G-W. (2002) *Dripper* [Installation]. Borderline Festival, Maubeuge, France.

Reymore, L., & Huron, D. (2020). Using auditory imagery tasks to map the cognitive linguistic dimensions of musical instrument timbre qualia. In *Psychomusicology: Music, Mind, and Brain, 30*(3), 124–144.

Rose, E. (2013). Translating transformations: Object-based sound installations. *Leonardo Music Journal*, 23, 65–9.

Russolo, L. (2004). *The art of noise: Futurist manifesto, 1913 (*R. Filliou, Trans.). Ubu Classics. (Original work published 1967)

Schafer, R. M. (1969). *The new soundscape: A handbook for the modern music teacher*. BMI Canada.

Shanken, E. A. (Ed.). (2015). *Systems*. Whitechapel Gallery.

Smith, B. C. (1998). *On the origin of objects*. MIT Press.

Sobchak, V. (2011). Afterword: Media archaeology and re-presencing the past. In E. Huhtamo & J. Parikka (Eds.), *Media archaeology: Approaches, applications, and implications* (pp. 323-333). University of California Press.

Sonfist, A. (1972). *Army Ants: Patterns & Structures* [Installation]. Automation House, New York.

Stanyek, J., & Piekut, B. (2012). Deadness: Technologies of the intermundane. In J. Sterne (Ed.), *The sound studies reader*. Routledge.

Sterne, J. (2003). *The audible past: Cultural origins of sound reproduction*. Duke University Press.

Sterne, J. (2006). The death and life of Digital Audio. *Interdisciplinary Science Reviews, 31*(4), 338–348.

Stockhausen, K. (2004). Electronic and instrumental music. In D. Warner & C. Cox (Eds.), *Audio culture: Readings in modern music* (pp. 370-379). Continuum.

Sullivan, G. (2009). Making space: The purpose and place of practice-led research. In H. Smith & R. T. Dean (Eds.), *Practice-led research, research-led practice in the creative arts* (pp. 41–65). Edinburgh University Press.

Thoreau, H. D. (1862, June 1). Walking. *The Atlantic*. https://www.theatlantic.com/magazine/archive/1862/06/walking/304674/

Toop, D. (2002). Humans, are they really necessary?
In R. Young (Ed.), *Undercurrents: The hidden wiring of modern music* (pp. 117-129). Continuum.

Trainor, J. (2002, January 1). Celeste Boursier-Mougenot. *Frieze*, 64. https://www.frieze.com/article/celeste-boursier-mougenot

Trimpin. (1991). *Liquid Percussion* [Installation]. New York Hall of Science, New York.

Trimpin & Focke, A. (2011). Trimpin: Contraptions for art and sound. University of Washington Press.

Trower, S. (2012). *Senses of vibration: a history of the pleasure and pain of sound*. Continuum.

Tudor, D. (1968-73). *Rainforest I-IV*. [Installation].

Tye, Michael, (2021). Qualia. In E. N. Zalta (Ed.), *The Stanford Encyclopedia of Philosophy (Fall 2021 Edition)*. https://plato.stanford.edu/archives/fall2021/entries/qualia/

Ungenda. (2010). *American Suikinkutsu* [Installation]. Cascade Valley Hospital, Arlington, WA.

van Eck, C. (2017). *Between air and electricity: Microphones and loudspeakers as musical instruments*. Bloomsbury Academic.

van Elferen, I. (2017). Drastic Allure: Timbre Between the Sublime and the Grain. In *Contemporary Music Review*, 36(6), 614–32.

Von Helmholtz, H. (1863). *On the sensations of tone* (4th ed.) (A. J. Ellis, Trans.). Longmans, Green and Co.

Weiss, A. S. (2016). The limits of representation: A case study of transformations in the sonic aesthetics of the Japanese tea ceremony. In T. Gardner and S. Voegelin (Eds.), *Colloquium: Sound art and music*. John Hunt Publishing.

Wessel, D.L. (1973) Psychoacoustics and music: a report from Michigan State University. In *PACE: Bulletin of the Computer Arts Society 30*, 1–2.

Whalley, J. 'B'., & Miller, L. (2017). *Between us: Audiences, affect and the in-between*. Palgrave.

Wynne, J. (2007). *Hearing Loss* [Installation]. VIVO (Video In Video Out), Vancouver , Canada.

Zareei, M. (2020). Audiovisual materialism. *Organised Sound*, 25(3), 362-371. https://doi.org/10.1017/S1355771820000321

Zurek, P. M. (1981). Spontaneous narrowband acoustic signals emitted by human ears. *The Journal of the Acoustical Society of America, 69*(2), 514–523.