Negotiating Entanglements in the Composition and Curation of an Ultrasonic Art Installation

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Abstract

This paper explores the entangled activities of composing and curating the sound installation *Sonographies* at a contemporary art gallery. The installation extends our work with an ultrasonic technology that sonifies and magnifies the physical entanglement of a listener with a spatial sound field to produce rich movement-sound interaction without using sensors. Taking a research through practice approach, we examine the process of creating *Sonographies* while deliberately allowing the nonhuman influences of site and technology to inform creative ideation and decision-making. We propose that an attunement to entanglement foregrounds the co-production of aesthetic qualities by the entire musical assemblage and fosters a sensitivity to fragile and changeable qualities of NIMEs, contingent on specific technical, material and social situations.

Keywords

Entanglement, Sound Installation, Ultrasound, Composition, Curation, Site-Specific, More-Than-Human Design, First-Person Research

1 Introduction

> *Sound is intrinsically and unignorably relational: it emanates, propagates, communicates, vibrates, and agitates; it leaves a body and enters others; it binds and unhinges, harmonizes and traumatises; it sends the body moving, the mind dreaming, the air oscillating.*
> LaBelle [34]

The phenomenon of sound is entangled with the materiality of acoustic space and audio technologies, the physical bodies and the perceptual activities of listeners [13, 50]. It is hardly surprising, then, that entanglement theories have been adopted across the fields of sound studies [13, 16], musicology [17, 38] and NIME [42, 44]. Entanglement theories are commonly described as post- or non-anthropocentric, meaning that the human is no longer placed in the centre [26]. They imply a shift in focus from the musicking of humans with music technologies towards broader ecologies, sociocultural forces and material agencies.

Under the umbrella term of entanglement, there are a plethora of theoretical frameworks and perspectives [26] through which we might examine NIME practice. We draw specifically on Karen Barad's agential realism [5] to conceive sonic phenomena as singular and fleeting, co-produced by the entire material configuration and co-constituted through listening. For Barad, objectivity is a decidedly posthumanist notion arising amid the entanglement of the observer and the observed. Our research, however, considers the entanglements of practice and the nonhuman from a first-person, human perspective. We temper Barad's posthumanism by advocating for embodied objectivity to interface between human subjectivity and the material world [11].

From this theoretical standpoint, we explore the entangled activities of developing, composing and curating a sound installation during a month-long creative residency at *no format Gallery* in South London. *Sonographies* is the second artwork to be created using ultrasonic technology that sonifies and magnifies the acoustic entanglement of a listener with sound, producing interactive experience without sensors [49]. Inspired by site-specific sound art [35, 36, 48] and more-than-human design approaches [45, 56], we harness nonhuman influences as an active influence on the design process, allowing the agencies of site and technology to inform creative ideation and decision-making.

The core contribution of this paper is an examination of entangled NIME practice and the twists and turns [18, 28, 31] of process. Through first-person documentation and reflection, we trace the influence and negotiation of nonhuman agencies in relation to artistic practice. We propose that an attunement to entanglements foregrounds the co-production of aesthetic qualities by the entire musical assemblage and fosters a sensitivity to the fragile and changeable qualities of NIMEs, contingent on specific technical, material and social situations.

2 Backgound

This work draws on both the site-specific traditions of sound art installation and contemporary approaches to more-than-human design. In each field, we find examples of artists or designers working to include nonhuman agencies in the creative process.

2.1 Site-Specific Sound Art

The development of sound art in the mid to late 1960s coincided with the rise of site-specific methods in the visual arts, along with performance and installation art. For LaBelle [34], this was not by chance, since the move toward environments and a multiplicity of viewpoints accords with sound's spatial and relational nature. Installations in the sound art tradition are considered inherently site-specific, to 'be experienced in a unique physical space that cannot simply be replaced' [51]. Working with site, some artists focus on associative qualities, such as social and historical context and its purpose or use [32, 53]. Others enter into a dialogue with its materiality via site-responsive improvisation or analysis of acoustic properties [24, 29].

The practical details of site-specific process are largely absent from sound art literature. For example, artist perspectives are well documented in collections such as *Site of Sound* [35, 36], but tend to focus on conceptual concerns and descriptions of completed work rather than the practicalities of method, tools and reception. In Robson et al. [48], we reported on interviews with sound artists working site-specifically. Artists then described a

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bottom-up approach in which sound, space, technologies and materials are - to use their terminology - 'brought together' or 'assembled' following extended periods of listening and looking, probing the site with different sounds or conducting acoustic analyses to understand what the site offers.

2.2 Entangled NIME Practice

Sound installations play a significant role in NIME research for exploring novel engagements with sound, space and interactivity. Though related to sound art traditions, NIME installations also inherit engineering principles of analogue synthesis [12, 40] and cybernetic thought [10, 59]. Indeed, it is predominantly interactive sound installations based on systems of mappings that feature at NIME [25]. Though there are notable exceptions [6, 23], interactive sound installations rarely engage with site-specific practice and are usually determined by the system design in isolation from external factors.

In the paper 'Sound Design as Human Matter Interaction' Sha et al. [52] describe sound design practices that blend computational techniques with the materiality of acoustic space. Nicolas Collins' installation piece *Pea Soup* exemplifies this approach. Here, 'a self-stabilizing network of analog circuitry nudges the pitch of audio feedback to a different resonant frequency every time the feedback starts to build', producing 'architectural melodies' that are influenced by any disturbances to air in the space [14]. Further examples of technological assemblies that harness the complex and nonlinear properties of audio may be found in Di Scipio's ecosystemic interfaces [19] and the extensive field of feedback musicianship and instrument design [20, 39, 43, 44].

These practices produce instances of what Mudd [43] refers to as 'material-oriented musical interaction' and Sha et al. [52] term 'human-matter interaction': rich interactive experiences in which human action is entangled with the sonic. For Sha et al. [52], *human-matter interaction* entails a shift in attitude to consider the direct interaction of a human with a medium as a site of analogue computation. There is no unidirectional, sequential processing, no 'non-grammatical' action and a temporal immediacy compared with digital tools, with systems responsive to all human movement on all scales.

2.3 More-Than-Human Design Practice

Homewood et al. [30] articulate a recent move toward consideration of 'more-than-human bodies' within HCI research: bodily perspectives that highlight the influence of non-human agencies. This implies 'decentring' human subjectivity, a topic that Nicenboim et al. [45] explore in the context of design research and HCI. Analysing a corpus of publications found in the ACM Digital Library[1] they identify a cluster of related practices, such as decentering human privilege to support cohabitation with multispecies [7, 37], decentering the designers' perspective to account for more-than-human senses, such as the perspectives and agencies of objects [1, 57], and decentering human intention and accounting for the vitality and agencies of materials [46, 54]. Wakkary's concept of 'designing-with' captures the relational disposition of such practices, recognising that design outcomes arise from interdependencies between humans and the broader ecosystem rather than isolated human intentions [56].

[1]ACM is the acronym used for the Association of Computing Machinery, and its library of associated publications is found at https://dl.acm.org/

3 Sonographies

This paper examines the entangled practice of creating *Sonographies*, an ultrasonic art installation. By way of introduction, this short curatorial text was presented to visitors upon arrival at *no format Gallery* during the work's public presentation in February 2024:

> Welcome to *Sonographies*, a sound installation exploring hidden and intimate spaces of experience. Concealed in near silence, a spatial composition sounds in the gallery but above the range of human hearing. Unstable and sensitive to movements of the body, the installation is revealed through bespoke headphones created for the work. Please, take a pair of headphones, wear the strap around your neck, and notice that there is a knob for you to adjust the volume if you wish. *Sonographies* is an invitation to dwell in sound, to listen with your body and listen with the space.

The following subsections provide an overview of the technology and a description of the artwork in its completed form, the result of an artistic residency described later in the paper.

3.1 Ultrasonic Technology

Sonographies is the second artwork created with an ultrasonic installation technology first described in a 2022 NIME paper [49]. It is inspired by artworks in which listeners explore physically present but inaudible phenomena via custom listening devices [33, 55]. For example, Kubisch's *Electrical Walks* invite audiences to explore urban environments using headphones that convert electromagnetic signals into sound [15]. Many installations [3, 21, 47] explore the directional and reflective qualities of ultrasound employing parametric speakers such as the Audio Spotlight [61], whereby an array of ultrasonic transducers projects sound in a hyper-directional beam. For example, in Alunno's *The Soundhouse*, a rotating speaker projects a soundscape around its environment like a lighthouse casts a beam of light across the sea by [2].

Sonographies, by contrast, is inaudible to the naked ear. Eight individual tweeters form a spatial arrangement in the exhibition space. These emit a multichannel composition created in the audible range and then shifted out of audibility using amplitude modulation. Each audio track is multiplied by a sine oscillator at 20.5kHz and output to a tweeter. Listeners wear custom headphones with tiny omnidirectional microphones mounted on the earcups that capture sonic phenomena. These signals are routed via an amplification circuit to a Teensy microcontroller, which performs the same amplitude modulation, which returns the installation to the audible range.

These processes of ultrasonic modulation utterly alter the spatial appearance of sound and exaggerate the Doppler effect such that the listener's movement is heard as pitch shifts, distortions or judders depending on the sonic material. These interactive effects result from the listener's entanglement with sound becoming magnified and sonified; they are closely coupled to bodily movement and produced without recourse to sensors or mappings. For technical details, please refer to earlier publications [49, 50].

3.2 Sound and Interaction Design

> The botanist's magnifying glass is youth recaptured. It gives him back the enlarging gaze of a child. With

> this glass in his hand, he returns to the garden...
> Thus the minuscule, a narrow gate, opens up an entire world.
> Bachelard [4, p. 155], *The Poetics of Space*

In *Sonographies*, an alignment was sought between representational and symbolic qualities of sound design and the intimate quality of embodied experience that the installation technology produces. In response to this intent, the sound design for *Sonographies* draws on themes of the domestic and personal space and is composed of sound materials collected at the first author's home. Mirroring the way that the installation appears to magnify phenomena, sounds were recorded with a sensitive microphone in close proximity to reveal intricate details that would otherwise be barely audible.

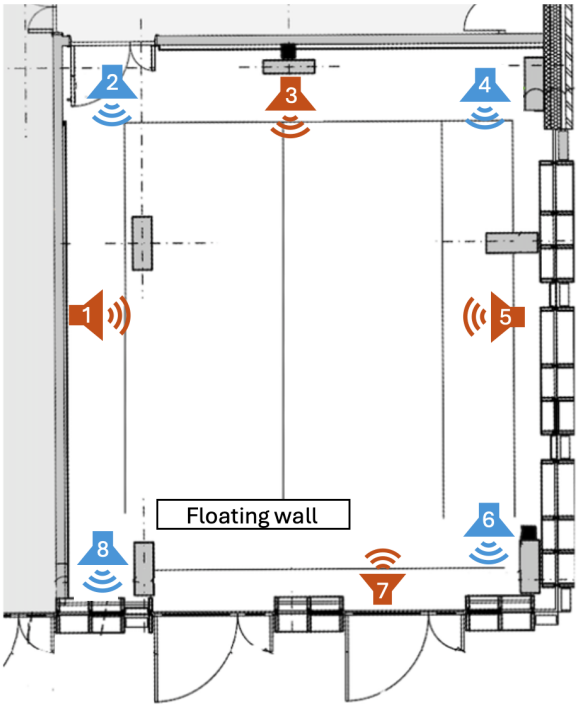

Figure 1: Speaker positions in *Sonographies* at *no format Gallery*. The speakers depicted by blue icons are ceiling-mounted tweeters pointing down to the floor. The speakers depicted by red icons are wall-mounted and face into the room.

The presence and audibility of the Doppler effect depends entirely on sound design choices. In *Sonographies*, a key intention was to frame interactive effects prominently in the artwork and organise the composition around different *flavours* of body-sound relationship. The result is a 20-minute composition arranged across eight tracks in the DAW, each corresponding to a tweeter in the gallery space (see Figure 1). The piece plays on a continuous loop and falls into three sections:

(1) A sparse interior scene composed of the whirr of a clock mechanism, hum of a fridge, the rise and fall of human breath and solo cello lines. The Doppler effect is prominent, drawing the body into a close relationship with individual sounds that have a distinct spatial location.
(2) A transition section whereby the crackle of a record player is emitted from the corner speakers. The carrier frequency for amplitude modulation on the transmitter side ramps up through this section from 20.5kHz to 40kHz. This modulates the pitch and timbre of the crackle from rock-like rubble to bright sparks. There is no Doppler effect here; the intention is to orient the listener toward the spatial arrangement of sound.
(3) A richly harmonic drone composed of time-stretched piano recordings and sine tones, creating a dense field of sustained sound. The drone is spatially distributed, with different selections of pitches emitted from each tweeter and continuously sensitive to movement. The Doppler effect is prominent but without a focus on directionality, promoting the feeling of being within a continuous field of sound.

3.3 Curation

Sonographies was curated in collaboration with Eva Martinez, an experienced curator, producer and dramaturg working across the visual and performing arts, with a particular specialism in contemporary dance curation. Together, we worked to curate the installation to emphasise embodied and relational experience. We collaborated on 1) aspects that prime the experience such as texts and imagery that the listener encounters in advance of listening to the installation, and 2) the staging of the installation and interventions that alter the gallery's appearance, such as the introduction of materials and lighting into the space, see Figure 2.

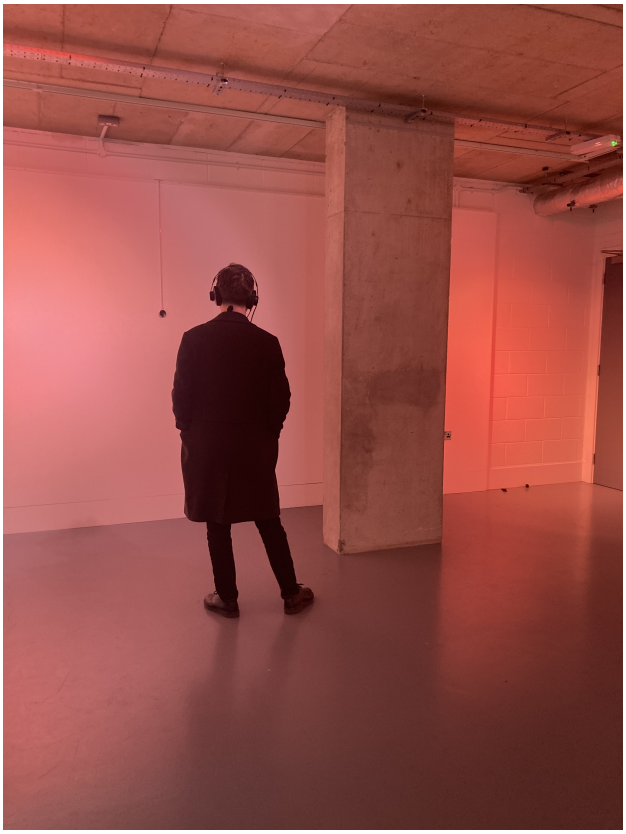

Figure 2: Listening to *Sonographies*

4 Design Journey: A First-Person Account of Entangled Practice

This section presents the outcomes of *research through practice* [22] (RtP) conducted during a creative residency at *no format Gallery* in South London in early 2024. We define RtP as a hybrid - drawing together the methodologies of research through design (RtD) with artistic practice. It addresses the research question: How do nonhuman material influences shape artistic practice and process with the ultrasonic installation?

Our findings are presented as a *design journey*, an RtD method for documenting processes and reflecting on the 'direction and decisions taken to elicit insights' by 'highlight[ing] details... and bring[ing] them together analytically' [58]. A first-person account of the design process is constructed from contemporaneous notes and recorded conversations with the curator, Eva Martinez. It consists of four 'design events' [18], moments of surprise, tension and dead ends that stand out against a background of more expected activity and creative experience.

The events are presented chronologically and offer insights into the interplay of (human) artistic intention and (nonhuman) material forces. The text is written by the first author in the present tense, which was found to aid the process of reconstruction and reflection. Unless otherwise stated, all quotations are their own and lifted from the design journal kept during the residency.

4.1 Event 1: Attending to the gallery context and its materiality as an active influence leads to feelings of discomfort and doubt

The gallery has a 5m x 7m footprint, 2.9 m ceiling height, and a light, contemporary, and industrial feel. The two external walls are almost entirely glazed with floor-to-ceiling windows, and the two internal walls are painted white. The concrete floor is painted grey, and bare, rectangular concrete columns punctuate the perimeter.

I spend the first residency day looking, listening, singing, making sketches and writing notes. I am attentive to the material form and acoustic character of the gallery and what it suggests for the installation's design and curation. For example, the columns create pockets of partially enclosed space in the far corners of the otherwise open space. Placing tweeters on the columns, sound might be projected not just into the centre of the gallery space but toward and alongside walls. I wonder about the effect of placing tweeters on opposite sides of the same column and how sound might be reflected off the walls and windows back into the gallery space.

Listening to the gallery, I am struck by just how different *no format Gallery* is from the previous locations where the artwork has been installed, which were black box venues with relatively dry acoustics and heavy doors that isolated the installation from the outside world. *no format* is prominently and pleasingly reverberant. I enjoy singing into the space and find the reverb comforting, noting that 'it sticks to me and extends my voice quite naturally'. The acoustic response produces a strong sense of being present in a physical place that I hope to bring into the installation headphones.

The gallery feels acoustically 'porous' in that the external environment spills into the space and demands my attention, creating a relationship with the outside world that hasn't existed in previous iterations. I hear cars passing, people talking as they pass by, the sounds of 'sirens, airplanes, and the clatter of construction'. The windows also change the experience of listening. Eva notes how the installation becomes a soundtrack to the observed. This experiential effect is at odds with the intended focus on embodied experience and awareness of sound inside the gallery. It is clear that windows must be covered and that curatorial interventions will be needed to alter the gallery space in the service of design intentions.

Figure 3: Working in-situ at *no format Gallery*

The following day, I bring the installation and its technologies into the gallery (see Figure 3). Wearing the installation headphones, I listen to different sound materials: simple arrangements of sine tones, string drones and recordings intended to capture a sense of domestic intimacy. The rhythmic mechanism of a clock, the breathing of my sleeping son, the rustling of a duvet, the motoric clicking of a wind-up toy.

Again, I am thrown by the influence of the gallery. Many of the sounds feel underwhelming - lacking impact, lost in the space - now mediated by the installation technologies in situ. The close and warm reverberance of the gallery does not translate to headphone listening; it is audible only as hissy, high-frequency transience: 'tss, tss'. I am aware of how reflective *no format* is compared with previous venues, 'sounds really stretch out into the space', and I discern a weaker sense of sounds existing local to their source. As a result, the speaker configurations I had sketched do not produce any strikingly new or engaging effect. In my journal, I note that the new context 'throws up different challenges, raises more questions, offers certain (and uncertain) possibilities'.

The more that I try to listen to the installation and understand how sound materials are transformed by the gallery acoustic, the more I find the external sounds of construction and traffic intrusive, oppressive almost, and I increase the output volume of the audio interface to compensate (thereby increasing the volume of ultrasound in the gallery space). The mic inputs on the Teensy do not clip, yet my ears begin to ache, and I become acutely aware that I don't know how loud the ultrasound is in the space: 'Do my ears hurt from the ultrasound? or are these headphones just really uncomfortable?'. I feel keenly that - inaudible to the naked ear - ultrasound is not for the human listener and that I am reliant on imperfect listening technology. Logically, I know that sound levels couldn't cause me any pain, but unable to perceive ultrasonic phenomena directly, I experience a loss of confidence and doubt my ability to judge.

4.2 Event 2: Site-specific experiments do little to advance the composition and appear in tension with the ultrasonic technology

Given the prominence of outside sounds in the installation, a key question is whether I include or refer to them or mitigate and possibly exclude them from the work. Despite the isolating quality of headphone listening in *Sonographies*, I am keen to create a sonic relationship between the gallery and the installation. Seeking to advance the sound design and dispel discomfort and uncertainty, I adopt compositional strategies that I have used in past site-specific musical work (albeit in the acoustic space, not using the ultrasonic technology): acoustic analysis and modelling.

I input the gallery's dimensions into the amroc room mode calculator[2] to generate a list of resonant frequencies and record an impulse response using the sine sweep method. Resonant frequencies are translated from hertz to musical pitches, which inform the choice of tonal centres and constrain the musical composition. I play these out into the installation as sine tones, which I find 'reassuring' but also somewhat 'arbitrary as not actually triggering room acoustics' as they would if played out acoustically and audibly. I also create simple audio effects that are intended to model or capture the character of the gallery acoustic so that, via the sound design, the gallery is brought into the headphones. Using Ableton's multiband EQ plugin ('EQ8'), I program resonant peaks at each frequency corresponding to an axial room mode and then duplicate the plugin to multiply the resonant feedback, thereby creating a crude physical model of the gallery space to be excited by input audio sources. Additionally, Ableton's convolution reverb combines incoming signals with the gallery's impulse response. I note how the reverb is recognisably 'of' the space, that it brings a feeling of warmth and being situated in an acoustic place.

I wonder how these acoustic effects should be deployed in the installation. Each audio track in the DAW relates to a tweeter in the installation and, therefore, has a defined spatial location. If I add reverb to a track (as a direct insert), should the reverb only be heard from the related tweeter or exist in the installation globally, with the effected signal routed to each tweeter? Would these effects and their connection to the gallery even be discernible to a listener visiting the space for the first time? I persevere for some time along this path, experimenting with different sound materials and spatial configurations, but remain dissatisfied: the effects don't seem to advance the project or relate the sound design to the gallery in a meaningful or perceptible manner.

4.3 Event 3: Minor changes to the listening technology result in major improvements to sonic fidelity, unexpectedly resolving a series of design problems

During the residency period, I work to complete upgrades to the audio amplification circuit that boosts the volume of incoming signals from the microphones before they are routed to the Teensy. I am keen to remove a continuous whine sound produced by an Adafruit power supply board and demodulated into audibility. A new component is sourced[3], which does not add any noise to the system. Alternative voltage regulators are tested and compared, and improvements to audio fidelity are achieved by replacing this component and tweaking component values to boost the gain of output signals.

A new PCB with these changes embedded was completed during the residency, allowing for a cleaner, louder and more transparent mediation of the ultrasonic space via the technology. This has a profound impact on the listening experience. The sounding space of the installation audio is more vivid and fills perceptual space, overriding external sounds. Additionally, the sounds of my footsteps and of my clothes rustling as I move are more audible as though part of the installation, which in combination with Doppler effects, creates a visceral awareness of being situated in my body and the installation space. These are desirable effects for *Sonographies*. The technology and its mediation of sound demand the listener's attention, producing effects that are more prominent and perceptible compared with the acoustic experiments described earlier.

My compositional practice shifts from attending to the gallery and its sonic characteristics toward sound design that supports and emphasises the effects of mediation in the installation. For example, I place an intimate recording of my son's breathing as he sleeps at a high volume in the centre of the space. Effectively rhythmic bursts of noise, an intense juddering is heard as I move. Similarly, the pitch of a sparse cello line warps wildly with my movement. These effects are uncanny and have a visceral effect that can't be ignored, which conceptually and interactionally meet my artistic intentions.

4.4 Event 4: Curatorial interventions bring the visible materiality of the gallery into the artwork creating 'intentional' space

Through my collaboration with Eva, the curatorial is elevated as a design priority, and we explore the effect of extra-sonic design elements on the experience of listening to *Sonographies*. She invites me to consider the whole experience: how visual, tactile and linguistic stimuli might suggest or coax a listener toward an embodied mode of perception, and how liminal spaces - the entry and exit - can be 'held' and actively contribute to the artwork. In our early discussions, we speculate about the effect of carpet or different textures underfoot, how the weight and design of the listening apparatus on the body might work to encourage bodily awareness, how and to what extent themes of the domestic are signified in the space, how lighting should be used, where headphones should be positioned, etc.

She also grounds me. This is a development process, I cannot do everything and need to prioritise. Time appears to accelerate in the run-up to public exhibition dates. I feel the expectations and conventions of the art gallery context keenly. The presentation of the artwork is suddenly a key concern, and there are a multitude of decisions to be made and materials to be purchased. I act on instinct, prioritising the interventions that I believe will be most impactful. A text provocation to 'listen with headphones, listen with your body, listen with the space' is displayed at the entrance, the windows are covered by long, semi-sheer white curtains and the space is lit in soft pink.

I hoped the residency would be an opportunity to thoroughly explore and develop sound design. However, compositional activities were relegated due to the need to present a complete, curated experience. On reflection, our curatorial interventions were transformational, more impactful on the listening experience than I had initially imagined. Eva describes the curation as creating an 'intentional space', meaning that the gallery is no longer the

[2]https://amcoustics.com/tools/amroc
[3]Seeed Studio Lipo Rider Plus, https://wiki.seeedstudio.com/Lipo-Rider-Plus/

background, a mere canvas upon which to hang artworks. Its materiality contributes meaningfully to the art experience. This is discerned by the listener because while the interventions are subtle, they are clearly intentional and, therefore, brought into relation with the sonic. Equally, housing the electronic circuitry in an organic form (see Figure 4) brings the object into the aesthetic sphere of the artwork, part of the experience and specific to the act of listening to *Sonographies*, rather than a generic tool that might be transferred to other settings.

Figure 4: The perspex form housing electronic circuitry

5 Discussion

Note that the first-person voice continues through this section due to the reflective character of the discussion.

5.1 The Doubtful Experience of Designing-With

The design journey captures a series of events salient to the question of how material agencies were negotiated during the creative residency at *no format Gallery*. While researchers and designers in the field of more-than-human and posthuman design deliberately work to decentre their own perspective or agency via techniques such as noticing [45], this was - I found - to be an upshot or consequence of my attunement to site. By seeking the inclusion of material agencies, I felt my own creative will or agency to be displaced or 'decentred' and experienced feelings of discomfort, frustration and doubt. Similar emotions have been associated with acts of decentring by Biggs et al. [7] and Nicenboim et al. [45]. Drawing on autoethnographic accounts of birdwatching as an act of noticing other species, Biggs et al. [7] describe the unexpected feelings of discomfort and 'abjection' - a kind of nauseous sense of being overwhelmed by the 'inescapability of birds'. Nicenboim et al. [45] also acknowledge feelings of discomfort, suggesting that decentering entails exposing and embracing the frictions in encounters with nonhumans, staying uncomfortable and remaining a beginner.

Since I characterised my experience of doubt and discomfort as a byproduct of the design stance, I sought to dispel those feelings and move forward by attempting to problem-solve and find more harmonious compositional methods. Had the residency been longer, more open-ended and without a close deadline for public exhibition, I might have willingly remained with the sensation of unease and unknowing for longer to examine whether it could be generative for design. In practice, there was a pressing need to move the design of *Sonographies* forward and seek resolution. The dissipation of doubt occurred with a shift concerning more-than-human agencies, from working with the materiality of the gallery to the materiality of the technology. Potentially, the feelings of doubt I experienced were due to an inherent friction between the installation's listening technology and site-specific practices.

5.2 Aligning Aesthetic Values with Material Agencies

> "The process of making the more-than-human elements 'cohere' entails 'feeling' among those heterogeneous ingredients such that they produce a 'cogent' event."
> Wilkie and Michael [60]

> **Cogent** adjective
> (1) a: appealing forcibly to the mind or reason : convincing
> | *cogent* evidence
> b: pertinent, relevant
> | a *cogent* analysis
> (2) having power to compel or constrain
> | *cogent* forces
> Merriam-Webster [41]

The practice of creating *Sonographies* was guided by a clear aesthetic direction. While the sound design and its interrelation with the gallery was unclear, I had a fixed idea of how the work should be experienced and felt. Design decisions were made in relation to the aesthetic register, always asking: does this serve or detract from the intended experiential mode? The above quotation by Wilkie and Michael [60] resonates with my orientation to the more-than-human elements. The intention was to create coherence, or an alignment, in the way that sonic and material qualities of site and visible curatorial interventions relate to the sound design of the installation. The disparate parts act together to produce a 'cogent' event that compels the listener to appreciate certain aesthetic qualities while appealing forcibly to the body.

Throughout Event 2, I persevered with the intention to forge connections between the sound design and the gallery acoustic to no avail: the sonic devices did not cohere with the installation nor work to produce a cogent event [60]. The resolution that occurs through Event 3 is due to a re-orientation. I shift from attending to the nonhuman agencies of site to designing-with [56] the listening technology and its particular mediation of sound. In other words, I perceive that of all the 'heterogeneous [more-than-human] ingredients' [60], it is the technology of the installation - producing an alternate audio reality to the one in which the listener's body is situated - that coheres with the desired aesthetic

experience and works to produce a cogent event. Doubtfulness is dispelled, and I experience a weaker sense of my agency being decentred because my intentions are more harmonious with the technology agency.

By articulating this re-orientation to the technology, I do not wish to make a dualistic distinction between the technology of the installation and the materiality and sonic environment of the gallery. Improvements to the listening technology entailed a more transparent and audible mediation of ultrasonic phenomena in the gallery space. The technology now brings the installation effects to the forefront of listener perception rather than the whine and hum of electronic circuitry. It is, therefore, the body-sound interaction that is centred rather than the material presence of the listening technology.

5.2.1 Entangled Aesthetics. By subtly decentring [45] human artistic agency and designing-with [56] the interrelated effects of technology, sound and site, aesthetic qualities may be appreciated as co-produced by the entire assemblage. I argue, therefore, that attunement to entanglement implies a view of aesthetics not as an object or quantity, a 'thing' to be mapped or manipulated within a system design as is often the case in gestural NIMEs, where movement data is mapped to compositional parameters. Rather, aesthetics are emergent qualities of those interactive processes when placed in a particular context with individual participants. In the case of *Sonographies*, the installation aesthetic is a cumulative effect of compositional practice, curatorial interventions, technology mediations, and the materiality and sociality of the gallery. These points echo Born [8] in her characterisation of 'musical assemblages' as a constellation of 'musical sounds, human and other subjects, practices and performances, discourses and representations, material and immaterial technologies, and spaces and locations', all entangled with the social sphere of mediations.

5.3 Specifying Site-Specificity

Through this study, I have learned that the installation is necessarily entangled with the site in which it is heard; it must be arranged and mixed with the gallery's acoustic profile but is poorly suited to site-specific compositional methods. Given the closed-off nature of headphone listening, described by Bull [9] as a 'hermetically sealed aural bubble', this is hardly a revelation. Yet, artworks such as Christina Kubisch's *Electrical Walks* and Edwin van de Heide's *Radioscape* [55] employ headphone listening and are richly site-specific, drawing the listener's awareness to sonic characteristics of the external environment within which the body is situated.

In the case of *Sonographies*, the interaction of emitted ultrasonic phenomena with the environment produces a minimally interesting effect. For example, the reverberant acoustic of *no format Gallery* diffused emitted ultrasound, diminishing effects of narrow directivity and modelled reverb was barely perceptible as relating to the gallery. The installation technology reveals a constructed sonic space, which appears as an audio-augmented reality (AAR). This AAR accompanies the visual space of the gallery that is curated to support and align with the installation's interactive and aesthetic effects. Arguably, it is the ambiguity [27] between visible and audible space that defines the relationship of *Sonographies* to site.

5.3.1 Attuning to Fragile and Changeable Qualities of NIMEs. In Event 1, I noted profound differences working with the ultrasonic technology at *no format Gallery* compared with previous venues. Similarly, aesthetics are not static or fixed but enacted by an individual listener through their embodied musicking, moving and exploring the installation. Our experiences highlight the fragility of the assemblage and suggest that an attunement to entanglement implies a sensitivity to flux and change. By extension, we might conceive DMIs and sound installations as more like events rather than objects [16]. For, as Born [8] points out, through its changing mediations, 'music is never singular but always a multiplicity'.

6 Conclusion

This paper described the practice of creating *Sonographies* during a creative residency at *no format Gallery* in South London. Inspired by the site-specific approaches of sound artists, we worked to create links between the sonic composition and acoustic features of the gallery, attempting a more-than-human disposition whereby nonhuman material influences are invited into the process and allowed to shape artistic practice. This attunement to site led to feelings of discomfort and doubt, potentially due to an underlying tension between the installation's listening technology and site-specific practices. Upgrades to the technology emphasised the strong mediatory effects of the technology on the listening experience, and only when our orientation shifted to working with these effects did esthetic intentions begin to cohere with and become amplified by the ultrasonic technology.

Based on our experiences with *Sonographies*, we argue that an attunement to entanglement foregrounds the co-production of aesthetic qualities by the entire musical assemblage and implies a sensitivity to the fragile and changeable qualities of NIMEs, contingent on specific technical and contextual factors. Finally, we advocate for NIME to embrace research through practice as a means to elicit detailed understanding of musical entanglement from embodied human perspectives.

7 Ethical Standards

The research study described in this paper received ethical approval from Queen Mary University of London Ethics of Research Committee prior to commencement. The curator-collaborator was engaged as a professional study participant and renumerated for their time. The aims of the study and the scope of their involvement were explained in advance of the creative residency. They gave their informed consent to participate and agreed to appear in this article non-anonymously.

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