

Unfoldings: Multiple Explorations of Sound and Space

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ABSTRACT

This paper describes a long term, collaborative project *Sound Spaces*. Within this project we creatively investigated various environments and built a collection of artworks in response to material gathered through a number of practical field visits. Our responses were presented in numerous, idiosyncratic ways and took shape through a number of concerted making activities. The work was conducted both in and with the public, allowing participants to inform the creative decisions made throughout the project as well as experiencing the building of the artworks. Within this essay we report on our process, presentation and offer alternative methods for collecting material and presenting representations of space using Ambisonic and other technologies. We describe the many responses made during our time and related these to research concerns relevant to the NIME community. We conclude with our findings and, through the production of an annotated portfolio, offer our main emerging themes as points of discussion.

Author Keywords

Field Recordings, Sound Space, Ambisonics, Spatialised Sound.

1. INTRODUCTION

Throughout the years there has been a large amount of research concerning spatialised sound space environments within the NIME literature (among many examples [3]). This research often reports on technologies that support surround sound listening, leading on the technicalities of a single device that achieves a set of particular results. Many of these technologies have been used by artists and performers to playback compositions or perform through.

Drawing on our previous work, we used Public Making [17] as means to investigate this area in *Sound Spaces*, a collaboration between the authors [TS, SB, JB], the Foundation for Art and Creative Technology (henceforth FACT) and a small creative business partner Kinicho. We configured this collaboration to encourage numerous pieces to be made with the intention of developing an Annotated Portfolio [2, 7] of our work. Beyond this creative work, the collaboration also enabled us to further our research interests in sound as a creative and concrete material, counterfactual representations of space and place, and collaborative creative practice. Here, making was both an enquiry into the creative possibilities presented by the technologies, locations and materials gathered, and a means through which wider insights emerged relating to our particular concerns. Our approach was akin to “Research Through Art and Design Practice” [7] and “constructive design research” [9] in using making as enquiry, but we also note that our making was explicitly informed by our interests in social studies of technology [14] critical-speculative applications of making [e.g. 1, 10], and our previous empirical studies of technology in action, amongst others.

Löwgren describes how such research can produce “intermediate-level knowledge” [16] where the insights developed translate beyond the specific making context although not abstracting completely to the level of general theory. Whilst our making has indeed stimulated our thinking beyond the particular context of our practice, we stress the mutual dependency between this understanding and the artefacts through which it was developed and is expressed.

Hence, in this paper, we present an annotated portfolio that both respects this indexicality and communicates the work in a manner that can inspire others’ creative practice and research.

Action Research (AR) [10] also gives practice a central role within research enquiry, and other writers have noted similarities between creative practice and Action Research [19]. Although we do not go so far as to claim our work as AR, like AR, we reflected on research concerns and insights throughout the project with our collaborators to ensure that the project became a *collective enquiry*.

We shall discuss three contributions from our work: insights from our Annotated Portfolio that relate to specific concerns for NIME; building on this, alternative ways of using sound to convey spatial character to methods emphasizing precision or realism; and, the methodological value of public making a portfolio of work.



Figure 1: *Soundspaces* Exhibition at FACT Liverpool

2. CONVEYING SPACE WITH SOUND

Historically, within academic digital sound studio literature, there have been many reports on how to create virtual listening environments [6], how to ‘optimise’ acoustic accuracy within Ambisonics [25] etc. and create acoustically ‘neutral’ spaces for listening. These reports often lead on scientific, psychoacoustic perception, building spaces that allow users to hear sound in ‘3D’ and also how to minimize distortions or artifacts in the acoustic image. Many artists have used this technology to realistically represent places, for example sound artist Chris Watson uses Ambisonic technology to record and playback various environments with very realistic results. As impressive as these pieces can be, our work is presented differently, we allow for multiple sounding devices to temporarily co-exist and strive to challenge views of sonic representations of space. Though our work uses some of these listening technologies, such as Ambisonics, this did not overly prescribe the direction of our creative explorations. Our activities do not focus on a single technology or outcome but rather create entangled listening spaces, making it possible for various devices to subtly interact with one another. Other artists such as Stockhausen [4], Cardiff [15] and Truax have also explored various creative approaches to spatialised sound. For example, Cardiff’s piece *The Forty Piece Motet*, playfully uses multiple loudspeakers to represent singers in a reinterpretation of Tallis’ *Spem in Alium*. Our approach to *Sound Spaces* was conducted in a slightly different way, we explored listening technologies as creative materials, allowing

for flexible and changeable speaker configurations to occur and thus creating hybrid listening spaces.

3. SOUND SPACES

Sound Spaces was part of *The Creative Exchange (CX)*, an Arts and Humanities Research Council (AHRC) funded program bringing together humanities academics, creative industries and creative practice PhD students. FACT are a non-profit media arts center based in Liverpool, Merseyside. Kinicho is principally Stefan Kazassoglou [SK] a music producer, sound recording engineer, and composer who set up Kinicho (“kinetic audio”) as a microbusiness within FACT. [SK] has a long-term interest in spatialised sound, and has made many spatial sound recordings as well as spatial sound listening environments, including his Icosahedron Sound System – an array of 20 loudspeakers and associated software for playback and spatial mixing of third order Ambisonic recordings [4]. Another collaborator was Magnus Williamson [MW], a medieval musicologist, based at Newcastle University, who offered an alternative perspective on sound and space.

Throughout the project, we wanted to explore creating imaginary sonic environments drawing direct inspiration and gathering material from some of Liverpool’s lost and forgotten spaces. An original inspiration for the project was John Bowers’ [JB] proposal to explore of Liverpool’s ‘sound lines’ (“one part song-line, one part ley line”) – imagined sonic ley lines between different locations, and how they might create virtual connections between seemingly disparate places.

The site visits included excursions to the Williamson Tunnels¹ (a network of tunnels with an ambiguous history built by the eponymous Liverpool industrialist); the Bombed-Out Church², the remaining shell of a local church largely destroyed in WWII that had become a public arts venue; and The Old Dock³, the World’s first commercial wet dock built in 1715, now 10 meters under street level.

Although largely informed by activities over two years, much of the creative work in *Sound Spaces* occurred during the last six months of 2015 (and some is ongoing the time of writing). This included running two Public Making sessions (over four days in August, and one day in early October), a residency/exhibition at FACT in late October that included public performances and invited artist talks, and creative work in support of and following on from these activities.

During the Public Making sessions we were located in a workshop/maker-space with access to a number of projectors, two small sound systems, several tables and numerous power points. We placed tables around the space each paired with an associated sound system and/or projector.



Figure 2: *SoundLines* public making workshop

Through web publicity, publics were invited to drop in at any time during the August session but we were also encouraged by

¹ <http://www.williamsontunnels.co.uk>

² <http://www.bombedoutchurch.com>

³ <http://bit.ly/2ORmMbo>

FACT to have a cohort of makers join us for the whole period. To encourage a wide demographic to attend we decided to not stipulate prior making experience. On day one ten participants joined us, with varied backgrounds and experience (from experienced musicians to first time sound makers). Days were typically structured as field visits in the mornings and working with recorded material in the workspace in afternoons. We conducted this work in a publically accountable way, people were invited to ask questions, interact with the devices made or just experience the installation space as we worked. The Public Making concluded with a presentation of all of work made during the sessions and a short performance from [JB] using some of the technologies he had built.

Three pieces made during the Public Making sessions were developed further for installation in a public gallery spaces at FACT Liverpool (*SoundMap*, *Icosahedron Sound System* and *SoundLines*, described below) (see figure 1). These pieces were presented together, their sonic output overlapping one another, which created an interesting layering for gallery visitors. Moving through the space would create complex crossfades between pieces, meaning one’s position in the room would directly inform the received composition.

4. SOUND SPACES PORTFOLIO

Throughout the project we created various pieces, gathered material from a variety of environments and explored the concepts of ‘sound lines’ and sound spaces through an active and pragmatic process. We adopted a flexible approach and made our work practically suitable to the places where we were conducting our activities and the publics we were engaging with. In this sense the making process and the presentation of things made were inherently interconnected. All of the material gathered throughout was shared openly with each collaborator, allowing open access to all the tools and resources to encourage collaboration and re-appropriation of the shared material. We now give more detail to the pieces that emerged during our making activities, followed by a description of the concerns and themes that link them.

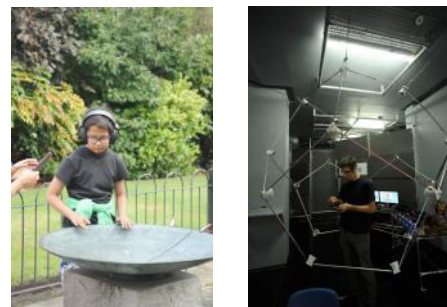


Figure 3: Field recording and Icosahedron (early version)

4.1 Sound and Space Constructions

4.1.1 Development of the Icosahedron Sound System

Prior to the project, [SK] had built a version of his Icosahedron Sound System for listening to and, via a mobile app, controlling third order Ambisonic recordings. This array of 20 loudspeakers, placed at the vertices of a dodecahedron, was rebuilt twice during the project – first to replace the cane structure with longer aluminum poles and upgrade the amplification, second to construct a larger version with larger loudspeakers and stronger metal frame, acoustic dampening and a floor-mounted sub-bass transducer (see figure 3). By using a 360-degree speaker array and playing sound through an Ambisonic encoding format, users were able to ‘place’ sounds

in space, specifically using height (vertical plane), rotational (horizontal plane) and distance (near and far) dimensions. We came to regard the Icosahedron Sound System (ISS) as being exhibited in three different modes. Mode One involved playing fixed media pieces composed using materials and data gathered during our field trips (e.g. *Unfoldings I*). Mode Two enabled participants to directly interact with the sonic space using an iPad running Lemur, connected through Open Sound Control (OSC), which allows the dimensional parameters to be manipulated. Mode Three presented participants with spherical photographs of various environments visited during our time together, which they could navigate using their own smart phones, with their physical movement directly informing the sound design and spatial diffusion. As well as providing a listening space, the Icosahedron added a sculptural visual form for our creative work which some of our later work built upon.

4.1.2 Impulse Response Readings

We took impulse response (IR) readings within the various sites we were visiting as a way of capturing the sonic signature of that environment. This was done by setting up an Ambisonics microphone within a central area of the space and playing a sine sweep using a portable speaker back into the space covering every frequency within the human hearing range (for more on this technique see [20]). These IR readings were then taken back into the workshop space to playback within the Icosahedron. Using this technique one could stand within the Ambisonics system and excite the IR by speaking into a microphone, giving the user the impression they were making sound within the referenced space.

4.1.3 Extended Field Recordings

During our visits to the locations within Liverpool we explored the environments with a diverse collection of listening equipment. Using contact microphones, electromagnetic coils, air pressure microphones, radio transmitters and a Raudive diode receiver of the sort sometimes used by researchers into electronic voice phenomena and a circuit made by artist Martin Howse, the Detektor, which frequency shifts infra- and ultra-sonic electromagnetic radiation into the audible range, we extracted sonic material from our visits. We allowed our explorations to be serendipitous—approaching places open to listening and chance. Collected material was then taken back to our workspace, experimented with in multiple ways and offered as a material anyone in the group could use.

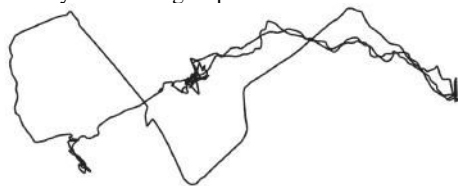


Figure 4: GPS trace from Tim Shaw [TS] during one day of the workshop

4.1.4 GPS Traces

As well as recording audio and visual material from our field visits, GPS data was collected using the iPhone application ‘Track’. Taking inspiration from the self-archivist Jacek Smolicki [24] each day was ‘tracked’ and at the end of the day these traces were distilled into minimal lines, keeping only positioning data and ridding it of all other metadata. Each day was shown as a different image and simply presented as a black line on a white background. An ANS style synthesiser [22] was built in Pure Data and used as a way of generating sound from the images. In this construction each pixel line related to a different oscillator. The gain of each oscillator was controlled

by the grey value of each pixel. The image was scanned vertically and then changed to another day’s image at random.

4.1.5 SoundLines

During the course of the August *SoundLines* workshop, [JB] devoted much attention to making a piece that embodied a creative concept of a ‘sound line’. The sonic component of this piece involved cross-fading between recordings made at one site in the city to recordings made at another. As the cross-fade took place the recordings were transformed by algorithms coded in Pure Data into more noisy, drone-like, pulsing or crackling forms of themselves. In this way, as the piece unfolded the listener was ‘transported’ between locations and in and out of more sonically abstracted forms. In [JB]’s creative conceit, these more abstracted forms were imaginings of the hidden ‘sound lines’ connecting the two locations. A visual projection showed the relative locations of the sites, the lines connecting them, and the current position of the cross-fade against a background created by collaging historical maps of the city. For the public exhibition, [JB] further developed the piece to work over a multi-channel loudspeaker system and five HD monitors.

4.1.6 Spherical Photographs

[SB] created spherical photographs using a camera mounted on a tripod with spherical panoramic head. Nineteen images were made using an 18mm lens on a FX-format Nikon DSLR: two rows of eight images at 45 degree yaw (rotation) intervals and +/- 30 degree pitch, a single zenith image, and two nadir images (one hand-held for removing the tripod later in Adobe Photoshop). Images were stitched into a single rectilinear spherical projection image using PT Gui Pro. The Marzipano Tool was used to create interactive versions of spherical images that could be viewed using standard web browsers. Marzipano code was then adapted for viewing panoramas according to mobile device orientation and other novel interactions (Icosahedron Mode Three, above).

4.1.7 SoundMap

Developed from a composition that two of our participants made with field recordings and an iPad, the pair suggested relocating their manipulated recordings by giving them the sonic character of the places we had visited. This was achieved by convolving the manipulated recordings using the IRs of the sites we had visited, playing them back through the Icosahedron, and recording the result onto personalisable audio greetings cards. Further, photographs one participant had taken of the sites were used as images on the cards. Alongside this, the authors had experimented with visualisations of Liverpool through layers of maps and using the location visited to plot imaginary sound lines across the city. We presented these ideas together as a *SoundMap* in two materialisations. The first at the first workshop where a map was projected onto a table with the greetings cards placed on the relevant locations. The second version at the public exhibition used a physical map mounted onto a wooden board and placed onto a stand. Audio transducers were placed underneath various relevant locations of the map playing back sound relating to that place. Some of the sounds were also processed through the relevant IRs to create a convolution reverb [19] effect.

4.1.8 Ship Horn Synthesiser

One of the participants to the August workshop brought a collection of sound files digitising a 1966 album entitled *The Ships Of Merseyside*. [JB] worked with him to create a software synthesiser in Pure Data that would analyse sound input to a microphone and output a sound texture comprised of sound grains derived from the ship horn recordings which was as closely matched in sound spectrum as possible. This technique

enabled any sound picked up by the software to be echoed with ship horn sound. In this way, the field recordings collected could be ‘timbre-stamped’ with the sounds of (now lost) ship horns—a rather poignant ghostly effect. Additionally, to much amusement, participants sang into a microphone, their efforts rudely accompanied by fog horns and other ship signals.

4.1.9 Concatenative Synthesis

During our activities we built up a large collection of recorded material from various sources, we wanted a novel way of being able to navigate this material using potential computational and algorithmic processes. Drawing on the work done at IRCAM by Diemo Schwartz [21] we used concatenative synthesis as a way of making sonic connections from our large corpus of material. For example, a virtual 2D space was created, one axis frequency, and the other amplitude. We loaded in our library and then the sounds were available to navigate, using an iPad as a way to quickly interface with sonic material. The top left corner of the graph was the highest in frequency and the highest in volume etc. We then used this method in the Icosahedron as a way of navigating the library but also generating sound with the Ambisonic space.

4.1.10 Random Jukebox

Another way of playing our corpus of recorded material in the August workshop’s workspace was through a random jukebox. Terminal commands sent through Pure Data were used to playback multiple sound files to create ‘layered’ soundscapes. The program periodically inspected the shared folder where we were placing our location recordings and so people’s contributions could soon be heard as part of an ever-growing, program-generated composition.

4.1.11 Layers of the Old Dock

This piece used spherical panoramic photographs of The Old Dock and the leisure and shopping complex now above it, overlaid with archive material (paintings, photographs, posters and text) relating to its historical links with slavery and child migration, and contemporary images and sound recordings to create a layered presentation of the many meanings of this place. Interactive media was explored using mobile phones and tablets (as a development of Mode Three Icosahedron, above), and was built by extending the Marzipano basic code to add new functionality such as the use of ‘gaze spots’ (holding the device still in a specific direction to navigate between layers).

4.1.12 IR ASAP (Impulse Response As Soon As Possible)

After building up a library of IRs from the various field trips we decided to use this material to create a slightly different work. When de-convolving the IRs the sound sweep can be distilled to a simple percussive slap with a reverberance characteristic of the space. These sounds offered a very simple impression of what the environments we visited were like. An algorithmic composition in Pure Data played back the collection of IRs randomly and as fast as possible. The speed could be varied to create different sonic textures. At its most extreme (at its fastest) this was a noise and as it was slowed various percussive elements also came through, while at its slowest the program played reverberant impacts (the IRs) separated by long silences.

4.1.13 Performance

During the public installation, there was an evening of performance within a gallery-sized Icosahedron (also built by [SK] at FACT for a parallel, but unrelated installation). [JB] and [TS] made an improvised performance together, while sound artist Philip Jeck also performed on the loudspeaker system with some of his sound material being the Public

Making location recordings of Liverpool provided by [TS]. The event was sold out several days in advance. For their performance, [JB] and [TS] made performable versions of some of the devices and software they had made during the course of the collaboration. For example, the software behind [JB]’s *SoundLines* installation was modified so that the loading of new files, the cross-fades and the mixing in of different processed forms of the location recordings could be made by hand from a MIDI fader box in addition to programmatically. A performable version of the Mode Three spherical photograph interactive was also developed by [SB] to visually accompany [JB] and [TS]’s performance and modified so that it could be displayed across three large screen projections. Here, Marzipano code was further developed to enable keyboard control of scene, rotation direction and speed and roll. In addition, [JB] wrote a series of short haiku-like texts, one associated with each of the sites, which were included in the projected material. Each text contained oblique references to the history of the site, our activity there and various associations that had occurred to participants as they worked with us. [TS]’s GPS traces were also incorporated into the performed visual material.



Figure 5: *Sound Spaces* performance

4.2 Annotations

Constructing an Annotated Portfolio of the diverse body of work created in *Sound Spaces* revealed several linked concerns that both informed and were informed by what was made (see figure 6), as we shall now describe. Bowers [2] explains in depth how AP offers an alternative to more ‘scientific’ ways of understanding research through creative work. By charting similarities and differences, this method helps make implicit connections within a corpus of work.



Figure 6: Annotating our Portfolio of Work

4.2.1 Minimal Ordering

From the offset our work was minimally themed around the idea of a line. For example, the exploration of the soundscapes of Liverpool was named *SoundLines* after the model of ‘songlines’, the paths Indigenous Australians trace in the landscape following the land’s creator-beings, and participants were urged to trace the hidden sonic connections in the city. The *SoundLine* piece, for example, was a very literal interpretation of this, creating a linear interaction between a variety of field recordings the group had collected. We also

explored the essence of the 'sound line' as a conceit or myth, (searching for the sound line with our field trips), creating counterfactual representations and 'eruptions' of 'sound lines' on the *Sound Map*.

4.2.2 Mappings

As many of our activities were related to specific locations we decided to creatively reimagine a variety of maps associated with Liverpool. Maps were collected of the local areas and a variety of mapping techniques were undertaken. *GPS Traces* involved gathering data from our numerous journeys. Other members of the group also appropriated an OS map, adding statements or connections between locations. Subsequent work derived from these activities including the sonification of the GPS data and visualizing of the GPS traces. This work was also folded into the visual aesthetic of the two versions of the *Sound Map*.

4.2.3 Documenting

Much of what was made involved, or derived from, the documentation of the locations we visited. Significantly this involved both 'precise' recording of acoustic character (IR readings, photography) and extended field recording techniques that emphasized alternative and complementary characteristics of the spaces. The documentation was not an end point, we also considered this as a collective creative material which was appropriated in numerous pieces following. This is evident in the *Layers of the Old Dock*, *Random Juke Box* and *Concatanative Synthesis* makings whereby matching material was used across a number of artworks. Our site activities explored the character and materiality of the locations we visited rather than approaching these places with preconceived ideas. By collecting photographs and using extended field recording techniques we allowed our explorations to include serendipitous occurrences, to use the act of collecting as a way of getting to know a space through its material qualities [18].

4.2.4 Virtuality (and its Alternatives)

An initial concern related to how the character of lost or disappeared spaces could be re-presented. For Magnus Williamson, virtual and augmented reality suggested means of achieving this. However, as we began to work with the material we gathered (see Documentation), we explored how spaces could be recreated in both literal and counterfactual ways. The Icosahedron Modes 2 and 3 provided a 'realistic' impression of space through audio convolution and spherical photography. Both the *Performance* and *Layers of the Old Dock*, however, showed that lost spaces could (indeed, should) be evoked using both literal and creative responses to their current incarnations. Many of the works made involved the incorporation and layering of diverse materials, e.g. the *Random Jukebox* and the sonic overlapping within the October installation.

4.2.5 Layers

Our progression from virtual or augmented reality, described above, also involved recognizing the value of layering literal and counterfactual elements. In *Layers of the Old Dock*, this was an attempt to demonstrate its 'perdurance' – a site always and already on its way to becoming something else [11]. From this perspective, the interaction should encourage the user to explore the many historical, contemporary and imagined accounts of this place as co-existent, and open to individual interpretation – a 'layered ontology' of place. Similarly the *SoundLines* piece took the numerous field recordings we had made over our time and used algorithmic processing to find commonalities between them. This created new, un-representational spaces, imaginatively opening up ideas of how sound is associated with space and place.

4.2.6 Performance

Throughout our creative collaboration there was an explicit intent for the work to be *performed*. This meant that, rather than being fixed (albeit interactive) representations of Liverpool, the work became a means for including others in this meaning making, via performance. This also opened up new applications, for example spherical photographs initially created as documentation became a performable instrument for engagement. Many of the devices made were also reconfigured for the public performance, allowing us to create additional performable versions of the exhibited pieces.

4.2.7 Varied Forms of Presentation

Our material was presented in multiple ways. We avoided a single outcome for the project by creating multiple layered appropriations of the material which we collected. Many of our makings were left open, presented unfinished so as to create multiple instances and for the piece to be appropriate for the context in which it was being presented. The *Icosahedron Sound System* was showcased in this way, with multiple modes of interaction involving a variety of material. Similarly spherical photography was presented on both mobile devices (*Icosahedron Mode 3, Layers of the Old Dock*) and on large projection screens for the *Performance*.

5. DISCUSSION

5.1 Research Contributions

Some previous NIME literatures have focused on creating digital instruments that promote collaboration through simplified interfaces and interactions on a single device. These devices are often presented to the public as finished objects, creating distance between how to use the instrument and how the instrument was made (one example of many [17]). Our work attempts to allow participants to experience the process of making, creating connections between material and interaction, *collaborating through making and making through listening*. By doing this we hope to open up a different research orientation, creating opportunities for participants to gain knowledge on how this process works, focusing on the process of making rather than a finished artifact.

5.2 Sound and Space

Specialized sound listening environments can be instrumental in their nature, music studios are acoustically treated and speakers are set with precision to the 'sweet spot'. With the development of multi-channel systems such as 'Ambisonics' and 'Wave Field Synthesis' this precision can become even more intense, with sound image being misrepresentative if the environmental conditions are 'incorrect'. Furthermore, exhibitions of technological sound work can be presented in a conclusive way, with the work 'black boxed' [13] making it potentially difficult to access the means in which it was made. We situate our sonic artwork differently. This work moves away from the precise, accurate representations of place to a more heterogeneous, layered, imagined listening space, combining material through 'real,' imagined and counterfactual investigations of the numerous places we visited.

Within our work here we have dealt with a collection of concerns relating to building creative work in response to locations of sonic and historic significance with participants using a variety of technologies. We have presented work in a variety of context and created complex entanglements between materials, devices made and spaces we have worked within. We left many of our makings open allowing them to be informed by the publics who visited us and respond to the contexts in which they were being presented. For example *Layers of the Old Dock* had multiple presentational instances and *Random Jukebox* was designed in such a way as to enable us to continually add material to it with ease.

We explored places of interest and approached the examining of these spaces through their material qualities, taking sound recordings, photographs, video material and data loggings. We allowed this material to inform our work, to build our devices from the material up, without always having pre-determined technological processes. We presented a collection of devices as a complex bricolage, a collection of artistic layering's.

Through this we avoided a purist approach to audio work, the pieces made were presented in plurality, allowing multiple outcomes to emerge. This is evident in many of the makings, for example the *Impulse Response Recordings*. This material was not only used to represent the space in a realist way, but also folded into *IRASAP*.

Towards the start of our work, [SK] and [MW] had particular ideas of how material might be recorded and presented in the Icosahedron. Emphasis was placed on precise capture of IRs, the representational value of IRs, and on minimising external sound interference with the Icosahedron. These views changed during the project as we used IRs as sonic materials in their own right, composed a fixed media piece for the Icosahedron that reconceptualised it as a 20-channel mono playback system, and developed an exhibition where the Icosahedron was integrated alongside pieces that presented spatialised sound in alternative and complementary ways (*SoundLines*, *SoundMap*). Similarly, our extended field recording techniques problematised recording as being solely concerned with representational accuracy and indeed contributes to debates as to what field recording is or may be.

5.3 (Public) Making Portfolios

Drawing on our previous work Public Making [23], we extend what it means to *make through listening*, creating spaces for collective, collaborative sound making. We present part of our work as a collection of unfinished devices, as prototypes, allowing trajectories of our work to be informed by the publics who visit us. We also open up this space as a shared listening environment, encouraging our audiences and participants to engage in the making of layered, collaborative sound worlds.

Our preceding discussion demonstrates how *Sound Spaces* was not only creatively productive, but also produced insights on the evocation and experience of space through sound (and image). *Sound Spaces* develops our previous work on Public Making by investigating how it can provide a methodology for larger, more complex collaborative work (e.g. including FACT, Kinicho, [MW] and various publics). The value of this approach, we propose, depended on the *intentions* we brought to our making, and the particular *environment* (or ecosystem) developed for that making.

Collaborative creative work, most typically in design, is often portrayed as the collective identification and solution of problems. In our approach, however, our intent was to conduct numerous making activities in parallel, with no explicit intention for a common objective to be reached (*Minimal Ordering* being an attempt to inspire, not proscribe creative work). This parallel making often led to individuals or small groups autonomously making together. However, our workspace *environment* ensured that making did not happen in isolation; rather opportunities for federations around creative work were created. Making together in the same space and making our materials (literally) audible and visible allowed materials to interact with one another, and ideas and responses to merge and entangle to form a cohesive assemblage.

This approach was not without its challenges: certain participants expected a more pedagogical format; maintaining several autonomous strands of making required intensive work; and, a sensitive balance was required between facilitating other's creative work whilst allowing sufficient time for one's

own. However, as several current projects developing from *Sound Spaces* will attest, this approach has much to recommend it.

6. REFERENCES

- [1] Archer, B. 1995. The nature of research. *Co-design*. 2 (1995), 6–13.
- [2] Bowers, J. 2012. The Logic of Annotated Portfolios: Communicating the Value of “Research Through Design.” *Proceedings of DIS2012* (Newcastle-Upon-Tyne, UK, 2012), 68–77.
- [3] J. Cannon and S. Favilla, 2010. “Expression and spatial motion: playable ambisonics,” in *Proc. NIME 10*.
- [4] Jonathan Cott, 1973, *Stockhausen: Conversations with the Composer*, Simon & Schuster.
- [5] Dunne, A. and Raby, F. 2013. *Speculative Everything*. MIT Press.
- [6] Peter Fellgett, 'Ambisonics. Part One. General System Description', *Studio Sound*, vol. 17 no. 8. 20-22.
- [7] Frayling, C. 1994. Research in art and design. *Royal College of Art Research Papers*. 1, 1 (1994), 1–5.
- [8] Gaver, B. and Bowers, J. 2012. Annotated portfolios. *interactions*. 19, 4 (Jul. 2012), 40.
- [9] Gaver, W. et al. 2003. Ambiguity as a resource for design. *CHI '03: Proceedings of the SIGCHI conference on Human factors in computing systems* (New York, New York, 2003), 233–240.
- [10] Hayes, G.R. 2011. The relationship of action research to human-computer interaction. *ACM Transactions on Computer-Human Interaction*. 18, 3 (Jul. 2011), 1–20.
- [11] Tim Ingold. 2013. *Making: Anthropology, Archaeology, Art and Architecture*. Routledge.
- [12] Tim Ingold. 2007. *Lines: A Brief History*. Routledge.
- [13] B. Latour. 1987. *Science in Action*, Harvard University Press
- [14] B. Latour. 1993. *We Have Never Been Modern*. Harvard.
- [15] A. Licht. 2007. *Sound Art*, Rizzoli.
- [16] Löwgren, J. 2013. Annotated portfolios and other forms of intermediate-level knowledge. *interactions*. 20, 1 (Jan. 2013), 30–34.
- [17] William Marley & Nicholas Ward Gestroviser. 2015. *Toward Collaborative Agency in Digital Musical Instruments, NIME 2015*.
- [18] Leandro Pisano. 2015. The Third Soundscape, *Third Text*, 29:1-2, 75-87
- [19] Swann, C. 2002. Action research and the practice of design. *Design Issues*. 18, 1 (2002), 49–61.
- [20] Cutis Roads. 1996. *The Computer Music Tutorial*, MIT Press, Cambridge, Massachusetts. 428-431.
- [21] Diemo Schwartz. 2013. *Interacting with a Corpus of Sounds, Symposium on Sound and Interactivity*. Singapore
- [22] Tim Shaw and John Bowers. 2015. *Public Making: Artistic Strategies for Working with Museum Collections, Technologies and Publics*. ISEA, Vancouver.
- [23] Andre Smirnoff. *Sound in Z – Experiments in Sound and Electronic Music in Early 20th Century Russia* (London, Sound and Music, 2013)
- [24] Jacek Smolicki. 2015. *De-totalizing Capture: On Personal Recording and Archiving Practices*. ISEA, Vancouver.
- [25] Franz Zotter, Matthias Frank, Christian Haar, *Spherical microphone array equalization for Ambisonics, Fortschritte der Akustik, DAGA, Nürnberg*.