Virtual 3-Dimensional Sound as Art – Presentation, Interaction and Immersion

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Abstract

Sound, used as a medium for artistic expression, has struggled to find place within a predominantly visually orientated art fraternity. The Virtual 3-Dimensional Sound as Art (V3-DSA) project was developed to explore ways in which people could understand and connect more readily with artworks of this type. A 3-dimensional sonic environment was created for participants to explore, without the aid of vision. Head tracking and a computer game controller allowed participants to interact with the soundscape created, in a self-regulated, non-linear fashion. Participants found, within this environment, that they experienced a significant level of immersion which was enhanced by the utilisation of the movement interfaces used. The V3-DSA project identifies many future possibilities to the utilisation of computer game engine technologies. This could globally connect people in a sonic world that holds potential for bringing sound art to the next level.

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Acknowlegements

I would firstly like to thank Dr Martin Parker for his help, motivation and enthusiasm throughout the year, teaching me how and when to listen. Also thanks to Owen Green for his insightful advice and Max/MSP wizardry, without which this project would never have happened. Lastly I would like to say thank you to Natalie for her support and encouragement and to all my friends and colleagues for a thoroughly inspiring year.

"...knowing place is never complete, for it always contains things beyond one's grasp, as instances of interference, which may in the end be a part of what it teaches us"

(Westerkamp in Labelle 2006, pg.211)

Chapter 1

Project Submission

1.1 Submission Description

Submission includes video and audio documentation that reinforces the core elements of the design work described in the text, as well as edited coverage of the finished installation and working Max/MSP patches. Instructions **in bold type** throughout the text will inform the reader when to access files on the enclosed DVD. The visual element of the sonic exploration of the FMOD Sandbox shown in some of the video files is a guide to the physical layout and the way in which participants can move around the virtual space. However, a closer connection to how the soundscape was experienced within the installation comes from disconnecting yourself from the visuals presented.

Good quality headphones should be worn to experience all of these DVD files.

A version of the fully working FMOD Sandbox environment used for the installation is also included along with the FMOD Designer set-up and all associated sound files. These will need to be installed onto a local drive as per instructions on DVD for the reader to be able to explore the virtual world themselves. This will be without the head tracking interface used for the installation; but will allow the same horizontal and rotational movement through the keyboard arrow keys and mouse control respectively.

The writing explores how this project relates to the use of sound as artistic impression and explains in detail how the project was conceived and executed. It concludes with thoughts around further future exploration that could be pursued.

1.2 DVD Contents

FMOD Sandbox and Designer – FMOD Designer 'Drips.fdp' file
FMOD Sandbox 'Drips.fev' file plus all associated .fsb files.
Instructions for FMOD Designer and Sandbox

Max Patches - Max patch 1 - Midi_controller.maxpat
Max patch 2 - Raw compass data to degrees.maxpat
Max patch 3 - Compass control centre.maxpat
Max patch 4 - Wii remote.maxpat
Max patch 5 - Nunchuck control .maxpat

pdf. Text Documentation – electronic version of current text

Videos - Video 1 - Project demonstration
Video 2 - Sound definitions and their placement within events
Video 3 - Effects example in Designer
Video 4 - Effects example in Sandbox
Video 5 - How distance parameters affect the soundscape experienced
Video 6 - Compass data into Max
Video 7 - Headphones moving Sandbox
Video 8 - Wii controlling Sandbox
Video 9 - Drip examples
Video 10 - Arena 1 walkthrough

Video 11 - Zone 2 walkthrough

Video 12 - Transitional area walkthrough

Video 13 - Proximity effect

Chapter 2

Introduction

Please begin by watching **Video 1- project demonstration** *on the DVD provided for a demonstration of the installation project.*

The artistic exploration of sound, outside its usual musical boundaries, highlights issues, including spatial and social conflicts that can struggle to establish an identity within a predominantly visually orientated art fraternity (Neuhaus, 2000; Migone, 2003; Rogerson, 2009). Preconceptions of sound presentation, in the form of music, may also provide barriers to how sound art is perceived. The V3-DSA project attempts to investigate new ways in which the use of sound as artistic expression, or 'sound art' as it has become commonly known, could use technological advancements to improve the connections made with people within the traditional art gallery framework. A 3-dimensional virtual sonic world was created as a way of exposing participants towards new ways of experiencing pieces of sound art. Investigation into the role of interactivity, as a key element to enhance participant immersion, was key to this project. This lead to the development of a head tracking system which allowed users real-time instantaneous interaction with a soundscape in a way probably never experienced before. It was hoped these interactions would promote a level of immersion that could create distinct connections with parts of our psyche, associating alternate functions to those bound to the visual. This virtual world, with its potential in worldwide communication, provides humans with possibilities to reach beyond our locality and connect through a more cerebral medium. However, Theodor Adorno (Grau, 2003) and other similar minded theorists suggested that in order to successfully reflect on a piece of artwork some kind of distance is required from that work. In regards to artwork presented within a virtual space, reflection may therefore be impossible if an individual is fully immersed within it. Installations, such as the V3-DSA, may have the potential to provide a platform for the development of a reflective language as experienced in visual art. Currently sound art lacks this due to the lack of historical base.

Several research papers exist describing the use of head tracking within virtual sonic environments (Goudeseune and Kaczmarski, 2001; Begault et al. 2001; Röeber and Masuch 2004; Mariette, 2007). However, little investigation or art work can be found investigating the use of virtual sound environments in a sound art context. The V3-DSA looks beyond traditional boundaries introducing advancements in tandem with the technological developments of our time. This technology has the ability to bring new experiences to individuals, highlighting the importance of future investigations into how the true potential of the V-3DSA can be achieved.

Chapter 3

Discussion

3.1 Sound as Art

Visual dominance in western art practices is easily observed throughout modern history. The makeup of our everyday lives, along with the manner by which we are social programmed, has us more consciously connected to sight than any other sense. This has inadvertently influenced the development of artistic intention and presupposition, implanting a rich history of literature, theory and language, alongside the entrenchment of a traditional framework for presentation. New challenges for the traditions of the art gallery have arisen due to the dynamic acceleration of modern day multimedia (Birchfield et al. 2008). More recent contemporary forms of art, including the use sound art, have caused disruption through attempts to slot this 'square peg' medium into the traditional 'round hole' visual presentation environment, developing a language which has little historical context for which to reflect on.

The categorisation of sound art has been said to loosely reside somewhere between music and noise, usually possessing neither the melodic structure of music nor the acute instability of noise (Kahn, 1999 pg.82). The analysis of the Arts Council's latest research of arts attendance in England even failed to provide a genre for sound art, assuming it to lie somewhere between 'music' or 'video/electronic art' (Bunting et al. 2008). This highlights a recognition issue for sound artists. The potential for sound saturation and leakage within a space "poses challenges to the white cube" (Migone, 2003 pg.81), and brings with it problems of containment when exhibiting alongside other artists. A recent exhibition in Manchester held this as its main subject matter, with focus upon exhibiting the sonic overlapping of individual piece's (SAM, 2010). However, it could be said that the majority of people express resistance towards the dominant imposing nature of sound in these settings. This is particularly evident within the reverberant gallery space which can often add hollowness to sound, perhaps carrying less appeal to the audience. Many sound artists propose to communicate their work through site specific colouration and character, critically discussing of sounds association with the space around. However, when presented within a visual art arena it tends to fall down, possibly reinforced by our preconceptions of how sound performance should sound.

These preconceptions have evolved through music which, again like the art gallery, has traditional proceedings and practices which still predominate today. The operation of a musical concert involves both social and spatial aspects. Sonic interactions with the surrounding structures and bodies provide a sense of location, as well as influencing interpersonal perception and social cognition, altering the way perception is processed by both the audience and performers. Brandon LaBelle (2006, ix) described sound as being "more than its apparent materiality", where it has the potential to make "privacy intensely public, and public experience distinctly personal". However an anomaly seems to exist when presenting the two within their counterpart's traditional artistic sphere, where there is an accepted osmosis from visual into the sonic world but resistance the other way round. Sound artists are subjected to pressure to conform and adapt to traditional visual artistic boundaries in order to receive the exposure that the setting brings. Neuhaus (2000) spoke of curators in the visual arts as "suddenly losing their equilibrium at the mention of the work sound". David Toop regarded sound art as being "homeless… living in limbo" (Rogerson, 2009). These statements describe sound art as searching for a home where it can feel able to fulfil its bubbling potential, gain its own identity, and discover an individual set of parameters that allow association of specific personal connections to these pieces of work. Historically popular music also carries with it a lack of discussion around the elements of sound themselves, in favour of the stability of order and rhythm. As a result when discussing a sound artist's work, translation becomes difficult as the work rarely possesses neither melody nor structure. Although sound art does not currently fit into a universal categorisation of music, or into the musical opinions of the genre's into which they have be placed, these musical preferences may act as a reference to any non-musical sounds experienced within a performance setting. This is not necessarily negative, but the sounds experienced could be so far removed from listeners predetermined ideas of how sound should be heard in this particular context, that the lack of associative language may provoke misunderstandings and dismissive reactions. But for all these contentions, this is an art form seeing an expansion of interest, all be it marginal (Sexton, 2007 pg.102), and the V3-DSA project attempts to introduce a new approach for sound artists by exploring new avenues of sound art presentation, pushing forward its popularity as a contemporary form of artistic expression.

V3-DSA has taken advantage of recent technological advances, such as laptop processing power and software development, which have opened up many intriguing, affordable options to a new wave of digital artists. It was believed that this type of exhibition could work within the traditional gallery framework, reaching an audience which would not specifically visit sound art events (see comments from Rogerson, 2009 and previous discussion of Arts Council research by Bunting et al. 2008). Visitors to such events could be exposed to a unique sound experience that would intend to connect with them in ways that sound art has previously failed to achieve. It was believed that the removal of loudspeakers, or the presence of some kind of live performance as a delivery medium, would attenuate listeners' preconceived associations. Although headphones have very been used frequently within gallery settings, the non-linear method of delivery intended to instigate new coalitions with the sonic not previously attempted.

In regards to presentation, this project aimed to investigate: i) whether the non-linear method of delivery of the 3-dimensional virtual sonic environment would be capable of providing different connections to the listener? And ii) how visitors would react to an alien sonic environment with no reference to the visual at all?

Subjective reactions were anticipated, as with any art work exhibited. All were positive; however, the presence of the project supervisor may have influenced participant feedback. Reports from participants suggested that the time spent within the virtual space was important to fully immerse oneself in the virtual environment, with around 3 to 5 minutes perceived to be a sufficient time to adapt. Those who exited after just a couple of minutes tended to provide less in-depth feedback than those who stayed in longer. Participant's feedback suggested that additional time enabled them to learn how to interact with the surrounding soundscape. Therefore to ensure the participants experienced the full potential of a virtual sonic environment they must be willing to spend an extended period of time interacting with it. Further feedback suggested that once participants crossed the initial adapting period (the first few minutes) then their perception of time passing was confused. This effect could promote longer engagement times, resulting in a more absorbing experience for the participant (Appendix A.1). The feedback left in association with the head tracking interface was again positive. The simplicity of the controls worked well allowing concentration on the soundscape itself, and this showed through reports mostly centred on the experience itself rather than the controls implemented. This could also be seen to support the idea that the interface gave such an in-depth direct connection to what was being experienced that the user failed to consciously notice its influence. The real-time binaural processing that FMOD provides it still at a very basic level, however, with the possibility of more advanced forms of binaural processing in the future this would certainly improve this control interfaces influence. By making the perception of sound in relation to actual head movement more in tune with reality, this could further emphasize the immersion felt inside the virtual.

3.2 Sonic Interactivity

As the exponential growth in communication and networked technologies has become a more poignant element of our daily lives, the role of interactivity and modern day affiliations with contemporary art has become increasingly relevant. The search for greater interaction would provide the observer with a greater connection in tandem with the prevailing technological advancements that people have steadily become accustomed to. Visual art provides many examples where user interactions have been utilised to enhance the experience of a piece of work, such as Duchamp's 'rotary glass plates' (Paul, 2003 pg.11) and Lygia Clark's 'mobius strips' (Benschop, 2008 pg.178). Experimentation with newer technologies of the 1970's and 80's, including video, telecommunications and machines (Paul, 2003 pg.18), along with recent advancements in digital-based work have also explored this field, an example being Charlotte Davis's virtual reality piece 'Osmose' (Grau, 2003 pg.193). So what makes a piece of sound art interactive? In interview, Christina Kubisch described new artist movements and "…the desire to create art which not only sits on the wall, but which instead can be a deeply personal experience" (Milani, 2009). Kubisch's work, which is centred around mobile sonic experiences of environments, is experienced through headphones which detect electromagnetic fields. This illustrates a prime example of an artist who has successfully made these interactive connections effective and immersive (Sexton, 2007 pg.95). John Cage philosophised that individual creativity and social practice detach themselves from the instigator's intentions through the use of non-musical sound, distancing the creator from their creation (Roth, 1998). This suggests that to imply interactivity one must give the impression that the user is creating their own personal experience, with little reference to the artist's embryonic intentions. This creates new avenues of exploration emerging into an infinite world that neither party can predict (Stone, 1995 pg.134).

User interactivity also has the potential to open up presently unexplored avenues for developing communication in sound art, exploiting the distinct connotations that exist between both the visual and auditory worlds. User interactivity has the potential to identify intriguing possibilities within sound art by transferring power to the user. It may also encourage cultural and social activities that traditional frameworks would struggle to promote (Stallabrass, 2003 pg.61). Several theorists such as Achim Wollscheid and Marshall McCulan hold similar views postulating a shift in contemporary culture, where art no longer looks towards the individual artist as the source of genius. However, the use of user interaction within the art world has been criticised for being subject to manipulation, claiming invalidity of artistic intention through the targeting of a niche, causing distraction from the quality of the piece itself (Baumgartel, 1999). This valid, yet slightly pessimistic view could be argued as true during the conceptual development of what interactivity and art can bring to each other. The very basic approach to interactivity, such as the pushing of a button to make a sound, clearly needs to be progressed. The technology available to artists in the present day however provides the potential to explore much greater levels of complexity. Eleven years after Baumgartel's (1999) criticism, the available computer processing power and improved usability found today ensures that complex real-time interaction is increasing feasible, but not necessarily more commonly observed. The most poignant question revolves around how this technology can best be utilised to involve the user and the learning of new approaches to tackle this. Therefore further aims of this project were to investigate: iii) how audience involvement could be an important factor in breaking through the barriers that sound art empresses. And iv) whether interactive elements of sound art presentation could utilise the unique mechanical characteristics of sound, and its direct association with distance and time, to help give it place and language?

User interactivity for the V3-DSA project was created through both head tracking and horizontal movements, which were sensed and computed by the system. This processed information delivered an instantaneous response to the participant's movements. This aimed to create a greater level of immersion than the same soundscape experienced in static conditions. The interface provided a creative tool for expression beyond that normally perceived as a fixed soundscape piece. The virtual sonic environment presented a unique experience, where participants could influence their sonic surroundings by turning their head and body. Although headphones are a usual method of experiencing music and sound, head tracking created an altered level of perception, beyond that normally expected. The combination of this with the depth of sonic potential that 3-dimensional virtual environments provide, has the potential to bring with it consequential amalgamations to yet be conceived.

The controls of V3-DSA were designed to allow the user to orchestrate their own unique sonic experience. Exploration in the horizontal plane, without visual cues, was found to be a challenge for all participants. Individuals displayed difficulty in attempts to purposely relocate sounds and escape certain areas. Although this could be interpreted as a negative by promoting annoyance or frustration, from a designer's perspective this aspect of the design was found positive as it encouraged an element of learning and investigation. Participants were found to experiment with the interactive procedures, including head movements and changing the direction they were moving in, to learn how the sonic virtual environment could be influenced. It was intended that interaction and learning would allow individuals to experience a greater sensation of immersion. This was created through the necessity of participants to focus more intently on how they influenced their environment, developing an interpersonal connection to the soundscape, rather than just passive reactions and responses.

The virtual sonic environment broke down the familiar physicality of movement, sound and space, and placed them somewhere more cerebral. This interactivity not only spans the local 'real-virtual' bridge, but also brings with it the possibilities of plugging into the global network now available to us. In such an environment, our own actions would not only affect our internal experience, but the interplay of others would also influence the surrounding soundscape. An analogy to Marshall McLuhan's theory of "collapsed distance" can be drawn, where global connections steer us to become "profoundly more involved in each other's lives" (Labelle, 2006 pg.249). Through advancing technology, such as communication over the internet, the dissemination of the physical location of sound has become a more prevalent occurrence in our lives. This could potentially instil a more powerful connection with virtual sound art, as our everyday lives become more exposed to such connections. The V3-DSA project demonstrated an artistic medium that introduced the physical to the once specifically mental. Different mental processes and responses to those experienced through traditional artistic conditions maybe experienced within such an environment. This would certainly make a strong case for one half of the interactivity model[1]. Distancing the creator from the sonic elements experienced through the V3-DSA project was a difficult task and not feasible with the software and time available. Randomisation of pitch, volume and spawn time was an effective function used to remove some of the core sound design linearity. This added interesting layers of unpredictability[2]. However, a substantial mass of the creator's essence still pertained throughout the soundscape experience.

Ideas of location loitering and proximity processing have been conceptualized for future system developments. These include:

- The length of time a participant spends within a specific area of the virtual sonic environment could trigger multiple reactions. These reactions could link sound sources in the vicinity and the passing of parameter changes could potentially flow through the entire soundscape.
- Elements, such as speed of travel, could produce corresponding sonic reactions. Faster user movements may suggest a search for more intense sounds, whereas slower movements may encourage intricate sounds requiring more intent listening.
- The introduction of networked systems that would allow more than one person, conceivably anywhere on the planet, to be simultaneously interacting with the virtual sonic space, handing a significant amount of power to the participant through a virtual sonic social network.

With just the two interface controls adopted so far, the introduction of further controls, such as buttons and sliders, largely extends the potential of this project.

Through the conceptualisation of all these possibilities a new breed of artistic expression could be created by handing predominant power to the people. This could be interpreted as

[1] As previously mentioned, that to imply interactivity, one must give the impression that the user is creating their own personal experience with little reference to the artist's embryonic intentions.
[2] A comparison can be drawn to Max Neuhaus' 1967 work '*Drive in Music*' where a variety of radio transmissions set along a stretch of highway allowed car passengers to listen to a unique set of broadcasts dependent upon their position on the road and speed of travel (Neuhaus, 1967).

diluting the divergence of individual artistic integrity that gives art its art. A more contemporary opinion would however be that we are creating a new level of artistic integrity that acts as a mergence of humanity, parallel to Marshall McCulan's claims of imploding society and the "retribalizing" of man today (LaBelle, 2006 pg.246). However distant the computer takes the experience from the fundamental artistic intent, it could still be argued that the product would never have existed without the artist, therefore providing support that the essence of the creator will always linger on.

3.3 Immersion

Immersion has always been a key derivative of art. Examples include the cave paintings and immersive sonic qualities of those spaces to early man (Blesser, 2007 pg.73), the 360-degree illusionist paintings of the renaissance period (Grau, 1999 pg.366), through to modern cinema and its ability to transfix an audience in a temporary story-stasis. As we have developed as a species our thirst for artistic interpretation has grown in parallel, helping people reflect on the world they live in. With this a hunger for 'progression' and new creative artistic methodologies logically follows. Humans have reached a point in where the exponential growth of technology has invited a plethora of artistic possibilities, including the potential for interactivity and what could be termed 'deeper immersion'. This natural desire for immersion could be interpreted as a consequence of a lack of stimulation or boredom in humans, arising from our current experiences. Everyday people's lives become saturated with rapidly evolving forms of stimulation. It could be argued that this produces de-stimulation in activities they once enjoyed, whilst also allowing less time for reflection and a desire for a greater level of stimulation.

The introduction of virtual art to the creative pool brings with it new concepts of immersion. The boundaries between the physical world and our sub-conscious become blurred as mentally we enter an alien environment that reacts to our physical actions. These experiences will have greatly enhanced subjective connotations as they delve deeper beyond the social framework that we have learned to live and react within. It could be argued that emotional connection is enhanced through this reduced material association and perspective, exploring a secular realm rarely yet discovered by the artist. Several analytical commentators, including

Theodor Adorno and Arnold Gehlen, hypothesised that a core aspect of art would be subjected to threat from this 'virtuality'. They claimed that as connections to the virtual become more natural, there becomes less aesthetic space between the observer and the observed, allowing little distance for reflection and critical consideration (Grau, 2002 pg.202-203). In response it could be argued that reflection would occur naturally after exiting the virtual and returning to the real; after all it is in human nature to reflect on and learn from our experiences. Although a deeper connection may be expected from a virtual experience, than from an experience within reality, it could be argued that this would provide a more dynamic transition back to reality and hence generate new contemplation pathways not yet explored. These new pathways could represent exciting undiscovered methods of reflection that simply could not exist without the introduction of these immersive elements. The phenomenological tradition of thought, and in particular Gadamer (Davey, 2007), who proposed that art does not provide an escape from reality, but instead provides passage to the exposure of matters within reality, with experience and subjective interpretation being of primary importance, provides support for this idea. This opens our eyes to the social constraints we live by, allowing us to stray in an alternate direction. Even though these theories were based on physical art, without accountancy for virtual immersion or the reduction of mental proximity to the experience, a strong case still stands for relative progression and our ability as human beings to adapt.

In relation to sound as art, this could this be an easier alliance to form than its visual counterpart. Whereas a piece of visual work still contains within its very existence the corporeal rules that dictate our lives, the differing levels of conscience interpretation possible through sound could provide connections that provide greater reflective distance than those in the visual domain. The introduction of virtual sound art could therefore potentially introduce a new concept of listening for people to engage with, removing them from the traditional boundaries that musical history has set. Labelle (2006 pg.211) identified the process of displacement of sound from its spatial roots as containing great authority by being "boundless, uprooted and distinct". This was a prominent response from participants of V3-DSA who described the singularity of sensual input as being a deeply immersive experience.

The nature of sound suggests a progression of time, which in turn suggests some kind of distance covered in that time. It could therefore be argued that people create subconscious physicality and boundaries that provide a gap which allows them to differentiate between experience and reality. This was a concept that emerged from the V3-DSA project, with a level of immersion that appeared to reach certain parts of the psyche than a more direct visual experience would obtain. Feedback from one participant spoke of confusion as to why the Sandbox screen wasn't visible whilst moving around the virtual space (Appendix A.1.1). Although this was a valid point, it was still felt the decision to block out all visual cues through the black tent was what helped make these connections stronger, thereby investigating experiences on a purely sonic level.

There is disturbance through the familiarity of sounds' relationship with the space it moves within. Even with complex algorithms, calculating realistic reverberation and 3-dimensional placement, the very 'humanness' of the social and physical intricacies involved still alert our innate responses to the oddities of what we are hearing. This innate response itself may open up pathways to a new level of sound exploration not yet discovered. In an environment where all the laws of physics become devoid and literally anything is possible, would a natural enforcement of aesthetic distance occur that would still give us the segregation needed to reflect? The V3-DSA environment generated interesting reactions from participants. The sound environment had triggered very subjective experiences, with feedback description's including "watery museum" and "liquid jungle" that the creator would have struggled to conceptualise (Appendix A.1.1). These comments provided support for the occurrence of post-artistic reflection. Such feedback could be attributed to the abstract nature of the piece, but alongside the unique immersion effect the V3-DSA could have the potential to trigger the investigation of less explored regions of our consciousness. Some participants were speechless on exiting, which could either suggest an inability to distance themselves, or just an inability to express into words, or to hypothesise a deeper insular reflection that sound can more easily provide due to its close association with our subconscious physicality.

Chapter 4

Methodology

Overview

The intentions of the project required software that could generate and deliver a binaural 3-dimensional virtual sonic world, which incorporated real-time changes in the surrounding landscape in tandem with user movements. The FMOD Designer sound design software, intended for use in computer game development, was utilised for its 3-dimensional, binaural capabilities and efficient sound sampling versatility. The accompanying FMOD Sandbox was selected as a presentation medium which fitted the requirements whilst also providing satisfying end results when balanced with its ease of application.

Head tracking was achieved through the use of an electronic compass sending head orientation data to Cycling 74's Max/MSP which in turn controlled orientation within the FMOD Sandbox. Horizontal movement within the 3-dimensional space was also possible through use of a Nintendo Wii remote connected through OSculator and Max/MSP.

4.1 FMOD Designer and Sandbox

The hierarchical organisation of sound events within FMOD Designer allowed systematic grouping of samples into relevant categories based on location within the Sandbox. Sound samples were placed within sound definition groups which in turn were grouped within events. Each event was represented by a sound emitter placed within the 3-dimensional Sandbox environment. Samples could be affected by properties settings within sound definition groups, by effect parameters set as part of event groups, and by the properties settings of each individual sound definition.

4.1.1 Emitter placement within the Sandbox

Events within Designer where organised into areas of application within the Sandbox. The 3 areas developed were: i) Arena 1 ii) Zone 2 iii) Transitional Area (Fig. 3.1). These areas were designed to provide a variance of experience to each area as the user travelled around the virtual space. Arena 1 and Zone 2 included specifically directed sound styles with the Transitional Area providing a more ambient, mood changing element that the user had to pass through to reach the opposite area.

The idea for the arena presentation model was developed from the desire to provide a particular area within the Sandbox where specific sounds could interact whilst avoiding intrusion into other areas (Fig. 4.1, Marker 1). The inward projection of sound created this space. However, through further testing a little sound leakage proved effective and was catered for with either an increase in the emitters distance range, or from the rear of an emitter set to project sound inwards via the events 3-D cone settings (Fig. 4.1, Marker 2).

Omni-directional emitters were also included within Arena 1(Fig. 4.1, Marker 3) as well as being the sole make-up of Zone 2 and the Transitional Area space (Fig. 4.1, Marker 4). It was felt these settings allowed a more universal blend of sounds in specific areas giving a differing dynamic to what was experienced within the Arena 1 area.

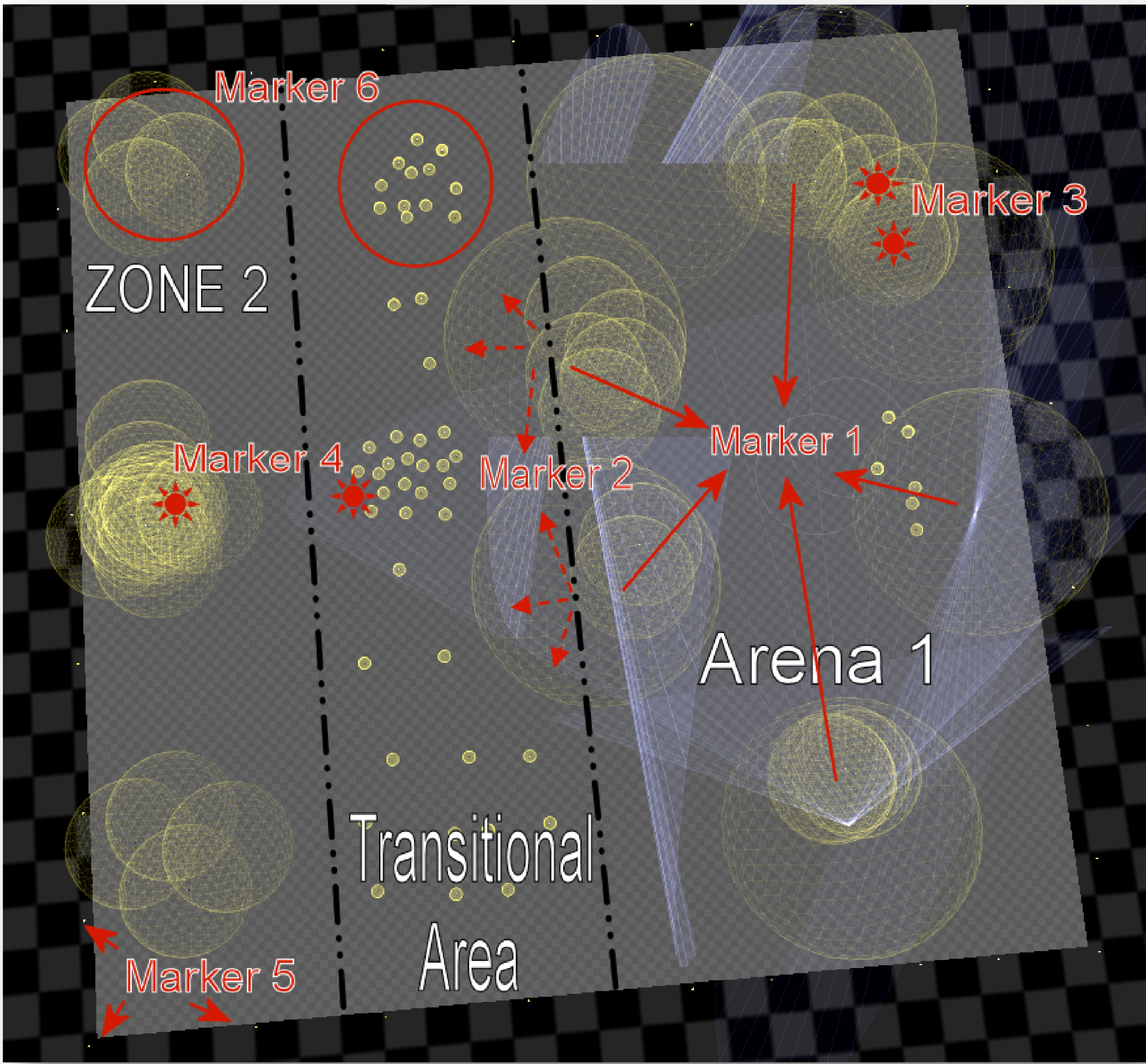
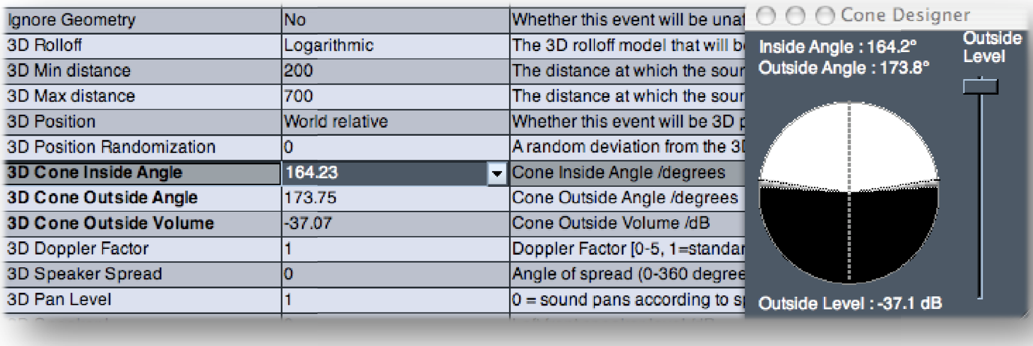


FIGURE 4.1: Sandbox screen capture, observed from above, with area divisions and markers referencing i) direction of Arena 1 perimeter 3-D cones ii) example of subtle rear leakage from 3-D cones iii) omni emitters within Arena 1 iv) omni emitters throughout Zone 2 and Transitional Area v) perimeter saw wave emitters to stop user walking off edge of space vi) clusters of omni emitters within Zone 2 and Transitional Area that complemented those around.

Around the extremes of the Sandbox, warning drones in the form of saw wave emitters told the user that they have strayed too far from the performance area and must turn back (Fig. 4.1, Marker 5).

4.1.2 Events

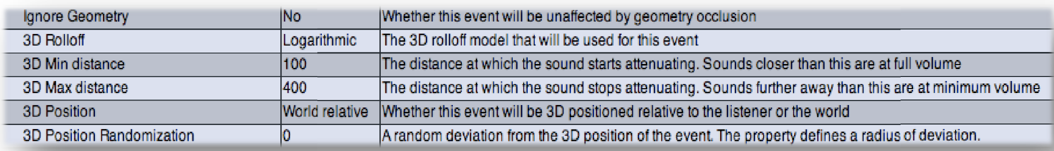
Each event had particular global properties dependent on its position and orientation within the Sandbox. The Arena 1 perimeter emitters utilised 3-D Cone Angles and distance limitation to isolate sounds towards its centre (see Fig. 4.2). The 3-D Min and Max Distance were set to limit how far the sounds could be heard in a forward direction, and 3-D Cone Outside Volume was altered according to how much sound leakage, if any, was desired from the rear.



Ignore Geometry	No	Whether this event will be unaf
3D Rolloff	Logarithmic	The 3D rolloff model that will b
3D Min distance	200	The distance at which the sour
3D Max distance	700	The distance at which the sour
3D Position	World relative	Whether this event will be 3D p
3D Position Randomization	0	A random deviation from the 3I
3D Cone Inside Angle	164.23	Cone Inside Angle /degrees
3D Cone Outside Angle	173.75	Cone Outside Angle /degrees
3D Cone Outside Volume	-37.07	Cone Outside Volume /dB
3D Doppler Factor	1	Doppler Factor [0-5, 1=standar
3D Speaker Spread	0	Angle of spread (0-360 degree
3D Pan Level	1	0 = sound pans according to s

FIGURE 4.2: An example of FMOD Designer 3-D Cone Angle settings for Arena 1 perimeter emitters. 3-D Cone Inside angle sets forward projection, 3-D Cone Outside Angle adds a small transitional stage to the 3-D Outside Volume set here to allow a small amount of rear sound leakage.

Omni-directional emitters had less explicit event properties depending upon their desired function. Those residing within Arena 1 had smaller 3-D Min and Max Distance to localise sound textures (Fig. 4.3). This was used as a baseline guide with specific tweaking of sound definition properties possible further down the hierarchy.



Ignore Geometry	No	Whether this event will be unaffected by geometry occlusion
3D Rolloff	Logarithmic	The 3D rolloff model that will be used for this event
3D Min distance	100	The distance at which the sound starts attenuating. Sounds closer than this are at full volume
3D Max distance	400	The distance at which the sound stops attenuating. Sounds further away than this are at minimum volume
3D Position	World relative	Whether this event will be 3D positioned relative to the listener or the world
3D Position Randomization	0	A random deviation from the 3D position of the event. The property defines a radius of deviation.

FIGURE 4.3: An example of FMOD Designer 3-D Min and Max Distance settings for omni-directional emitters within Arena 1, which kept sounds quite localised.

The same functionality was seen with events in both Zone 2 and the Transitional Area but with a broader range of 3-D Min and Max Distance. These short distance-from-user trigger settings provided a variety of sound textures as the emitters were navigated around. These areas also included a higher Max Playback setting as many of the same events were intended to be heard simultaneously with variations in the sound produced coming from sound definition properties further down the hierarchy (Fig. 4.4). Emitters were predominantly grouped in sound bed regions (refer back to Fig. 4.1, Marker 6) which complemented those surrounding them. This presented a less confusing experience to what had been implemented in previous trial set-ups where more mixed sonic textures had been reported to disorientate (Appendix A.1.1).

Pitch randomization units	Octaves	Units in which the pitch randomization value is specified (variations snap to units if not s
Priority	128	The priority at which the sounds in this event will be played. 0 = most important, 256 = le
Max playbacks	20	Maximum number of times this event can be played simultaneously
Max playbacks behavior	Steal oldest	If max playbacks is exceeded, use this method to steal existing events
Steal priority	10000	How important this event is in relation to other events in the project. This event will neve
Mode	3d	Whether or not this event will be positionable in 3D
Ignore Geometry	No	Whether this event will be unaffected by geometry occlusion
3D Rolloff	Logarithmic	The 3D rolloff model that will be used for this event
3D Min distance	10	The distance at which the sound starts attenuating. Sounds closer than this are at full vo
3D Max distance	500	The distance at which the sound stops attenuating. Sounds further away than this are a
3D Position	World relative	Whether this event will be 3D positioned relative to the listener or the world
3D Position Randomization	0	A random deviation from the 3D position of the event. The property defines a radius of d

FIGURE 4.4: An example of FMOD Designer 3-D Min and Max Distance settings and Max Playbacks for omni-directional emitters in Zone 2 and Transitional Area, which provided a broader range of possible sound attenuation than those found in Arena 1.

4.1.3 Sound Definitions and placement within each event

Sound definition properties were an important element to the triggering and evolution of the sounds presented. Spawn time, volume, pitch, 3-D position, number of spawned sounds to be triggered simultaneously and random selection of samples were all utilised in a variety of ways to give interesting results, whilst maintaining efficient use of the samples utilised. Their use was subjective and dependent on the dynamics of the sound samples within them, as well as how they interacted with other sounds within the virtual vicinity. This was considered the baseline of the hierarchical structure and was where the most intricate sound manipulation took place (Fig. 4.5 and **Video 2 – 'Sound definitions and their placement within events'**).

long waiver 1

Property	Value	Description
Name	long waiver 1	The name of this sound definition
Spawn time	[1, 10266]	Minimum & maximum time in milliseconds before this sound definition will repeat. Both 0 = no repeat
Maximum spawned sounds	3	Maximum number of simultaneous sounds that this sound definition will spawn
Play mode	RandomNoRepeat	How individual sounds are chosen from this sound definition
Volume	-8.09	Volume in decibels at which this sound will be played
Volume randomization	-7.62	A maximum random negative gain that will applied the sound
Pitch	-3.09	Relative pitch in octaves at which this sound will be played
Pitch randomization	0.19	A random deviation from the relative pitch, in octaves
Recalculate pitch randomization	Every spawn	When to recalculate random pitch
3D Position randomization	0	A random deviation from the parent event's position, in game units (meters/ft/etc.)
Trigger delay	[0, 0]	Minimum & maximum delay in milliseconds before this sound definition will trigger
Notes		Notes related to this sound definition

water bath fluttering

Property	Value	Description
Name	water bath fluttering	The name of this sound definition
Spawn time	[10, 18240]	Minimum & maximum time in milliseconds before this sound definition will repeat. Both 0 = no repeat
Maximum spawned sounds	5	Maximum number of simultaneous sounds that this sound definition will spawn
Play mode	Random	How individual sounds are chosen from this sound definition
Volume	-8.18	Volume in decibels at which this sound will be played
Volume randomization	-0.34	A maximum random negative gain that will applied the sound
Pitch	0.01	Relative pitch in octaves at which this sound will be played
Pitch randomization	0.48	A random deviation from the relative pitch, in octaves
Recalculate pitch randomization	Every spawn	When to recalculate random pitch
3D Position randomization	0	A random deviation from the parent event's position, in game units (meters/ft/etc.)
Trigger delay	[0, 0]	Minimum & maximum delay in milliseconds before this sound definition will trigger
Notes		Notes related to this sound definition

pan_lid_altered_long_tail

Property	Value	Description
Name	pan_lid_altered_long_tail	The name of this sound definition
Spawn time	[130, 1215]	Minimum & maximum time in milliseconds before this so...
Maximum spawned sounds	5	Maximum number of simultaneous sounds that this soun...
Play mode	Random	How individual sounds are chosen from this sound defini...
Volume	0	Volume in decibels at which this sound will be played
Volume randomization	-5.76	A maximum random negative gain that will applied the s...
Pitch	0	Relative pitch in octaves at which this sound will be played
Pitch randomization	1.61	A random deviation from the relative pitch, in octaves
Recalculate pitch randomization	Every spawn	When to recalculate random pitch
3D Position randomization	0	A random deviation from the parent event's position, in g...
Trigger delay	[0, 0]	Minimum & maximum delay in milliseconds before this s...
Notes		Notes related to this sound definition

FIGURE 4.5: A selection of sound definition properties that trigger groups of similar sound files within event groups. Variations to Spawn time, Maximum spawned sounds, Volume randomisation, Pitch randomisation and Play mode produced a variety of transformations to the resultant sound.

Layers of sound definitions were acted upon within the virtual space through parameters set to manipulate FMOD's built-in effects. These altered the sound in relation to the distance of the user from the emitter's virtual location. Effects to be controlled in this way included volume, spawn intensity, echo, tremolo and reverb with a variety of combinations which provided intriguing sonic results (Fig. 4.6 and **Video 3 – 'Effects example in Designer'** / **Video 4 – 'Effects example in Sandbox'**).

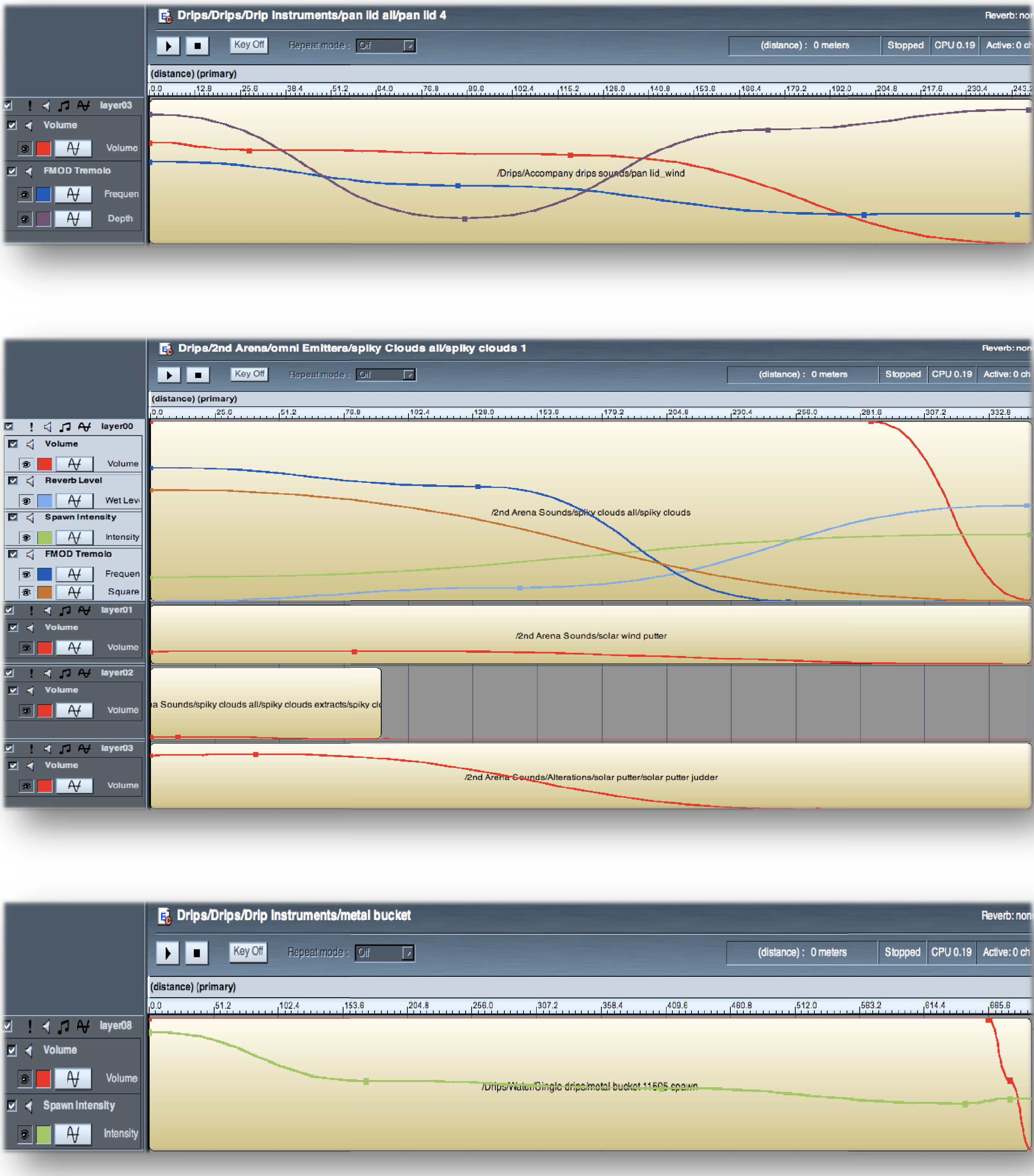


FIGURE 4.6: A selection of event groups showing the use of FMOD's built in effects. A distance parameter controlled how these effects were utilised.

Initial testing had up to 5 parameters per emitter manipulating various independent sound elements and effects via a vast array complex distance relationships and midi control assignment. This was deemed too confusing for users as the resulting cacophony of sound resulted in the loss of the 3-dimensional spatial effect intended. Because of this parameters were merged down to one distance parameter and the use of the midi controller was eventually discarded (refer to section 4.1.4).

4.1.4 Parameter Control

Linking FMOD with a compatible game engine would have provided the ideal virtual space required, however the time constraints of the project, coupled with the project supervisors' limited present knowledge within this area, lead to investigation into other methods of working around the limitations presented.

A major pathway explored was the use of a midi controller which allowed user manipulation of sounds within certain areas of the Sandbox. This pursuit identified some very interesting techniques for interface interaction with mouse-only operating software; however was this discarded for the final design in favour of simplifying the controls (Appendix A.2.1 and **Max patch 1 – 'Midi_controller'**).

Eventually all sound manipulation was obtained through the implication of distance parameters, with variations controlled by the user's corresponding distance from the source emitter. This allowed a variety of sonic interactions whilst still retaining the simplicity of head tracking and Wii remote control (refer to sections 4.2 and 4.3 and **Video 5 – 'How distance parameters affect the experience'**).

Proximity effects also became possible. These intended to provide the user with the sensation of brushing past sounds as they moved within very short distances of an emitter's source (Fig. 4.7). The proximity effects are explained in more detail in section 4.4.

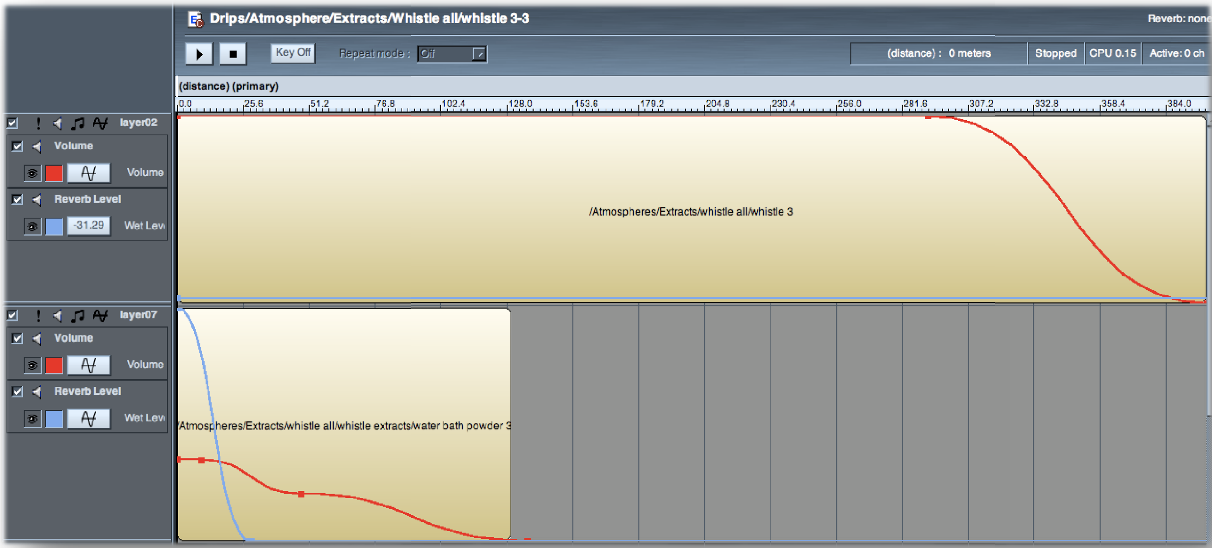


FIGURE 4.7: example of proximity effect implemented in FMOD Designer, see volume curve and reverb on lower sound definition to initiate close proximity sound

4.2 Head Tracking

Head tracking was selected as a means of orientating the user within the virtual space. This intended to provide a natural interface to increase the immersion experienced through the binaural delivery of sound through headphones. Research within this area supported the role of head movement in sound perception, suggesting that an innate reactionary response, evolved for communication and survival, provides people with the inborn ability to use their head movement to spatially position sound (Heffner and Heffner, 1992 pg.691; Fay and Popper, 2000 cited in Fay, 2005 pg.1). Studies have also indicated that the improvement of sound localisation with head movement increased virtual immersion (Thurlow and Runge, 1967 cited in Begault, 1995 pg.39). Headphones were found to improve binaural sound localization (Minnaar et al. 2001 pg.4), and front-back binaural distinction (Mariette, 2007 pg.5; Begault et al. 2001 pg.909). Deeper immersion was found to be induced through more natural forms of interface interaction (Röeber and Masuch, 2004 pg.6), and a more natural binaural experience, claimed to be "startling effective" (Goudeseune and Kaczmarski, 2001 pg.1), through head tracking

(Wightman and Kistler, 1999 cited in Begault et al. 2001 pg. 904). Even though precise sound localisation was not intended or required, it was felt that head tracking helped to increase the immersion experienced by utilising an innate, auditory associated physical movement.

4.2.1 Digital Compass

A PNI Prime 3-axis digital compass module[3] was used to acquire accurate real-time yaw orientation of the head. The module was attached to the top of a pair of Beyerdynamic DT 770 Pro headphones which were worn by the user so as to track their head movement during binaural delivery of the soundscape through the headphones (Fig. 4.8). The accuracy of the data is dramatically increased with the automatic tilt compensation function of the module. This is important in maintaining consistent reading when users unavoidably roll and pitch the compass beyond the horizontal axis with their natural head movements (see Goudeseune and Kaczmarski 2001).

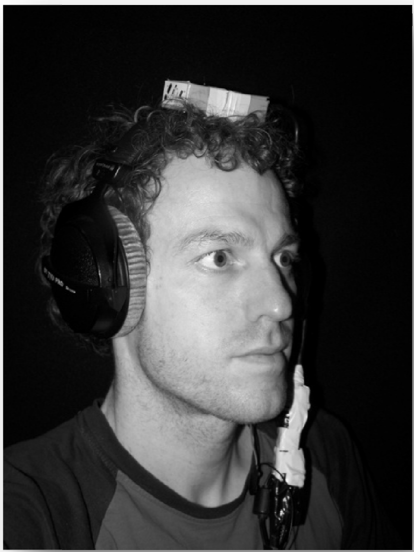


FIGURE 4.8: Participant wearing headphones with digital compass connected to top

Connection through a RS-232 serial port and USB/serial converter allowed direct real-time data transfer to Max/MSP.

[3] See http://www.pnicorp.com/products/prime accessed 14th August 2010

4.2.2 Max/MSP Patches

Due to the inability of the Prime compass software to output the real-time data required to communicate with Max/MSP, a patch was written that interpreted the raw data output, turning it into degrees of rotation to an accuracy of 0.1 degrees (**Video 6 – 'Compass data into Max'** and Appendix B.1.1 / **Max patch 2 – 'Raw compass data to degrees'**). Driver limitations for the RS-232 to USB converter lead to a necessity to utilise a Windows 7 operating system in order to take real time data from the compass. This was transferred via a Max/MSP UDP network to a Macintosh laptop which ran the rest of the software needed.

Within the Sandbox, the number of pixels moved by the mouse to rotate 90 degrees was calculated and then used as a scaling factor for the data input from the compass. The data could then be interpreted by the aka.mouse object (developed by Masayuki Akamatsu[4]) and used to accurately turn the Sandbox in sync with the users head movement (**Video 7 – 'Headphones moving Sandbox'** and Appendix B.1.2 / **Max patch 3 – 'Compass control centre'**). This method proved a worthy substitute for game engine utilisation.

4.2.3 Calibration Methods

Calibration was performed at the presentation site as per the Prime compass user manual. The test software provided compensates for all surrounding static magnetic fields that may have affected the accuracy and performance. These calibration settings were then saved as default within the module.

4.3 Wii Remote

The cross-hair thumb control of the Nintendo Wii remote was utilised to control the user's horizontal movement around the virtual space. This was selected for its ease of application to the required task, allowing free exploration of the horizontal plane through wireless

[4] http://www.iamas.ac.jp/~aka/max/

communication. The controller was connected via Bluetooth to the program OSCulator [5] which interpreted the controller's forward, backward, left and right actions, outputting these as midi data.

4.3.1 Max/MSP Patches

The data was transferred via midi to the aka.keyboard object (developed by Masayuki Akamatsu) within Max/MSP (**Video 8 – 'Wii controlling Sandbox'** and Appendix B.1.3 / **Max patch 4 – 'Wii remote'**) which in turn controlled the horizontal movement within the Sandbox.

Initial testing was conducted with the xy joystick of the nunchuck add-on controller, with its gradated data output allowing relatively realistic testing whilst the compass was still being coded for use. The Max/MSP patch written was designed to be used as a template for the receipt of compass data and functioned in much the same way as the final patch used (**Max patch 5 – 'Nunchuck control'**).

4.4 Sound Design

The sound design intended to place the user within an abstract sonic world that was both intriguing and captivating, with the intention of providing a suitable virtual environment to immerse those who experienced it. In regards to the presentation as a piece of sound art it was hoped that the environment would provoke a sense of being lost or completely removed from reality. Although some sounds evoked a sense of grounding, such as water drips, the main purpose was to place the listener on some other plane through the development of abstract sounds that gave little reference to those heard in the real world (refer to section 4.5). Watery timbre was a key ingredient, mixed with constantly evolving fast repetitive sounds and long singular textures that were hoped to place the listener somewhere else.

A distinct approach to how the sounds were designed and structured was required to be able to make them work within this unusual setting. Sound sources where designed and

[5] See http://www.osculator.net/ accessed 14th August 2010

grouped for testing, dependent upon their original makeup and how they responded to FMOD's in-built effects, within the presentation areas of the Sandbox. All sounds, within the Sandbox environment, were then meticulously examined and analysed with particular consideration to 3-dimensional placement, sound interactions, binaural effect, reverberation, sound leakage, and movement interactions.

It was hoped that all three areas (refer back to Figure 4.1) would be different enough to provide noticeable changes in the aural landscape but not so drastically different as to break any continuity felt whilst travelling around the virtual space. Arena 1 and Zone 2 could be imagined as constituent parts of a composition with the Transitional Area in between acting as a musical bridge.

The sounds were mainly processed within Camel Alchemy, chosen for the diverse range of sound processing and blending possibilities of custom recorded sound samples that it provides.

4.4.1 Arena 1

Sounds for Arena 1 were primarily sourced from studio recordings of water drips falling onto a variety of different surfaces. These included polystyrene, plastic sheeting, a pan lid, a champagne bucket, cardboard, a paint pot and a tub filled with water. From hundreds of samples each variety of drip was assessed and analysed to provide a range of up to 10 samples per variety, differing in pitch and timbre. Further intricate sound design, using the original drip sounds, was developed creating a much more interesting palate to experiment with. The palate allowed the development of additional textures which still retained characteristics of the original sound **(Video 9 – 'Drip examples')**. These sounds were decided upon as it was felt they provided a nice 3-dimensional binaural effect due to their sharp attack qualities, and textural resonances that became exaggerated through audio processing. The intention was to provide a greater amount of aural space than found within Zone 2 as well as attempting to provide the listener with a kind of association to reality, through the familiarity of water drops.

The distribution of samples around specific regions of the Arena 1 area allowed various interactions to occur between localised events, and sonic responses to real time movements within the 3-dimensional environment provided some interesting sonic results (**Video 10 – 'Arena 1 walkthrough'**).

4.4.2 Zone 2

Zone 2 also contained water based sounds but had a greater emphasis on more surging, rapidly evolving repetitive sounds, combined with moody tail-end resonances and strange alien outbursts. Other sources such as cassette tape rubbing and stones spinning on various surfaces were included in various manners. These where designed in contrast to the style of the Arena 1 sounds, whilst still attempting to retain some of the core watery qualities. Immersive feelings were aimed to be more fluid within this zone, with less fast attack sounds and greater sonic density, creating a greater floating feeling and hopefully a disparity between itself and Arena 1. These induced feelings were also intended to have a darker edge to them developing a sense of entering a dark tunnel filled with disturbing sounds. This intended to put the participant on-guard thereby promoting greater immersion.

Emitter layout was more concentrated than those in Arena 1 with a greater number of emitters all playing a variety of the same sample type. This provided a different dynamic to the sounds as they were explored. Here, it was felt that an interesting cacophony of similar sounds, varied through pitch and close proximity, gave an immersive effect through horizontal movement and orientation adjustments (**Video 11 – 'Zone 2 walkthrough'**).

4.4.2 Transitional Area

During initial experimentation, abstract samples, sourced from my personal sound library, were used as base sounds to create a substantial quantity of abstract ambience. This was intended to be used throughout the sonic environment (Appendix A.2.2). However, due to their overwhelming presence they were rigorously broken down into what eventually became the Transitional Area between Arena 1 and Zone 2. The design intentions, within this area, centred around constructing a sonic transitional area, with the development of sounds reminiscent of distant transmissions that gave a feeling of being lost somewhere in between. Within this domain the intention was to create sounds similar to lost radio-signals, picked up somewhere beyond the far reaches of our galaxy. With the receiver not quite able to tune in, but still able to just about hear a message. Brief bursts of sound from the close passing of emitters was also intended to provide a contrast, delivering almost too much signal as the odd collection of radio waves break through a gap in the cosmos (**Video 12 – 'Transitional area walkthrough'**).

4.4.3 Proximity Effect

The use of close proximity settings which triggered particular sounds when very close to an emitter was particularly prevalent across the entire Sandbox. An extra sonic layer was set to exponentially increase in volume, and decrease in reverb intensity, within very short distance boundaries. This was intended to provide a feeling of actually passing, or even touching, the sound. It was felt that these design subtleties would give the user a sonic reaction that would feel familiar inside an abstract environment which could be disorientating (**Video 13 – 'Proximity effect'**). Research has indicated that the immersion experienced can be enhanced by the use of realistic interactional sounds which represent the touching objects within a virtual environment (Corbett, 2007).

4.4.4 Reverberation

Spatialisation was achieved through the use of Designers' onboard reverb effects customised for the presentation medium. Due to the constraints of the FMOD Sandbox the same reverb was used across all sounds, in varying degrees of intensity. Distance parameters were mainly used to vary the reverb level, however not all sounds benefited from this and assessment of each individual sound was made to determine its appropriateness. Spatialisation was deemed important to increase immersion and give the user a sense of presence with the decision to use reverb (Shinn-Cunningham, 2000; Begault, 2001; Bormann, 2005). Begault (2001) suggested that the early reflection level, set at 80ms, was sufficient in producing a spatialisation effect, removing much of the 'inside the head' perception of sounds frequently reported with binaural presentation. This was implemented within the project.

4.5 Presentation and Testing

A 2 x 2 x 3 meter square tent was constructed using thick black material to completely blackout the space within, minimising any visual distractions to the auditory world being experienced. Within this tent the user would stand wearing the adapted headphones with the manoeuvrability to rotate a full 360 degrees if they so wished. A brief introduction was given to the functionality of the system, and then they were allowed to explore the space as the so wished (Fig. 4.9).

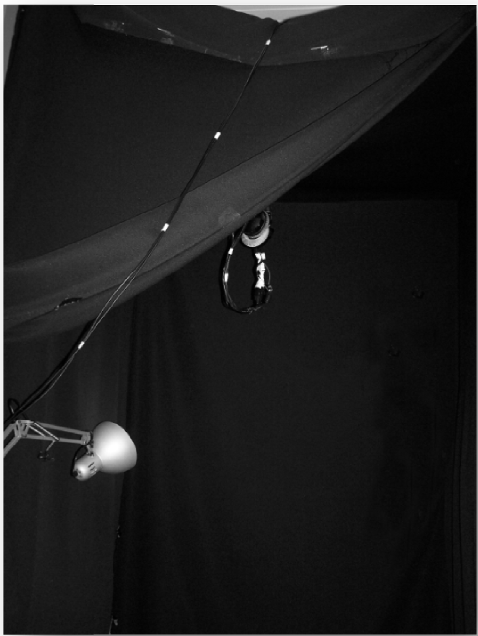


FIGURE 4.9: Black canvas tent which provided a black space for the installation presentation.

Testing was conducted with 5 subjects who were asked to explore the virtual world then fill in a questionnaire on their impartial thoughts about what they had just experienced. This feedback was used to develop the sound design further, attempting to maximise the immersive effect desired (Appendix A.1).

Chapter 5

Conclusion

The V3-DSA project has shown potential for the introduction of new ways of approaching and experiencing sound art. However this would need to be tested in the public surroundings of an art gallery space. Feedback from participants suggested that a significant level of immersion was experienced, particularly for those who remained in the virtual sonic environment for an extended period of time. The interface controls straightforward application worked well for the intended purpose, contributing to the immersion experience by allowing direct real-time interaction within the virtual environment. The soundscape design was effective in creating a non-linear environment in which participants could engross themselves and feel as if they were visiting a place far removed from reality.

Further investigation and development would enhance the V3-DSA project, opening up many interesting ways in which the device could be used. Initial alterations would include refinement of the headphone wiring, and improvement of the general presentation standards. Many interactive possibilities lie beyond the technological boundaries that V3-DSA was developed under. V3-DSA has the potential to advance through game engine utilisation. This would result in providing free-reign to an implementation of interactivity, which not only produces direct user feedback, but also the spread of a participants influence throughout the entire virtual space. Currently only one person can experience the sonic environment at once, however with further development this would increase. Without cost constraints a number of these systems could be installed with the possibility of each participant existing within the same virtual space. Ultimately, each individual's sonic interactions could influence other's experience within the space. Virtual sonic environments have the potential to spread globally, with galleries around the world becoming linked, comparable to on-line gaming communities. Advancements in real-time binaural sound processing and delivery would also provide a greater depth of sonic possibilities, conceivably providing a greater sense of spatial placement within the virtual environment.

As we enter an age where digital interaction has become a part of our everyday lives, we see our creative nature follow closely behind. Projects such as the V3-DSA could help to guide sound exploration in finding it artistic identity and place to be recognised as a popular form of artistic expression. Possible limitations of the project, identified in the discussion section, such as the problems that could arise from an inability for people to distance themselves from virtual art will still continue to be asked. However, as we become more accustomed to the technologies available and the best ways in which to creatively utilise their potential, the answers to these questions may gradually become clearer.

Appendix A

A.1 Participant Responses

A.1.1 Summary of questionnaire's completed after first testing stage.

Separate lines represent separate individual answers

1. How involved or immersed did the soundscape make you feel?

Pretty immersed... It was definitely like inhabiting a specific world; with quite clear spatial qualities as well as sonic ones.

Tracking head movements helped tremendously towards bringing the experience closer to 'real world' experiences... I felt immersed too... It all seemed very fluid and liquid, so if that was the point then you succeeded...

Immersion was made. When eyes were closed you could easily be taken to another place in your head. I even tried it with my eyes open and still had pretty much the same effect.

2. Did you feel the 3-D environment benefitted the sound or just distracted from it?

I thought it worked well. Definitely it would have been less interesting just as a soundscape that one couldn't navigate in some way. One is clearly devoting less attention specifically to the sounds themselves, but I suppose that the locations/interrelations/juxtapositions of the sounds are an important aspect of what one is expected to attend to (or, I mean, of the experience one is intended to get).

No, on the contrary I felt there was a clear 'theme' to the sonics and all the samples and textures used seemed to be emanating from the same 'world'... Nothing to me was jarring or incongruous.

Not really but my mind was constantly trying to image what was making these sounds and put images to them and when I could not image a thing making that sound it was hard to tell myself I was not in a black cloth room with head phones on. For some reason I imagined a watery museum?

3. Was there any confusion felt within the soundscape? Did you feel disorientated or unable to focus on the sounds around you?

Sometimes, or even quite often. I think this would improve if one experienced it for a while. Sometimes the focus would be more on getting one's bearings or figuring out how to navigate, than on listening to the sounds as such.
I was confused in the landscape as it was so immersive, rather like a liquid sonic jungle where after a very short time you don't know from where you came or where you are going. At points there was almost too much sound but this didn't upset my ear or make me want to stop, for me it simply meant that I should spend more time in certain spots in order to try and deconstruct slightly all the little noises that I was hearing.

There is for sure some disorientation. And I think it is normal. We as seeing humans relying so much on what we visualise. It is tough to turn it off and let our ears lead us around.

4. Did you feel the experience was interactive? Were your movements within the virtual space effective in amplifying your involvement?

I did feel that the experience on the whole was interactive, although as I mentioned when talking to you, I wasn't so sure as to why you tried to hide away the screen... but I did think that if one could have seen the 'landscape' it would have motivated me to look and move towards things that I could see in the virtual distance.

I did find it totally interactive. The controls you had set up I think are very sufficient if not totally spot on for the interactivity.

5. Any other comments?

I'd have preferred it to be more predictable. The sound "objects" seemed to move about or change identity in ways that one couldn't really follow, so the contents of the world remained on the whole unclear. I'm not sure if a longer session would have allowed this to resolve, or whether in fact this was what you intended. (Equally, one could imagine a 3D visual environment full of changing blobs of colour that might or might not be distinct objects, the same object changing or moving about, etc. -- that might be OK if one wasn't trying to understand it as a world with specific objects in it.)

A.1.2 Summary of general comments left by participants. Collected during open day exhibition of the finished project.

- Comments from those who participated for a few of minutes.

I remember a sense of unease on entering initially, not quite knowing what to expect. I thought it was fun.

Very nice, bit freaky...

As the sounds used were abstract, the setting allowed for one's imagination to work uninterrupted.

- Comments from those who stayed in beyond 5 minutes.

Floating, definitely got an impression floating. Was a very pleasant experience, like being on another planet, maybe Venus for some reason? Some quite intense moments but then you can find calm as well which was nice to just stop and listen to. Once you a tuned yourself into how the place worked you could move around and seem to make the sounds work better, I couldn't believe it when Phil said I had been in there for 25 mins!

I was trying to search for sounds that I had heard before but couldn't seem to find them again, that maybe wasn't a bad thing though. But then I would find myself returning to sounds that I kept hearing over and couldn't seem to get away from them. Wanted to make structure out of what I was hearing, maybe some musical structure. There seemed to be dynamic ranges but I was told afterwards that I hadn't explored half the space. Very good though, never done anything like this before.

You learnt to find your way around by hearing instead of hearing and you seemed to see with your ears without actually seeing anything. It was difficult to get close to sounds, would of liked for more possibly of contact. Certain sounds I found quite emotive, quite scary in parts but also quite calming in others. Easy to get caught up inside the world, I think if I had more time I would of spent a lot longer in there.

Being in the virtual environment was a strange kind of isolated immersion. The lack of visual stimuli immediately forces you to engage fully in listening to the environment around you. (Since you implemeted) Clusters of sounds became interesting and felt quite distinctly like they could possible have physical presence, the otherworldy soundscape made it interesting to explore but also put you out of your comfort zone of expectations. This is not a negative factor however and is interesting and useful on many levels-there is not much point in creating reality virtually as I can experience that anywhere!

As a compositional tool, I think it would be unfair to rate it so prematurely. I believe if someone has a certain amount of time within the sonic environment you built, they will will gain some kind of mastery over it and be able it to use it as a "practised" player.

A.2 Project Development

A.2.1 Midi Control of FMOD Sandbox parameters

The restrictions imposed by the FMOD Sandbox meant that no external control of parameter values, other than by use of the mouse, could be achieved. Without this capability it was initially felt the project would fall short of its targets by reducing the interactivity available to participants. Through the aka.mouse object in Max/MSP and specific mapping of mouse location commands, the mouse actions required for emitter selection and control where mimicked. Each emitters name tag selector and parameter control slider were analysed for corresponding x/y screen coordinates. This then allowed midi interface slider values to be assigned to corresponding parameter sliders, therefore allowing the real-time manipulation of these parameters (see **Max patch 1 – 'Midi_controller'**)

A.2.2 Initial Sound Design testing within FMOD Sandbox

Initial experimentation with placement of emitters within the 3-dimensional virtual space provided challenges as how participants could interact with these compositional elements in a meaningful and effective way. Testing began with the use of relatively large sound files that were split 3-dimensionally in relation to their spectral content. Separated into octave divisions and placed within separate emitters these spectral segments were positioned in and around a specific area of the Sandbox with the intention of maximising the 3-D binaural effect. This method proved to be ineffective, with little interest maintained or 3-dimensional effect experienced. The make-up of the soundscapes themselves appeared too long and linear to create any feeling of submersion or user participation. Even though the sounds were being delivered from a variety of different virtual locations they still failed to provide anything beyond listening to a recorded compositional piece. These trials led to the pursuit of smaller fractions of sounds to provide the spatial effect envisaged, and hence the drip recordings.

Testing within the Arena area concluded with the stripping back of the spawn rate of most sounds included. Again trials with a more full compositional sound were attempted alongside the drips to see if the combination of shorter and longer samples was any more effective. The general higher intensity and richness to the sound was found to become quite tiring to listen to and also confusing within the 3-D environment. The 3-D element was almost lost through a bombardment of sound that plagued the aural environment. The addition of head-handed effects also seemed to defer from the subtleties around, with attention being drawn to this obvious change of dynamic.

APPENDIX B

B.1 Max/MSP Code

B.1.1 Raw compass data interpreted

Raw data from digital compass processed through this Max/MSP patch on a Windows 7 operating system then transferred via updsend to a Macintosh laptop.

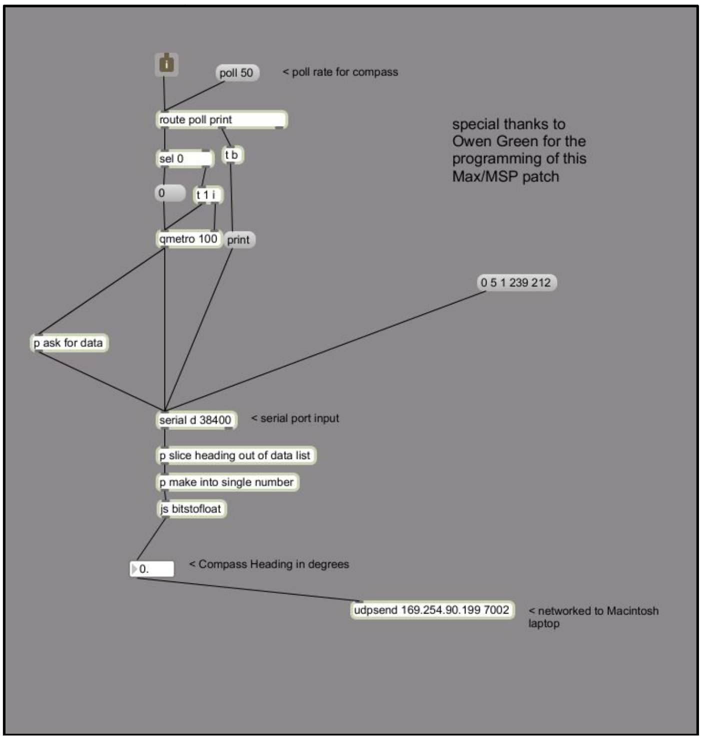


FIGURE B.1.1: Max/MSP patch used for raw compass data interpretation.

B.1.2 Compass control centre

Here compass data from the networked link is processed and sent to the aka.mouse object which then moves the sandbox in tandem with the users head movements. Within p compass › p head_tracking a midi controller with rotational dials can be connected and used to show how this works. If the FMOD sandbox is opened and the patch turned on the rotation can be roughly imitated with the rotational control. You may need to move the sandbox initially with the right mouse button pressed to allow this to start working.

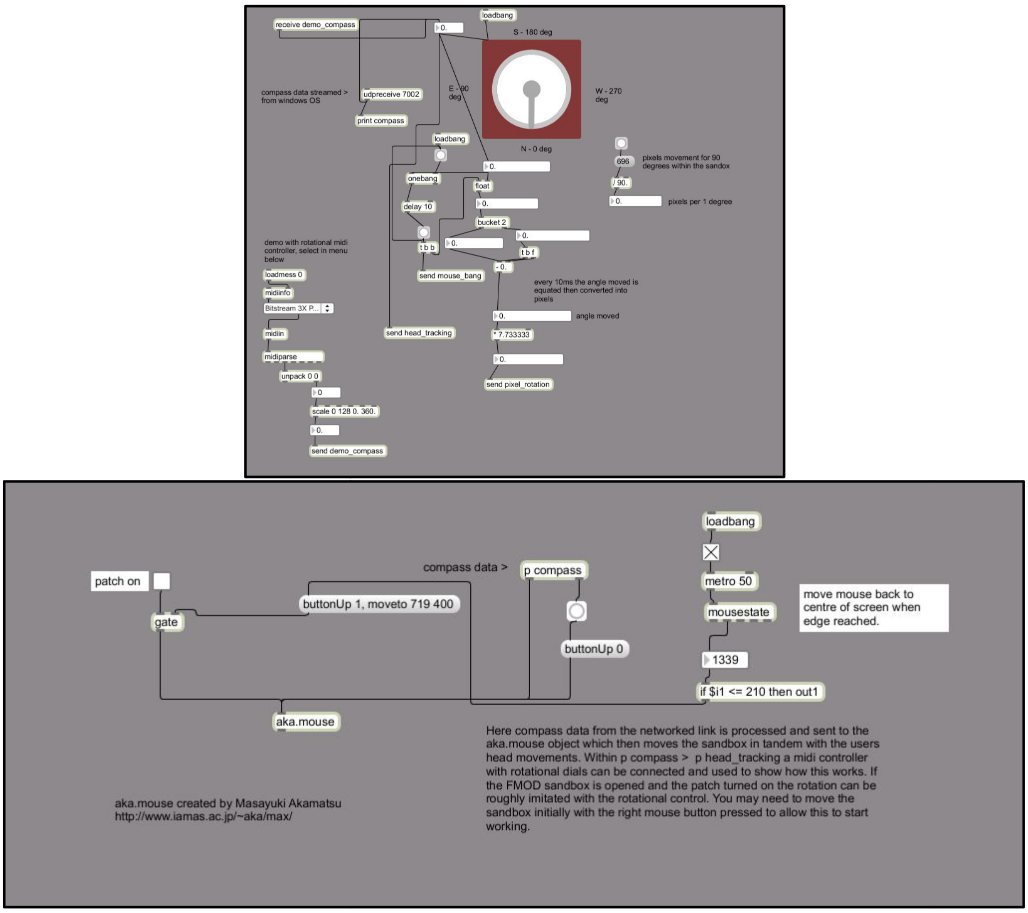
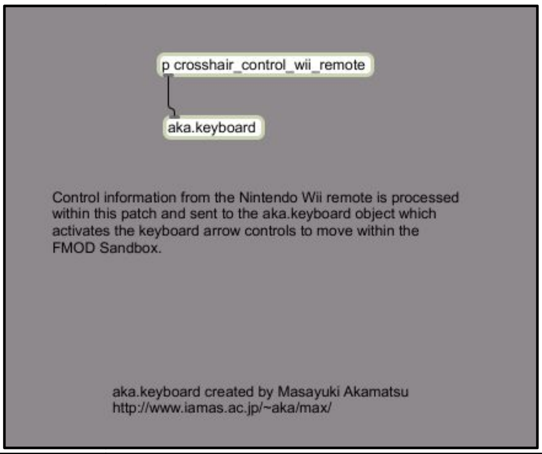


FIGURE B.1.2: Max/MSP patch for transfer of compass data into movement within the FMOD Sandbox.

B.1.3 Nintendo Wii remote operation

Control information from the Nintendo Wii remote is processed within this patch and sent to the aka.keyboard object which activates the keyboard arrow controls to move within the FMOD Sandbox.



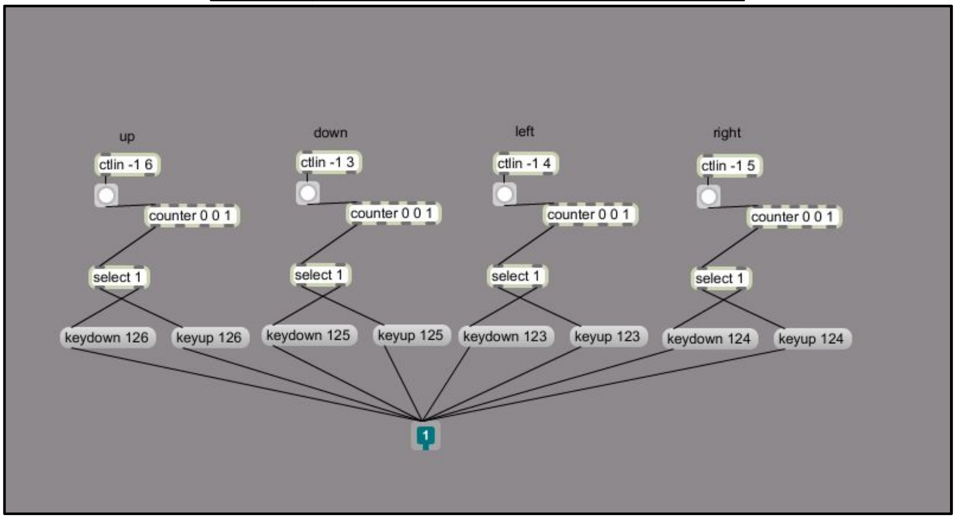


FIGURE B.1.3: Max/MSP patch for the transfer of Wii remote actions into movement within the FMOD Sandbox.

See DVD for all working patches

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