Multimodal Performance Approaches in Electronic Music

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Abstract

Within this portfolio are three pieces which explore the use of video, improvisation and noise in the performance and production of electronic music. The pieces are presented as both fixed media and videos of performances. Also included is preliminary research in the form of two smaller research projects. Video has been used in various forms either as a stimulus to improvisation and composition, as an input for sound control, or more traditionally, as an accompaniment to a composition. The use of improvisation both in the composition and performance of the pieces was also investigated. Noise was used in the composition of the pieces, recorded from field recordings, performed by live instrumentalists or generated by synthesisers. Noise is an important theme in the work and is used to bind sounds together, to create tension and release and to provide a contrast to the more traditional melodic and rhythmic structures.

This research endeavors to expand the idea of electronic music performance and explore different approaches to presenting electronic music in a live context. The aim being to break out of the paradigm of the laptop musician staring at a screen and doing little else whilst performing. For each piece I have explored a different mode of performance. For example in the piece *Aberfan* (2013) the traditional three piece band line up of guitar, percussion and bass, was mutated, creating instruments from springs, heavily distorting conventional instruments such as double bass and using improvising musicians to accompany a film.

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Song for Aberfan Ambisonic to Stereo.wav – Stereo mix derived from Ambisonic mix.

Song for Aberfan Lyons Performance.avi – Video file of *Song for Aberfan* Lyons performance (2013).

Song for Aberfan Stereo Mix – Fixed media Stereo mix of *Song for Aberfan.*

2. *Sense(or)* (folder) –

Sense(or) Max for Live Patches (folder) – Contains Max for Live patches of *Scrubber* and *Soundsculpt* patches for *Sense(or).*

Sense(or) NSCD Leeds.mov – Performance of *Sense(or)* at Northern School of Contemporary Dance, Leeds (2014).

Sense(or) Rymer Auditorium.mpg – Performance of *Sense(or)* at The Rymer Auditorium, University of York (2014).

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4. Photographs and Video (folder) –

Contains photographs and videos from production and performance of the portfolio pieces.

5. Preliminary Research (folder) –

Contains videos and audio from the piece *Transport* (2013) and research into Drum Augmentation with Physical Modeling.

<u>CD and DVDs</u>

Fixed Media Audio of *Song for Aberfan (2013), Sense(or)* (2014) and *FL00D* (2014) Audio CD.

Song for Aberfan (2013) Performances Jack Lyons Concert Hall 14th November 2013 and The Rymer Auditorium March 24th 2014 (5.1 Audio) Video DVD.

Sense(or) (2014) Performances Northern School of Contemporary Dance 13th March 2014 and The Rymer 19th May 2014 Video DVD.

FL00D (2014) 5.1 Video DVD – Fixed Media video of *FL00D* (2014) with 5.1 Audio.

FL00D (2014) Rymer Performance 23rd June 2014 5.1 DVD.

Acknowledgements

Author's Declaration

I declare that this dissertation is my own work. Presented for the degree of MA by Research at the University of York. This work has not previously been presented for an award at this, or any other, University. All sources are acknowledged as References.

The work has not been published or presented anywhere else apart from my paper Realtime Drum Augmentation with Physical Modeling (2013) which was presented at the InMusic conference in York, 2013. *FL00D* (2014) is due to be released on the label Time Released Sound (San Francisco) in early 2015 and published by 5 Missions More (London).

1. Aims

The purpose of this thesis is to provide artistic context and technical background for the multimedia pieces I have included within the portfolio.

The portfolio is included in the accompanying DVDs and USB drive.

The main ideas explored in the document are:

1. The use of video, noise and improvisation in live performance and production of electronic music.

2. How video can be used in performance as central material to a performance for example in the control of sound through motion tracking of a dancer or as a fixed part of a performance around which other, more improvisatory, materials can be arranged.

3. How live performers can be used in electronic music performance, for instance as an ensemble or a dancer creating sound through movement.

2. A Brief History of Live Electronic Music

 The following section gives an edited history of electronic music in relation to my own musical aesthetic and focus on live performance. It contains an overview of the early history of electronic music and the advancement of synthesis (Cologne School) and tape manipulation (Music Concrète). My own work takes influence from both schools, including the use of analogue synthesis and the use of found sounds, treatments of conventional instruments and the use of tape manipulation techniques, albeit within the digital domain. Sounds created for my pieces often started as live manipulation of instruments in real time using analogue or digital emulations of analogue effects, similar to those techniques used in Musique Concrète.

 I then focus on early performance of electronic music and how performances developed from the early playbacks of Stockhausen's tape music, to more involved participatory works involving images, light and dance, relevant to my own work which investigates use of video, dance and improvisation within musical pieces.

 Early electronic instruments were relatively crude, based on simple analogue synthesis to create sine waves. These included the Theremin, Ondes Marenot and Trautonium. Both the Ondes Marenot and Theremin used heterodyning oscillators based around vacuum tubes to generate pitching sine waves.

 Excepting the Telharmonium (a 200 tonne early valve synthesiser) and the later Hammond organ these instruments were monophonic and therefore really only suited to solo melodic parts in ensembles, as opposed to full solo pieces or more complex works.

 Typically these instruments would play pieces with parts written specifically for them along with traditional instruments (Holmes, 2002 : 125).

The idea that initially electronic musical instruments, such as the Theremin and Ondes Martenot, were treated as performance instruments just as a solo violin would be used is interesting. These instruments were not considered particularly experimental, or certainly were not used in an experimental way, but simply treated as new instruments. Both Varèse and Sala produced work with the Theremin. It was Varèse that stands out as creating experimental work with these instruments (Holmes, 2002: 125). Varèse's piece *Ecuatorial* contains parts written for Theremin and it makes great use of the extreme portmento possible on the instrument (Saggini, 2003: online, accessed 18 November 2014)

 However outside a small group of composers the rest of the world was slow to see the potential in electronic instruments. Varèse pushed for access to facilities to

explore electronic instrumentation. He contacted Harvey Fletcher, the director of acoustical research at Bell laboratories to request help and visited Paris in 1928 with the idea of setting up a sound synthesis studio and associated composition school (Manning, 1993: 8).

However, along with an application to Bell Laboratories for research into sound synthesis through the planning of the 'Dynaphone', Varèse was unsuccessful in his attempts to get financial backing for new electronic musical instruments. This was both unfortunate and ironic as Bell later on made many millions of dollars from the sale of Vocoders (Voice synthesisers) to the American Military (Tompkins, 2010: 60).

2.1 Tape Music

Alongside the development of new electronic musical instruments such as the Theremin and Ondes Martenot the new sound recording medium of magnetic tape was developed. The recording of music had previously been carried out on wax cylinders, disks (Edison's Diamond Disc Phonograph), magnetic wire and recordings made by cutting straight to acetate (Milner, 2009: 18).

The introduction of magnetic tape from post war Germany allowed composers to create music from recorded sound, inspiring a revolution in electronic music. Tape opened up the world of captured sound. Any sound could become 'music', a recording could be looped, manipulated and bent into tones, clusters and drones. The idea of found objects in art had become commonplace in the early 20th Century, with the likes of Picasso and Ducamp using everyday items in their painting. This new creative freedom also found its way into music with structures and complex compositional ideas entering the lexicon of classical music. However found objects within a musical context were not commonly used (Chadabe, 1997: 23).

The will to use such found objects, alongside conventional instruments, within music became prevalent in the Early 20th Century. In the production of *Parade* in 1917 Satie had attempted to use air dynamos, Morse code machines, sirens, steam engine and airplane motor amongst other items. However the technology was not present that would allow clear sound reproduction and unfortunately the typewriters could not be heard over the sound of the orchestra. Today the sounds of the objects would be sampled and played back on a sampler or a Digital Audio Workstation

(DAW) on a computer. In 1917 the only way to use these items musically was to actually have the objects 'played' in the concert hall. There was no way of reliably playing back recordings in a concert setting. However technology was to catch up with composers wanting to push the sound palette forward. Schaeffer had made experiments in Paris into found sounds using variable speed Phonographs however the phonograph recordings could not be edited.

The magnetic tape not only revolutionised recording technology, but the very creation of music itself. More so than the invention of the electronic musical instruments before it which although exotic and new, had been used to create relatively traditional music. It was magnetic tape that allowed composers such as Cage, Schaeffer, Henry and Verese to organize found sound, to create music from any sound at all.

The process of Music Concrete was both revolutionary in its technology and the very thought processes behind it. Cage broke sounds down into five different categories pitch, envelope, loudness, timber and duration. Silence had only one category, that of duration (Chadabe, 1997: 25). In this way sounds could be collected, categorized and organised. In fact Cage called for this new system to be called 'Organised Sound', instead of 'music'.

Found sounds could be captured on tape and then manipulated, slowed, sped up, cut and looped on those same tapes, whilst recordings of the manipulations on another tape deck could be made. Suddenly the studio as a single entity became an instrument in its own right, rather than a place in which a facsimile of a musical performance was generated.

Magnetic tape also allowed composers to reject the traditional method of music creation through the use of scoring and instead concentrate on sound qualities such as texture. As Cage said:

'It made one aware that there was an equivalence between space and time, because the tape you could see existed in space, whereas the sounds existed in time. That immediately changed the notation of music. We didn't have to bother with counting one-two-three-four anymore. We could if we wanted to, but we didn't have to. We could put a sound at any point in time.' (Holmes, 2002: 158)

Techniques such as splicing, crossfading, speeding up, slowing down, tape echo (which was the feedback between the replay and record heads of the tape machine), reversing and looping allowed composers to create new sounds and musical

structures from existing instruments and every day objects. Along with commercial tape machines the advent of the audio mixer allowed sounds to be combined together to create juxtapositions and blends. To this day these techniques have been one of the fundamental processes in the creation of electronic music, now known as sampling. That is the recording, playback and manipulation of recorded sound through electronic means.

 With the advent of the tape machine changing electronic music composition so drastically, so too did it change musical performance. Excepting the Theremin, previous electronic instruments such as the Ondes Martenot had been loosely based on existing keyboard based musical instruments. The Ondes Martenot had a traditional keyboard interface, although this was augmented with a ring and ribbon arrangement which allowed the player to slide the ringed index finger up and down the instruments range, giving a sound similar to the Theremin. The keyboard also gave lateral movement of individual keys giving a vibrato of a semitone below or above the pitched key (Holmes, 2002: 67). The tape machine however involved little actual performance. Rather the studio itself became the performance space.

 This idea has been taken forward by electronic musicians such as Simon Emmerson. His piece *Spirit of '76* (flute and accelerating delay, 1976) used a huge, shortening tape loop in a performance. The act of creating a tape loop in the studio has in this case become part of a live performance, as the tape loop shortens, the time between each repetition of the flute decreases.

 To create tape music sounds would be cued up on tape machines and a master mix could be generated through the mixing process. This might involve several people creating a mix together operating tape machines, effects and mixers, much the same way an ensemble may co-ordinate to create music together, so composers and technicians created recordings of these studio 'performances'.

With the advent of tape however, electronic music then became something that was made in the studio and presented, in the main, as a finished product in a concert setting. At the time synthesisers, tape machines and the associated equipment were incredibly bulky and setting up for concerts was a laborious process.

 A photograph of the WDR studio for Electronic Music in Cologne in 1966 around the time when Stockhausen was composing *Hymnen* shows many different items of equipment. These include a 4-track tape recorder, mixing console, mono tape recorder, Springer with rotating heads for suspending sounds, board with 6 roller guides for long tape loops, switching board with 3 sliding faders sound meter, large

stop watch, second mono tape recorder, 9-octave filter, 2 Albis filters and portable Telefunken M5 tape recorder (Holmes, 2002: 102).

Hymnen was unique at the time, consisting of sampled national anthems from countries around the world, these were then manipulated using the process of 'intermodulation', superimposing one characteristic of a sound, for instance amplitude, onto another (Chadabe, 1997: 41).

His earlier work *Gesang der Junlinge* was unique at the time and stands out as going against both the Cologne and Paris 'schools' of electronic composition. These two theoretical schools of thought were pitched against each other and each studio (The WDR studio in Cologne and the GRM studio in Paris) stuck vehemently to their theoretical principles. The Cologne school adhering to the idea of creating music from electronic tones generated from oscillators and connecting them to the musical elements of serialism. The Paris school basing its principles on Schaeffer's and other composers' Music Concrète (Wolf, 2013: online, accessed 4 December 2014). Stockhausen's piece used acoustic recordings of a choir boy (Paris school) mixed with the traditionally electronic tones of the WDR studio. The choir and electronic timbres were fused together, as opposed to the typical juxtaposition. (Holmes, 2002: 138). According to Holmes this marked the end of the first period of tape composition, a mature long form piece which breaks out of the mold of repetition and instead uses evolving sounds, dynamics and timbres which are unrecognisable from their original sources.

2.2 Into the Live Realm

Stockhausen took his machines from the studio and into the concert hall and would 'perform' using the tape machines to play pieces back to the audience, although he would later build on this simple performance format. However his early methods of presenting finished work underestimated the demands of the audience. Audiences require interaction and an understanding of the processes at work. Boulez and other artists understood this and strove to create live electronic music in front of an audience either through the manipulation of instrumentalist or vocalist.

Early Notable works include Cage's *Imaginary Landscape No.1* (1939) featuring two variable-speed phonograph turntables and sine-tone recordings. Pierre Schaeffer attempted live generation of his works of musique concrète in 1951. The 1950s and 60s however saw the transition of studio techniques to the live stage. Mauricio

Kagel's *Transcion II* (1959) combined two tape recorders for live manipulation of the sounds of piano and percussion. Beginning in 1964 Karlheinz Stockhausen entered on a period of intensive work using live electronics with three works, using the microphone as an instrument to pick up otherwise unheard sounds, *Mikrophonie I* and *Mixtur* (both 1964), and *Mikrophonie II* (Manning, 2013: 157–58). While earlier live-electronic compositions, such as Cage's *Cartridge Music* (1960), had mainly employed amplification, Stockhausen's innovation was to add electronic transformation through filtering, which erased the distinction between instrumental and electronic music (Toop, 2002: 495).

In considering what is meant by the term 'Live Electronic Music' Emmerson states the difference between Live and Mixed as being:

'In English the term 'live electronic music' has often meant both music produced and performed through real-time electroacoustic activity of some kind and music which combined live performers and fixed electroacoustic sound ('tape'). In French the former is now known as using *traitements en temps* réel. But this has never superseded the phrase musique mixte which had earlier come to be used for any music combining live performers with music on tape (or better in French, sur support). But, unlike the English equivalent, the French usage of temps reel extends to studio processes. Thus at the GRM in Paris the 'Syter' (Systeme temps reel) was developed as a tool that processed sound in real-time in response to gestural and other control inputs. It was used in both studio and live concert systems.' (Emmerson, 2007: 104)

So we can see that there is a difference between music that is performed with real time electronics (audio manipulation using filters, reverb, tape delays and synthesis) and live performers playing instruments along to a fixed element (tape) to it. The 'tape' part of the performance can be problematic as it is set at a fixed structure and tempo, either recorded onto a CD or more often nowadays, a hard drive played back via a computer. The musicians must play along to the piece and have no influence on the fixed media. They are not completely free to improvise, slow down or speed up. There is still a performance and the instruments are played live but adhering to this fixed medium can stilt the music and performance itself.

Much research has been done into music performance systems which do follow the performer however, the 'hyperbow' being one such example (Nunn, Young, Vassiliev, 2006). These systems can follow musical gestures using sensors and

change parameters of the music accordingly, either triggering samples or applying digital signal processing to the instrument in real time.

However, even though these interactive systems exist and are used widely, many pieces performed today in academia and music institutions use fixed media, sometimes out of practicality but also because it is an accepted method of performance. Examples of fixed tape pieces include Edgard Varese's *Deserts* (1950-54) and Boulez's *Poésie pour pouvoir* (1958). In these pieces ensembles of acoustic musicians play along to a tape accompaniment of music and sounds created in an electronic studio.

It should be noted that Boulez was less than happy with both the fixed nature and low fidelity of the tape accompaniment to his piece and the restrictions playing to a fixed medium imposed on the performance (Carvin, online: accessed 10 December 2014). For these reasons he returned to electronics later on in his career, but with added impetus to work with live sound manipulation.

He discussed with French President, Georges Pompidou the possibility of creating an institute for the exploration and development of modern music. This was to become the IRCAM (Institut de Recherche et Coordination Acoustique/Musique) Institute in Paris.

At IRCAM Boulez gathered the best musicians and technologists and created works such as *Rèpon* which used computers to capture the resonance and spatialisation of sounds created by the ensemble and processed them in real time. Boulez had taken the ideas and techniques of electro-acoustic music traditionally being made on tapes in the studio into the live arena. This is an important landmark for electronic music performance and paved the way for many electroacoustic musicians today.

Earlier to these developments, Pierre Schaeffer had a desire for a performance instrument, which could be described as a phonograph based sampler:

'23 April [1948] … Let there be an organ of which the stops each correspond to a disc player of which one would furnish the fitted turntable at will; let us suppose that the keyboard of this organ sets the pickups into action simultaneously or successively, instantly and for the duration that one wants… one obtains, theoretically, an enormous instrument capable not only of replacing all existing instruments, but of every conceivable instrument, musical or not, of which the notes do or do not correspond to the pitches given in the range' (Schaeffer, 1952: 15-16)

Schaffer has described both the early Mellotron instrument (which used multiple magnetic tape as a sound source for each key) and the modern day sampler, even including a description of key grouping (mapping keys to different groups of sound samples) some years before these instruments were invented and which all modern electronic musicians take for granted.

Richard James in his interview on Radio 3's 'Mixing It', whilst expressing an interest, denied any direct influence from the early music pioneers such as Cage or Stockhausen on modern day techno musicians. (1995: online accessed 18 May 2015).

However, this denial of influence is misleading. James is well known for his obsession with musical equipment, particularly obsolete and rare synthesisers and effects units (Noyze, 2014: online accessed 11 December 2014). The obsession and quest for new sounds is something he shares with composers such as Cage and Boulez. The modernist approach, to kick out the old and bring in the new, is found in both Cage and James' music, as it is with many other modern contemporary electronic musicians. To start again however is impossible, we are surrounded by music and other influences that stretch long into the past. Sounds can now be easily made and manipulate on computers using software freely available on the internet. Particular sounds such as the 'Amen break', 'The Hoover 'and 'Wobble' are used throughout dance music and electronica as cultural signifiers. It is easy to fall back on clichés and take the easy route with modern technology. Therefore, in order to create something new I looked back to see how the original electronic composers created sounds, using fundamental principles, analogue technology, bending and hitting objects, recording acoustic instruments and capturing soundscapes, both natural and urban. With these principles, based loosely around the two schools of electroacoustic music, and by defining a set of parameters, musical, rather than technical choices can be made. That is there are less technical choice to be made when generating sounds, leaving space to make musical decisions This attention to method is shared by both electroacoustic music and contemporary electronica. Many modern electronica musicians (including James himself) highlight the importance of method in order that they can limit the scope of their work; for example, using only one piece of equipment for a whole piece, The Tuss 'Fenix Funk 5' (2007) . However there is of course, some distance and perhaps no lack of snobbery between the two schools. Stockhausen famously denounced Aphex Twin's music :

'I heard the piece Aphex Twin of Richard James carefully: I think it would be very helpful if he listens to my work Song Of The Youth, which is electronic music, and a young boy's voice singing with himself. Because he would then immediately stop with all these post-African repetitions, and he would look for changing tempi and changing rhythms, and he would not allow to repeat any rhythm if it were varied to some extent and if it did not have a direction in its sequence of variations.'
(1995: online, accessed 18 May 2015).

However James was less disparaging of Stockhausen in return, perhaps in deference to the composer he said of Stockhausen's Song of Youth :
'Mental! I've heard that song before; I like it. I didn't agree with him. I thought he should listen to a couple of tracks of mine: "Didgeridoo", then he'd stop making abstract, random patterns you can't dance to. Do you reckon he can dance? You could dance to Song of the Youth, but it hasn't got a groove in it, there's no bassline. I know it was probably made in the 50s, but I've got plenty of wicked percussion records made in the 50s that are awesome to dance to. And they've got basslines. I could remix it: I don't know about making it better; I wouldn't want to make it into a dance version, but I could probably make it a bit more anally technical. But I'm sure he could these days, because tape is really slow. I used to do things like that with tape, but it does take forever, and I'd never do anything like that again with tape. Once you've got your computer sorted out, it pisses all over stuff like that, you can do stuff so fast. It has a different sound, but a bit more anal.'
(1995: online, accessed 18 May 2015).

These two composers talking about each other's music with some fifty years between compositions is revealing. It shows that even though they disagree about fundamentals, they are still listening to the music and dissecting its structures, critical to any electronic musician's skillset. However both artist's motivations are very different. Stockhausen's music set out to reject and disrupt what had come before it , he was strictly modernist in approach. James has always made music for himself to enjoy and listen, reluctantly releasing music whenever he is contractually obliged. However both composers share the use of technology at a very intricate detailed level in the creation of new sounds, structures and the realisation of new ideas.

Here is a screen shot of a modern day software based sampler that I use in my own compositions:
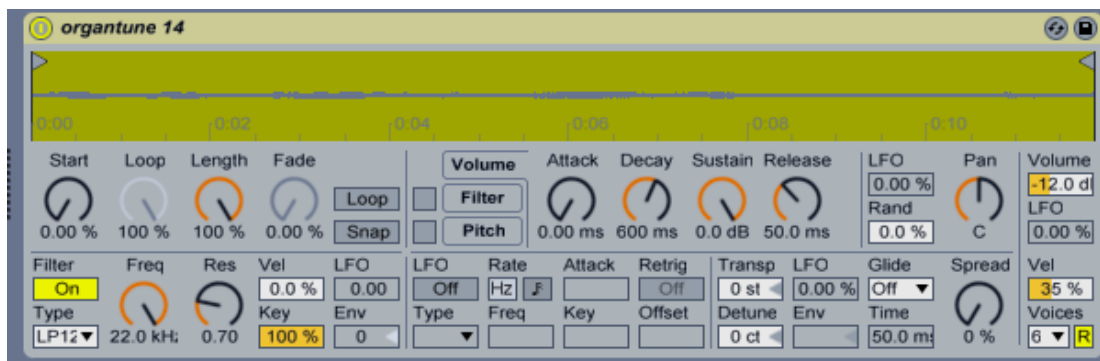

Figure 1 Screen shot of the Ableton Live's Sampler (known as 'Simpler') . Note the high level of control over length of loop, envelopes, lfo, pitch and filters.

 The above screen shot shows the detail and amount of control a modern software sampler has over individual sounds, the modern day equivalent of Schaffer's theoretical disk based system. Individual samples can be shaped very easily using ADSR envelopes (Attack Decay Sustain Release), Multimode (High, Low and Band pass) Filters to control timbre and LFOs (Low Frequency Oscillators) to modulate pitch, panning, filtering and amplitude. The sampler is very easy to use, using a drag and drop interface to bring sounds into the software and can be easily controlled using external MIDI controllers, quickly assigning faders and knobs to the software's controls.

 Emmerson discusses Schaefer's perception of the studio as instrument: 'In this view the studio is a huge instrument (l'instrument de musique le plus general qui soit) (Schaeffer, 1952: 15-16). In effect one rehearses actions which produce the right perceptions. The finished work instantiates an idealized performance – only one which did not happen at one particular time.' (Emmerson, 2007: 25)

 The sum total of studio equipment as a single, playable instrument is an interesting idea and which has really come to reign in today's world of the laptop musician. The idea that a performance can be generated from the manipulation of audio, whether live or pre-recorded and the gestures and movements be interpreted as performance is worth pursuing.

Hugill describes such performances using the catch all term 'electronica'. He says the word refers to electronic dance music and has widened to include more experimental electronic music, furthered by the convenience of laptop computers and fall in the price of music technology for example; groove boxes and portable samplers (Korg's Electribe series). Electronica music has a thriving culture based around clubs, venues and a strong online presence, with websites such as the EM411 website and We Are The Music Makers website providing a forum for electronic musicians to discuss new releases and DIY electronic music making.

In recent years this culture has advanced with the formation of many electronica festivals such as 'STFU' (STFU website), a European wide touring festival and 'CTM' (CTM website) based in Berlin. It is interesting to note that both STFU and CTM are now not exclusively based around laptop or electronica performances, and have broadened their remit to include a wide variety experimental music (sometimes not involving electronics at all) and often involve workshops, discussions and film showings.

This 'liveness' and improvisation using audio software (such as Ableton Live and Max/MSP) in front of an audience is also taken up by Emmerson, he talks about DJing but it could just as accurately describe the actions of a laptop musician:

'While the DJ does not produce the sound in a mechanical sense, their highly coordinated actions must synchronize, launch, cross-fade and mix a variety of sources.' (Emmerson, 2007: 112).

The difference between MIDI (Music Instrument Digital Interface) and digital audio are worth mentioning here. MIDI is a control protocol to control instruments such as samplers, synthesisers and computer software patches, such as those created with Max/MSP or software instruments such as the Korg Legacy collection of vintage synthesizer emulations (Wavestation, MS-20 and Mono-Poly). Laptop musicians use MIDI controllers such as the Korg 'Nano Kontrol' and Novation 'Launchpad' to control Ableton and other performance software. MIDI messages such as 'note on' and 'note off' are sent to hardware or software and the corresponding notes are played by the instrument or software in question. When using a MIDI controller such as the Nano Kontrol it is possible to program 'scenes' and have each knob, button and fader output different MIDI commands such as CC (Control Change) messages for controlling filter parameters, MIDI notes and program change messages. MIDI can even be used to control lighting, video software and mechanical acoustic instruments (See 3.4 Bjork - Biophilia).

Digital audio on the other hand is also a form of digital data, stored as a series of zeros and ones on a hard disk or solid state drive. The data could be recordings of instruments, voices, or anything at all. Audio signals are sampled using an Analogue to Digital Convertor (ADC), usually built into an audio interface connected to a computer. The signal is encoded using Pulse-Code Modulation (PCM). Whilst in the digital domain previously complex manipulations, such as time stretching (lengthening or shortening a piece of audio without changing pitch), can be performed easily. Even the simple task of editing is made far simpler and quicker by using editing tools rather than cutting and splicing tape. Digital audio is played back using a Digital to Analogue Convertor (DAC) again usually contained within an audio interface.

Digital audio can be triggered in a sampler using MIDI, played back on a timeline in a Digital Audio Workstation (DAW) or as loops in software such as Ableton. Ableton has in its own way revolutionised the performance of live electronic music, freeing up musicians from using timelines and working along the lines of improvisational instruments and pattern based samplers such as the Roger Linn designed Akai MPC (Music Production Centre).

Ableton's session view allows clips (patterns of MIDI or digital audio samples) to be quickly laid out in a grid. In combination with a MIDI controller such as Ableton's own 'Push' or Novation's 'Launchpad', improvisation using clips as building blocks for a live performance set is very intuitive and leads to many creative new arrangements and 'happy accidents'. Sets can be made up of carefully arranged songs whilst new loops, MIDI sequences and audio clips can be dropped in and beat matched in real time. Even effects such as reverbs and delays can be dropped onto channels whilst the set is running, without any audio interruption. This 'workflow' allows the musician to perform and improvise live with the software whereas previous DAWs would not allow such improvisation, instead relying on a linear timeline, where clips of audio data are played in a linear stream.

Figure 2 A live techno set laid out in Ableton Live 9. The columns represent each group of sounds – drums, percussion, fx, bass, pads and leads. The rows represent different parts for each instrument (e.g. verse, breakdown). Note the rack of effects on the master bus along the bottom row including Beat-Repeat and Buffer Shuffler.

2.3 Electronic Music Improvisation

Improvisation has been a big part of electronic music performance, as seen in groups such as The San Francisco Tape Orchestra. Cage and Tudor performed with the Merce Cunningham Dance Company and many improvisational groups such as AMM and guitarist Keith Rowe performed improvisations with live electronics. (Holmes, 2002: 245). The advances in music technology such as powerful laptops, compact MIDI controllers, and real time audio processing environments such as Max/MSP has allowed new subcultures of music based around live electronic performance. IDM, Glitch, micro-sound, techno and electro all feature a thriving live performance culture. There are some genres of electronic music that have less of a focus on live performance – these include house which is traditionally based around DJ culture and playing vinyl records - however with the advent of low cost computers and software such as Ableton live house sets are becoming more common. From glitch artists such as Tim Exile, who utilises custom made Reaktor software patches, to techno artists such as Orbital, who rely almost entirely on sequenced analogue hardware, live electronic musicians are free to improvise and create music in front of an audience.

'Improvisation defies clear definition. Even though most musicians have difficulty explaining what it is, many can tell you the basic way that they approach it. Unlike jazz, which often deals with improvisatory rules in a kind of game-like exchange of rhythm, harmony, and melody that many jazz musicians rely on. Instead, electronic music improvisation is largely based on the spontaneous modification of non-pitched aspects of sound: the shape of the envelope; timbre; rhythm; layers of filtering; effects (echo, delay ring modulation etc); amplitude; and duration. A seasoned improviser learns how to listen to many layers of sound activity as part of a performance.' (Holmes, 2002: 240)

Electronic music practitioners, in parallel with Jazz and other improvised music, have embraced improvisation, with musicians performing music in front of audiences both large and small, from small experimental laptop performances at improvised noise shows in the back of clubs to musicians such as Squarepusher (Tom Jenkinson) who take live electronic performance to large scale arenas and festivals and perform large synchronised audio visual sets.

2.4 Live Coding

Live coding is a fairly recent development, having become popular in the last ten years, and consists of performers entering lines of code into custom software to produce music live in front of an audience. Often video and audio are combined with performers improvising musical gestures by inputting code projected on a screen in front of an audience.

Live Coding has a respectable following and is very popular across Europe where it has the largest number of Live Coding performers with regular events such as 'Algorave' being put on in cities throughout the UK and Europe (Algorave website 2014: online, accessed 5 December 2014).

The idea of live coding is to start from nothing and create music in front of an audience. There are various manifestos (Toplap website 2014: online, accessed 5 December 2014) associated with the genre mostly aligned with the philosophy of openness and transparency, something it shares with the open source software movement. Many strains of live coding software have been produced by the community, all of which are released as Open-source code allowing the software to

be hacked and adapted. Notable releases include Chuck and Sonic Pi (website, 2014: online, accessed 21 December 2014).

  Although Live Coding is in its infancy there are problems inherent in the performances. Because the performers often start out with no planned musical structures or code in place, it takes time for the performer to create something that could be heard as music. In the author's experience audiences are left waiting some time for the music to actually begin properly. Due to the nature of live coding, changes in arrangement and timbre are made slowly, with the music emerging and coming together only after the initial patterns have been created. However the performances are educational, the fact that changes to the code are projected allows the audience to see the music being created in front of them.

3. The multimodal approach to live electronic music

 Many different artists and musicians have been inspired by or taken a similar approach to Boulez towards creating a performance on stage since the 1970s. This section will look at some of these and how they have incorporated other art forms into their work to create multimodal live performances.

 Many of today's artists employ multimodal performance productions in their work. The following looks at some who have been influential in my own work and who are worthy of closer examination. These artists are not necessarily exclusively electronic in the musical tools they use, but take as many influences from other art forms and include it in their musical work.

3.1 Early Adopters

 'Everyone's attention went away from the *Williams Mix* to the piano tuner because he was *live.'* (Holmes, 2012: 412)

 Cage was perhaps the earliest adopter of taking electronic music into the live arena and creating dynamic performances that laid bare the processes forming the sounds. *Cartridge Music* (1960) used contact microphones and phonograph pickups applied to chairs, tables, wastebaskets, toothpicks, matches, slinkies, piano wires and feathers. (Chadabe, 1997: 81)

 The open ended scoring system that Cage adopted allowed him to structure his performances to incorporate other artists and musicians. In *Variations V* (1965), Cage wanted to explore if sound could be affected by the movement of dancers. The piece was performed by the Merce Cunningham Dance Company on 23 July, 1965 at Lincoln Centre in New York. As well as the music composed by Cage and several other composers including David Tudor there were also films by Stan VanderBeek and video images by Nam June Paik. Robert Moog built twelve modified Theremins placed on the stage. The dancers would interact with several poles placed around the space triggering sounds, photoelectric cells at the bases of the poles also triggered sounds. Exactly what sounds the dancers triggered was controlled by musicians and technicians using tape machines, oscillators and shortwave radios. Found objects were also used as sound generators – a plant, a pillow, a pad, a table and two chairs all with contact microphones attached which produced sound when moved by the dancers. The finale consisted of Merce Cunningham riding around the venue on a bicycle with wheels wired for sound.

With *Variations V*, Cage took electronic performance and combined it with other art forms – namely dance and film. Introducing the idea of interactivity with dancers and allowing them to (partially) control parameters of sound. The addition of live instruments in the form of oscillators and radios opens up the piece to Cage's themes of chaos and chance occurrence in his music.

Outside of Europe, America proved a fertile ground for new ideas on how to perform electronic music. San Francisco had a particularly active scene based around the Tape Music Centre, which was based in an old house that was due to be demolished.

An early performance as part of their 'Sonics' concert series was called *Smell Opera with Found Tape* (1962). The piece involved a found tape that had been sealed and brought to the concert. The audience was sprayed with different scents as the tape was unsealed and played out. The piece was unpopular with critics but could be seen as another example of experimentation with multimodal performance, with scent being included in the list of senses being used in the performance. More performances were to come with a six-day festival entitled 'TudorFest' featuring *Duo for Accordion, Bandoneon and Possible Mynah Bird Obbligato Seesaw Version*. In this piece the mynah bird was suspended above a spinning seesaw, again showing the imaginative performance ideas the group had. (Chadabe 1997: 86)

For *Martin's Room* (1968), a collaboration between Subtonick, Oliveros, Sender and Martin, 'combined projections included hand-painted and overlaid slides, sixteen-millimeter films, and improvisations involving the manipulation of liquids and various objects on the transparencies of overhead projectors.'
(Chadabe 1997: 88)

1961 saw the start of the production of the Once festivals in Ann Arbor, Michigan. These became increasingly ambitious with Gordon Mumma's piece *Megaton for Wm. Burroughs* (1964) consisting of six synchronized channels of taped sound, and long steel wires which supported objects flying through the performance area. The Once Festival contained many different art forms – including performance art, dance, theatre and film and even opera in the form of Mary Ashley's piece *That Morning Thing* (1967).

We see that the 1960s, along with the revolution in pop music production, also saw a performance revolution with the combination of various art forms such as film and dance combined with electronic music to create multimedia shows and spectacles.

3.2 Xenakis' Polytopes

Xenakis, a trained engineer, started working on computation and design for Le Corbusier's workshop in Paris. It was here he started research into light and shadow play, the adoption of musical and mathematical motives and scores as ornamentation and structural experimentation (Socks Studio Website, 2014: online accessed 9 December 2014).

His design for the Philips Pavilion at Expo '58 in Brussels combined nine hyperbolic paraboloids (mathematically derived curving structures) into which Edgar Varèse's *Poème électonique* (1958) was spatialised using speakers positioned throughout the structure.

Xanakis continued his experimentation with the combination of architectural and modern electronic music producing a series of Polytopes which combined music, light and physical structures that engulfed the spectators on entering the structures and provided a mixed sensory experience.

The *Polytope de Montréal* (1967), a media installation in the French Pavilion, combined sculpture, light show and a musical composition. The light sculpture consisted of cables stretching in a geometric pattern throughout the atrium of the building, to which 1,200 flashbulbs created large volumes of light which, whilst flashing at the rate of $1/25^{th}$ of a second, appeared to be one continuous movement.

Xanakis' take on multi-modal performance sees the very performance structure being created especially to maximise the impact on spectator. The musical, structural and visual aesthetic forming one whole experience. Xanakis' early adoption of techniques such as spacialisation of material across multiple speakers is also worthy of note. Stockhausen too had conceived of the need for a 'spherical chamber fitted all around with loud speakers… a platform, transparent to both light and sound …' (Stockhausen, 1959: 59)

This was realized in his pieces written for the German pavilion at Expo '70 in Osaka, Japan. 50 loudspeakers arranged in seven circles (with three rows beneath the audience) reproduced his work. He was able to move sound around using a potentiometer that produced a variety of rotation shapes and even a spiral motion (Emmerson, 2007: 158).

Both composers saw the need to take their music from the usual format of speakers in front of the audience to surround the audience with the music and to design their pieces and sound reproduction systems for specific venues.

3.3 Sun Ra and The OVC

An early example of the combination of cutting edge video technology and live music performance was the use of the OVC (Outer Visual Communicator) for Sun Ra Arkestra's performances in the late 1970s. The OVC was a video synthesiser, developed by Bill Sebastian, after having seen an Arkestra performance in Boston (Tompkins, 2011: 104).

The large hexagon shaped machine, 16 feet in length, was controlled by an array of touch sensitive keys and pedals which allowed the controller to paint onto the screen and electronically and optically manipulate patterns of light. The OVC operated in very low light levels (the scotoptic range) during concerts, taking advantage of the brains ability to create optical hallucinations when starved of visual information. Scotopic vision relates to human vision at low ambient light levels (e.g. at night) when vision is mediated by the rods of the eye. Rods have a much higher sensitivity than the cones but are not as sensitive to colour. At low light levels the brain perceives colours more vividly, as it makes up for the loss of colour information coming from the rods of the eyes.

The machine produced complex patterns of coloured light which could be played, with a low latency of 10ms, much like an electronic musical instrument, in time to the music. This instrument could be said to have a similar lineage to the original Colour Organs (produced first as mechanical then electromechanical machines in the past century) and to modern video software such as Cycling 74's Jitter and VVVV. The Colour Organ was invented in Louis Betrand Castel in 1740 to explore the direct relationship between light and sound. When a key was struck a specific glass pane was lit by candle light. Recitals would be performed in darkened rooms lit by the different coloured lights (Visual Music Systems website, 2014: online accessed 5 December 2014).

3.4 Bjork - Biophilia

Bjork's early work was notable for its innovative use of music technology, using sampling (using portable samplers to create field recordings) and collaborating with notable electronic musicians such as Mark Bell from LFO, Matmos and Howie B. Her music takes in influences from classical music, experimental, dance rock and jazz. *Debut*, her first album, mixed pop music and the (at the time) new underground electronic sonics of dance music. *Post*, her second album, was performed using live

electronics with Leila Arab, an electronica artist signed to Warp and Rephlex, who mixed live input effects on stage.

In 2011 she unveiled her 'Biophilia' project. This combined custom made instruments, multimedia performances and unique musical tablet computer applications to accompany the traditional album release format.

The first steps of writing were done using Max/MSP patches which were controlled using a Logitech game pad, a Reactable interface and the Jazz Mutant Lema (a dedicated musical tablet interface). The Reactable interface gives users a unique method of interaction using three-dimensional objects placed on a surface. Parameters are controlled using the relative position of each object on the table. Objects such as oscillators, filters and LFOs can all be moved around and connected to create sound (Sonicscoop website, 2014: online accessed 9 December 2014).

Premiering at the Manchester International Festival in 2011 in a hall next to the Museum of Science and Industry the show contained many multi-modal performance aspects. The most obvious of these were the large custom acoustic instruments, dominating the stage that Bjork had built for the recording of the album and subsequent tour. Some of the instruments were controlled via OSC (Open Sound Control) or MIDI, whilst some were played live by performers. This produced an interesting dichotomy between the fixed media of the sequenced instruments, that were still acoustically 'live' and the live musicians.

The following is taken from The Creators Project website and personal view of the stage on the night.

3.4.1   Gravity Harp Pendulum

This instrument, designed by musical robot maker and MIT Media Lab alumni Andy Cavatorta, largely relies on the natural motion of four 11-stringed pendulums. Software controls the rotation of each pendulum head to determine the note that is struck when it passes the equilibrium position. The plucked string sound produced by the 25 foot high instrument are on the song *Solstice.*

3.4.2   Sharpsichord

A completely unique instrument made by Henry Dagg. The Sharpsicord is also called the pin barrel harp and operates the same way a player-piano or a music box does. It produces sound by the rotation of a studded cylinder which rotates and each

stud hits a note, which is amplified through a gramophone bell. The Sharpsicord can be heard on the track *Sacrifice* on *Biophilia*.

3.4.3   MIDI controlled pipe organ

 Similar in principle to the MIDI player pianos and pipe organs used by Aphex Twin (Vozick- Levinson, Simon, 2014: online accessed 9 December 2014). The instrument was created by Bjorgvin Tomasson and allows the performer to play a midi sequence into the instrument and generate sound from the pipes.

3.4.4   Gameleste

 Another instrument built by Tomasson, the Gameleste, derives its name from a combination fusing the classic instrument called the Celesta and the gamelan, a traditional Indonesian percussion ensemble. Built like a piano, but the tones sound almost discordant by the standards of Western music. Again the instrument can be controlled via MIDI.

3.4.5   Musical Tesla Coils

 The Tesla coil is an electrical resonance transformer that produces high voltage, low current, high frequency electricity and gives off electrical discharge as sparks. Tesla invented the Tesla coil to investigate electrical phenomenon. Bjork uses the coil to generate a bass line in the song '*Thunderbolt*' from the crackle of the coils electrical discharge. A solid state Tesla coil is used to produce sound by modulating the rate of spark generation (which is normally around 120 times a second). To create the note of low C the sparks must be generated 130.8 times a second. Using MIDI to control a micro controller which in turn creates a PWM (Pulse-Width Modulation) output it is possible to modulate the spark generation timing in order to create notes and even simple chords.

 During the performance there were many of novel uses of technology. The performance used an on screen scoring system devised by the animator Stephen Malinowski, whose work is also seen in the *Biophilia* App for tablet computers. The performance was made in the round and made use of line array speaker technology to provide a balanced sound across the seating rake.

Large video screens were also hung above the stage, to reproduce the complex 3D visuals in high resolution clarity, as opposed to the use of projection screens which can lose definition in dark auditoriums.

To supplement the custom made acoustic instruments more traditional performers were present with a live drummer performing acoustic and electronic D-Drums, using them to perform a complex cut up of the '*Amen*' break in the song *Crystalline*. A live laptop musician was also present playing keyboard parts, drum and stem samples and queuing the MIDI parts for the various custom acoustic instruments, all of which were controlled from Ableton Live. A large 'Reactable' 3D control surface was also present which was not used in the performance I saw.

The all female choir from Iceland also played a large role in the performance performing all the vocal parts and harmonies and providing a human counterpoint to the more technological aspects of the show.

The performance was truly multimodal, with the impressive custom acoustic instruments, visuals, audio and live performers combining to provide an immersive, multi-sensory experience. It also succeeded in conveying the interrelating themes of nature, mathematics and science of the album through the music and visual material.

Bjork chose to use the phenomenon of Somatics as visual source material (the vibration of material into patterns by audio material). The vibration of water was used in the track '*Crystalline*' along with images of crystals being formed.

Bjork also succeeded in taking the idea of performance into the hands of the spectator. By creating tablet computer applications (apps) that could be used to manipulate the music of *Biophilia* and explore it, creating new music in the process. The apps were also part of an educational program that formed part of the *Biophilia* tour, and are now used to teach music as part of the Icelandic National music curriculum.

3.5 Aphex Twin – Robotic Musicians

Richard D James has created a large body of work that covers all aspects of electronic music, from pioneering early, analogue created, hard techno and ambient music to electro-acoustic experimentation on the album *Drukqs* (James, Warp, 2001) and modular synth based electro on his *Analord* (James, Rephlex, 2006) series. He has also notably experimented with the format of live performance of electronic music.

One of his most ambitious projects was the remote control of the fourty eight piece AUKSO Chamber Orchestra and a 24 strong choir in the City of Tychy, Poland in 2011 and again in the Barbican Centre, London.

Musicians were supplied with headphones through which pitched saw waves were played. The saw wave destination and volume were controlled using Max patches and MIDI controllers under the direct control of James. A live scoring system was also used in order to communicate dynamics and style of playing as well as direct instructions such as 'play as high and as fast as possible' and 'scream like a dying cat'.
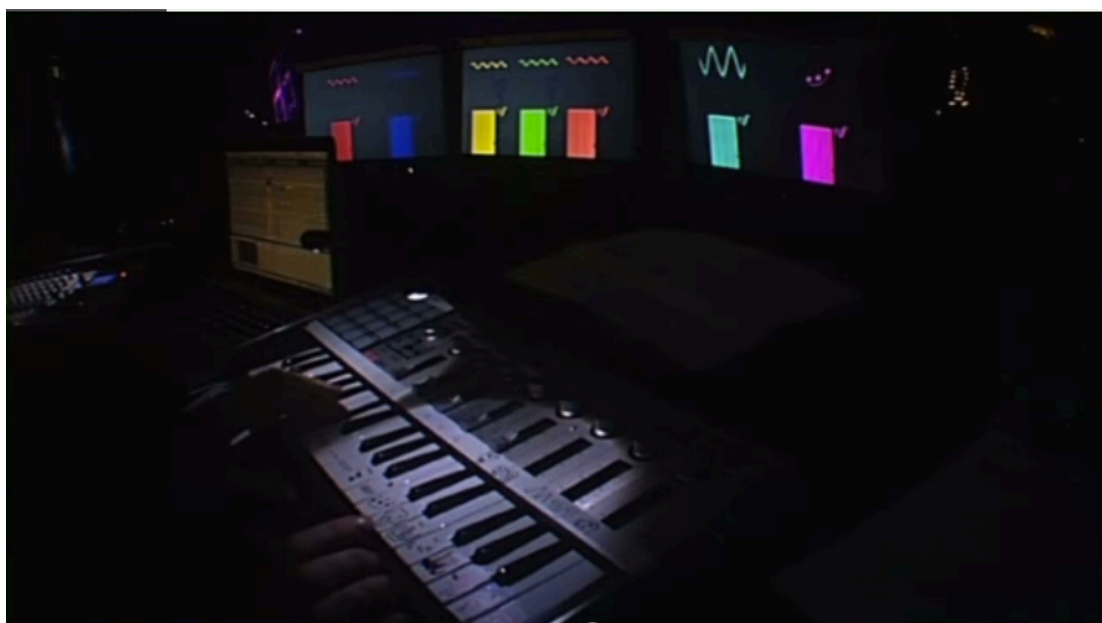
Figure 3 Still from a video of Aphex Twin's *Remote Orchestra*. Seen clearly in the foreground is a Korg MIDI controller covered in handwritten labels, on the monitors is the live scoring system. (Aphex Twin Remote Orchestra Video, 2011: online accessed 10 December 2014)

Extract from Remote Orchestra Performer Instructions:

'play' also means 'sing'.Try and play as close to the pitch in your headphones as possible, the pitch will sometimes change in very small amounts, try and play it as accurately as possible, microtonal outcomes will be desirable most of the time. Try and follow the bend of the note as it increases or decreases.

If you can't follow the pitch because it is too high or low or too fast, just play as close to it as you can or play in a different octave.

Don't worry if you make mistakes when the pitch is changing too erratically to follow.

I will be exploring the players inability to reach the pitches immediately and when its impossible to play.

For instance if the pitches are too fast to hear and respond to, just try and respond as best as you can.

Try to ONLY play for the duration you hear the tone [sawtooth wave sound] and not play when it has stopped, or in other words try and match the note length accurately. The duration and speed will vary and it will take you a few seconds sometimes to adjust to the new speed and duration, don't worry about mistakes in this adjustment period.'

(Noyze, 2014: online accessed 11 December 2014)

The work obviously references previous fixed score pieces by composers such as Xanakis' *Eonta* in which computational algorithms are used to create scores for live musicians. However producing such a work on such a large scale in real time is a very challenging project. In fact it is notable that up until recently James' work had mostly been in the live domain and for over ten years he has rejected releasing music. Aside from a collection of analogue electro and techno under the AFX pseudonym, his work has been in the area of experimental performances and DJ sets which often consisted of extreme manipulation of his own pre-recorded material and other artist's work.

His other performances include the Reich piece *Pendulum Music* (1968) which he reworked to Reich's approval using multiple microphones and speakers to create a feedback matrix. His own piece *Aisatsana* (2012) involved a remote controlled Yamaha Clavinova piano being swung across the stage on a large rope to create the Doppler effect, which gives the auditory illusion of bending notes.

James, as well as being one of the most influential electronic musicians of the past twenty years is also seen to be a true multimodal artist, taking electronic music performance into new territories using new technologies to create rich and rewarding work.

Electronica has become an all-encompassing term to mean everything from dance music, such as techno and jungle, to the more experimental electronic music such as drone, IDM, glitch, hip-hop and many other sub-genres. The term electronica can be generalised to music made with exclusively, or mainly electronic (analogue or

digital) means through the use of synthesisers, drum machines and computer software. For this reason it shares the forward looking technologically-reliant philosophy of modernism. Electronica's reliance on technology is fundamental to the generation of new sounds.. In the 21st century music technology has also looked backwards to the early days of analog technology. Vintage analog equipment is held with high esteem and many companies are now copying old instruments such as analogue synthesizers to create new instruments.

 However the relationship to modernism is also more complex. Just as modernist painters such as Picasso came up with new ways of painting, rejecting such fundamentals as perspective, so too electronic musicians attempt to reject the past and look forward, constantly pushing to develop new sounds and techniques including the use of found sounds (Dadaism and the surrealists), situationist interventions in the form of installations and even the rejection of music itself in favour of recorded soundscapes within the field of sound art.

  As well as looking back to the earlier electro-acoustic musicians of the 20th Century my work is also influenced by the post-rock movement of the late 20th and early 21st Century. Post-rock is a difficult term and has come to encompass a music made by bands or musicians who take a more experimental approach in their methods than traditional rock bands. This can be in the way a record is recorded, such as the later Talk Talk albums which made heavy use of improvisation and layering of overdubs to the treatments of guitar and the use of synthesis and post-production with bands like Isis creating huge soundscapes of noise. My piece 'Song for Aberfan' (2013) could be said to have its roots in both post-Rock and noise, with the guitar taking an alternate role of providing atmosphere and tension through the use of large amounts of delay and reverb. The guitar was played with a drumstick in certain sections to provide glissando, again a technique taken from the earliest of so called post-rock bands Sonic Youth.

 The structures of my pieces could also be likened to some of those lengthy works of bands such as Isis who often create movements within songs as opposed to the usual rock structures of verse, chorus, verse. 'Fl00D' (2014) although primarily based around guitars does not have any conventional guitar sounds in it. With the guitar processed through many effects to take the form of washes of sound, drones and glitches.

4. Intermedia and Expanded Cinema

Expanded Cinema is a term given by Gene Youngblood that describes work that uses new cinematic language. That is the idea of using film, video and television in non-conventional, creative ways utilising and expanding conventional cinematic technique. At the same time as Cage and Xenakis created multi-sensorial multimedia shows, so artists were looking at new ways of presenting film and performance and working with sound and light. Some of the more interesting work was carried out under the banner of 'Intermedia.'

In the 1960's a group of artists and engineers under the name of USCO along with behavioral scientists from Harvard University formed the Intermedia Systems Cooperation. The mission statement was to '…explore multi-channel audio-visual techniques and design of facilities, hardware and software.' The group defined intermedia as '… the simultaneous use of various media to create a total environmental experience for the audience.' (Youngblood, 1970: 347)

Youngblood continues to give examples of notable intermedia and expanded cinema works including Roman Kroiter's *Labyrinthe* presented at Expo '67. This consisted of a large vertical screen which was suspended between four levels of balconies, in which the audience sat. They were also presented with a perpendicular screen across the floor, both screens were 40ft in height. Two hundred and eighty-eight speakers provided a fully immersive sound system. Francis Thompson, another artist describes his work:

'We're interested in films expanding and swallowing a huge audience… I would like to make a theatre that would be a huge sphere…' (Youngblood, 1970: 354)

His piece *We Are Young* for the Canadian Pacific-Cominco Pavilion at Expo '67 covered a screen area of 2,952 square feet. So we see that many years ago the idea of total immersion for audience both with visual and sound stimuli was being practiced successfully. Artists saw the potential of audio visual technology and created ambitious work that pushed the boundaries of the technology and conventional cinema of the time. A lot of the different works from this time include the idea of sensory overload with the use of domes as performance structures, immersion and surround sound being common techniques amongst these artists.

One example of a modern day approach to the Expanded Cinema idea is the performance 'Massive Attack v Adam Curtis' at the Manchester International festival in 2013 (Adams, 2013: accessed online 3 January 2015). Curtis worked with United Visual Artists to create a film projected onto large translucent screens placed

around the audience in a 360 degree configuration with the band playing behind them. The music played live by the band along with cutup and split screen footage can be seen to create an overwhelming, disorientating effect, seen in video taken from the night (Bell, Vimeo video, 2013). The narrative of the film, that of disorientation and manipulation of the populace by mass media and corporations, fit with the presentation style of the film and the music. The band are not the headlining act, but are an accompaniment to the overall piece.

5. Post-Rock in a Digital Age

The term post rock was coined by Simon Reynolds in his review of Bark Psychosis' album *Hex* (Reynolds, 1994). He described the music as 'using rock instrumentation for non-rock purposes, using guitars as facilitators of timbre and textures rather than riffs and power chords.' He further expanded on the term, stating:

> 'Perhaps the really provocative area for future development lies...
> in cyborg rock; not the wholehearted embrace of Techno's methodology,
> but some kind of interface between real time, hands-on playing and the
> use of digital effects and enhancement.'
> (Reynolds, 1994)

However it is interesting that the first albums labeled as post-rock were conceived using conventional instruments with very little technology. It was the chosen approach by the musicians that conjured up certain sounds, atmospheres and moods, rather than any reliance on technology. The use of digital technology in post-rock has only come about in recent years and has obviously flourished.

Talk Talk had been a pop chart success in the 1980s using the technology of the time, drum machines, guitar synthesisers and Fairlight sequencing to create slick pop music. However, unlike many acts who only get safer as their career progresses, Talk Talk under the leadership of Mark Hollis became more experimental and embraced jazz music, improvised electronics and noise, but at the same time favoring a stripped down and raw approach to recording. (Young, 2010: 578)

Their album *Spirit of Eden* (Talk Talk, EMI, 1988) is credited as the album that later inspired many post-rock artists. However unlike many of the latter post-rock imitators the album was produced using techniques going back to the 1960's. As opposed to close microphone placement the instruments such as drums were recorded with a single microphone and the acoustics of the studio space were recorded along with the instruments. Minimal equipment was used including a Hammond organ, Vox AC-30 amplifier and microphones that would have been available in 1967 (Neumann U-87, Neumann U-48 AKG C-12a and Shure SM-57) and all instruments were tracked without noise reduction and with whatever effects were in place, much like dub music. The few concessions to this vintage aesthetic were a Neumann KU-100 binaural head (which records binaural stereo) and a 32-track digital recorder. (Brown, 2010: 280)

Within *Spirit of Eden* the guitar work is atmospheric with small flourishes of melody and even noise solos, but never simplistic and conventionally 'rock' sounding. The textures hark back to the raw violent strumming of The Velvet Underground as well as to the ambience of Sonic Youth's more gentle refrains.

Engineered by Phil Brown, he mentions how the band spent long periods improvising until a final take had been captured. The tracks are layered with unusual instrumentation for a pop album including Variophon (an early 1980s German wind instrument) Dobro, 12-string guitar, harmonium, violin, clarinet, double bass, the 'shozgys' (contact microphone based electronic device) and many forms of percussion.

Mark Hollis, when interviewed in 1998 speaks of his love for acoustic instruments, which are used throughout the album and also the use of silence in composition. The arrangements in *Spirit of Eden* have plenty of space and use silence in unexpected ways with sharp cutoffs and sudden endings and changes in direction (Mark Hollis Interview, 1998: online accessed November 11 2014).

Spirit of Eden and its subsequent follow up albums *Laughing Stock* and *The Colour of Spring* set a template for experimentalism in the rock/pop genre. It showed that sonic exploration, minimalism and acoustic instrumentation could be used alongside traditional rock instruments with excellent studio technique to great effect.

It is only relatively recently that post-rock has come to rely on studio manipulation and digital technology. Bark Psychosis' influential piece *Scum*, which laid the template for other Post-Rock artists, used the natural acoustic space of The Church of St John The Evangelist in London's East End to provide the suitable atmospheric reverb (Wallace, 2014: online, accessed 10 December 2014).

The atmosphere and mood of the early post-rock bands has evolved, so much so that the very term post-rock has become somewhat meaningless, being a catch all term to describe atmospheric, usually instrumental music that may, or may not be made with guitars. Taking the conventional sound of a strummed guitar, it can be made to sound like a wash of sound, drenched in reverb, filters and delay. More recently digital manipulation techniques such as granular synthesis push the sound of the guitar still further into uncharted territories with Christian Fennesz (*Venice,* Touch, 2004) taking the use of digital noise and guitar atmospheres to extremes.

With the sophistication of modern effects pedals and computers the textures and washes can be recreated live so that performances recorded in the studio can be recreated along with the use of samples, analogue or digital synthesisers and the

manipulation of effects pedals. Reynolds is correct with his prediction of cyborg rock. Pedals such as Electro Harmonix 'Cathedral' allow the freezing of sounds to create walls of sound from guitar chords..

 'In the absence of truth' (Isis, Ipecac Recordings, 2006) is a song from the post-hardcore band Isis. The guitars do everything but play a solo or rhythm part. The guitars are arranged in a much more orchestral style with layers of sound creating textures and interweaving counterpoint, the main part of the song does not begin until the two minute mark. This is typical of many post-rock, or post-hardcore bands who combine various sub-genres of rock, such as heavy metal and doom rock, and the atmosphere and ambience of post-rock.

 The influence of Sonic Youth on the post-rock landscape has been vast. Their complex tunings, use of feedback and heavy guitar treatments with custom effects, vintage valve amps and textural arrangements has proved both critically and commercially popular. Their early work could be said to write the post-rock template that many bands and artists such as Mogwai and Bark Pyschosis were to follow.

 However Sonic Youth were, in turn, influenced by the avant-garde musicians around them in New York such as Glen Branca, as much as the rock music on the radio. Branca rethought the guitar, in much the same way Jimi Hendrix had done some years previously. He saw the guitar as a noise generator, to be exploited for its sonic potential rather than just its ability to provide rhythm, melody and/or harmony. Blanca used micro-tunings and loud drones to create his work. Later on he was to create whole symphonies using orchestras containing only electric guitars and percussion. He created complex sonic landscapes, much as Reich or Feldman had before with orchestras and tapes.

On his latest piece *Hallucination City* for 100 guitars :

'Many people at the show last night thought the piece could have been a improvisation. It's not. And with the 100 musicians on stage it couldn't possibly be improvised. Even though the music sounds noisy, it is composed. One hundred guitarists making lots of noise would not be something you'd want to listen to.' (Dasha, 2006: online, accessed 10 December 2014)

 The Sonic Youth album *Daydream Nation* (Sonic Youth, Blast First, 1988) encapsulated the formula of noise, drones, complex arrangements and unusual tunings. Of particular note is the use of noise and feedback against conventional conventionally 'beautiful' sounds. The song 'Theresa's Sound World' from their

album *Dirty* is a great example of this. The first section has a beautiful arpeggiated section which builds layer upon layer, until a flood of feedback and noise enters. The song then crescendos as the guitars take over, before collapsing into sheer noise, and back into the 'beautiful' section before building again into a huge wall of noise before the final drop out to the quietist, picked out arpeggios. This juxtaposition is a common occurrence in all forms of noise music, from the genres of post-rock to electronic noise.

Christian Fennesz also makes much use of noise in his music. His album *Endless Summer* contains many tracks of guitar melody, steeped in the tradition of surf rock, yet it is set against noise, glitch and distorted electronic and acoustic instruments. (Demers, 2010: 107) In this way he highlights the simplistic naïve beauty of the melodies against the harsh noise and glitches drawn out of digital equipment.

To conclude we can see how post-rock, although perhaps started as a reaction against modern technology by bands such as *Talk Talk*, has come to embrace digital tools to create exploratory and vital music. Infact the very term post-rock has become controversial as the structural ideas, timbres and experimentation using conventional instruments such as the guitar cross over into electronic, ambient and even popular music.

6. Portfolio Commentary

6.1 Introduction

In this chapter I will discuss the pieces in my portfolio, putting them into an aesthetic context and describing and justifying the technical and creative decisions I made. I will provide stills and video from pre-production, signal flow diagrams, and Max/MSP patches (available on the accompanying USB disk).

The works are presented as both finished audio-visual pieces and live performance videos. Some of the work has been mixed in 5.1 Surround (*Aberfan* and *FL00D*) and Ambisonic B-format (*Aberfan*). All three pieces are presented on the stereo audio CD as fixed media.

The related preliminary research consisted of two projects consisting of research into drum augmentation using physical modeling and a multimedia piece entitled *Transport (2013)* written for harpsichordist Jane Chapman using live processing and video. I completed a paper on my work on physical modeling which is included in the appendix. *Transport* was performed at the York Spring Festival of New Music in 2013, and a video of the performance is included on the USB disk.

The aesthetics of my work are based in the genres of post-rock, noise and ambient music. Artists that have inspired the electronic ambient elements of the music include Christian Fennesz (*Venice*, Touch, 2014) and Aphex Twin (*Selected Ambient Works II*, Warp, 1994). I have also drawn on the use of guitar and acoustic instruments as a sound source for extreme audio manipulation which aligns with the genres of post rock and artists such as Bark Pychosis (*Hex*, Circa Circa, 1994) and Talk Talk (*Spirit of Eden*, Parlophone, 1988). The noise elements are inspired by the work of Sonic Youth (*Daydream Nation*, Blast First, 1988) electronic noise artists such as Pansonic (*Vakio*, Blast First, 1995) and early electronic music by composers such as Cage (*Imaginary Landscapes No.4*, hat ART, 1995).

6.2 Related Preliminary Work

I completed two projects prior to the pieces I have submitted for my portfolio. These projects laid foundations for my later work into the idea of multimodal performance using video and video sensor technology and resulted in a published paper and a series of performances.

6.2.1 Real Time Drum Augmentation with Physical Modeling

This work started around early research into using facial recognition software to control physical models of drums. Using physical modeling it is possible to augment the sound of drums using the initial sound of the drum as an exciter in a physical model. The resulting sound can be blended with the original acoustic drum signal to create an augmented drum sound. I used a Karplus-Strong model of a string in the Dronebox VST plugin created by software programmer Oliver Larkin.

Originally I intended to use facial recognition software, FaceOSC, to control the model but due to the development time and slight unreliability for performance I chose to work with manual MIDI control of the Dronebox model. FaceOSC works by scanning a video input into a computer and picking up facial characteristics. such as mouth diameter and eyebrow height. These facial feature parameters are then converted into OSC controls which can, in turn be used to control software such as Ableton Live.

I worked with percussionist Martin Scheuregger to create a performance for the InMusic Innovation in Music conference in York, 2013. Two microphones were used to create the exciter signal, one for the snare drum and another for two rototoms. Each signal was fed to a different channel which has a different instance of the Dronebox on it. The string model in Dronebox was then controlled by a Peavey MIDI controller mapped to various parameters in the model including pitch, LFO dept, LFO frequency and string dampening.

I also wrote a paper which was published in this conference book (see appendix). The paper, Real Time Drum Augmentation with Physical Modeling, discusses the research work I undertook into using drums with physical models. It also discussed the piece *Triptych*, I created with Martin Scheuregger and the techniques and problems encountered (Eyes, 2013).   My work in drum modeling is continuing and I plan to release a Max 4 Live plugin for Ableton in 2015 based on my research.

This initial work provided me with a template for my portfolio pieces in which I could explore the themes of live manipulation of acoustic instruments, use of video both to control sound and as part of a piece and noise. It also freed me aesthetically from the beat based music I had previously worked on and exposed me to creating free time music, concentrating on texture, sound quality and timbre, as opposed to rhythm and melody.

6.2.2 *Transport* for Jane Chapman

I proposed a piece for harpsichordist Jane Chapman as part of a composers' workshop with a view to performing the piece in the York Spring Festival of New Music 2013. The piece was work-shopped successfully and selected for performance. The idea for the piece was inspired by my daily commute to York along the A64 road between Leeds and York. The piece starts with field recordings of a car starting, trains and planes and then slowly builds into a noisy middle section where the piece crescendos to a dramatic ending. The performance concept was to have live harpsichord processed in real time using buffers, filters, reverbs and delays as a patch created in Ableton. The rest of the piece would be played from Ableton with parts triggered live. The buffers allowed incoming sound from the harpsichord to be repeated, re-pitched and reordered with fine controls over the size and decay of the buffered repeating phrase. This allows textures to be built out of small fragments of sound. Similar in technique to that of granular synthesis used by Fennesz, creating small fragments of sound and freezing and manipulating them in real time.

Video material was filmed by myself using a camera strapped to the bonnet of my car as I drove from Leeds to Norfolk. I then processed the video which was further processed live by VJ Gesuidoh (a Video Jockey group from Japan). During the performance the video was projection mapped onto Japanese umbrellas surrounding the Harpsichord (See video in Preliminary Research/Transport folder on the accompanying USB disk).

The finished piece combined live digital processing of the harpsichord and percussion (bell tree) and live processed video (using a hardware video mixer). Although not aesthetically similar to my portfolio pieces, as it was beat based, the performance set the template for the rest of my research and provided me with the basis to research the themes of noise, live performance and video further.

6.3 Song for Aberfan

2013 was the 47th Anniversary of the Aberfan Mining disaster and I thought it would be a good starting point for an audiovisual piece to pay tribute to those who perished in one of the United Kingdom's worst disasters. One hundred and sixteen children and twenty-eight adults died when an untended colliery spoil heap collapsed onto a school and houses in the village (On this Day, BBC Website).

The work of documentary film maker Adam Curtis is a good example of the expanded cinema ethos, presenting works of art in the format of television documentary (Youngblood, 1970: p257). Curtis is known for his experimental films and documentaries that combine library footage, innovative editing, sound and experimental music to present extremely compelling subversive narratives that comment on our society and the political ideas of the late 20th and early 21st Centuries.

For *Song for Aberfan* I wanted to create a piece of music and performance that would include the use of library film, much like Curtis, which tells a dramatic narrative. The piece would have the visual and audio components synchronized for dramatic effect similar to Curtis's film *It Felt Like a Kiss* (Curtis, 2009) with the music adding to the atmospheric visual material. Unlike Curtis's work the musical material would be created in the studio and during the live performance of the film, as opposed to using pre-existing material.

The piece was constructed by firstly editing library footage of the disaster into a narrative that would work over a short time frame. The footage was edited down to make four main parts:

1. Introduction – The descent into the dark, steep valleys are seen and the warning sign on the spoil heap comes into view.
2. The collapse of the spoil heap.
3. The aftermath of the disaster and the rescue and realization of what has happened.
4. The ending with scenes of the valley and cemetery.

As well as the footage itself I wanted some form of human narration so I chose a poem entitled '*Under the Arc Lights*' by Rhys Keidrych (Keidrych, 2012). Using the film as a score in the studio I then asked several musicians to react to it and improvise whilst I used hardware effects to manually change the timbre and artificial

acoustic space of their instruments as they played. Instruments played include urhu (a Chinese two-stringed bowed instrument) double bass and a set of six springs that I mounted on two pieces of wood which were played with drumsticks or coins.

 By applying reverb and delay effects in real time I wanted to create a suitable artificial acoustic for the musicians to play in. The musicians would then play and react to the artificial acoustic, as opposed to a dry studio, in the same way Phil Brown used the open studio acoustics to create mood for the recording of *Spirit of Eden* (Brown, 2010: 292).

The signal chain for recording guitar, amplified springs and urhu was as follows:
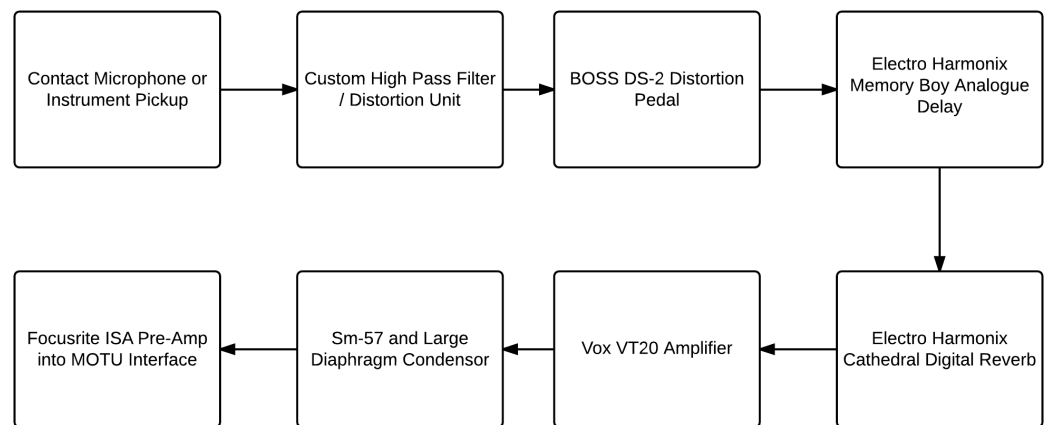

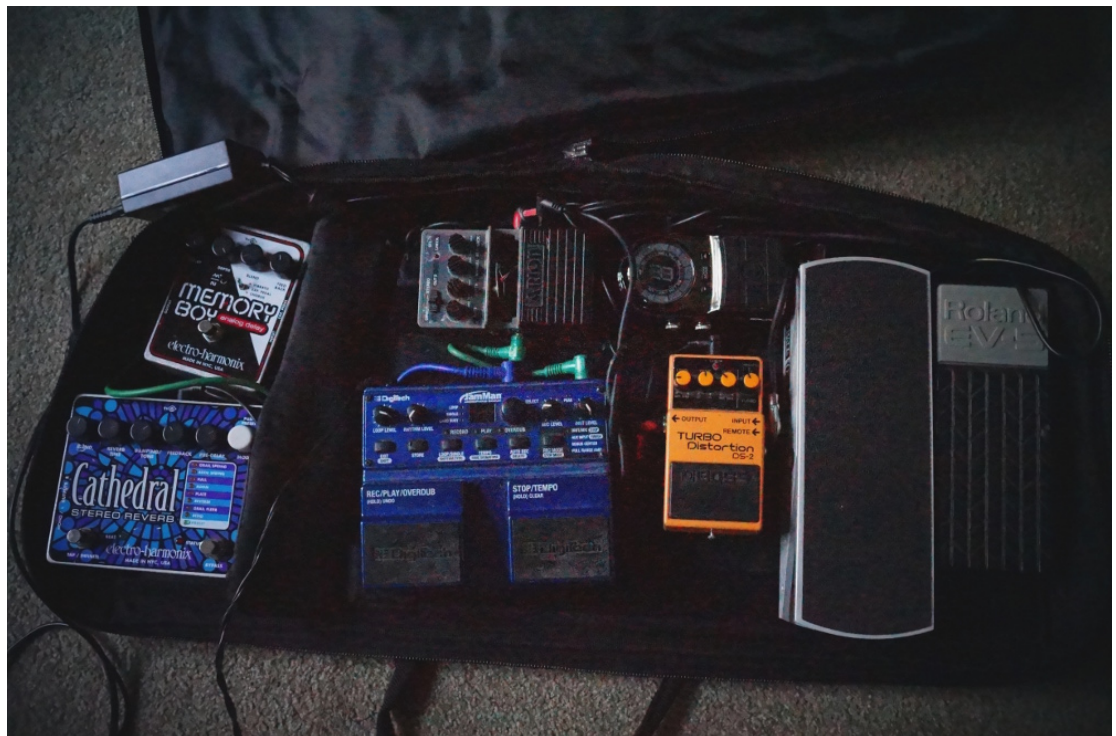**Figure 4** Signal Chain for the recording of *Song for Aberfan* Instrumentation.

Figure 5 Effects pedals used for processing urhu, amplified springs and guitar (*Song for Aberfan, Sense(or)* and *FL00D).*

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Figure 6 Effects chain for bass recording (*Song for Aberfan* and *Sense(or))*. From left to right: Marshall Guvnor distortion, Danelectro FAB fuzz pedal, Boss SYB-5 bass synthesiser, TC Electronics Delay ND-1 Nova Delay. The signal was then fed into a bass amplifier, which was recorded using a AKG D-112, and also fed to the instrument input on the Focusrite ISA pre-amp.

A contact microphone was attached to the urhu, 'spring' instruments and in the case of the double bass I used the pickup already attached to the bass. The signal was then passed through a Ruin custom high pass filter. This acted as a pre-amp for the contact microphones and pickups with some bass roll off and a little distortion to add presence. The signal would then be distorted to varying degrees using the DS-2 usually set to the Turbo I setting. The delay and reverb would be used in a variety of ways, in a static way to create large ambiences and sense of space, with the Cathedral reverb pedal set to hall reverb mode with long decay times of around five seconds. The reverb and delay was also used in a 'played' mode where I would manipulate the time and feedback settings to create washes of sound and dub delay effects where the signal would start to distort and clip and give a pitched delay effect. I made extensive use of the Cathedral pedal's 'Infinite' effect which allowed me to create drone sounds, much the same as a buffer freeze in Ableton or Max MSP, but in hardware form. These drones, produced by acoustic instruments with electronic manipulation are similar to those created with guitars by Christian Fennesz (Venice, Touch, 2004). The double bass was both bowed and plucked to give a range of

timbres, with the bowing being particularly effective through the Boss distortion pedal giving long drawn out drones.

Once I had recorded the basic instrumentation, namely the Urhu and Double Bass I edited the parts in Ableton to form a skeleton piece to accompany the video. I then began to add guitar parts using a similar signal path to that of the Urhu and Double Bass. For a slide the guitar was played with a drum stick on the fret board, in a similar style to Thurston Moore and Glenn Branca (Holmes, 2002: 242). This gives a particular quality to the timbre of the instrument, a slightly more muted tone than the bright tone of the commercially available metal slides. It was used on the noise section at 2:00 and the rising glissando that starts at 4:00. The drum stick as slide is particularly used in the noise sections as it is easier to create fast strokes of all the strings using a drumstick rather than a small metal slide that only just covers all the guitar's strings.

The noise section at 2:00 was created by asking the musicians to react to the statement: 'Most witnesses report a noise that sounded like a jet plane passing low over the village' (Petley, 2011: online, accessed 9 December 2014)

I recorded several passes of each instrument playing the noise part. I then re-amped some of the recordings and sent the recorded signal back through the Vox VT20 Amplifier. As I was recording the re-amplified signal I quickly moved the effect type selector switch on the amp, from chorus all the way through the various effects round to the delay setting, to give a 'glitch' effect similar to those heard on Fennesz's work *Endless Summer* (Touch, 2001) or the noisier parts of *Codename:Dustsucker* (Fire Records, 2004*)*. This 'glitching' was then recorded back into Ableton.

I added bass synth and noise parts using a Korg Mono-Poly synthesiser. The Mony-Poly is a four Oscillator analogue subtractive synthesiser capable of monophonic (single note) and polyphonic (four note) operation. Although the Mono-Poly was produced in the 1980s, and not in production at the time of the disaster, I thought it was fitting to use an older electronic instrument, as opposed to anything digital, that would sound possibly too clean and polished. The control surface, presenting a knob for each function, allows access quick programming of sounds and access to the cutoff and resonance controls of the low pass filter. This allowed me to shape the timbres of the sounds, both for the timpani like rumble and noise sections. The filter sweep heard at 4:15 was created by adding some envelope (ADSR) control to the amount of cutoff. I got a wide variety of tones from the synth, whilst passing it through the same signal path as the other instruments (Figure 4) again to provide

atmosphere and character to the sound. These included the noise bass part at 2:00 and the low timpani like rumble that is heard at the beginning of the piece.

The final section at 5:22 came from a guitar improvisation I recorded whilst using the tremolo effect on the Vox amp. Unusually I had the reverb and delay in the chain before the tremolo. Usually any amplitude effect would be applied before a reverb effect. This unusual setting gives a large open reverberant guitar sound that slowly cuts in and out with the tremolo closing and opening the reverberant signal. This shapes the envelope of the sound, with the long decay of the reverb cut off unnaturally when the tremolo closes the signal down, then opening up again when the tremolo lets the signal through. The bass part of this section was then played and recorded using a Carlsboro bass amp on both the bowed and plucked sections for a cleaner more defined sound than the previous drone sections. At this point the spring percussion had not been recorded but was later added to the performance and the finished piece.

6.4 Performances of *Song for Aberfan*

6.4.1 Jack Lyons 14 November 2013

This performance was planned for the YoCoCo (York Composers Collective) concert in the Sir Jack Lyons Concert Hall within the University of York Music Department. I wanted to utilise the large screen in the Lyons and use this as a centerpiece for the performance, whilst the performers, who would be lit quite dimly, would be dwarfed by the large screen. I wanted to perform in a similar style to the pianists accompanying silent films in the 1930s, (Brand, 2014). It would be quite clear to the audience that the soundtrack was being performed live and was a musical performance to a film, with the film taking a central role. In a similar style to the pianists of that era we would also be improvising around a set structure, so that each performance would be unique.

As the Urhu player, Cheong Li, was unavailable for the concert I decided I would have to play the Urhu parts from hard disk in Ableton, but I intended to keep all the other parts live. To make up for the loss of a third player I added live percussion in the form of springs attached to pieces of wood which would be amplified using contact microphones and sent through the Valhalla Room reverb in Ableton; these were played by Nektarious Rodosthenous.

Figure 7 Amplified Spring Boards. Two boards with a number of different size springs stretched between nails. The springs were played with a number of objects including drum sticks and coins.

The Urhu parts and video were played through Ableton along with some drones that were useful to use as audio cues. The video was projected on a large screen behind the ensemble.

The ensemble consisted of Twm Dylan (double bass and poem narration), Nektarious Rodosthenous (Spring Percussion and Synthesiser) and myself (electric guitar). During rehearsals the musicians were free to improvise around the sections (Introduction, Collapse, Rescue/Realisation, Ending). We came up with alternatives to the recorded material, some of which was later recorded and used in the final piece. A live synth part was also added, using an FM (Frequency Modulation) software synth in Ableton which was performed by Nektarious. This provided a suitably atmospheric and haunting sound.

The performance itself, although satisfactory, presented a number of problems. The first being that the acoustics of the Lyons (a long reverb time and large amount of mid-band resonance) made the narration of the poem, *Under the Arc Lights*, hard to hear clearly, this is obvious on the video recording of the piece. The other problem was that of the visual cues from the video not being clearly seen by the ensemble. Reflecting on the performance it would have been more satisfactory to have the urhu played live, as this forms the main structure of the piece and gives it a haunting other worldly quality. As Emmerson states: 'The fixed nature of the electroacoustic part

means that in many cases – unless the composer does not consider sychronisation of live and tape important – the tape part is a dictatorial and perfect metronome (beating clock time).'(Emmerson, 2007: 108)

However the piece is in a loose time, having no fixed time signature, with a pulse sometimes added by the spring percussion. This allows the musicians to move around the fixed Urhu part, and to improvise within the four sections. This use of loose or no time signature is used in my other work (*Sense(or)* and *FL00D)*, although *FL00D* does have some rhythmic devices via the use of looping sections of field recordings.

6.4.2 Rymer Auditorium 24 March 2014

This performance was for the University of the Third Age visit to the Music Department. The Rymer was a good choice for the piece as it would allow us to hear the poem narration more clearly, having a short reverberant time, and allow the rest of the piece to be heard more clearly thanks to the excellent sound absorption of the venue. On advice from my supervisor I re-recorded the narration and set this up to be played from Ableton for the live performance. On reflection I think the performance loses something without the live narration, however it is much more clearly defined and able to be heard clearly by an audience. In future I may use an extra narrator and ensure there is a clear and loud PA system set up specifically for the narration, separate to any surround sound system in the venue.

As Stockhausen and Xenakis had spacialised their pieces for performance across multiple speakers in purpose built exhibition structures (Emmerson, 2007: 158) I too wanted to experiment with the spatialising of this piece as I thought it would allow the audience to experience the effects of the different parts, particularly the 'Collapse' part in a far more visceral way. The sound would surround and move around the audience and appear to come from above, below and behind, as if the audience were themselves caught in the collapse. As the Rymer already has an ambisonic reproduction system it seemed logical to present the piece in ambisonic format. Ambisonics is a method of recording and reproducing a three-dimensional spherical sound field (Malham, 1997). A soundfield may be recorded using a specialist microphone such as the Soundfield ST-450 or by using mono or stereo recordings and placing them in the field using tools such as the Music Research Centre (MRC) Panners and encoding to B-Format (a native four channel ambisonic audio format) using software. The resulting signal (in the four channel B-Format)

may then be decoded and distributed to an array of speakers (sixteen in the case of the Rymer) to reproduce the soundfield.

To do this I selected which parts would be presented in ambisonic format and which parts would be played live (played back through the Genelec stereo pair). The Urhu parts (Cheong was again unavailable to play live), the narration and some bass and synth drones were mixed and panned using the MRC ambisonic panners in the Trevor Jones studio. The mix was then bounced down to B-Format for playback through the Rymer ambisonic decoder. I also added some extra guitar noise and drones which were panned around the back and above the audience. When faced with unlimited choice of sound placement in a 360 degree sphere it can be hard to make panning decisions and so a systematic approach is necessary. My main rule was that the narration and the main body of the piece including the urhu and double bass should be clearly heard and presented towards the front of the soundfield, whilst the 'noise' parts such as the spoil heap collapse and additional guitar and synth parts could be panned around and behind the audience. The guitars, double bass and springs were played live with the sound being emitted from the Genelec speakers or the respective instrument amplifiers.

In rehearsals the musicians found it hard to hear the audio cues from the ambisonic system, due to the nature of the sound being quite diffuse and at a distance from the stage. To cure this I routed some of the sounds to the Genelec stereo pair at the front of the venue, so these sounds could be used as a reference for the musicians to improvise. A Yamaha SPX-900 hardware reverb was used to add a hall reverb to the amplified springs. This was to take some load from the computer which was running Reaper to reproduce the audio cues in ambisonic format and play back the video.

The performance was successful on many levels, both from a technical point of view with the problems of monitoring being solved, clear narration of the poem, and the ambisonic system distributing sound throughout the auditorium in a convincingly three dimensional way, and also from an artistic point of view. The idea of expanded-cinema, to take film, narration, pre-recorded material and musical performance and combine them had been accomplished with the audience enjoying the combination of the four elements. One audience member commented that the piece reminded him of the early work of Syd Barrett, the one time member of Pink Floyd, a reference I had not thought of, but perhaps showing people make connections to work they are already familiar with. This is an insightful comparison

as the noise sections and slide guitar parts are very reminiscent of early Pink Floyd material.

6.5 Sense(or) (2014)

The University of York music department runs a successful collaboration project each year between Post-Graduate composers and undergraduates at the Northern School Of Contemporary Dance. The project gives composers opportunity to work with undergraduate dancers and choreographers on their final year project. As a post-graduate composer I was asked to join the project and collaborate with the school.

The first stage of the work was an informal meeting with dancers and choreographers at the school in December. At this meeting I demonstrated work I had been doing using the Microsoft Kinect. This sensor, usually used with the X-Box gaming platform, allows the 3-dimensional, infra-red detection of human movement, specifically limbs and facial characteristics. Coupled with 'Synapse,' (Synapse website) which translates movement data to OSC (Open Sound Control), control messages can in turn be interpreted by music software such as Ableton. Used this way the Kinect makes an excellent full body, movement based musical interface controller (Wilson and Bromwich, 2000: 9-16).

From this initial meeting I found some common ground with a group of undergraduates who were interesting in producing work with live computer generated visual material. The visual material would be derived from dance movement using VVVV software. One Kinect sensor would detect movement from the dancer and control audio material produced in Ableton, a second sensor would convert the movement into control messages sent to visual patches in VVVV.

We decided on a theme for the piece, which was to be a voyage through deep space using audio and visual material to accompany the dance piece. A quote was used as a starting point taken from an article referencing interviews with astronauts:

'Your eyes are telling your mind lies that your inner ear, that register of balance and momentum, cannot abide. Your mind creates a map of the craft around you, assigning logic to its contours: this is up, that is down, here is starboard, there is port. You move, see the space move, and your mind tries in vain to feel the effects. But your inner ear requires gravity. Without it, part of your mind—the lizard part—is certain you are still. The mixed-up messages make you space-sick.

When you open your eyes, you sense that the space station is moving, vibrating, rippling with the beat of your heart. You are an air bubble suspended in liquid. Only you aren't. It's your body that's gently moving—moving to your pulse, ever so slightly. The walls of the station are still. The sensation of connectedness is transcendent.' (Ryan Bradley, *Whats it like to play in Zero Gravity,* 2013)

I agreed to create a series of audio sketches for the dancer and choreographer to react to. The sketches were created by multiple sound design sessions. These sessions allowed me to choose a sonic palette, something that would conjure up travelling through deep space and allow the choreographer and dancer to pick which 'colours' of the palette they would like to work with.

Each session revolved around a fixed set of tools or musicians to create the basic palette. For each session I implemented Brian Eno's idea of setting certain parameters and limiting choices when making music in the studio (Redbull Music Academy Website, *Brian Eno Interview,* 2013). My tools were two Max/MSP patches for sound generation, the 'Space Drone' Reaktor software synthesiser patch, electric guitar and urhu played through the pedal board used in *Aberfan,* a bowed and heavily distorted double bass, a Marantz radio tuner fed back into itself, an EMS VCS3 Synthi and an AtomoSynth Mochika analogue synthesiser/sequencer also played through the pedal board.

Taking early beat-less electronics such as Stockhausen's Spiral (1968) and Aphex Twin's selected *Ambient Works Volume II* (Richard D James, CD, 1994) as a reference point several recording sessions were undertaken. These were then edited down and mixed into miniature pieces and given clear, descriptive names such as 'Epic Black Hole' and 'The Spaceship Crashed'. Sent to the choreographers they then worked with the dancer and decided which pieces would work well and the best sequence for them.

I then developed the system that was going to be used to produce sound from the dancers' movement. The initial thought was that I would not have the whole piece controlled by the dancer, but instead use the micro pieces as a bed on which we could base the whole performance. The dancer would then generate textures and sounds which would augment the music.

Two patches were developed in Max for Live, software which allows Max/MSP patches to be used in Ableton. I wanted the dancers to have direct control of the sound they were controlling, as opposed to simply controlling some parameters of a

synthesiser. The difference being a parameter is a single element of control of a sound, but I was interested in creating a system where the sound is sculpted and formed in realtime. I thought that using sound buffers would work well, because a digital audio sample could be loaded into a buffer and thenenabling the dancer to scrub the sound. Experiments showed this would work (See Research Work on USB Drive/Research Work 'Scrubber Demo.mp4'). Hands were chosen as the controlling limbs, because the video software was tracking head and main torso movements and I thought it made sense to track other limbs not already covered. Added to this, arms in dance tend to be very expressive and are constantly moving. Parameters of the patch were then mapped to movement. The dancer's hand moving horizontally would scrub through the sample buffer and vertical movement would control the frequency of a band pass filter.

 The patch, known as 'Scrubber' would work for one hand. I then created a second patch 'Soundsculpt' for the second hand which would load a sample buffer scanned by a read head controlled by an LFO. This resulted in the audio equivalent of a vinyl DJ pulling a record back and forth across a needle, i.e. a 'scratch' effect. The frequency and shape (sine or triangular wave) of the scratch would be controlled by movement of the dancer's hand. Various samples were created from synthesiser improvisations using the EMS VCS 3, the Animoog App, wavetable synthesis using the Waldorf Nave app and recordings of people talking.

 Rehearsals then took place trying out the different pieces in the order selected by the choreographers, experimenting with 'Scrubber' and 'Soundsculpt' and finalising the visuals produced in VVVV. Various changes were made to the pieces including timings and mixing decisions. I also used the Animoog App on the iPhone to improvise along with the piece as a final layer of sound. This app allows the drawing of paths to create amplitude and pitch modulation patterns. I based each pattern on some of the dancer's movements for each section and then changed the speed of modulation during the performance; as the dancer's movement became more intense, so the modulation speed increased.

Figure 8 Modulation pattern drawn on the Animoog App for iPad.

The structure of the piece was as follows:

1. Epic Black Hole – Large sphere visual tracking Head
2. Sadness In Space – Dotted patterns tracking head
3. Transition – No dancer or visuals
4. Lonely Rain – Grid visuals tracking dancer's body

Rehearsals went well but an audio only transition was needed into the last section. The choreographers asked me for a 1:30 minute long audio only intermission to take them into the final section. The piece used radio elements similar to Stockhausen's *Spiral* (1968), however the radio was modified by placing the receiving antenna on top of the radio casing. When tuned to itself the radio produced a deep, bass like hum, heard at 7:50. The radio was 'played' by moving the tuning dial up and down to go from the sound of static and half tuned stations, to the bass note.

6.5.1 Performance of Sense(or) at Northern School of Contemporary Dance 13 March 2014

Sense(or) was performed in the Black Box space at the Northern School of Contemporary Dance. The main problem we experienced was the lack of high quality speakers in the venue. The speakers were not able to produce some of the low frequencies and would distort at higher volumes. However, apart from this, we experienced few technical problems. On viewing the piece I decided that a tighter integration between the dancer's movements and the sound they generated would be necessary.

6.5.2 Performance of Sense(or) at The Rymer Auditorium 19 May 2014

The piece was performed for a second time at the Rymer Auditorium at the University of York Music Department. The problems faced with the poor quality speakers in Leeds were solved by using the high quality Genelec speaker system, able to reproduce the lower frequencies in the piece.

The patches also worked successfully, creating a close link between the dancer's movements and the sound. One problem we did encounter however was the Kinect system for the audio at the beginning of the piece failed to pick out the dancer's body to calibrate itself. This was possibly due to a sudden change in the lighting before the piece started. In future work this will be noted and consistent lighting will be ensured during rehearsals and performance, as the system worked flawlessly during the rehearsals.

Overall both performances were well received. The audio and video interaction with the dancer was integrated enough for the audience to perceive a direct correlation between movement and audio/visual reaction. Further development might involve taking the piece further with no pre-planned audio and complete improvisation from the dancer creating all sound live using further Max/MSP patches. The piece evokes the feeling of weightlessness and isolation of space travel and the theme of disorientation and uncertainty. The sound palette and arrangement I used were determinately awkward and unsettling to try and capture and evoke these feelings.

6.6 FL00D (2014)

Both Xanakis and Stockhausen designed multi-modal pieces for specific architectural spaces such as exhibition pavilions and purpose built spherical concert halls (Emmerson, 2007: 158). I wanted to create a piece that would utilize the very high quality sound reproduction and low reverb times of the Rymer auditorium within the Music Research Centre at the University of York. Recorded sound can appear very 'real' in this space and is ideal for a piece involving a soundscape made from field recordings and live electronics. The high definition projector, large screen and surround sound equipment (5.1 Genelec system) are also of great benefit when designing a multimodal piece as these allow video and sound to immerse the audience. Creating a piece using these features, I would be composing with a specific performance space in mind. The piece would be performed in the dark, similar to the concerts of the Sun Ra Arkestra and the OVC video synthesiser (Tompkins, 2011: 104) with the visuals and music surrounding the audience.

The idea for the performance therefore, came before any compositional or musical processes had been decided upon. Instead the music would fit the brief of its technical task, to surround the audience. To do this I would create a soundscape and use field recordings similar to the work of Chris Watson (*Storm,* Touch, CD, 2006) however instead of the raw field recordings I would create a musical accompaniment to create a hybrid of music and soundscape, similar to the work of the KLF on the album *Chill Out* (KLF, KLF Communications, 1990). This groundbreaking album combined samples of Elvis American preachers, various environmental sounds such as wind and train whistles mixed with synthesiser drones and slide guitar samples. The whole album takes the listener on a journey with song titles such as '*Dream Time in Lake Jackson'* evoking a drive across mid-west of America (Demers. 2010: 117).

I spent several months recording an archive of field recordings using small portable handheld recorders, my mobile phone and more sophisticated stereo microphones and hard disk recorders. These were made at the following locations:

Lindisfarne, Berwick upon Tweed, Craster and St Marys Bay, Northumberland

Whitby, Staithes and Runswick Bay, North Yorkshire

Barry Island, Vale of Glamorgan

Oxford Circus and Soho, London

Department of Music, University of York, North Yorkshire

The recordings were edited down, from hours of material, and laid out into a coherent narrative structure in Reaper. The structure was to mirror the ideas behind the piece, that of the threat of global warming and impending mass flooding and possible repeat of the severe storms seen in the winter of 2013. The piece was also inspired by the ideas of James Lovelock and his Gaia theory, that the earth is a complex living organism, of which we are a small but important part.

'Perhaps the saddest thing is that Gaia will lose as much or more than we do. Not only will wildlife and whole ecosystems go extinct, but in human civilisation the planet has a precious resource. We are not merely a disease; we are, through our intelligence and communication, the nervous system of the planet. Through us, Gaia has seen herself from space, and begins to know her place in the universe.
We should be the heart and mind of the Earth, not its malady. So let us be brave and cease thinking of human needs and rights alone, and see that we have harmed the living Earth and need to make our peace with Gaia. We must do it while we are still strong enough to negotiate, and not a broken rabble led by brutal war lords. Most of all, we should remember that we are a part of it, and it is indeed our home.'
(Lovelock, 2006: online accessed 10 December 2014).

The narrative was constructed as follows:
0:00 Introduction – intimate bird sounds, opening up to wider sounds of nature.
3:00 The sea in a peaceful state.
4:00 Walk across the beach and a kiss (human level).
6:00 Human disruption conflicts with nature.
8:21 The storm approaches.
9:00 Into the city and civilization.
11:24 The flood.
19:00 The sea returns.

Very little processing was applied to the field recordings apart from some looping and basic EQ and filtering. I wanted the field recordings to come across as pure and unadulterated to contrast with the more dissonant sounds I would generate to accompany them. However artificial soundscapes were constructed, and as opposed to the work of Shafer (Demers. 2010:121) who set out to honestly capture sonic environments, I layered many of the field recordings to create new sonic landscapes.

This can be heard particularly at 9:13 where samples from Staithes, Barry Island, Soho and Oxford circus all combine with electronic music to create an acoustic space that would never occur naturally. Sounds such as a recording of a taxi driver practising heavy metal guitar whilst waiting for a fare and a street preacher (both recorded using a mobile phone) can be heard mixed with synthesisers and distorted ukulele sounds.

Once the basic structure of the field recordings was in place I overlaid guitar drones and textures using the same pedal setup as *Aberfan* and *Sense(or)*, however the effects chain was usually plugged straight into the audio interface, bypassing a guitar amp. This gives a slightly purer, synth like tone to the guitar sound much the same as David Gilmour used by plugging straight into the desk on the guitar solo for *The Wall*. (Pink Floyd 1979, CD reissue, 1994). The drones were created by using a Digitech Jamman looper pedal. The looper records a loop which can be triggered by the operation of a foot pedal. Further loops can then be overdubbed to create large textures. I used the looper pedal in conjunction with the Electro Harmonix Cathedral reverb and a TC Electronic Nova digital delay to aurally animate the loops and create different textures from them (2:21) as they were recorded into the DAW (Reaper). This was done by modifying delay, feedback and modulation settings manually, similar to how dub producers such as King Tubby may create textures from relatively simple sonic material using the Roland Space echo analogue delay (Demers: 2010. 101).

Further recording sessions were undertaken using vocalists, a vintage (1970s) Minimoog synthesiser and EMS VCS3 synthesiser (See photos on memory stick for patches) to create bass, noise and high frequency drones. Of particular note was a recording session for one of the vocalists carried out on a beach in Staithes. Using an iPod the track was played back in headphones whilst a recording of the vocals was made using a portable recorder. The resulting recording was used in the finished piece (heard at 14:17). Another session involved using a live vocalist to produce synth and guitar like tones though a distortion pedal and Eventide space reverb pedal. This can be heard at 16:18.

To produce an accompanying video for the piece I sent a simple brief to Emma Jane Richards; a film maker and photographer based in London. The brief was to simply create a video that would accompany the piece, however there should be gaps in the film and periods of black (visual silence) to allow the sound to take over the audience's imagination. The video was shot using a high speed camera (60 fps) and

slowed down to create a smooth slow motion effect. It was also processed to appear much darker than was shot by reducing the video's opacity. It was shot and edited in high definition (1080p) to allow a large image to be reproduced on the screen in high resolution.

6.6.1 FL00D Rymer Auditorium Performance 23 June 2014

The original stage plan for the piece was for two video screens installed in the Rymer either side of the audience so the visuals would be in their peripheral vision at the same time as projection onto the main large screen. However time constraints meant this would not be possible, but for future performances I would like to try out this screen configuration.

The layout was fairly straightforward with the large screen at the front and the speaker configuration in 5.1 around the audience. The audio and video would be played from hard disk, however the piece would have live elements in the form of amplified spanish guitar, an iPad running Waldorf's Nave wavetable synthesiser and the AtomoSynth Mochika analogue synthesiser/sequencer routed through a Korg lowpass filter. I also controlled the spatialisation of the pre-recorded material in the auditorium using a mixing desk. The guitar was played and looped at various points in the piece and processed through the Eventide space pedal. The synthesizers were used in the last quarter for adding noise and bass to the finale. All instruments were routed through a mixer which had the Eventide reverb on an auxillary send allowing me to route any synthesiser or guitar loop to the reverb and delays and to send audio to any of the six speakers in the auditorium.
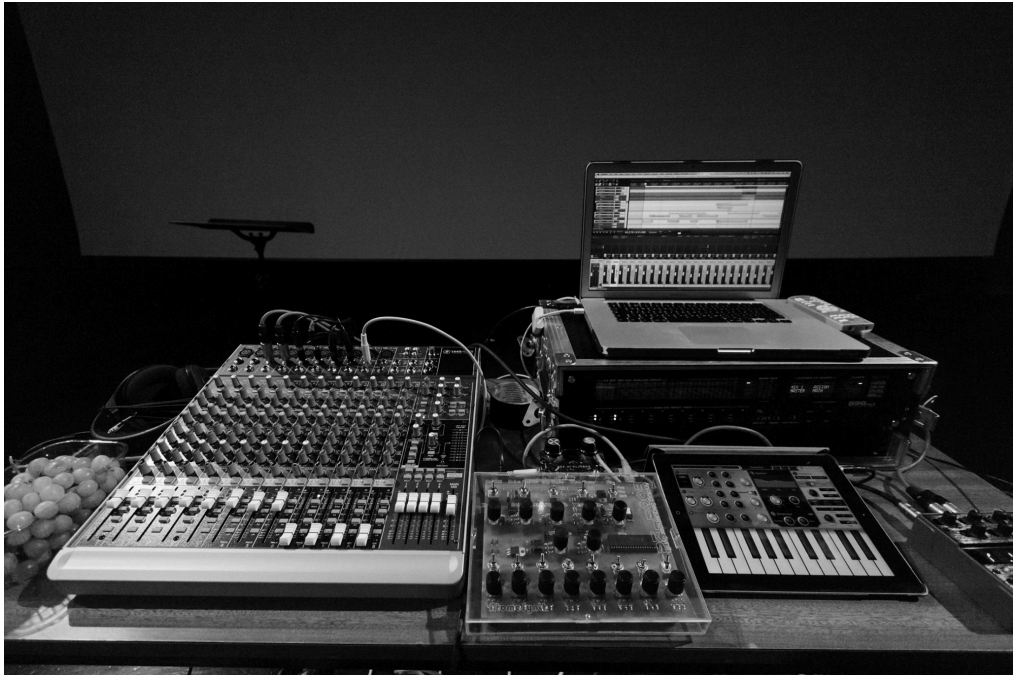
Figure 9 Instruments for *FL00D (2014)* from left to right: Mackie Mixing desk, AtomoSynth Mochica sequencer/synthesiser, iPad running Waldorf Nave and the top left hand corner of Eventide space reverb. (Photograph: Jakob Hadar)

6.6.2 Further performances of FL00D

 I performed *FL00D* at several festivals and concerts after the first performance in the Rymer. However the overall effect, of being in the dark surrounded by sound and immersed in the visual content with a large projection screen was lost in less than adequate venues. To some extent this proves that the piece was designed for one venue, where it was performed successfully. The budget required to put it on in other venues with surround sound and high definition projection means it is always going to be slightly compromised. However I did have one successful performance in an outdoor venue at the STFU festival in Dresden, the screen was quite small but the moon came out above the stage and added to the visual content on the screen and provided a suitably dramatic backdrop. I also used a live singer for this performance, which added to the live, 'Expanded Cinema' aspect.

Figure 10 Performing *FL00D* at STFU Dresden. festival, September 2014. In the foreground can be seen the AtomoSynth Mochika sequencer/synthesizer and Korg Monotribe being used as a lowpass filter. (Photograph: Konrad Behr).

7. Conclusions and Further Work

The work presented within this portfolio explores the use of video, noise and improvisation in live electronic music. Video was used in *Song for Aberfan (2013)* both as a score to which the musicians improvised and as a finished film. *Song for Aberfan* was presented as a multimodal performance of 'Expanded Cinema', with live improvising musicians accompanying a film, which was central to the performance. The unusual and exotic instrumentation in the form of the urhu and custom made spring percussion created an alien sound palette. Whilst the use of hardware reverb processing during both the recording and performances allowed me to recreate the eerie nature of the spoil heaps and steep sided valleys of South Wales. The vintage news footage of the disaster sets the time frame and era of the 1960s, however, I used digital hardware to model the spring reverbs and tape echos that would be used at the time. I used layers of distorted instruments and synthesisers to create the spoil heap collapsing section. Noise was also used in a sliding crescendo on the guitar to build tension in the third section of the piece. The aesthetics of the piece were definitely set in the genre of post-rock and noise however the use of urhu and double bass set it aside to create something very different and outside of the drums, bass, guitars band setup commonly used in post-rock.

In *Sense(or) (2014)* video was used as an input device using a Kinect, both to control projected visual material and to control the Max for Live patches to create sound. I used the Animoog app to create music and improvise to the dancer's movements. The dancers also rehearsed and improvised using the Kinect system to create sounds. Noise was used throughout the piece, for example in the form of detuned radio to provide an audio intermission at 7:50 before the final section of the piece and distorted acoustic instruments throughout the whole work.

Due to the use of analogue synthesis and the use of some analogue hardware to manipulate acoustic instruments, the aesthetic of *Sense(or)* lies in early electronic material and musique concrète similar in style to the Paris school. It is also reminiscent of early ambient music such as Aphex Twin's *Selected Ambient Works (*James, CD, 1994) and the ambient productions of Brian Eno, for example *Music for Airports* (Eno, LP, 1978). However the material is not all electronically generated as some of the sounds were made using acoustic instruments treated using analogue (or digital recreation) hardware. The performance of *Sense(or)*(2013) with the interaction of live dancers with light and sound could be likened to the earlier 'Intermedia' works produced by the likes of Cage and the Intermedia group.

In *FL00D (2014)* high definition video was used, created from the sites of the field recordings, to create an immersive environment to accompany certain sections of the performance. Video was also used as a source of sound, notably filming street preachers with my mobile phone to later extract sound. Noise was again used heavily in *FL00D (2014)* captured in the form of field recordings including a taxi driver playing heavy metal guitar and a thunder storm. These recordings were then blended with synthesized noise to create an artificial soundscape. In *FL00D(2014)* I improvised using guitars and synthesisers and hardware effects to accompany the piece and an improvising singer was present for the performance of the piece in Dresden (2014). The vocal section towards the end of the piece is made from edits of vocal improvisations from the three separate vocalists, all responding to each others' recorded vocal parts. These were then edited and layered. I also used sections of distorted vocal, with a section where the vocalist distorts the microphone capsule (a Neumann U87) used to mark the end of the piece. Aesthetically *FL00D* includes post-rock noise, similar to that produced on *Hex* by Bark Psychosis (Caroline Records, CD, 1994), drone and glitch found on records such as *Venice* (Fennesz, Touch, 2004) produced by Fennesz and the artificial soundscapes created by the KLF on *Chillout (*The KLF, KLF Communications, 1990). The long form nature of the piece owes something toward the ambient films and post rave chill out music of the 1990s, namely The Orb and their album *Orb - Live 93 (*The Orb, Island Records, 1993) and its use of traffic noise and found sounds in a live context. *FL00D's* performance aesthetic is perhaps closest to the idea of productions intended for specific architectural spaces such as Xenakis' *Polytope de Montréal* (1967) installation and Stockhausen's German pavilion at Expo '70 in Osaka, Japan.

My research into the history of live electronic music and recent multimodal performances has informed my creative practice and motivated me towards developing innovative live performances. Some of the work may have benefitted from being more 'live', with sections and parts unavoidably played from hard disk as musicians were not available, or there were simply too many parts to play live. However I succeeded in creating engaging performances drawing on the ideas of multimodal performance.

I have successfully created work that draws on a number of recent developments in music, namely the genres of post-rock, drone and electronic ambient. It also takes into consideration of some of the performance aspects and aesthetics of earlier art music from the last century, such as Cage and Stockhausen, and uses a multilayered

approach. Combining older technologies, such as the EMS VCS3 synthesiser with acoustic instruments, digital video and digital recording and editing techniques has allowed me to create compelling multimedia works that explore novel ways of production and performance of electronic music.

 In the future I would like to push performances into being completely live, with generated video material also being part of the performance. I am currently developing Max 4 Live devices to create a live improvised set with generative visual material, all music and video being generated in real time with no fixed audio or video material. I am also performing *FL00D* at further festivals and concerts in 2015 and the audio from the piece is being released on the Time Released Sound label, based in California.

Appendices

Appendix 1 Hardware and Software Used during Performances and Recording

Song for Aberfan (2013)

Hardware

Squire Stratocaster Guitar (Japan, 1993) with Overwound Ironstone pickups

Urhu

Acoustic Double Bass

Marshall Valvestate Guitar Amplifier

Carlsboro Bass Amplifier

Orange Guitar Amplifier

Vox VL20 Guitar Amplifier

Korg Mono-Poly Synthesiser

Ernie Ball Passive Volume Pedal

Ruin Custom High Pass Filter/Distortion

Boss DS-2 Turbo Distortion

Electro Harmonix Cathedral Stereo Reverb

Electro Harmonix Memory Boy analogue delay

Custom Made Spring Instrument

Marshall Guvnor distortion

Danelectro FAB fuzz pedal

Boss SYB-5 Bass Synthesiser

TC Electronics Delay

ND-1 Nova Delay

Yamaha SPX-900 Digital Effects

Focusrite ISA Pre-amp

MOTU HD-24 Audio Interface

Shure SM-57

Neumann U-87

Contact Microphones (custom)

Software

Ableton

iMovie

Reaper

MRC Ambisonic Plugin Suite

Sense(or) (2014)

<u>Hardware</u>

'Space Drone' Reaktor patch

Squire Stratocaster Guitar (Japan, 1993) with Overwound Ironstone pickups

Urhu

Double Bass

Marantz radio tuner

Electronic Music Systems VCS3

AtomoSynth Mochika sequencer/synthesizer

Ernie Ball Passive Volume Pedal

Ruin Custom High Pass Filter/Distortion

Boss DS-2 Turbo Distortion

Electro Harmonix Cathedral Stereo Reverb

Electro Harmonix Memory Boy analogue delay

Microsoft Kinect

Focusrite ISA Pre-amp

MOTU HD-24 Audio Interface

Shure SM-57

Neumann U-87

Contact Microphones (custom)

<u>Software</u>

Ableton Live

Max for Live

VVVV

AniMoog for Ipad

FL00D (2014)

<u>Hardware</u>

Olympus LS9 Portable Recorder

Tascam DR-100 Portable Recorder

Sony Xperia Smart Phone

Edirol R-4 Portable Recorder

Rode NT-4 Microphone

Squire Stratocaster Guitar (Japan, 1993) with Overwound Ironstone pickups

Electric Ukulele

Yamaha Spanish Guitar

Electronic Music Systems VCS3 synthesiser

Minimoog vintage analogue synthesiser

AtomoSynth Mochika analogue synthesiser/sequencer

Korg Monotron Duo

Ernie Ball Passive Volume Pedal

Ruin Custom High Pass Filter/Distortion

Boss DS-2 Turbo Distortion

Electro Harmonix Cathedral Stereo Reverb

Electro Harmonix Memory Boy analogue Delay

Eventide Space Digital Reverb Pedal

Mackie 1604 Mixing Desk

Focusrite ISA Pre-amp

MOTU HD-24 Audio Interface

Shure SM-57

Neumann U-87

Contact Microphones (custom)

<u>Software</u>

Reaper

Final Cut Pro

Walforf Nave for iPad

iMovie

Premier Pro

Appendix 2 List of Performances

<u>Song for Aberfan</u>

Jack Lyons Concert Hall 14 November 2013

The Rymer Auditorium 24 March 2014

<u>Sense(or)</u>

Northern School of Contemporary Dance 13 March 2014

The Rymer Auditorium 19 May 2014

<u>FL00D</u>

Rymer Auditorium 23 June 2014

The Basement, City Screen, York and The Woolpack York, 18 June 2014

The Leeds Music Hub Wednesday 13 August 2014

STFU Dresden 3 September 2014

Appendix 3 Real Time Drum Augmentation with Physical Modeling (paper)

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1.1 Abstract

Whilst digital drum kits have become ubiquitous across the performing and recording realms of the music industry over the past few years, research into extending real drum performance and sounds is still in its early stages. As digital drums have become more common on the world's stages and recording studios, the way that sounds are triggered using piezo based triggers and the sounds themselves, generated from samples, has changed very little. This project looks at how acoustic drums and percussion can be augmented using physical models of acoustic instruments and how new performances and sounds can be created.

1.2 Introduction

The sounds generated by physical modeling can be recreations of existing instruments, a particularly proportioned snare drum for example, or completely new instruments that might be difficult or impossible to create in the real world such as a 20 foot long kick drum.

Using the acoustic sound of a drum as an exciter to the physical model, new sounds can be played using real drum kits and percussion. This hybrid approach creates dynamic performances and sounds that could be used in many different scenarios, from reinforcing the live sound of a rock band's kick drum to the development of new sounds for avant-garde composition.

Existing digital drum approaches rely on the triggering of fairly static digital samples with little variation built into the performance other than velocity information that is sent from the drum pad to the drum brain. The digitally augmented approach allows performers to use the dynamics and sound of their existing instrument as a starting point to the creation of new sounds. Importantly their playing technique remains

unchanged, whereas digital drums require pads which have none of the expression and dynamism of real drums.

1.3   Physical Modeling and Drum Augmentation

Aimi's PhD thesis 'Hybrid Percussion: Extending Physical Instruments Using Sampled Acoustics' [1] explores the idea of digital drums and covers in detail some of the various digital drum kit models. It goes some way to explore their flaws – i.e. that they do not behave in the same way as real acoustic drums. They convert velocity into timbre changes for instance, but do not differentiate between brushes or sticks to change the sound. There is also no haptic response from the virtual drum skin back to the musician.

In their thesis they use convolution to process a sampled drum sound :

> 'In this work, the continuous acoustic output of a struck physical object is processed to add the resonance of a sampled instrument. This is achieved by employing existing low–latency convolution algorithms which have been extended to give the player control over features such as damping, spectral flattening, nonlinear effects, and pitch.'

This results in a closer relationship between the drummer and the sound being played back.

Figure 1: Simplified Convolution Instrument (figure based on Aimi's)

Aimi also brings a good quote in the form of his musical vision for the project:

> 'The core musical vision for this work is to make a system that gets out of the way of great players and lets them do what they do best: explore the range of sounds possible, expand the timbres available, find new and surprising ways to play, and get good at playing it. All through acoustic interaction with physical objects.'

It is arguable whether this system is actually acoustically driven as the piezo is a form of pressure transducer and is not reliant on air pressure generated by the drum itself, rather the body of the instrument in contact with the piezo microphone. Factors such as microphone placement, microphone type and more subtly nuanced acoustic sounds will not be picked up by the piezo microphone.

The idea of the percussion instrument being something that can be explored and that timbres and new ways of playing are there for the taking by the musician is very appealing. Percussion lends itself to sonic exploration with the player using different beaters, techniques and patterns to create different textures and sounds, often combining two sounds together or using various stick techniques such as flamming. A digital extension of this where the player can control timbres and explore the textures they create directly is something worth researching further.

Aimi uses convolution to change the sound of the drum, another idea would be instead to augment the drum spectral processing. In the paper 'The Augmented Drum Kit: An Intuitive Approach To Live Electronic Percussion Performance' by Michalakos [2] this approach is taken. He uses spectral processing, acoustic feedback and samples to augment his very personalised drum kit. This works extremely well as can by his demonstration videos, performances and experimental album 'Frrriction' [3]

However this approach has a number of problems. Namely that the kit and individual instruments it comprises of are heavily customized to Christos' playing and would not suit another percussionist. Therefore there would be a steep learning curve for

someone to learn how to play the kit. Although there is GUI for the kit it is again designed with one user in mind and not useful for general distribution of the software:
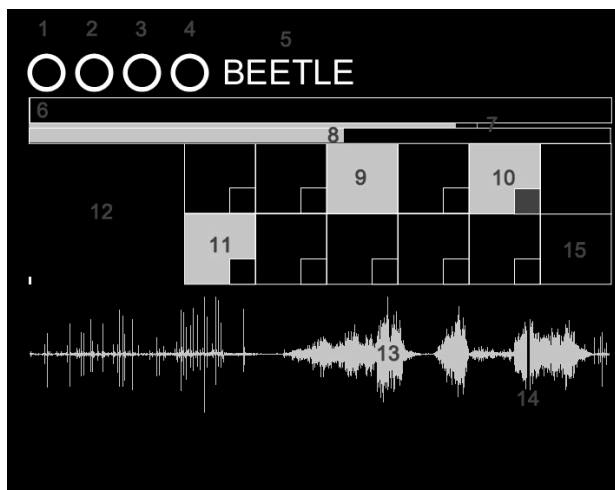

Figure 2: Michalakos' Performance Graphical User Interface

Michalakos' work is interesting, and although taking a very personal and customized approach it does go some way to demonstrating what is possible with digitally augmented percussion.

In another paper, yet another approach is taken. Adam Tindale's [4] focus is to use physical modeling, instead of samples, to recreate the sound of the drums. The interesting part of this method is that he uses a timbre recognition and strike location algorithm to modify the parameters of the physical model of the drum.
Thus the drummer can modify the drum model using a paradigm that the musician is already familiar with i.e. hitting the drums in different ways and with different implements. Something that is important when creating augmented instruments to be played by others, as opposed to personalised instrument augmentation.

In this way the resonator is the only physical modeled part of the system, with the drumhead and stick being real objects. This allows the musician to use familiar implements as opposed to striking unfamiliar rubber pads used in most digital drum kits. The rubber pads of older digital drums are usually quite unforgiving and have been associated with RSI, although this has been improved with the likes of the Roland TD20 mesh head system. Also Tindale's system will allow the musician to

use any drum or percussion instrument to create an impulse signal for the physical model.

The drum then becomes both the instrument, responsible for creating the initial impulse which then in turn reacts with the physical model, and also the controller – modifying the signal depending on how the drum is struck.

Waveguide modeling is used to create a model of a tube which then has a number of adjustable parameters including length of the tube, dampening of the tube and timbre. In this way many different drum sounds could be generated quickly with a relatively simple interface.
This method is relatively CPU efficient and also results in many different sounds, from boxy to bell like. It also allows a low latency, important for live performance.

It is worth noting that both Native Instrument's Machine software and FXPansion's drum plugin BFD3 have both made use of physical modeling to enhance the sound of sampled drums in their software. The original samples are processed using adjustable physical models allowing the user to edit such parameters as drum dimension, head tension and drum materials.

1.4   The Dronebox Physical Model

Oli Larkin's Dronebox is a physical modeled VST plugin effect based on modal synthesis. It consists of a bank of 6 tunable comb filters. A comb filter can be thought of as a resonator. When you walk in an alleyway or underpass the resonance you hear is a comb filtering effect that occurs because the sound waves bounce between the walls very quickly. This resonance is similar to the physical vibration of a string, which is why comb filters are used in physical modeling synthesis and why Dronebox can be used to emulate the resonant strings of a sitar or piano etc.

Triptych, a piece for Snare, Rototom and Physically Modeled Strings

As a proof of concept a piece of music was created that explores the potential of working with live percussion and physical modeling in real time. The piece uses the timbres and textures that can be generated using a simple percussion set consisting of a snare drum and two roto–toms feeding into a physical modeled set of strings running as a VST plugin (created by Oliver Larkin, University of York). Research follows on from work by Christos Michalakos[2] who devised a physical modeling system for augmented drum kit at Edinburgh University.
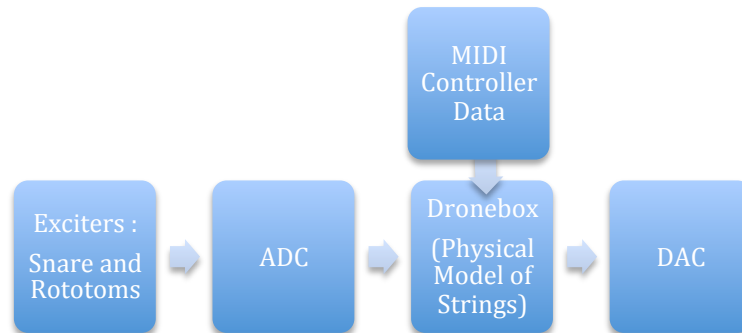

Figure 3 : Signal Flow for the Triptych Piece

The percussionist plays the piece using a variety of extended techniques to excite the string model. The model is controlled in real time using a standard MIDI controller to change various parameters of the model.
it demonstrates the benefits of the strong interaction between the physicality of the performer's gestures and the changing textures of the electronic sounds produced. Sonically it is extremely engaging as it explores the range of sounds generated from the extended percussion techniques exciting the physical model. The performer reported a deeper, more intuitive relationship with the sound when compared to a standard digital drum kit.

Dronebox contains a huge range of adjustable parameters including pitch, LFO rate and shapes, audio effects including delays and reverbs and a number of different pitching modes.

In the piece 'Triptych' we used two strings of the possible eight to add drones, sound effects and melodies to the percussion kit. After a long period of improvising with Martin the key parameters we were commonly using were mapped permanently to MIDI controls to allow quick, intuitive control of the plugin.
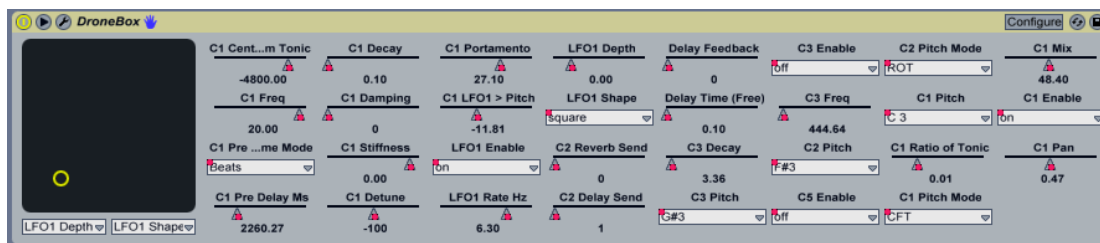

Figure 3: Screen–grab of mapped Dronebox parameters for 'Triptych'

1.5   Transcript of an Interview with Martin Schureger, Co–Composer and Percussionist

1. What was the composition process for Triptych?

Ben and I started by collectively improvising with me playing a small selection of percussion instruments: roto–toms, snare drum and bongos. As rehearsal sessions progressed, we refined the selection of instruments to just snare drum and two roto–toms and a large selection of traditional and non–traditional beaters.

By recording sessions we were able to listen back and filter out the better sections and build on those as rehearsals progressed. With quite long improvisations, sometimes just one idea came out, but this process allowed the later versions of the piece to be far more distilled. Once we had a good idea of what did and didn't work, we went through a similar process with structure, deciding on a loose order of events.

The piece is vary variable and will be very different in every performance, nevertheless we both have an idea of what we can achieve, so it is much more developed than an initial improvisation would be.

2. How did this alter to your usual process (if at all)?

This process of devising a piece through improvising and discussing was relatively new to me. I have done this before, but usually in a situation in which another musician takes on more of the 'composer' role and usually starting from a more fixed idea. Here, we were both inputting equally, although the idea of the piece – a work for solo percussionist and this specific patch – was Ben's.

3. How do you differ your playing technique when performing with the system?

Playing with this system, I felt the more varied the sounds were I put in, the more Ben would have to work with and the more interesting the end result would be. As such, I used a lot of non–traditional and extended techniques on the drums, as well as using a wide variety of sticks and playing with my hands. I was also aware of the positioning of the microphones, so the playing area would change depending on how much I wanted to be picked up: for example, really quiet sounds work well very close to the microphone.

4. What sounds do you like out of the system? How do you think this could be used by percussionists and composers?

All of the sounds have a lot of possibilities for both percussionists and composers. The nature of the system lends itself well to having an element of improvisation, as it is not entirely predictable: this is a great thing though. It could form part of any musician's toolkit of sounds for live shows or could form part of a more through–composed work. I don't think it is limited to any style of music, as you can get such different sounds from it.

5. Limitations of the system?

The limits of the system could be seen as the unpredictability of it; however, this is really a limitation that gives more creative possibilities. One issue is the huge array of sounds possible, and the need to know exactly what you want before starting, or make sure you have enough time to experiment and find what works. It's not a system that would work for a musician or composer who wanted a quick solution to something, it has instead to be learned like any instrument. (The same could be said for learning to compose and perform with any instrument or type of music...)

6. Future developments, what would you like to see?

This could work really well as a system which the player operates themselves. By assigning parameters to midi controllers (pedals, trigger pads, etc), this could form a natural extension to a percussion or drum kit setup, or indeed to any instrument. Making the parameters which are being controlled really understandable in a musical way would help too: i.e. a pedal which increases the amount of bass frequencies, or

something controlling the 'franticness' of the sounds. The more understandable it is in musical and sonic terms, the quicker and easier a musician could get on with using it.

1.6   Conclusion

There are many ways to approach the problem of augmenting percussion with physical modeling. However the approach I am taking currently with string models results in interesting and useable sounds suitable for composition and improvisation. Future work will involve the development of my own drum models to extend the range of the instrument with more realistic percussion sounds and a suitable interface with which to control the output of the model whilst playing drums. I am looking into using facial recognition and the Microsoft Kinect as possible options as a means of control by the musician. Further work will include more pieces and compositions and the development of a full plugin that can be used in hosts such as Ableton Live.

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