DRIVING A WEDGE – THROUGH SOUND

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1 INTRODUCTION

Although “sound as art” has been of interest to some since the pioneering work of Luigi Russolo[1] in the first half of the 20th Century, it is only relatively recently that sound-art has entered the mainstream (for example, the 2010 Turner Prize was won by Susan Phillipsz for a sound installation featuring her singing versions of a Scottish lament[2], first performed under Clyde bridges in her home city of Glasgow, but subsequently as a recording played in an empty room in the Tate Britain gallery in London). In this paper, we describe a project to create a multi-modal experience, based on sculpture and sound. There is a plan to extend this to a range of gallery and site-specific interactive experiences.

“Resonance” is a sculpture by Richard Trupp, composed of large hollow steel wedges, which is a metaphor commenting on the function of a wedge —its potential to support other structural elements and hold them in place, and its contrasting propensity to intervene more radically and force two elements asunder. We are now extending the project to give the viewer an audio-visual experience by “driving” the wedges – stimulating them with vibrations at their resonant frequencies and harmonics thereof, in order to generate sound.

“Resonance” explores the relationship between the shape and volume of an inner space and its ability to act in kinetic affinity with the spectator through sound. We will use kinetic components, vibrations applied to the sculpture to excite standing waves, causing it to resonate, and tracking sensors to trigger such stimuli when a spectator moves within the sculptural space.

This paper describes and discusses the acoustic analysis involved in this, and the technical features of producing the “sound art” part of the experience.

(a) (b) (c)

Figure 1 Views of wedges forming the “Resonances” sculpture : (a) with sculptor Richard Trupp, (b) single mounted wedge, (c) group of wedges, not mounted.

2 REVIEW OF SOUND ART – RESEARCH CONTEXT

The work of sculptors such as Richard Serra[4], Anthony Caro, Hans Haacke and Conrad Shawcross, as well as that of sound artists Bill Fontana, Bernhart Leither, Harry Bertoia, Robert Rutman and the Baschet Brothers represent the broad context in which the work "Resonance" can be considered.

Much of the work in the field of abstract sculptural has sought to release the dormant sonic component of the sculptural form through movement in relation to the object itself - moving the spectator through and around the physical space - the sonic component being offered to compliment / empower / challenge and question the physical attributes of the object. For example the large-scale metal works by Richard Serra[4] use spatial configurations whereby the spectator's sonic experience is formed by walking through the sculpture itself.

Currently there is a sense that sculpture is on the cusp of a new age - where the most exciting developments in the field occur as a result of interdisciplinary engagement - where the ancient and the contemporary interact and sculpture is able to forge a renewed focus in the domain of public art.

Contemporary sculpture uses physical space as a material to be manipulated - cut, sliced, bolted, squashed, moved and so on. Similar ideas can be applied to a potential resonating space. Bernhard Leitner creates sculptures and sound installations that investigate the spatial trajectories of sound. The "*Sound Cube"* [5] (1970) is a set of speakers on the six walls of a cube, with sound "drawing" imaginary lines, waves and planes that move through the space.

The idea of movement is fundamental to this practice-as-research exploration where the ambition is to produce sculpture that explores the relationship between the shape and volume of an inner space and its ability to act in kinetic affinity with the spectator - releasing sonic potential by sounding or 'voicing' the identity of the sculptural object.

"When sculpture affects flows in space as a function of its siting, viewers are potentially displaced in the experience of the sculptural object inasmuch as the typically invisible framing of space emerges into vision"[6] (Salyer[6], p 229)

Such ideas can now be realised using contemporary digital tools applied in innovative ways along with amended traditional production practices. We have been developing concepts and designs for kinetic components, internally or externally positioned in relation to the sculptural form, to activate a sculpture's resonant potential - to use sonic, subsonic or ultrasonic signals to excite standing waves within the sculpture, causing the object to *resonate* – and to use tracking sensors to trigger such reactions when a spectator moves within the sculptural space. This builds upon ideas used in the performance piece "*Sphere and Cross"* by Sasha Frolova and Dave Lawrence where a Theremin is embedded in a sculpture[7].

This idea is particularly pertinent for large-scale work. The large sheet steel (2.25m x 1.5m x 0.75m) welded and sealed wedge sculpture, when gently hit with a mallet, creates a sound that when first heard appears to signify a space much larger and more expansive than the actual physical sculptural space. This experience seems to contradict the imagined size of the physical outer shell of the sculpture itself.

Hans Haacke (in Sutton[8], p 82) points out that a sculpture which physically reacts to its environment can 'no longer to be regarded as an object' and that a sculpture - 'merges with the environment in a relationship better understood as a "system" of interdependent processes' [8].

Such ideas have been influential in shaping the focus on our explorations where we have maintained an ambition to realise a finished work that 'merges with the environment … as a "system" of interdependent processes". Successfully producing such work will contribute conceptual and practical understandings about space and the transference between digital and

analogue production processes that rely on precise measuring of modeled objects. This has important cross disciplinary significance such as in the design of objects or tools used in open environments where the management of space and / or volume is an issue, e.g. water - air - weather and so on.

Further, it will provide importance knowledge for the fields of art and design, sound design and engineering large-scale sonically resonant objects - where interactive engagement between the physical and the imagined have significance - including the specific areas of multimedia (using video documentation as scaled exemplars), product design (models testing usability experience), architectural space design (where sonic resonance is a factor in spatial consideration) and to observe proposed large-scale public sonic sculpture or objects as a virtual or online experience.

3 TECHNICAL DETAILS AND ACOUSTIC ANALYSIS

3.1 Wedge construction and dimensions

The wedges are constructed as hollow isosceles triangular prisms (the triangular faces of dimensions 2.25m , 0.75m, 2.25m and of depth 1.5m) using mild steel sheeting of thickness 4 mm. The individual sheets are welded at the edges to produce the prisms. A preliminary version of the sculpture[3], as a single embedded wedge entitled “Juggernaut of Nought”, was exhibited at the “Sculpture al Fresco” event at the Great Fosters Hotel in Surrey during the Summer of 2011.

3.2 Acoustic Analysis

It was anticipated that the set of acoustic resonances of a single wedge – let alone those of a set of wedges in contact, and hence mechanically coupled – would be non-trivial. Hence, it was decided to investigate the resonances, and any harmonics, experimentally. Recordings were made of the wedges being struck by implements such as a rubber mallet, which were encoded as .wav format files. These were then analysed using the SFS (Speech Filing System)[9], version 4.8 for Windows, software suite.

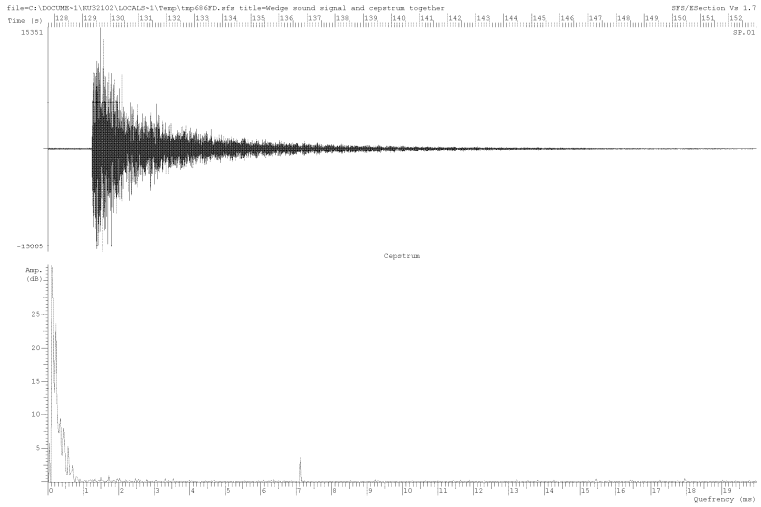

Figure 2 Waveform and cepstrum of sound produced when one wedge is struck by a rubber mallet

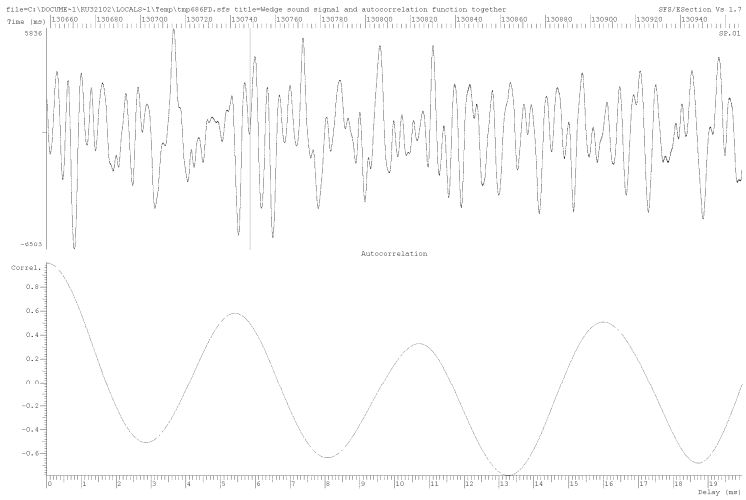

Figure 3 Waveform and autocorrelation function for a portion of the signal shown in Figure 2

Unsurprisingly, the sound waveform produced when a single wedge was struck decayed in amplitude as time progressed, but showed strong periodic components. There was strong evidence of a regular repetition approximately every 5.1ms, corresponding to a frequency component of about 196 Hz. This showed up in both the waveform (when the time scale was magnified) and in the autocorrelation function. However, the cepstral analysis showed evidence of repetition at a delay of 7.1 ms, corresponding to a frequency of 141 Hz. Pitch period and fundamental frequency estimation gave a value of around 60 Hz for the lowest frequency variation present. Allowing for measurement errors, this could be consistent with the dominant repetition being the third harmonic of the fundamental note. However, the sound signal is still undergoing further analysis.

For comparison, the fundamental frequency for sound waves in a rigid pipe, of length 2.2 m and of constant cross-section but open at one end, would be about 39 Hz (λ = 8.8 m), and for standing waves in closed “boxes” of dimensions 1.5m (λ = 3.0 m) and 0.75m (λ = 1.5 m) would be about 114 Hz and 228 Hz respectively.

4 ACOUSTIC STIMULATION OF THE SCULPTURES

It was originally proposed that the wedges be stimulated by external sound beams, using periodic waveforms containing the main resonant frequencies of the wedges, triggered automatically when a viewer approached the sculpture. To date, this has not yet been done due to practical complications – for example, how should this be carried out if the viewer is between the source of the sound beam and the sculpture ? Instead, each wedge is to be stimulated, using a signal containing components at its principal resonant frequencies, by means of piezoelectric transducers concealed within the wedge. This can still be triggered as a viewer approaches the sculpture using motion sensors.

5 DISCUSSION AND FUTURE WORK

This project aims to bring new knowledge to the field of sculpture through the making of work that addresses conceptual thinking about design and production processes. Its aim is to challenge ideas about the relationship between physical and imagined space by investigating the nature of the sonic potential of that space. To also explore the ideas contained within the gestalt of hearing an object that is being viewed – the association of sound with vision. We are interested to extend the idea that questions the coupling of assumed synchronicity. Is this object really making this sound ? Is there some ‘other’ involvement ? If so, what could that be ?

How is the physicality of a sculptural space transformed by realising the sonic potential contained within its form ? How can we describe and evaluate the nature of an inner space ? What are the most significant attributes to be used to excite such a sonic potential ? Where does the line between the spiritual and the scientific become blurred ? These are some of the questions we are continuing to explore through exhibiting the work in different sites and contexts.

By developing an emotive interactive exchange between the physical manipulation of sculptural space and the imagined evocations of sonic space, the work interrogates a range of ideas about public art, its significance and its meaning – political, cultural and social.

Agencies involved in educating populations about environmental issues will find that the outcomes of this project sit well with narratives about the spiritual and physical nature of conservation and the creation of spatial identity - where an object in a space speaks to and with that environment.

This work expects to impact on current attitudes about the 'public art experience' or the 'experience of public art'. We are of the belief that our world is better served when the ancient and the digital together provide a platform for negotiating understandings across cultural, social and intellectual boundaries. The physical and the imagined, the touch and the sound, the object as sound, the object as environmental spiritual guardian and timekeeper - all have power to transfer as workable applications in a range of situations. From fun parks to architectural built environmental design, this work has a multimodal impact footprint, the nature of this footprint being dependent on the focus of the narrative assigned to sculptural outcome and designed adaptability.

Because of the spiritual nature of the sculptural forms, we are approaching churches and cathedrals as possible sites of exhibition - inside or outside the place of worship. The sculptural form in this context sits well with notions of inner space , inner resonance and the idea of the ‘inner voice’. This narrative has the potential to position the twelve wedge sculptures in a context to sponsor discussions about the role of spiritual engagement in contemporary life, where the object has a sonic identity or a voice – a ‘sonic plinth’.

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