Recreating the real, realizing the imaginary - a composers preoccupation with acoustic space - Rob Godman

- **The 'newness' of spatialization?**

For centuries composers have been concerned with spatialization of sound and with the use of acoustic spaces to create feeling, atmosphere and musical structure. The Gabrieli's placed their performers throughout specific buildings (San Marco, Venice for instance), creating 'echo' effects with spatialized antiphonal writing. Musicians were placed in front, behind and above the audience, providing a true surround sound. Some of the sound sources could be seen but many were hidden, playing from high in galleries or in other rooms obscured from the audience. The effect of the physical surroundings was an integral part of the music that was heard. The buildings own inherent filters combining with the speed taken by the sound to reflect from various surfaces to the audience all added to the complexity of the resultant sound. Arguably, it enhanced the spirituality of the music. It did provide a music that was greater than the sum of its parts!
The spatialization of sound is not new. It is not reserved for electro-acousticians armed with batteries of loudspeakers! It is part of all music. What happens to a sound when it leaves the confines of a performer and enters a physical space? Does an acoustic space 'interpret' the sound? Does it have the ability to interact and respond with an instrumentalist? Can the space evolve and learn about events that are going on around it? Does the building and hence its acoustic actually 'live'?

- **Acoustics as a *musical* parameter**

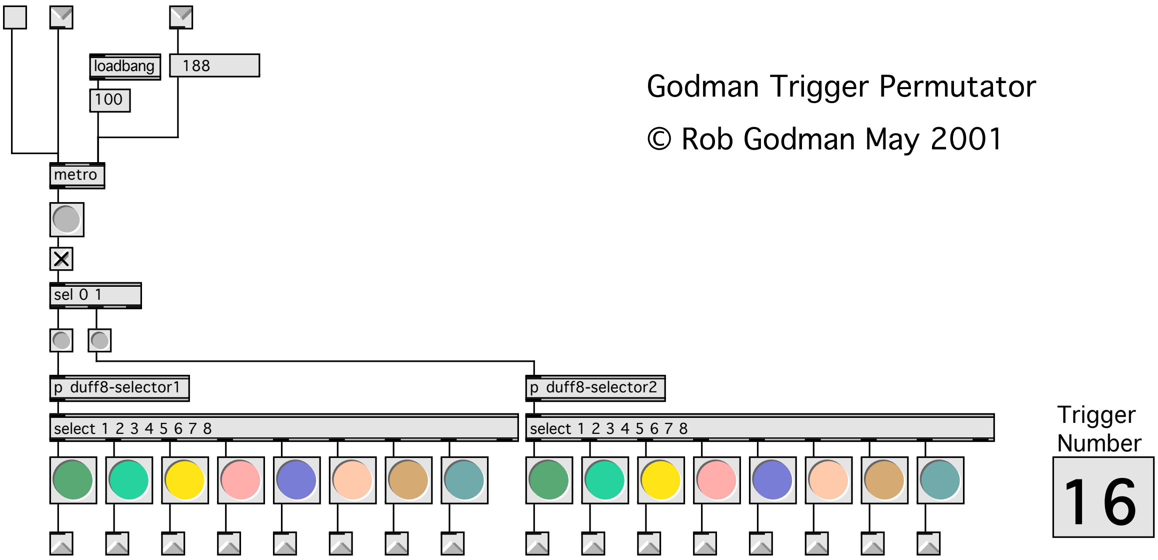
In a traditional musical score, from Classical to late 20^{th} Century composers, we will generally find information regarding pitch and harmony, rhythm and duration, dynamic, timbre; plus many more sound and visually based variables. The composer uses combinations of these to communicate a 'message' in the best language that he or she sees fit.
The score may provide further information as regards instrument placement and other forms of spatialization (this may be particularly relevant if the score contains pre-recorded audio or forms of live electronics that are to be manipulated during performance). Arguably, the score *becomes* music in performance and interpretation. The instrumentalist provides life to the score and in combination with the performance space; it takes on a whole new persona.
The sound is projected from the instrumentalist into a given space and we begin to understand more about the acoustic of the space we are in.
We may begin to describe the acoustic in subjective terms as being *good, bad, lively, dry* etc.
Some of us may go on to describe the acoustic in more scientific and objective terms by analysing the reflections and reverberation times. We might be tempted to physically model an acoustic, this model providing us with detailed information (potentially in terms of numbers)

of a particular space. As a result of this, we may be able to anticipate how a sound might behave in a particular space in the future.

It may be unclear as to the benefit of having this type of numerical information in purely musical and artistic terms (for instance; if the reverberation of a particular hall has an RT 60 time of 3.126 seconds with a pre-reflection delay from the centre of the space of 0.1103 seconds - is this *good, bad, lively, dry*…? Or, *expressive, emotional*, *musical*…? Or simply providing us with information as to where we are in the world?).

If acoustic parameters can be expressed numerically then traditional musical ones can be expressed in a similar way. If pitch and rhythm can be variables, why shouldn't the variables of a particular space be included in a 'score' as well (Room Size, Pre-delay, RT 60 Time, Low and High Pass filters, Early Reflection Levels and Spread, Density, Diffusion)? Well, by using digital means, and a new type of score (a computer programme), of course they can.

FIGURE 1 - a Parameter Permutator (written in the Max/MSP Programming Language)

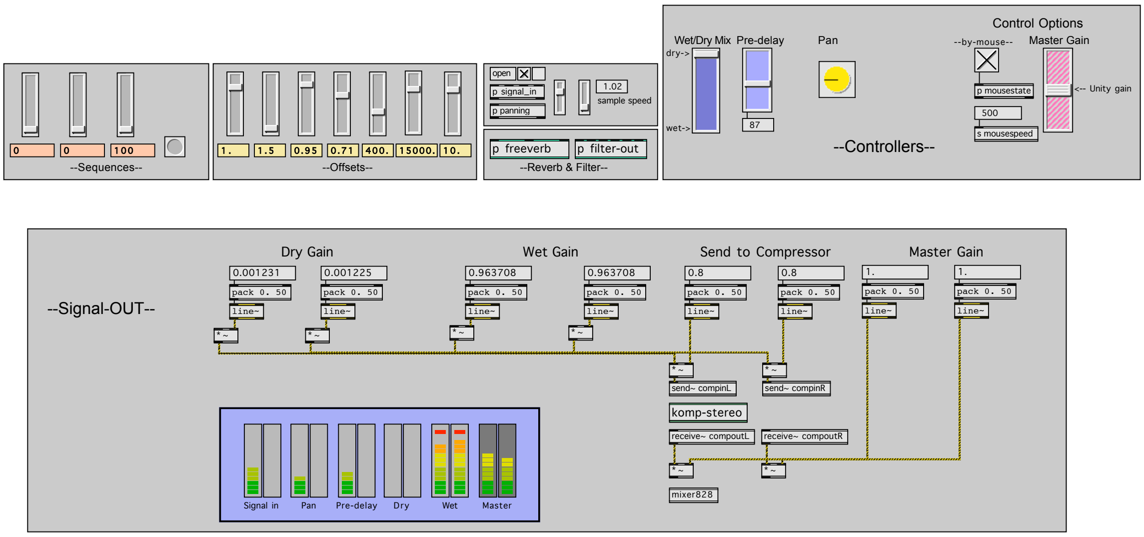


In **FIGURE 1**, [p duff8-selector1] and [p duff8-selector2] permutate a series of bangs (shown underneath the [select] objects). They can be linked to any parameter acting as a variable in Max/MSP (MIDI, pitches, duration, samples etc.). Each bang might be a different setting of an external effects processor, an internal VST~ plugin or individual parameters of a reverberation patch written within the programming language itself (with some of the variables indicated above).

In this case, the variables are being changed in accordance with the permutation patterns derived from English Change Ringing patterns - Duffield 8. As there are 16 outputs altogether, [p duff8-selector1] and [p duff8-selector2] alternate and trigger as a mirror.

As we are dealing purely in terms of numbers, all of the parameters can be manipulated simultaneously with equal emphasis. Potentially, this leads us into a virtual acoustic world that is now no longer dependant upon the physical attributes of our surroundings. A very important question must be asked – are these changes understandable to us as listeners? Can we appreciate the sounds as acoustic space from a psycho-acoustic stance?

<u>**FIGURE 2** - an early spatializer</u>



<u>**FIGURE 2**</u> shows part of a simple early spatializer (distance-panner) patch that enables sound to be moved in a quasi 360º pattern (foreground/background, panning, up/down) within a *stereo* speaker environment. Variables include a Doppler effect, reverberation wet/dry mix, decay time, and high and low pass filters plus many others. In this example, the spatialization is controlled via the mouse. A more developed patch was used for interactive control whereby all parameters were controlled by a single sensor as shown in FIGURE 3. This enabled visitors to travel through real and imaginary spaces.

<u>**FIGURE 3a & b** - *Installation* at Prema Arts Centre, Glos, UK (2000)</u>

<u>**FIGURES 3a and b**</u> show a table containing four LDR sensors. One is controlling all aspects of the Spatializer and the others are controlling a series of comb filters (providing an 'abstract' space). These real time parameter changes were combined with pre-recorded sound files processed with convolution and other forms of cross-synthesis.

Contradictory aural spaces were superimposed with the fixed visual acoustic space within the framework of the composition.

- **Early Science of Acoustics: Vitruvian Resonating Vessels**

The Roman Architect Vitruvius' understanding of acoustics is extremely impressive for its time. He was aware of an acoustical problem caused by the reflection of sound waves, namely that interference to the original source is created by reflections making the original less clearly audible or defined.

Vitruvius called this reflection of sounds *resonantia* (which differs somewhat from our modern day meaning of the word resonance which implies a sound being bounced back and forth repeatedly at a specific pitch).

The *resonantia* would have been seen as a considerable problem in Roman and Greek theatres. If strong reflections come back to a listener at slightly different times, then speech, for example, would have become difficult to understand. As Vitruvius pointed out, an inflected language such as Latin is difficult to understand when the final syllables of words arrive at slightly different times.

These theatres were outdoor venues often built into the side of a hill. The apparent dryness of the resultant acoustic was also a problem for Vitruvius when dealing with music and he went to considerable effort to invent a system that would counteract it. Resonating bronze vessels were his solution to this problem.

"...let bronze vessels be made, proportionate to the size of the theatre, and let them be so fashioned that, when touched, they may produce with one another the notes of the fourth, the fifth, and so on up to the double octave.

"...the voice, uttered from the stage as from a centre, and spreading and striking against the cavities of the different vessels, as it comes in contact with them, will be increased in clearness of sound, and will wake an harmonious note in unison with itself."

Vitruvius, The Ten Books on Architecture, translated by Morris Hicky Morgon.

Arguably, the vessels might be considered an early artificial reverberation unit, with specific frequencies enhanced and others excluded. Obviously 'real' reverberation does not function in such a way. How well might these vessels have worked? It remains unclear.

- **… and before Vitruvius?**

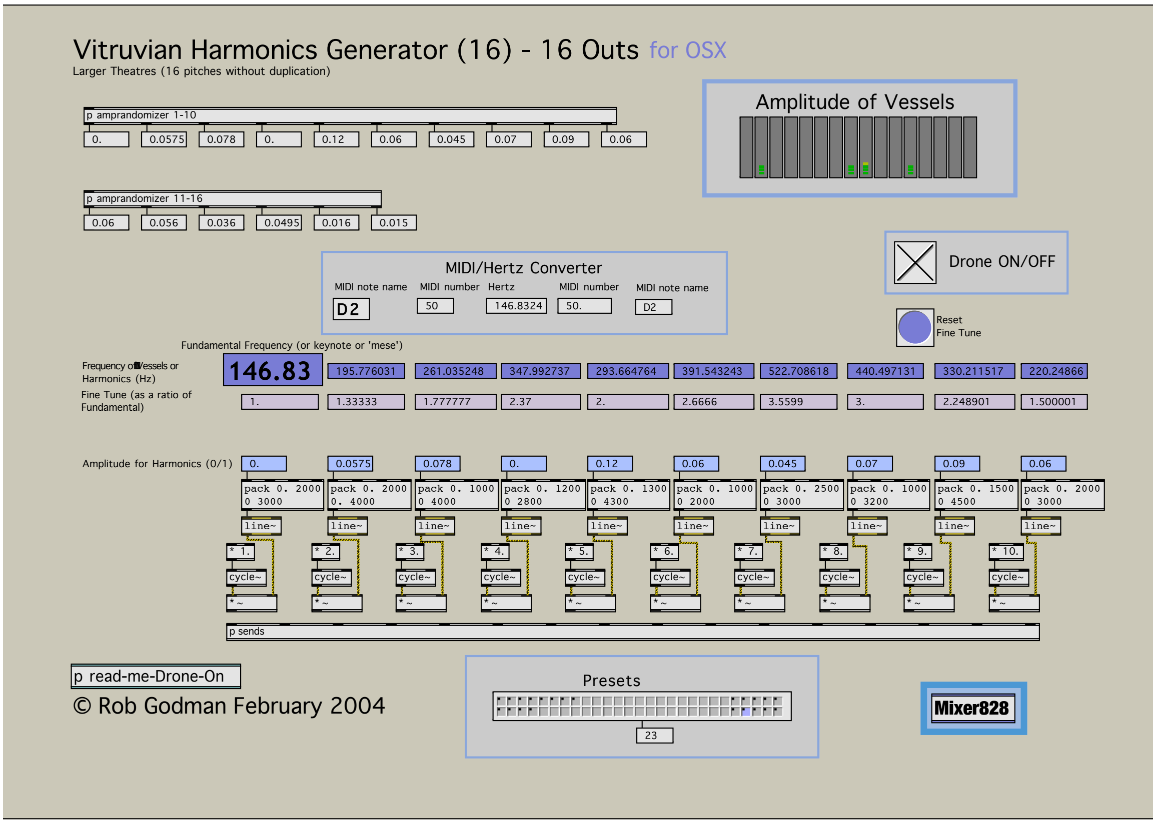
There has been a significant amount of research produced other the past ten years that attempts to prove that ancient prehistoric stone structures and burial chambers were constructed with acoustic properties in mind (*Aaron Watson, Reading University*). Whilst the overall purpose of such structures is still debatable and far from singular, ancient man is likely to have been aware of how sound was able to 'appear' from sources where there was no visual confirmation (i.e. the source of the reflection of an echo would not have to have the original sound source visually present). It can only be imagined how these sounds might have been interpreted. So, when we visit Stone Henge or the Avebury Stone Circle, are we seeing a cathedral for worship, an open sanctuary associated with a sky-god, a monument dedicated to a fertility cult, a huge clock, or; a series of reflective stones for the diffusion of sound?

FIGURE 4 - *Avebury Stone Circle*

- **Virtual Reconstructions**

My interest in the Vitruvian concept was born partly from the combination of science and the arts that was prevalent in Greek and Roman times but also from a psycho-acoustic stance into the vessels effectiveness. Clearly, the Vitruvian vessels were dependant on external sound stimuli to be heard. Vitruvius stated that the vessels were to be 'touched', presumably meaning that sound waves from a sound source (a musical instrument for example) would radiate outwards and 'hit' the vessels making them ring sympathetically.
As much of my work has involved attempts at abstracting acoustic spaces from their sound source it became clear to me that with the aid of digital technology, it would be possible to abstract the ringing vessels from any sound source by simply triggering its sound mathematically. It would be possible to hear a Vitruvian resonance without the influence of any other sound.

<u>FIGURE 5</u> <u>- a Vitruvian Harmonics Generator</u>



<u>FIGURE 5</u> is an additive synthesis patch consisting of sixteen oscillators (ten shown here). The programme can be used to trigger the oscillators via external sound (using percussive or pitch detection objects, [bonk~] or [fiddle~] for example), which would be close to the original function of the Vitruvian vessels. Video input via SoftVNS, other sensor input or via a quasi-random process for automatically 'sounding' the oscillators are also possible. As we are in the digital domain, we are not dependant upon further physical constraints – my Vitruvian vessels do not have to decay once 'struck', nor are they dependant upon external sound sources to resonate!
Ironically, what began as an experiment (what would these vessels really have sounded like?), turned into something of an obsession. The assisted resonance has featured in most of my work over the past four years, whether it is virtually or physically though the use of musical instruments.

- **Sampled acoustics – Impulse Responses**

By clapping your hands in a church, you are listening to the church's response to the impulse your palms have made. Commercially available convolution reverb software is now available for anyone with a processor fast enough to run it. What this means is that it is possible to 'sample' an acoustic and use it as a plug-in of your choice. *Audioease* have developed Altiverb™ that allows the user the opportunity of combining a dry input sound with an impulse response created in a real acoustic environment. They have provided *Impulse Response Pre-Processor* software that allows the user to create their own impulse responses.
Combinations of the two applications allow samples of any acoustic environment to be made. These can be conventional acoustic spaces with which we are familiar (rooms, buildings etc.) to unusual spaces whose 'acoustic' may seem very alien.

There are a variety of ways of recording such acoustics – the most common being recording the impulse of a starter-pistol. Convolution is a technique capable of remarkable results (see http://www.soundhack.com also).

FIGURE 6 - *The Pantheon, Rome*

Take a picture of the acoustic of **FIGURE 6** in a similar way to taking a picture of the image…

- **From air to water to solids to music…**

Over the summer of 2002 I worked on two installation projects, both exploring how sound might behave in different environments. ***Solid*** (a collaboration with glassmaker *Colin Reid*, Prema Arts Centre, Gloucestershire, UK) took the viewer through an imaginary virtual journey as if they were inside the glass rather than outside in the atmosphere listening to the glass resonate.

Inside the Eye of Silence (a collaboration with harpsichordist *Vivienne Spiteri*, New Adventures in Sound Art, The Chemistry Building, Toronto Island, CA) explored the concept of resonance within the harpsichord. Individual pitches from the instrument were recorded with the resonance of each pitch being abstracted from its source (i.e. the attack was removed). By using a technique known as *Granular Synthesis,* we were literally able to 'freeze' the resonance in time. It was no longer dependant upon physical constraints (causing decays for instance) enabling us to fully explore the 'sound' of the harpsichords resonating chambers. The work was presented in a multi-room environment using an eight-speaker diffusion system. It enabled listeners to explore different aspects of the harpsichords resonance by virtually walking within its sound. A version of the spatialization software

(FIGURE 2) mentioned earlier in this paper was used to further enhance the feeling of movement and journey through the virtual space.

Most of us will have no wish to be physically inside a solid but the closest we can come to experiencing a truly unique physical surrounding (that is survivable!) is to be underwater. The artistic possibilities for presenting work underwater and for bringing the physical attributes of an underwater acoustic into the atmosphere are huge, something that I am continuing to research.

FIGURE 7a & b - *Ephemeral Cube/Solid* at Prema Arts Centre, Glos, UK (2002)

FIGURES 7a & b - glass sculpture by Colin Reid as part of *Ephemeral Cube/Solid* – a quadraphonic work providing an artistic interpretation of the inner resonance of a block of glass.

- **Conclusion**

We live in a multimedia age, where our senses *should* combine to create a global picture. In reality we are swamped with visual information that greatly overrides other stimuli, particularly aural. So why manipulate space? It has been my experience that by producing aural and visual pictures that are contrary to each other, the viewer may explore their total surroundings in much greater detail. With the aid of technology, the sound that you 'see' does not have to be the same as the image that you 'hear'. An acoustic does not need to be fixed; it can evolve and change through time. It can be a reconstruction of a physical space or an entirely abstract environment.

Many of us take ambient sound for granted. When John Cage visited the anechoic chamber (an environment designed to be echo-free, with all surfaces insulated with absorbent material producing a space that might be as near silent as technologically possible) at Harvard University in 1951, he maintained that he still heard two distinct sounds coming from within the space (unavoidable sounds as Cage puts it!). One sound was high, which he claimed to be the sound of his own nervous system and the other low, the sound of his blood circulating. As a result of these experiences, Cage proposed that the term silence should now be described as 'non-intentional sounds', or, from a compositional viewpoint, sounds not intended or prescribed by a composer.

Clearly Cage is 'forcing' the listener to listen in a very new way. The sound source is now far from obvious. We are listening to the whole, to everything, to the acoustic, to the ambience. With these thoughts in mind, imagine how virtual reality environments could be developed to *really* produce the true picture! If a picture is worth a thousand words, then surely a sound is worth a thousand pictures. The ambience and acoustic is all encompassing. It describes our sense of place.

The resonating vessels as specified by Vitruvius demonstrate a very early ‘solution’ to an acoustical problem. Vitruvius was creating an artificial ambience for a particular purpose. As a composer, I have found the potential resultant sound world to be of much greater interest than the ‘problem-solving’ for which it was intended. The Vitruvian ambience takes on a new function – sound for sounds sake.

Composers and artists must continue to pose questions to the world. It is my hope that they will continue developing new things to listen to *and*, new ways of listening…

References

-Landels, John G. Assisted Resonance in Ancient Theatres - Greece and Rome XIV, Routledge 1967
-Landels, John G. Music in Ancient Greece and Rome, Routledge 2000
-Vitruvius. The Ten Books on Architecture, Dover 1960
-Robert G. Jahn, Paul Devereux, and Michael Ibison, Acoustic Resonances of Assorted Ancient Structures (J. Acoust. Soc. Am. 99(2): 649-658. February 1996)
-Burl, Aubrey, Prehistoric Avebury, Yale University Press 2002
-Roads, Curtis, The Computer Music Tutorial (for Granular Synthesis, 168-184), MIT 2001
-Roads, Curtis, Microsound, MIT 2003

http://www.thedark.net (2004)

http://www.soundtravels.ca (2002)

http://www.digitaljourney.org.uk (2002)

http://www.philophony.com/pages (2001)

http://freespace.virgin.net/colin.reid2/ephemeralCube.htm (for further details on Ephemeral Cube/Solid)

http://www.cycling74.com (for information regarding the Max/MSP programming language)

http://www.audioease.com (for information regarding Altiverb)

http://www.soundhack.com (for a free convolution engine)

This paper was first presented at the Pan-American/Iberian Meeting on Acoustics, Cancun, Mexico, December 2002 and again at the Leeds International Music Technology Education Conference - Sound-Image-Space: Applying Music Technology, Leeds, UK, October 2004

Rob Godman

The University of Hertfordshire, UK

r.godman@herts.ac.uk - +44 (0) 1453 521895