Earth Pulse: vibrational data as artistic inspiration.

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Abstract

The use of scientific data to create artworks has always played an important part in the arts, and music has been no exception. The impact of developments such as electricity, the phonograph, the cassette recorder and the now ubiquitous computer on the aural arts is well documented. This paper looks at a different influence however; the use of scientific data as a source for musical artworks, in particular the use of seismic and other low frequency data logged in various formats. As sound art offers different ways to experience aural media, this paper looks at some artists who have experimented with methodologies to create works using meteorological, geological and hydrological data.

Keywords

Music – vibration - sound art - installation

Introduction

"Imagine: everything you hear now was very, very slow, very, very wide" (Hess 2001, 127)
Audible sound for human beings - known as the audio frequency range - spans approximately from 20 Herz (Hz)– 20kilo Hz (or ten octaves, using musical language). The threshold of hearing is defined as the point at either end of this range where the sound is no longer audible to the human ear, and our hearing ability gradually fades. The hearing threshold varies slightly from person to person, and depends on a variety of factors – loudness, the age of the listener, past hearing damage and the environment in which we listen (Leventhall 2008, 12).

Infrasound is a term used to define sound below the audio frequency range, that is below 20 Hz. Sounds below this threshold can be audible if they are amplified at sufficient volume, but the ear does lose its ability to define pitch or even a tone (ibid.,13). Whilst infrasonic microphones can record signals as low as 0.1 Hz, the reproduction of these sounds is a problem. Powerful amplifiers can generate enough volume yet speaker design struggles with efficiency issues in relation to low frequency reproduction. Most amplified infrasound we hear is the sound of the mechanism engaged to reproduce it.

Infrasonic information that has been collected for scientific purposes can be altered to become audible by transposing the infrasonic range into the audible range. This most often involves a literal transposition which involves the 'speeding up' of a recording, transposing it to a high enough pitch that is in the general audible range, which also makes the duration of the recording shorter. Another method is to assign tones to data and then applying the relationships existing between the data to sonic relationships. But importantly, the source material needs to be composed. That is, to consider them as art or music they need to be organised, contemplated, created and/or controlled to some extent.

Where is infrasound found?

Infrasound occurs commonly in the natural world, where most infrasound recordings are made. Certain animals emit infrasound, usually for communication purposes. This includes whales, giraffe, alligators, hippos, rhinos, lions, okapi, tigers and several birds. For example, infrasound is used for long-distance communication in African elephants allowing communication for up ten kilometres. Their calls range from 15-35 Hz and can be as loud as 117 dB (Larom et al. 1997, 421). Man made infrasound is also common, usually as a by product of heavy machinery such as air conditioners, ferries and aircraft engines, but also sonic booms, explosions, sub woofer speakers and even travelling in a car at speed with the window open (Bryan and Tempest 1995, 398). The Comprehensive Nuclear-Test-Ban Treaty Organization looks for infrasonic signals as one of its monitoring technologies. But it has been the infrasound emitting from nature that has provided the majority of stimulus for artists to date. Wind, rain, ocean surf, avalanches, lightning and thunder all emit infrasound to varying degrees (Marrin 2004,1). The infrasonic sound wave that is generated by a volcanic explosion can be so large as to propagate around the earth several times. Explosive volcanic eruptions and other related activity such as earthquakes are recorded using arrays of infrasonic microphones and notated with seismographic plotters.

Environmental Infrasound translated: composing with data

American artist John Duncan (b1953) created a composition released as a CD recording entitled *Infrasound – Tidal* (2003) that features a variety of infrasonic sounds transposed into audible ranges. It features the musical manipulation of tidal, atmospheric pressure and seismic movement data provided by Australian acousticians Densil Cabrera and Arie Verveer. The source material is fundamentally scientific audio representations of scientific data that follow meticulous rules of time compression as to make them workable. Duncan manipulates them into four movements coming together to form just over 41 minutes of unique musical representation of scientific inquiry. The piece is divided into four interlocking sections.

The tidal recordings are based on tidal spectra collected from sixty ports around the Australian coastline. These sounds have been resynthesised using sine tones and sped up 32 million times allowing one year of tidal activity to be translated into one second of audio. The different strengths of tides at varying locations are evident and the period of the sound waves can range from 23 to 24 hours in length. The spectra consists of around 20 diverse frequencies, and as raw recordings (available on Cabrera's web site) create extended, sinuous sounds with gentle undulations and interesting harmonic relationships resulting in strange chords and volume combinations of the different components unique for each location. Duncan plays with these sounds using stereophonic effects, adjustments in volume and slight changes of sound colour. The result is a smooth drone coloured by minuscule detail and phasing effects.

The seismic data featured in the release was recorded using seismometers located on the property of Arie Verveer in Kalamunda, in the foothills near Perth, Western Australia, in 1998. Unlike the tidal material, these were recorded in stereo creating an audio image not unlike that recorded with an eight microphone array. Seismometers have a dipole sensitivity pattern, so the North-South data and the East-West data were used for the two audio channels. A wide variety of activity was recorded, including a nuclear test in India, an earthquake in southeast Taiwan and varying local micro-seismic noise. The original material was recorded at a sample rate of 40 Hz and was converted to the standard audio format, 44100 kHz by Cabrera. These produce very different recordings to the tidal information, as defined events can be heard – clicks, pops and rumbles, with a surface noise not unlike record hiss. There is a lot of down time in these recordings that are full of smaller detail. The earthquakes sound like an explosion, the nuclear test has a lot more spiky and discontinuous activity. Duncan respects these spaces and junctures in his manipulation of the material, and uses the more defined sounds to bookmark the start and end of this lengthy middle section of the piece.

The third component consists of barometric data obtained from the Australian Bureau of Meteorology, measured at Laverton and Williamtown Air Force Bases over a fifty-year period. The sample period for these recordings was usually around six hours and the data was supplied in text format. Cabrera devised a simple computer program that converted this text into a sound file. The atmospheric 'tide' and sudden pressure changes can all be heard in the short rather raw sound files. They combine the drone texture of the tidal recordings with the hissy nature of the seismic. Continuous tones are layered with spiky, yet constant sounds, at times sounding like a distortion effect. As with the tidal recordings, the resulting sound was sped up so that one year's record corresponded to one second of playback - that's about 32 million times faster than the original recording, and here we have some 48 years of data. As a result, the yearly tide is compressed into these small sound bytes. Duncan's manipulation of them results in the most low frequency part of the piece, the drone here is a rumbling, cavernous almost machine room like atmosphere, swaying

through rolling and gently surging patterns.
Duncan initiated this project after he noticed a forum post by Cabrera offering up his recordings for use. Duncan had never met Cabrera – any communication was by way of email and not much communication re the use of the recordings seems to have been made. Cabrera's sounds had also been used by choreographer Tess De Quincey in her site specific performance work, *Form of Scent* (De Quincey Company, 2001). Duncan points out that he has destroyed what he calls the 'inherent linearity of the scientific data', modifying the sound into layers and destroying its original shape (Duncan 2003). There are three elements of construction in the work; the data collection, its translation by Cabrera and the musical composition process applied to it by Duncan. These long dark, dense and continuous pieces play with the idea of listening to the world beneath and around us. Listening to this recording is like being underwater in a vacuum, where the slightest change in the texture of the sound becomes a significant event. It reflects Duncan's interest in the nature of drone, and this recording investigates a variety of them: humming, buzzing, scraping, pure and dirty. Reviewer Daniela Cascella proposes that Duncan's intention is to suggest the atmosphere of scientific research: the isolation, the long flow of eventless moments before arriving at a relevant discovery (Casella 2003).

Air Pressure Fluctuations – from scratch
Dutch sound artist Felix Hess (b1941) began his career as a physicist and started making art in the early 1990's where he became known as a sound artist working with semi-autonomous sound machines. Hess describes his interest in sound as being an interest in sensitivity, and is preoccupied with creating works that listen (Schultz 2001, 37). He prefers the term 'air pressure fluctuations' to infrasound, a literal translation of what all sound is, but more specifically the way infrasound is experienced by us. His work *It's In the Air (cracklers)* (mixed media installation, 1995) uses small machines that indicate changes of air pressure as short clicks. After extensive testing in his own home, Hess found these machines sense not only the weather and wind but also the opening and closing of doors, the movement of human bodies and activities many meters away (ibid., 60). By transposing very low volume, low-pitched recordings of air movement into articulations of the audible range Hess's installations and instruments make complex patterns of vibration and movement appear to our senses as audible qualities.

Hess's recording *Air Pressure Fluctuations* (2001) is a single 20-minute recording taken in the coastal town of Noorlaaren, The Netherlands, where infrasonic microphones are placed some 64 meters apart and set to record for five days (Hess 2001, 126). The recorded infrasonic air pressure changes are presented at 360 times their original speed to allow them to become audible. Here all the recording and transposition is done by the artist himself using self-constructed tools such as a number of digital microphones. These are fed into computer software by way of a sound card and manipulated by Hess.

As a result of the transposition process on *Air Pressure Fluctuations,* one second of sound on the Compact Disc is equivalent to six minutes of original time. An hour of sound, as featured on the disc, is a translation of 15 days and nights. Likewise, the recorded sound range between 0.03Hz and 56 Hz is transposed to between 18Hz and 1800Hz. This creates radical changes in the original recorded material and Hess suggests characteristics of these new sounds. What was originally the deep rumbling of a factory he describes as a high pitched, insect like sound (ibid., 64). Every four minutes indicates the start of a new day where he identifies there is a flurry of activity. Hess even claims to be recording microbaroms, a sound created by standing water waves on the very top of the Atlantic Ocean. Transposed, they sound like a very low drone, almost an aircraft engine. These create signals of less than one Hz, so even transposed they are still technically infrasound. In this recording, sounds we would not normally notice due to their low pitch and volume become clear and articulate. Others are completely transformed, unable to represent their source even when we know the sounds origins.

Air Pressure Fluctuations presents a series of high-pitched whistles, beeps and buzzes, some recognisable as natural sounds, others lost in the translation and becoming something new. Sounds such as the opening and closing of doors, machines and vehicles are redescribed from kilometres away. In this process nature and the man-made change places, they filter each other. These are not simple representations: rather they are interpretations through time, space and capture.

Sounds of Decay - in real time

In my own work, I have investigated low frequency sounds emitting from decaying matter as part of the sound art collective *Metaphonica* with sound artist XXXX. During a 2005 artists residency at the art science laboratory Symbiotica, we initiated a project entitled *Sounds of Decay* (multi media installation, 2005 to date), where methodologies for recording infrasound using time lapse were investigated. Unlike Hess and Cabrera, *Metaphonica* was not interested in transposing the sounds we recorded. Rather, we wanted to filter the frequency range of the sounds to record, keep all the sounds in their original length, and join them together into a large loop that grew in real time. To facilitate this combination of requirements, a MaxMSP program written in association with XXX was devised to control the desired frequency range to be recorded, and to be recording continuously so as to enable the recording of any sound to begin at the very start and absolute end during the slow decay process of a dead animal in a controlled environment (interface illustrated in Figure 3). The program would dispose of recordings outside our preset frequency range s well as recordings of silence, and then send any saved recordings to a simple itunes loop that would grow longer as material was added. The preset range for recordings was 10 to 40 Hz, determined after investigations into recordings of insect activity. Recent research into the European House Borer, a destructive pest in pine forests, has demonstrated that listening for low frequency sounds is the best way to detect insect behaviouri. We used a hydrophone inserted in the decaying corpse and a peizo microphone on a skin surface to record the audio.

The sounds are not dissimilar to Cabrera's seismic sounds – there is a lot of small detail (usually flies and fluid movement) layered over notable 'events' (such as the collapsing of sections of the corpse). After these initial experiments in the field we plan to exhibit the decaying animal (which has been a guinea pig in our first experiments) in a controlled environment so as to speed up decay and contain odours, alongside the building loop of live and recent sounds played back through a sub woofer system. The sound pressure level is adjusted to enable audibility of all sounds – lower sounds are boosted by way of volume, not altered in any other way. This is in an attempt to keep association between the sounds and the process linked – the data is as it sounds (there are no sine wave versions of data as provided by Cabrera) and the sounds, whilst they may surprise, do connect with the sound source as it is presented simultaneously in the room.

Conclusion

Humans can hear over ten octaves of sound as mechanical vibration, yet only a single octave of light as electromagnetic vibration. It could be said that as a result of this, our hearing provides a more robust sense of our environment. Yet these artists are looking to extend our encounter of reality even further by transforming the normally inaudible into the human hearing range. *Infrasound – Tidal*, *Air Pressure Fluctuations* and *Sounds of Decay* are works that listen. They operate at a timescale beyond the normal linear perspectives where music often operates. Rather than simply seeking to evoke a feeling of timelessness like most drone music, these infrasound recordings work on a concrete timescale that is simply larger than humans can usually comprehend. Like the notorious *John Cage Organ Project,* which presents Cage's relatively short keyboard composition entitled *ASLSP (As SLow aS Possible)* (1987) over a period of 639 years, these works examine time. They take natural processes that would normally defy comprehension and transform them into a human timeframe, evoking the mystery of the earth's natural rhythms.

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i Associate Professor Adam Osseiran in Edith Cowan University's Electron Science Research Institute uses infrasonic microphones to identify, characterise and differentiate the sounds of the European House Borer larvae.