GEO SOUND HELMETS: BREATH-CONTROLLED INSTALLATION

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Geo Sound Helmets is an interactive and immersive installation of personal sound environments controlled by the participant's breath. *GSHelmets* are geologically inspired over-sized objects containing new technologies and soundscapes from specific geographic locations. The project explores aural geography, art/technology/audience collaboration, sensory interactivity, artist as facilitator, and audience as simultaneous composer/listener.

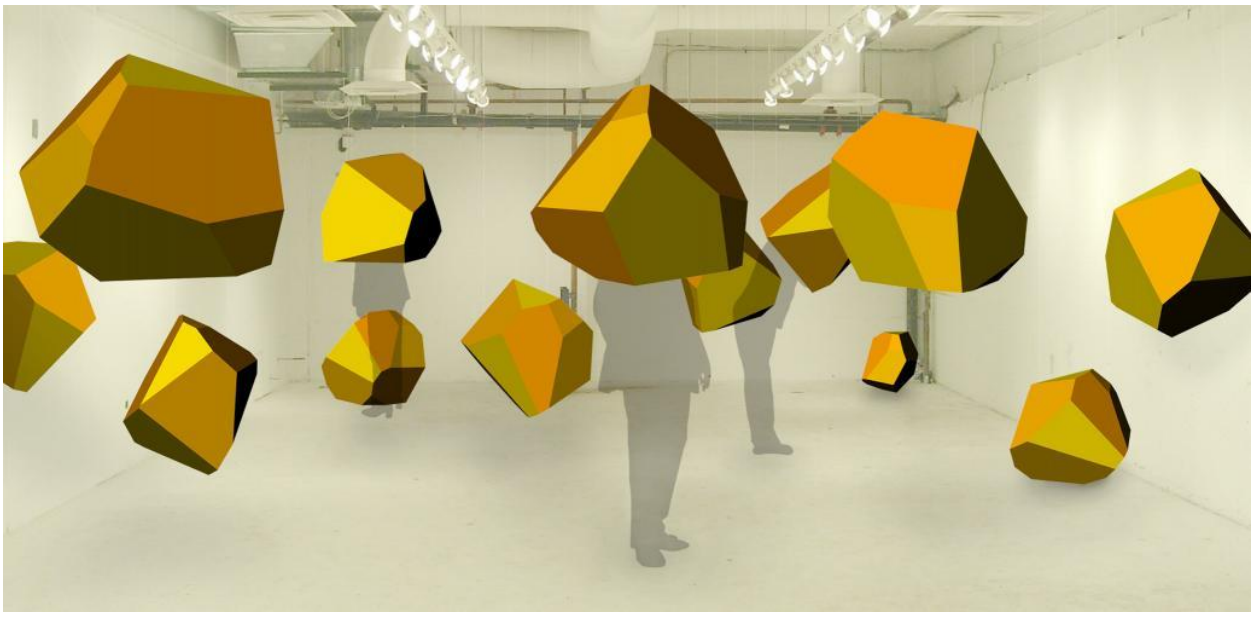

Fig 1. Geo Sound Helmets – installation concept, 2011, Ben Landau, digital image. © Ben Landau and Cara-Ann Simpson.

Fig 2. Geo Sound Helmets, 2011, Cara-Ann Simpson and Ben Landau, digital image. © Cara-Ann Simpson and Ben Landau.

Geo Sound Helmets (referred to as *GSHelmets* for brevity) is a series of immersive and interactive personal sound environments. *GSHelmets* are irregular shaped helmet-objects containing surround sound Vibrating Technology Speakers (VTS), motion detectors and breathing sensors. *GSHelmets* investigates how an individual's control over their biological impulse to breathe and move can be applied to drive an artistic and creative project. The project creates personalized sound worlds of geographically distant locations where the individual has control over the audio composition by changing their breathing patterns and shifting within the object.

The term 'geo', which is often used as a prefix to mean 'of or relating to the earth,' is important to the concepts behind *GSHelmets.* The sound recordings used as the basis for the compositions within *GSHelmets* are field recordings from specific physical locations, and as such they strongly relate to the use of 'geo' as geographical. Similarly, the design of the objects is influenced by the idea of 'geo' as geological and references the rock and gem cutting where strong planar surfaces exist in an asymmetrical geometric structure.

GSHelmets explores differing roles of artist and audience, interactive installation within public spaces, new technologies within art, and the importance of physicality. As an exhibition *GSHelmets* questions the validity of the author/artist as sole creator and suggests that the artist (and collaborative team) lays a foundation for the public to mould and manipulate into his or her own artwork or composition. Thus the artist's role within *GSHelmets* is that of facilitator, while the public becomes simultaneous composers and listeners. This paper will discuss *GSHelmets* in the context of other artists' works, cultural theory relating to social and environmental sounds and the listener, object design, and the technology involved.

The physical construction of the installation invites participants to within the space to put their head and shoulders inside different helmets where they will hear three-dimensional manipulated soundscapes from locations including (but not limited to) Australia, Singapore, Hong Kong and Canada. It is important to note that the helmet-objects are quite large and are not worn as helmets; rather, they are attached to existing architecture and act as isolation booths for the participant's head and shoulders (refer to Figure 1). Motion sensors built into the helmet enable the unit to be switched on automatically when a participant interacts with the object, and switched off when the participant leaves. Similarly, breath sensors (located between 10-30cm from the participant's mouth) detect changes in breathing patterns and react in close to real-time to manipulate the soundscapes according to the participant's breathing pattern. The sound is altered as the person breathes faster or slower, more deeply or more shallowly, or moves substantially within the helmet.

Human senses are intimated connected, and in particular our internal processes have large, subliminal effects. For example, during a heartbeat (which is quite noisy and causes the entire body to pulsate) proprioception and other senses are modified, leading us not to notice our body changing as we are accustomed to the phenomenon. Similarly, when we work in time with breathing it makes subtle changes more difficult to notice. We are, however, used to a number of natural bodily functions occurring when we breathe such as varying blood oxygen, which directly affects alertness. Using sound spatialization algorithms, in particular, is an interesting investigation into subconscious bodily changes and modifications of our senses as it will be relatively difficult for people to detect exactly how the soundscapes are being altered.

Bernhard Leitner's (b. 1938, Austria) project, *Headscapes* (2003), is designed to exist neurologically within the physical constraints of the listener's head and uses headphones for listening. [1] Leitner's

practice is dedicated to hearing sound through different parts of the body, and in *Headscapes* the listener's head becomes a new type of interior acoustic architecture where the experience is solitary and encompassing. [2] In many ways this work is the more extreme step taken from his body of work, where interior architecture and highly designed objects embrace the listener to cradle and enforce a particular type of listening that is specific to the human body.

Maryanne Amacher's (1938-2009) work, *City-Links* (an ongoing project from 1967) explores the sonic potential of urban environments. This work in particular, shows how site-specific sound can be transported to a different location. The work's outcome in the early 1970s for example, used a microphone installed in a window at the New England Fish Exchange in Boston (overlooking the ocean), which transmitted the live sound to Amacher's home studio. [3] This work engages with the idea of aural geography being used to portray 'absent locations' - where the site of the sound is removed from the audience's location. *GSHelmets* utilizes aural geography to portray the character and search for the keynote sounds (and frequencies) and find soundmarks (i.e. an aural landmark) that are unique to a site.

This idea of locations having unique aural identities is exemplified in *World Soundscape Project (WSP)*, initiated by R. Murray Schafer in the late 1960s from Simon Fraser University, Vancouver. The project recorded environmental sounds to understand the principles of aural geography (also known as acoustic ecology). The ultimate aim of the project was to examine the aural impact of humanity on the environment and to find solutions to balance the ecological soundscape. [4] The project also caused the notion of locations having unique aural identities through the detection of keynote sounds and soundmarks. [5] Schafer understood, however, that sounds are intrinsically different to the visual and can never be understood in the same way. [6] He suggested that "Seeing is analytical and reflective" and that sights could be described as nouns. [6] Conversely, Schafer suggested that sounds and "soundings" are active and generate actions, that "sound are verbs." [6]

GSHelmets' use of aural geography underpins another concept within the work - the exploration of the differing roles of the artist and participants or audience. The project questions the validity of the artist as sole creator and suggests that the artist lays a foundation for the public to mould and manipulate into his or her own artwork or composition. The artist's role within this project is that of facilitator, while the public become composers and listeners. Achim Wollscheid's (b. Germany) work, *missing recipient* (2004) uses the Akademie fur Tonkunst in Darmstadt to monitor movement on the stairs of the lobby, which in turn triggers corresponding moving lights. Environmental noise from the immediate surroundings is recorded, manipulated and played back in real-time. The work enables the audience (general public) to manipulate and interact with the installation on a very subtle level. [7] *Missing recipient* uses motion detectors, real-time audio effect and public interior spaces to investigate the physiological reaction of the audience that is determined by psychological decisions in a similar manner to *GSHelmets*.

This idea of the artist as facilitator and audience as composer is also apparent within the electromagnetic induction works by Christina Kubisch (b. 1948, Germany). Kubisch has worked with this technology since the late 1970s. Using wireless headphones Kubisch enables participants to wander freely around the space - whether this is within an art gallery, park or urban landscape. Kubisch suggests that the participant becomes a "mixer" who has control over the composition and duration of their experience. [8] The works work in a similar social manner to *GSHelmets* in that they isolate the individual participant to experience a personal soundworld that immerses and encompasses the participant in sound. *GSHelmets,* however, creates a small personal sound environment - an interior architecture within interior architecture. It isolates the participant to enable full immersion of an absent aural location where the actions of the individual determine the outcome and duration of the composition.

The act of isolating the participant occurs for three reasons, the first being to highlight the contemporary trend of deliberate isolation in public and social situations, such as individuals using headphones and mp3 players to listen to music on public transport or when exercising in public spaces. These examples draw on Michael Bull's suggestion that individuals feel the need to create personal sound environments in which they live daily. [9] With this in mind, *GSHelmets* acts to re-create a personal sound environment for the participant, and to then introduce the second reason for this isolation. Environmental sounds that individuals are deliberately wanting to block out are re-introduced to the participant in such a way that seeks out the beauty and subtle musicality of these locational soundscapes. This re-introduction of environmental noises also facilitates the ability to listen and understand the aural geography of a location that an individual may not have visited. For example, a listener from rural Australia could listen to a cityscape of the bustling metropolis of Hong Kong.

These ideas draw on theories posited by philosopher Roland Barthes and sound artist Pauline Oliveros. In 1984 Barthes proposed that hearing was physiological, whilst listening was psychological, suggesting a formal separation between the two. [10] *GSHelmets*works on both levels, where the subtle physiological changes of the body (and of hearing) can alter the audio, thus creating a psychological awareness of listening to the soundscapes and looking to deliberately alter the outcome. Pauline Oliveros suggested a new form of listening, which she labeled "deep listening" where the listener is open to the entire field of sound - a deliberate psychological decision to incorporate the surrounding environmental soundscapes. [11] This form of intense listening to the audible environment as a holistic guide reveals the situation specific nature of sound that depends not only on a particular site, but also on circumstantial time in which the field of sound was deeply listened. In this way the soundscapes presented in *GSHelmets* are not only locational to the aural geography but to the times and dates of the recordings as well.

The design of the helmet-objects is particularly important to the philosophy of *GSHelmets* as the comfort, both physiological and psychological, of the participant is paramount. The use of VTS technology allows the helmets to be slim-line and lightweight, where the interior of the object is seamlessly integrated into a singular component. The design of the installation objects is informed by their intended use, the term 'geo,' and the idea of the group of helmets acting together to form an installation. The helmet's use relies on the inviting nature of form and promise of sound permeating within. The functionality of the helmet relies on the positioning of the sensors around the inside edge of the helmet, which need to be aligned with the users face, in order for them to affect the audio output.

The angled form of the helmets references the term 'geo'. An initial exploration of geo revealed designs that represented earth itself in a geocentric view. This centered on geodesic domes which were attractive for their even form and integral strength. However, a more powerful metaphor was found in geological nuggets. The irregular angled forms reference crystal growth, while the sound bites are compared to precious stones captured from the earth. The angled forms are offset to form a skin within the helmets to give the idea of a geo interior.

The group of helmets forms an installation in a gallery space or thoroughfare. They therefore need to make an impact in the space. The modular and irregularly angled silhouettes form a stark contrast to clean walls, and regular, expected interiors. The bright and complementary tones reference precious or unusual geological finds, and again stand out in the monotone environment such as the gallery space (refer to Figure 2). The specific design of the helmet also impacts upon the layout of the sensors and components within the object, which have precise requirements for functionality.

The technical components of *GSHelmets* are comprised of a breath (humidity sensor), and an InfraRed (IR) LED sensor for detection of the participant, which are interfaced to an Arduino microcontroller connected to a computer running Max/MSP. Breathing is sensed by detecting humidity and since exhaled air is close to 100% relative humidity, breath can be easily detected. In order to avoid processing the ambient humidity changes as a signal (10-70% is common), the project uses differentiators to extract only the short-term, time-varying component of the humidity signal. This signal will decrease if the ambient humidity is high (>80%). The humidity sensor used for *GSHelmets* has a relatively slow response time; thus, the derivative of the derivative is taken (chaining two differentiators of different speeds) to obtain a strong signal.

The presence of the participant is sensed with an IR LED and sensor (a bright LED is used). The infrared receiver is designed for conventional use in TV remotes, where the IR light is modulated (turned off and on) at 38kHz to avoid interference from background and outside light. The 38kHz signal is turned on and off a few hundred times a second to ensure that the sensor is not overloaded; this compensates for background light levels by turning the receiver sensitivity down (automatic gain control).

Both sensors are driven and read using an Arduino microcontroller. The firmware has been modified from the default standard to enable the project to drive the LED at 38kHz, whereas standard Arduino timers are limited to <25kHz. Modification was required with the computer serial interface, as the default Arduino serial routines are not compatible with the 38kHz signal generation. This has resulted in more complex software, but is compensated by straightforward hardware as specialized 38kHz circuitry is not required. The IR receiver is directly interfaced to the Arduino digital inputs and drives a test LED, while the humidity sensor is interfaced to analog inputs. The inputs are converted to numbers and sent to the computer over a serial port.

Max/MSP was used for the prototype of the installation, reading from the USB serial port and performing the double-differentiator filtering as described above. Each differentiator stage subtracts a delayed version of the signal from the current signal, which calculates how much the signal has varied in that time. A moving-average smoothing filter occurs before and after each differentiator. The first differentiator is reasonably slow (1000ms difference), and serves predominantly to remove the ambient humidity signal. The second differentiator is faster at around 200ms and detects the breathing cycle, rejecting the ~5 second slower components of the sensor response. Together, these filters work effectively to reject the large changes in the input signal that occur while someone moves close to or away from the sensor.

The ‘head’ sensor is used to gate the audio on or off and uses a slow fade for a perceptually smooth transition. Positive humidity peaks (exhalations) control an effect applied to the signal. The humidity signal is tied to a wet/dry reverb mix, where the filter output is most apparent at maximum humidity. This generates a time-varying effect controlled by the user’s breathing, and is intended to permit perceptual manipulation. Surround sound spatialization in the helmets have initially been produced through amplitude panning and phase decorrelation, with a view to implementing state-of-the-art near-field 3D sound spatialization algorithms**.**

Geo Sound Helmets is an exciting project that will continue to evolve and develop as further geographical compositions are added to the installation. The work enables a diverse audience to interact and become composers and creators, while the artist and collaborative team facilitate. By isolating individual’s to re-introduce them to the audible environment surrounding them and in absent locations, *GSHelmets* questions our societal trends and how we interact with each other, as well as our environment.

The technology involved in the project demonstrates the validity of incorporating new and evolving technologies into creative projects that can enrich the experience of the audience.

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