Assemblages For Sound Work

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Material and Method: Encoded Practice

The following folio of documents provides six snapshots of context for a body of art research, aimed towards the sonification of virtual events in the computer-mediated environment.

The work is characterized by the synthesis of an art practice, a reflective process and an investigation into auditory display mapping strategies. The art practice involves the organization of electro-acoustic sound representing virtual events. The reflective process involves a theoretical basis and encoding of the art practice into a software sound performance framework. In this way the software or code can be viewed as the art material and also a formal documentation of the techniques of the art practice. The mapping strategies form a generative process, which traces the virtual events and describes methods for rendering the electro-acoustic sound. Since this is essentially a creative positive feedback system, special attention will be taken to establish limits on the systems' complexity, so that functionality is maintained. The functionality is the communication of the virtual events as an audio augmented reality, or sonification. Since this system also is self-referential, special attention will be taken to open the system, through collaboration, open source methods and public presentation.

Context: The Computer-Mediated Environment

Science fiction author William Gibson is accredited with coining the term cyberspace, to describe an immersive Internet virtual reality. In his genre, dubbed cyberpunk, Gibson describes an Internet with it's own geometry – a spaces with territories and zones. The Gibsonian cyberspace is immersive, a virtual reality. Gibson's world is a hi-tech dystopia in which technology pervades the everyday experience, and so the genre also bares the literary moniker Near Bad Future. The prospect of a society in which there are hundreds of microchips for every person on the planet peering back at us, could be scary. In his keynote speech to 2000 Conference of Human Factors in Computing Systems (CHI2000) and opening of the Interaction Design Institute Ivrea, John Thackara, outlined this problem, and introduced the discipline of Interaction Design as focusing on solutions to it.

Thackara (2001) notes that computing is becoming pervasive and invisible. The ideas of ubiquitous computing developed at Xerox Palo Alto Research Center (PARC) in the early 90s are a reality today. 'In 1998 some 4.8 billion microprocessors were sold, only 2.5 percent of those where for personal computers. The other 4.7 billion chips went --- where? They went everywhere. They're like cockroaches. Only smarter', Thackara (2001) tells us. But why the view them as cockroaches you may ask, why not flowers, as science fiction author, Bruce Sterling, also working in the cyberpunk genre, states, 'you will go to look at the flowers and the flowers will look back at you'. Thackara has read his cyberpunk, and quotes this same statement from Sterling. Thackara's alarm stems from the focus that technological development is taking. Humans have been treated as just a factor in computing; the focus has been toward the technology itself away from humans. Computing problems have been solved creating more computing problems to be solved, while almost nobody is looking at technology in the light of human needs and desire. The Faraway project (Andersen et al, 2002), performed at the Interaction Design Institute Ivera, is a counter example. In this project surrealist creative methods formed the basis of a qualitative research methodology used to uncover human desire.

Andersen, K. Polazzi L. Jacobs M (2002), "Faraway", (i f o n l y), Available: http://www.ifonly.org/ (Accessed: 2002, December 28).

Thackara, John (2001) "The Design Challenge of Pervasive Computing", Interactions, May/June 2001.

Paradigm: Technology as Cultural Material

I see people continuing to invest their collective time and energy into the computer-mediated environment. To quote Thackara (2001) again, 'We cherish the fact that people are innately curious, playful and creative. We therefore suspect that technology is not going to go away; it's too much fun.' Until recently computer interfaces were not created in the spirit of fun, they were designed to be task based, and allow us to get our work done. This is changing rapidly, now we are looking to our ubiquitous computing environment for entertainment, and social interaction. But instead of going into the virtual reality, and focusing on the technology as another world, I would see the virtual being pulled back into the physical world, augmenting reality. The virtual is being mapped onto the actual, augmenting it.

In his book Information Arts, Stephen Wilson (2001), catalogs the work of more that 200 artists have performed in 82 scientific research areas. He argues that technological and scientific research now influences every corner of everyday life. Thus science and technology have **cultural** effects, which can benefit from the critical perspective and traditions held by the arts. The recent pop in the financial hi-tech sector's speculative bubble has spurred questions of how useful it has been to rely on speculative financial markets to guide technological direction. Wilson (2001 p.6) further notes that the effects of scientific and technological acts have changed our view of the world and our humanity and have had profound philosophical effects. Specifically communication technologies have challenged our ideas on time, distance and space. It is thus no wonder that artists, who are in the forefront of social and philosophical change, are engaging with science and technology as a medium itself. Science has been less reciprocal in acknowledging this state of affairs, but now faces the challenges laid out by Thackara, Wilson and others (Newby, et al 2002); to acknowledge the poetic nature of scientific/technological works.

Newby, K. & Dulic A. (2002) "Encoding Practice – Visual Performer in Electronic Theatre", Journal of Media Practice, Vol 2, No. 3.

Thackara, John (2001) "The Design Challenge of Pervasive Computing", Interactions, May/June 2001.

Wilson, S. (20001) Information Arts: Intersections of Art, Science, and Technology, MIT Press.

Forum I: Sound as Mediator, Acoustic Ecology

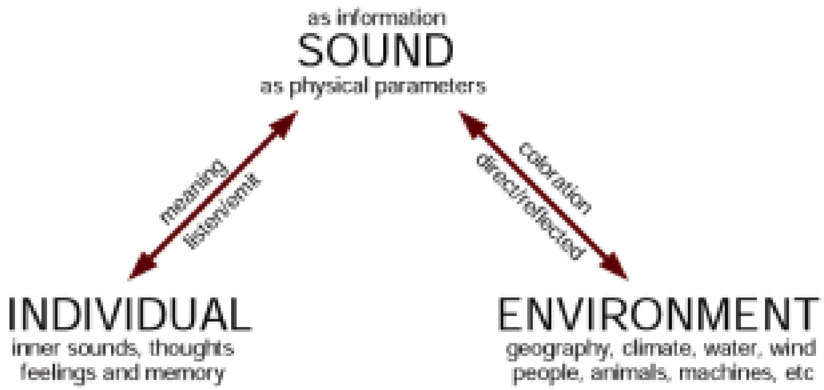

Figure : The Acoustic Communication model illustrating the mediating role of sound

Barray Traux (2001) and R. Murray Schafer (1977) have established the discipline of Acoustic Ecology in their classic works Acoustic Communication and The Tuning of the World respectively. These works explore the roles of sound in the environment, and have displayed and formalized how the audio spectrum is a rich resource that is shared and utilized by natural processes for communication. In particular Schafer characterized a hi-fi soundscape, as an environment where masking by noise and other sounds is absent, with the result that sounds of all frequencies "can be heard distinctly" (Schafer 1977, p 43). Their Simon Fraser University (SFU) colleague, Hildegard Westerkamp, rephrased this stating there are 'no anonymous sounds', (in the hi-fi soundscape). Beyond connecting sounds to their originators, Schafer notes that acoustic coloration caused by echoes, reverberation and absorption as sound bounces around a space, gives listeners information to navigate their environment. Kendall Wrightson writes in his excellent Introduction to Acoustic Ecology, "The resulting colouration offers significant information for the listener, providing cues relating to the physical nature of the environment and expressing its size in relation to the listener. This fosters a sense of place for individuals as they move around the community" (Wrightson, 2000). The Acoustic Communication model illustrating the mediating relationship between the environment and an individual through sound is pictured in figure 1.

This sense of place is not communicated to us from the virtual environment with the subtlety and range of expression found in the acoustic ecology. Current mobile devices and virtual and augmented reality systems suffer from the same technological focus Thackara laments. They do not reflect the complexity of invisible physical interactions, like sounds in the acoustic environment do. They are not aware of the acoustic ecology they are involved in, and thus do not react based on their context. Perhaps sound can mediate between the virtual environment and individuals.

Schafer, R. M. (1977) The Tuning of the World, New York: Knopf, republished in 1994 as The Soundscape, Destiny Books, Rochester, Vermont.
Truax, B. (2001) Acoustic Communication, Second Edition, Ablex Publishing, London.
Wrighton, Kendall (2000) “An Introduction to Acoustic Ecology”, Soundscape, vol. 1, no. 1, pp 10-13.

Example: Sonification of a Virtual Landscape

Presented at the 2001 International Conference on Auditory Display, Babble Online is project which sonifies, in real-time, the web browsing behavior of visitors to the www.lucent.com website (Hansen, et al. 2001). This project was designed to convey qualitative information to the website content providers, designers and visitors. It aptly demonstrates the initial ideas of reflecting virtual processes (web traffic) to give listeners a sense of activity in their eminent virtual surroundings. The sonification can be heard online (Hansen, et al. 1999). Specifically the auditory display system was designed to answer the following questions:

- What is the overall level of activity of the website, is it busy or quiet?
- What proportion of the visitors browse depth within the site, as compared to those visitors who briefly view the home page and continue elsewhere?
- How are users distributed across the various content areas of the site?
- Which portions of the site are visited together?
- What kinds of patterns can be found in user behavior?

Lucent's website is divided into five main content areas. A low-pitched drone effectively provides the answer to the first question. This activity drone is a make up of 5 continuous pitches each of which varies in loudness according to the aggregate number of visitors in each area of the website. As visitors browse deeper down the hierarchical branches of the web site architecture, their behavior is categorized as mid or deep level browsing depending of their distance from the site's home page (the top). The volume of mid level accesses is sonified as a middle register rhythmic tone. The pulse loudness, repetition speed rises and the timbral brightness increases with increased volumes of browsing at this level. Deep level browsing is mapped to an even higher pitched voice, with a characteristic plucked steel string timbre. Both mid and deep browsing sounds, are synthesized at 5 discrete pitches to allow listeners to differentiate in which of 5 different sections the access is occurring.

The acoustic design is ambient and consonant. The 3 layers of symbolic representation (total volume, mid and deep browsing) can be quite clearly picked out. Patterns can be identified such as a correspondence between web accesses in the search area followed by access in the enterprise area, which is suggested by the observation of coinciding pairs of tones. However no semantic tie is provided between the 5 web site areas and 5 pitches. To extract this relationship the listener needs to be able to identify pitch intervals and have explicit knowledge of the mapping between pitch and website sections.

Aural phenomena are exquisitely multidimensional. Tempo (repetition speed), loudness and pitch are readily mapped in this sonification, however the timbral complexity is under utilized.

Brightness is redundantly used along with loudness and tempo as representation of volume in mid level browsing. However, David Wessel (1982) has shown that brightness best articulates stream segregation. Fixing brightness across web site areas or browsing levels streams would have provided more identifiable beacons to the layers of representation, rather than varying brightness to an analogic parameter.

There is more potential for informational display using the multiple dimensions inherent in complexities of timbre. This project seems to fall into the trap of what Douglas Kahn (1990) refers to as the "musical conceit", where mimetic sound is discarded in favor of “received musical notions”. The display could be trying too much to be a piece of music and in the process throws out much potential for more sophisticated meaning making.

Hansen, M. H. et al. (2001) “Babble Online: Applying Statistics And Design To Sonify The Internet”, Proceedings of the 2001 International Conference on Auditory Display, Espoo, Finland.

Hansen, M. H. et al. (1999) “Experiments with Web Traffic Data”, [Internet], Brooklyn Academy of Music, Available from: http://stat.bell-labs.com/cm/ms/departments/sia/ear/samples/web_traffic/, [Accesed 21 April, 2003]

Khan, D. (1990) “Audio Art in the Deaf Century”, in: Lander, D. & Lexier, M. (eds) Sound by Artists, Art Metropole & Walter Phillips Gallery, Toronto & Banff.

Wessel, D. et al. (1982), "Exploration of Timbre by Analysis and Synthesis," in Deutsch, D. ed, The Psychology of Music, Academic.

Forum II: Computational Processes as Medium, Auditory Display

Formed in 1992 the multidiscipline of auditory display (AD) is involved in the rendering of information as sound. The researchers in this new field have sought to complement the visual graphical user interface with its audible counterpart. Similarly to the acoustic ecologists their starting point is the way humans use sound in the everyday environment, but their focus is more technological and less communicational. The AD texts tend to view data and information with little distinction. Their model is the generalized computational processing model: Input data is captured or generated. This data/information is processed to enhance its representational meaning – normally to allow humans to detect patterns in the data. Finally the data is rendered as acoustic output. The auditory display's function is to 'help a user monitor and comprehend whatever it is that the sound output represents' (Kramer 1994, p.1).

The generalized system is composed of 3 parts; information generator, communicative medium, and information receiver.

- The information generator is a database, generative computer model or, possibly real-time data-capturing component.
- The communicative medium is a digital replacement for the physical acoustic propagation medium. This heart of the AD system includes data receiving means, intermediary structures providing the mapping from data to sound, and the sound generator.
- In AD terms the listener is dubbed as the information receiver.

This model is typically unidirectional: information flows left to right, input to output. Similar to the linear signal-processing model, this information-processing model does not acknowledge the active role of listener or the role of context that is fundamental to the acoustic community model.

In the signal-processing model, the signal flows from source to destination, in a series of systematic effects, there is little room for feedback, which is treated as a dangerous potential for undesirable noise. Feedback is important in the computer-mediated environment (CME), where the interactor's sense of agency is a "characteristics delight of electronic environments' (Murray.1997, p. 126)

Despite the atavistic ties in the AD model to the signal-processing model, the multidisciplinary nature of the research performed in AD, seems to have softened its effects. AD draws on cognitive and experimental psychology, psychoacoustics, communication, education, computer science, mathematics, statistics, linguistics, psychomusicology, sound analysis and synthesis, physics, economics complex systems, machinery and instrumentation and sociology - truly a bewildering array. We will proceed by looking for generalizable conceptual apparatuses in AD.

Analogic/Symbolic Representation

If a AD functions to 'help a user monitor and comprehend whatever it is that the sound output represents', we should ask in what way the display represents information?

A symbolic representation describes a categorically denoted representation, where the symbol replaces the information, and stands in its place. The symbol is discrete or is composed of discrete elemental quanta that do not correspond to the internal structure of datum being represented. A doorbell is a good example, where the structure of the bell tones and the structure of the event that caused the tones have no correspondence.

An analogic representation reflects an immediate and intrinsic correspondence between the structure of the represented information and the representation itself. In analogic representation there is a mapping or tracing of the data, where structural features are directly represented or extracted but are not categorized. This means that relationships present in the representation are structural homomorphs of the relationships in the data being represented. A good example would be a Geiger counter, in which a change in the rate of clicks corresponds to a change in the amount of radiation present.

The distinction between analogic and symbolic representation is not binary but forms a continuum. AD systems employ combinations of analogic and symbolic representation. On one side of the continuum is sound produced by direct mechanical interactions which is the most analogic. Spoken language is placed on the other side of the continuum because in speech the symbolic sound of 'cat' does not have even onomatopoeic reference to a cat.

Kramer (1994a) adds another dimension to this continuum. He sketches the horizontal analogic/symbolic continuum with a added vertical dimension. This new dimension seems to indicate the degree of abstraction away from the real world soundscape present in the sonification. In this sketch the division between analogic and symbolic representation is indicated strongly at the lower levels of the real world soundscape, but weakly in more abstract sonifications. There is a sharp distinction between speech and sound produced by physical interaction. Kramer points to a greater blurring of the analogic/symbolic divide as we look at more abstract representations.

Sonification of pure data can be performed using an astoundingly arbitrary array of both symbolic and analogic mappings. Since a single sound percept can be synthesized using multiple parameters, both symbolic and analogic mappings can be used concurrently as parameters of the same sound. Data can be grouped or sorted into discrete “pigeon holes”, which provides symbolic structure to the sonification. For example, streams of data could be associated with identifiable instrument types (horns, woodwind, etc). Then a mapping function can be used to analogically display the data’s numerical relationships over time using pitch. This would yield a hybrid display forcing us to place it in the middle of our continuum.

Spatialization can add an analogic quality to a symbolic sound, where the relationships between sounds can be represented as relative distances in space. Earcons were initially conceptualized to function as symbolic icons of virtual events. But they have been analogically parameterized to reflect the dynamic properties of their event’s structure (Gaver 1994). The classic purely symbolic earcon sound is an analog of an everyday sound. These earcons are not analogs of the information involved in the virtual event. For example when selecting a GUI desktop object a sound similar to tapping a small real object is produced. In this example there is no analog of the computer’s actions required select the desktop object in the earcon.

Finally the dichotomy of analogic and symbolic representation is upset during listening when the human cogitative processes pick out signatures from complex analogical representations. Over time foreground signatures are learnt as gestalt formations comprised of elements that where not fused together by the AD mapping. These elements come to symbolize the events that they coincide with and a symbolic language emerges around them. This is what musicians and SONAR operators are trained to recognize. In the AD literature these signatures are termed beacons (Kramer 1994b). Once beacons are learnt and if they are static, listeners can disregard the analogic representation, and work in a symbolic realm. Dynamic beacons convey a hybrid analogic/symbolic function, symbolizing a class of events with the analogical component providing details, which may not be understood, but can differentiate one instance of the event from another. If beacons are strung together they can start to function analogically again, because the relationship between symbols can be discerned as an arrangement that displays a contour formed by the sound symbols. This arrangement can be used by the AD in analogical representation.

Gaver, W. (1994) “Using and Creating Auditory Icons”, In G. Kramer (ed), Auditory Display. Addison-Wesley.
Kramer, G.(1994a) “An Introduction to Auditory Display”, In G. Kramer (ed), Auditory Display. Addison-Wesley.
Kramer, G. (1994b) “Some Organizational Principles for Representing Data with Sound “, In G. Kramer (ed), Auditory Display. Addison-Wesley.

Algorithmic Composition: Creativity and Mapping

The signal-processing model is broken, most profoundly, by Bargar (1994) who asserts, 'Auditory display may be approached as a collaboration between sound designer and listener, where sounds inform a listener to extract information from them. The listener determines how to extract meaning based upon previous encounters with sounds carrying information' (Bargar 1994, p. 152, original emphasis). Here the listener is active, and the sound designer and listener are peers. In fact, the sound designer caters to the listener, by considering her previous experience with sound. Looking to the listener's action of reception, Bogar show how we can start to determine what the AD needs to display for communication, as opposed to what it can display, and what communication might result. This model positions the composers as message designers predicting the potential presence of listeners capable of formulating meaning from a repertoire of auditory signals, and prompts the search for structures in music composition that can 'inform auditory display designers of the descriptions of listeners and sound-production techniques' (Bargar 1994, p. 153). The structures of music composition, established through creative exploration, have become the subject of scientific research for techniques. Technology is gleaned from art making. Bagar extracts many insights into the functioning of artificial (non-speech, non-environmental) auditory communication. These are especially valuable guidelines for the representation of abstract data, which also have no speed or environmental analogues.

Leitmotivs

Leitmotivs, short musical themes associated with a character or narrative event, and sound effects have been used extensively in computer games. Game players can glean a type of auditory foreshadowing, by attending to these sounds.

Frames of Reference

Sounds can be used to set up a frame of reference, and do not to represent the information, but form a contrast to the information. In music sounds form a background (e.g. harmony and tonality), which changes slowly compared with the foreground features (rhythm, melody and ornamentation). Abrupt changes in the background texture can serve to illustrate a change of context.

Multimodal Frames of Reference

Audio augmentation is often subordinate to text, image or actions, if these other modes of communication occur concurrently, observers may extract correlations between the modes. For example, the text may be viewed as ironically stated because of a sound effect present. To avoid unintended messages composers have developed techniques to accommodate or disengage these correlations, which occur between the audio and non-auditory frames of references. For example, the stage separates listeners from performers, and allows one to disregard the significance of fellow audience members' actions.

Unintended Messages

The composer does not have perfect knowledge of the frames of reference the work will be exposed to during a performance because their are hidden frames of reference present in the listener's memory. The performance may then use a sound that triggers significant symbolic reference to other sounds. If this is undesirable the composer may wish to articulate the relationship between his or her sounds and the history of sounds in the local environment, in an attempt to ground the sounds a tradition and avoid unintended messages.

Auditory Display Techniques

- Inflection augments syntax and influences content, such as providing importance. It is derived by analogue with vocal expression. Inflection maybe synthesized by altering timbre and loudness.
- Meter and rhythm summarizes local time into groups, which allows listeners to predict the on set of next group.
- Register allows the formation of a perceptual voice or musical stream, which improves the display of simultaneous sequences.

The above observations, show how musical structure can be studied to reveal valuable and functional techniques for auditory display, these can be used to increase the intelligibility and complexity of auditory display. It also lays the groundwork for a type of audio design that might be better termed algorithmic composition. Studies like Bargar's are valuable and need to be extended to incorporate a close reading of electro-acoustic and soundscape compositional methods, in a reflective process. Unfortunately, a recent qualitative study of six algorithmic composers' mapping strategies did not reveal any generalizable concepts or techniques (Doornbusch 2002).

Bargar, R. (1994) "Pattern and Reference in Auditory Display", In G. Kramer (ed), Auditory Display. Addison-Wesley.

Doornbusch, P. (2002) "Composers' Views on Mapping in Algorithmic Composition", Organized Sound, vol 7, no. 2.

Endnote:

The preceding sections inform my proposed sound work. Here we will link them together into the big picture. Firstly we established a context, the computer-mediated environment then I indicated a view of technology as culturally significant medium.

In the introduction I stated the aim of "representing virtual events". I would like to restate this as the notion of **mediating virtual environments through sound**. By the virtual environment I mean the growing invisible digital system of networked computing devices. But we might also extend this meaning from the CME to the more general meaning of virtual: that which is in effect but not directly in evidence. Certainly we can get a hint of sounds role in bring awareness to invisible processes in our everyday experience of listening. This role, of sound a mediator of environment has been thoroughly explored by Acoustic Ecologists. While we know that humans have an interest in technology, we have not directly spoken of an interest in the virtual. What is the case for the human intent to be aware of virtual events?

Here the Babble-Online example contextualizes this case. The extended project (termed a Listening Post) was exhibited at the Whitney museum of American Art in New York. But the idea of human investment in the virtual is still puzzling; some people do see themselves invested in the virtual space, via their homepages on the internet. They are interested in the activity around the virtual home. But many people view the internet not as a space, but as a medium for interpersonal communication or a tool for completing a task. These people may be more interested in a silent perfectly functional medium, without noise interfering with the signals they are trying to send. Since humans are not natives of cyberspace, I would suggest an approach for constructing an audio augmented reality that represents virtually in the everyday, rather than complete immersion into cyberspace.

Is such a representation is a software composition or instrument? Are we making tools or perhaps some things more - an encoding of the programmers point of view? In an attempt to establish some grounding for this research we have looked briefly at the conceptual frameworks of Acoustic Ecology, Auditory Display and Algorithmic Composition. Acoustic Ecology provides a description of a coherent soundscape characterized by complexity and variety in balance. Auditory Display provides valuable computational strategies for information and sound processing, such as spacialization. Lastly, Algorithmic Composition as an art practice in a critical discourse can provide a guiding role for the use mapping to form meaning.