Cyberspace and sound[1]

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1. Introduction

The emerging Virtuality Reality[2] (VR) technologies promise to provide composers with the means of exploring immersive cyberspace (computed space) and the new musics therein. Yet their usefulness continue to be hampered by a wrong paradigm: that the perception of 3-space is primarily visual.

The hearing organs are formed very early in a developing embryo and are fully mature before birth. In-utereo the foetus is already becoming aware of the "outside" world through sound. Upon birth and weeks before the eyes have developed focus, the ears continue to function in exploring this new world. If permanent damage is sustained in the first post-natal weeks to even one ear (through injury or infection for example), spatial perception, and perhaps even more interesting, spatial *reasoning* is permanently affected, possibly because neural pathways normally completed in the environment post-natally, (a adaptability feature of evolution), are not so completed. This is clear evidence that hearing is our first and primary sense when it comes to the perception of 3-space.

2. Stereo

Many interesting works of electroacoustic music made since 1945 are now approximately impossible to experience. Whilst one can occasionally catch a five-channel performance of *Gesang der Jünglinge*, almost none of the multitude of the historically important quadrophonic works are readily accessible, and the situation regarding multichannel works is even worse. Despite its inadequacies in representing anything but the basics of spatial information, stereo has become became the norm. Whilst this 2-channel restriction has encouraged multichannel performance spatialisations, they remain spatial realisations; performing the same function as orchestrations in the timbre domain.

This position has been exacerbated by the saturation of the Digital Compact Disk. The Dolby 5.1 format and it's family, with the centre-front channel being used to "widen the stereo image" and the rear channels being used for sound effects, is essentially designed to enhance the domestic cinema experience and relegates it to being just another spatialisation technology: enhanced stereo, if you will. The inclusion of more channels for sound in the DVD format will at least permit the distribution of soundfield encoding formats such as ambisonics.

3. Sound of space

Todate, stereo and it's enhancement technologies and techniques have entrapped spatial thinking into a Cartesian conceptualisation, which treats space as though it is an empty cube, or worse still an in-front sound-stage, into which sound is placed and/or moved. As I have outlined elsewhere [Worrall 1997][Worrall 1998][Worrall 1999], there is another, more topological way of thinking in which, rather than 3-space being the canvas onto which a musical idea is inscribed, it is thought of as a omnidirectional verigated field which is composed of sound. Sound is *of* a space. Composition involves topological deformations, transformations and morphologies of these soundfields.

Fortunately there is a calculus for non-Euclidean spaces. Hyperbolic geometry was first developed independently by Nicolai Lobachevsky (1793-1856), János Bolyai (1802-60) and Karl Gauss (1777-1855) in the early 1800's and later extended by Georg Riemann (1826-66), in 1854. Frank Morgon [Morgan, 1993] gives a readable introduction. The topology of conoids (elipsoids, paraboloids and hyerpoloids) have particularly interesting applications in acoustics and psychoacoustics and could form the fundamentals of a compositional calculus for soundfield transformation.

4. Immersive cyberspace technology

The creation of cyberspaces (computed immersive perceptual spaces) have, to date, been dominated by attention to detail in the visual domain. The most immersive of these is known as the CAVE.

4.1 The CAVE

Figure 1.

[1] Proceeedings, ACMA Conference, University of Wellington, Wellington, N.Z. July 1999

[2] The term Virtual Reality, as Brian Massumi eloquently points out [Massumi 1998] has unfortunatley shown a distinct tendency to decompose into an oxymoron and has quickly degraded into a synonym for "artificial" or "simulation".

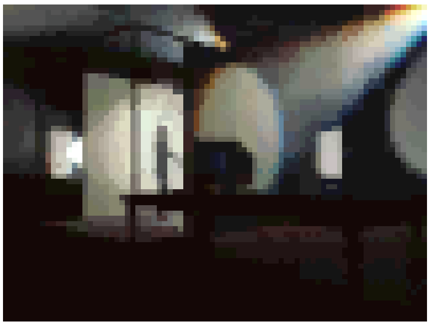

Figure 2.

The CAVE was created by the Electronic Visualization Laboratory at the University of Illinois, Chicago in 1991-92. It is a 10x10x9 feet “cube”, made up of rear-projected screens for walls and a reflective projection for the floor. See Figures 1 & 2. The images are projected in stereo, so that users wearing stereo glasses find themselves immersed in 3-D space. A user's head and hand position and orientation are acquired using a tracking system with electromagnetic sensors. The CAVE user can put projected images in motion and isolate segments of images for analysis or repositioning. Computer-controlled audio provides a sonification capability to multiple speakers. The CAVE can hold up to 10 people, each of whom will experience many of the visual and auditory sensations that simulate "being there."

4.2 The WEDGE

With setup costs of approximately US$1.6M, the CAVE is quite expensive. The WEDGE project was started at the ANU in 1996-97. It is led by Rod Boswell and Henry Gardner who were motivated to build a VR system that would be affordable and appropriate for typical scientific applications in Australian Universities and which could be readily modified as computer and projection technologies change.

Figure 3.

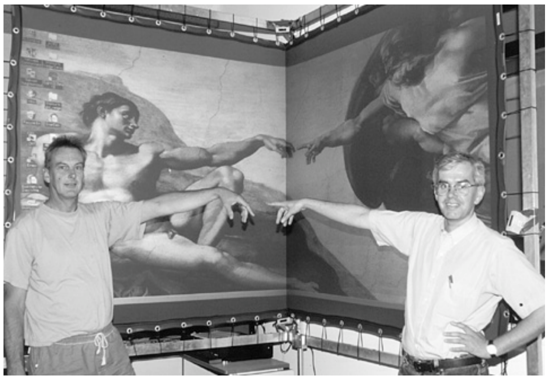

Figure 4.

An early configuration (see Figures 3 & 4), located in the Supercomputer Facility Vizualisation Laboratory, consists of two vertical screens of 1.5 x 1.5m that are elevated about one metre from the ground and which meet at a right angle. Images are back-projected, with the viewing area being large enough to allow several people to view the data at the same time. Each person wears a pair of LCD shutter glasses to allow stereoscopic vision and one person can use an ultrasonic head-mounted tracking device to allow different perspectives to be projected automatically. A remote 3D mouse control is also available.

In December 1998 a new, wide-angle WEDGE was opened at the Research School of Physical Sciences and Engineering. See Figure 5. With each screen having dimensions of 4 x 2.2m, this "WEDGEORAMA" goes someway towards having the look and feel of a real theatre and can accommodate about 20 viewers simultaneously. A multi-channel ambisonic sound system is currently being installed.

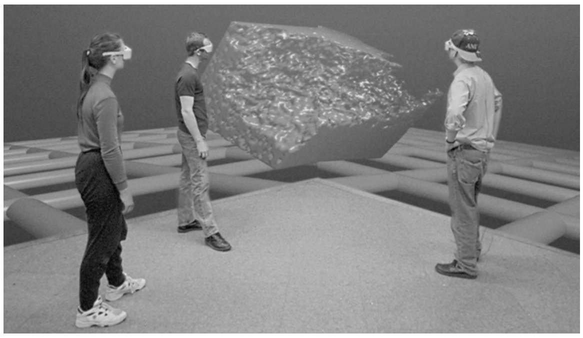

Figure 5.

5. Immersion: the role of sound

These technologies enable some degree of immersion. Whilst they are still extremely primitive, what is readily apparent is that they offer a different type of experience to the contemplation that we experience with a piece of music, a film or a book. By reacting to any moves the body might make to counteract what it is experiencing, cyberspace immersion inhibits the participant’s ability to ‘frame’ or contexturalise the illusionary space at will (by turning away when viewing a cinema screen, for example). Instead, the illusion continues and deepens as it is tested; it is no longer "out there" or "over there", it is "here" and one is present in it like the prisoners in Plato's Cave.[3]

Being omnidirectional, immersive cyberspace is more like a forest than a theatre. In a forest, nothing stays fixed in relation to an origin of a Cartesian perspective. Sight is continually obscured, allowing us to see for only the most local distances. As in all biological systems, there is no absolute centre, it is always shifting. In a forest, one is the geometrical origin of the (polar) space. Any place can become a centre as required by the moment. Likewise in immersant cyberspace, the real-time calculations of the system always start from wherever you navigated the 'frame' before. Wherever we turn, our perspective follows; our view being only revealed as we move into re-calculated space.

What surrounds us and brings us in contact with the forest is directly accessible to the hearing; it is the primary sense. It is hearing, not vision that provides us with an experience of omnidirectional coherence and listening directs our "point-of-view"; it *leads* our vision. Anecdotal reports of immersant experience strongly support this hypothesis. This should not be too suprising, as even in cinema the ear (soundtrack and music) is frequently used to "lead the eye" and this technique provides much of the sense of continuity in current cinematic language.

6. Composition

In painting, the use of perspective orients a static work towards the viewer. Stereo and multichannel point-source sound spatialisation techniques which are optimised to a "sweet spot"are visual perspective's aural equivalent. An ideal listening position: the centre of the space, the conductor's podium, etc. Installations are actively responsive to their audiences. Immersions go further. Spatial separation between performer and audience being dissolved, the audience is included in the work. There is no objective observance, no single perspective.

An issue for a composer/producer may be the degree to which is it interesting to lose control of the point-of-hearing of a work to an immersant. At what point does interactivity cease to be a rewarding model with which to work, because of the potential for the content or intentions of the piece to become diluted or unrecognisable? These problems having already been explored in improvisatory music where instructions or suggestions to performers can be either very specific or quite general but rely on the participants having a common understanding of performance practice or style. The difference in immersion is that is that the audience/performer divide is breached, so communication between the immersor (the composer/producer) and the immersant can be more direct.

7. Performance

The notion of performance relies on awareness of action. Awareness requires an abstraction, a disconnection with the world we take for granted. So actions are not performances unless they are observed; "Per-form" literally means "through formed"; thus to be aware of (self or other) carrying into effect.

When three-year-old Johnny throws a tantrum, we observe "what a performance!", because we sense that Johnny is aware both of his own actions and that they are being observed. When a robot executes a given task, whether deterministic or not, we think of it as performing it's actions. Of course it may also be aware of them, through feedback for example. Conceptual art has taught us that an everyday event can be considered as performance as long as the *observation* or *recognition* of the event is sustained. The moment we "forget to watch" or "forget to listen", it ceases, for us, to be a performance.

So what of performance in immersive cyberspace? Watching someone navigate through an immersive space is like watching them grope around in the dark, which is not a very fulfilling experience! However a performer can become a sort of expert navigator and by "joining" them in cyberspace we could experience a journey in a way that is deeper and more fulfilling that doing it ourselves, unaided. Of course this expert navigation could be recorded and accessed at a later time - much as we currently do with sound recordings, films, etc. I'm reminded, by analogy, of how much more fulfilling it is to participate in "bird-listening" with the guide of an aurally-aware ornithologist.

8. Cyberecology

Gibson's ecological view [Gibson 1979] is that organisms are so enmeshed in their environment that one cannot be understood without the other. Humans are beings 'within' the world, as participants. Buckminster Fuller put it like this:

> I don't know what I am. I am not a thing–a noun. I am not flesh. At eighty-five, I have taken in over a thousand tons of air, food, and water, which temporarily became my flesh and which progressively dissociated from me. You and I seem to be verbs–evolutionary processes. Are we not integral functions of the Universe?
> [Fuller 1981:132]

This idea extends into cyberspace, where there is a reciprocity between the artificial and the living: an abolition of boundaries between "exterior" environments (media, technology, etc.) and "interior" environments (cognition, perception, modelling, etc.). The machine penetrates us, we

[3] See [Lee 1974:316-325]

penetrate the machine and this folding and knotting creates a new identity and a new ecology.

One way of assessing the value of an interactive immersive cyberspace experience is how well it invites immersants not only to make choices, but to take initiatives. Part of the fascination with these environments is that they, like some computer games, are not linear but have the potential, through a multitude of possibilities, to form a sense of a coherent environment. I suggest that for an immersant this provides for a deeper aesthetic experience of an imaginary world than from a film made with the most seamless special effects or a composition with sounds wizzing between loudspeakers. This can be so even if the immersant enjoys the creative process without worrying too much about the end product, much as does a child in play. A satisfying work seems to involve not so much an immersive experience that is tightly controlled by the artist/producer, as one that affords an immersant the opportunity to dwell in a *place* (a space with character, a verrigated space) and where there is a greater possibility of encountering interesting *transitions*.

A full discussion of the aesthetics of immersion and the philosophy of virtuality is outside the scope of this paper. However there are many important issues for music composition in these developing theories. Richard Coyne [Coyne 1994] provides an interesting theoretical perspective. Whilst much of the discussion of immersive cyberspace to date has been focussed on producing convincing visual space, there is a growing recognition of the primary importance of sound in creating a sense of coherence in immersive spaces: new navigations, new compositions.

9. References

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