Understanding Spatial Information with Integrated 3D Visual and Aural Design Applications.

Gregory More, Lawrence Harvey, Mark Burry.

Spatial Information Architecture Laboratory (SIAL)
RMIT University, Melbourne Australia.

Abstract

The ability to arrange information graphically in digitally represented Cartesian space offers obvious advantages over two-dimensional graphical reductions. Adding time to the spatial palette provides a dynamic dimension. Cartesian space used for these purposes, however, reinforces an ocular-centric approach to information delivery. We can include sound in order to seek a sensory balance, thereby improving cognition and enhancing dimensionality within an 'information space', especially for complex material requiring greater interactivity or 'audience' participation. Combined visual and audio synthesis offers multidimensional and multi-sensorial environments that challenge existing linear and two-dimensional presentation orthodoxies – 'audience', for instance, presupposes a lecture to be listened to. This paper presents work in progress investigating the use of sonification as both a thematic and navigational vehicle in dynamic presentation environments.

1 The SONISPACE project

This paper reports on work in progress investigating presentation environments using 3D aural and visual digital techniques. The underlining themes of the research--the convergence of media, time based architectures, and experience as duration--are presented in the paper through an introduction of the SONISPACE project at the Spatial Information Architecture Laboratory at RMIT University (SIAL). SONISPACE converges portable 3D sound capability with 3D real-time graphics on commonly available PC platforms. As an exploration of dynamic information presentations, the SONISPACE project questions two main themes: firstly, the inherent occularcentricity of information presentation environments that typically avoid combining sound and content; and secondly, the ability of the presenter to operate in a nonlinear interactive manner with their audience. Here we consider work that develops from the discrete component based nature of both digital audio and visual components to presentation, and explores how these attributes can be combined from repositories of discreet components of information into continuous, dynamic, and interactive spaces--spaces that will explore the possibilities of sonification in order to aid the understanding of dynamic informational landscapes.

The SONISPACE project locates sonification within spaces of information. The pedagogy of architecture is based on the information of space and, in turn, spatial information. Sonification is defined as "*the use of nonspeech audio to convey information*" (Kramer et al. 1997). More specifically, sonification is the *"transformation of data relations into perceived relations in an acoustic signal for the purposes of facilitating communication or interpretation"* (Kramer et al. 1997). Familiar examples of sonification devices are the Geiger counter, sonar, and the auditory thermometer.

2 Image and Duration

The digital age has accelerated the convergence of various media--audio, video, and graphics--all handled as numerical data by the computation ability of the computer. The convergence of media types is not a direct effect of digital developments, however, but is nevertheless a common trait in information technology evolution (Levinson 1997). The pre-digital technologies of the moving picture industry, its assimilation of recorded sound, and later transgression into broadcast television is an example of how forms of media transform and in turn effect the production of their content. As with developments in virtual reality (VRML) and other interactive immersive environments, they are no longer cinema or television but amalgams of both precedents termed as *audiovisions* (Zielinski 1999). They facilitate the increased ability to simulate virtual or real environments that engage our aural and visual senses. Audiovisual technologies have developed ever since the prehistory of cinema, from the desire to animate and enliven the experience of the static image.

The discipline of architecture has increasingly explored issues of animation and movement within the last decade (Fear 2001). This engagement is related in part to the greater use of cinematic software to visualize architectural concepts and projects. Few projects continue to display the animate qualities of their design imagery when physically built. The work of Greg Lynn, for example, a major proponent of dynamics and animation, resolves his built designs as immobile constructions (Lynn 1998). One project that bridges this animate/inanimate gap is the Aegis Hyposurface© (Goulthorpe, Burry, & Dunlop 2001). This project is a physically animate surface that can be used to convey information. Time based and interactive, the Aegis Hyposurface© is activated by sound, video source, user input, and pre-configured effects. Although the information of the Aegis Hyposurface© is updated in a similar frame based manner as cinema, the material properties of the surface, aluminium facets glued to rubber articulations, ensure a fluid visual continuum. This example illustrates a complex understanding of dynamic form and space in a physical environment. It also illustrates the animate qualities of such designs that iterate the visual developments of spatial (re)configuration relying on known properties of vision and visual culture.

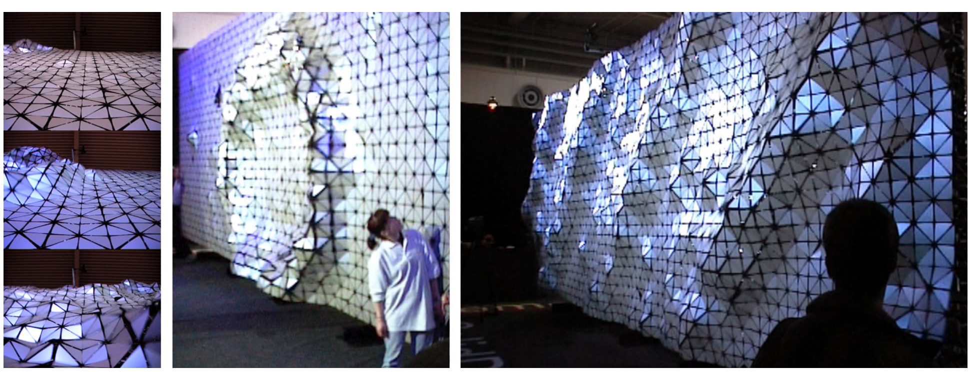

Figure 1. Aegis Hyposurface©, dECOi Architects.

Martin Jay presents in *Down Cast Eyes* (Jay 1993) an argument that the majority of Twentieth century French thought is predicated on properties of vision above the other senses. This privileging of the visual stems from the frozen movement photographic plates of Muybridge and Marey, the development of the cinematic apparatus (Aumont 1997), and the influence these technologies had on the philosophical developments of the time. Dynamics at the turn of the twentieth century also became important in the scientific fields where time became an added dimension to Cartesian space. The process of photography and cinema were seen as scientific and reductive to the qualities of actual movement. Information was captured into components (images), and reconstituted into movement. Although Bergson held strong beliefs in the links between philosophy and science, he was skeptical about the reductive approach to the nature of time within modern science (Bergson 1907). He discusses the divergence between movement as experience and movement as constituted by modern science. The issue here is the difference between the qualitative and quantitative experience of movement. The instant cannot express the qualitative experience of a movement's duration. Bergson argues that movement and its duration between starting and stopping is indivisible. Movement therefore becomes “singular, heterogeneous, and mutually irreducible.” (Rodowick 1996) Although movement is irreducible, its trajectory is not, and the path of movement within space is infinitely divisible as Cartesian points located within space and time.

Bergson's thoughts on durations and instants have been discussed, not only as visual conditions but also in the experience and interpretation of sound. Audio artist John Potts, in his discussions on the transfer from analogue to digital recording techniques (Potts 1995), refers to Bergson's writings when describing the shift from continuous analogue to quantized 44,100hz digital recordings. The digital revolution in sound recording and manipulation places the editing and mixing process into graphically represented vertical hierarchies similar to nonlinear video editing software. Audio components are layered and visualized via a nonlinear system that handles the stacking of sound components.

3 Audio technological components

Recent developments in 5.1 sound systems and its increasing availability supports the reintroduction of multi-channel sound experiences back into the public domain. At the time of this writing, small break-out boxes connecting to a lap-top computer can be used to achieve the digital-to-analogue conversion for a 5.1 sound field, delivered via an “off-the-shelf” domestic amplifier and speakers. This allows a user to prepare the spatial sound components of a presentation in his own home, and use either small portable multi-media speakers or a theatre with 5.1 equipment to deliver the final sound environment. Although sophisticated spatial sound systems are used in production and presentation facilities, this project focuses on the use of spatial sound systems for information navigation in small to medium sized spaces.

As Roads (Roads 1996) notes, “Only with the dawn of the post–World War 2 era were the aesthetic possibilities of sound projection via loudspeakers exploited in electronic music.” Roads goes on to list a number of key compositions and installations from 1958 onward that use 4 channels and up to 800 loudspeakers under computer control for their realization. Although these are exceptional examples, and rarely presented in public, cinema audiences can now experience sophisticated spatial sound designs in commercial or domestic configurations.

By the late 1980's and early 1990's, the authors observed through their own professional practice that the introduction of digital audio formats onto the domestic market raised the general public's expectations for quality sound. ‘Quality’ in this instance refers to a low signal-to-noise ratio between the program material recorded on a medium (tape, vinyl LP etc) and any hiss, crackle or pop being produced from the playback media itself.

Our research also has components to investigate if a related change in expectations for spatial sound design is occurring in listeners with the advent of multi-channel format associated with games, commercial and domestic cinemas, and DVD recorded music. Further investigations will determine the types of sound-to-space mappings that best support cognition in various presentation and information scenarios.

4 Animated Representation

SONISPACE uses the proprietary software product Macromedia Director™ for spatial visualisation. The software has constituent tools for dealing with digital media (text, image, digital video, sound) and user interaction. In July 2001, Macromedia (www.macromedia.com) released a 3D engine that allows three-dimensional digital spaces to be created and navigated. These spaces are controlled by the Director native language LINGO, and provide a similar environment to VRML (mesh geometries, bitmap texturing, lighting capabilities), but in a stable browser-independent platform. Director also has software extensions through additional 'xtra' components that allow the software to expand its base tools: complex sound input/output capabilities, file structure manipulation, and multi user web connections.

The SONISPACE project explores a series of audio and visual alternatives. One dynamic visual representation from which the research develops is the Aionic Memoria Project (More 2001). This project examines the spatial relationships of information representation in animation relating to concepts of discrete and continuous time. The majority of the Aionic Memoria Project visualization and modeling is achieved with the animation software 3DSMAX. The object oriented language 'Maxscript' constituent to 3DSMAX is used to handle the complex data and information of the project.

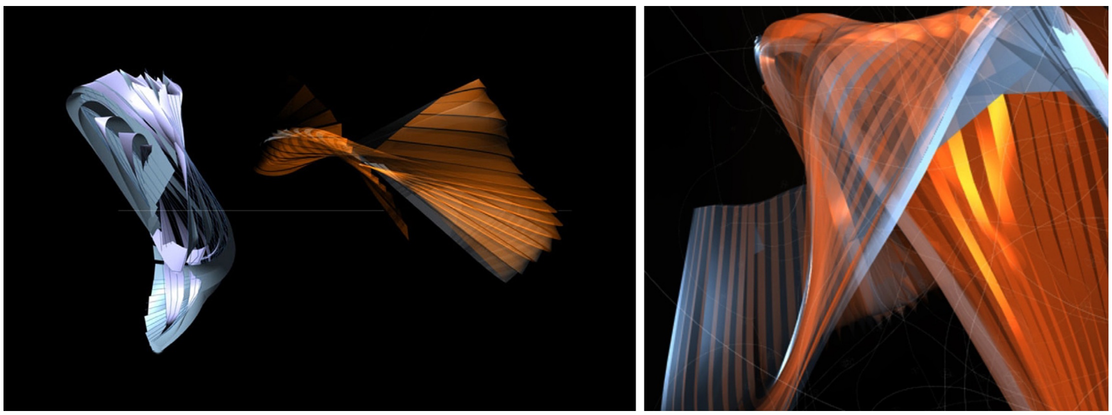

Figure 2. Animation stills from The Aionic Memoria Project.

Aionic Memoria explores the use of animation and programming techniques to inform the generation of animated digital architectural forms and spaces. This exploration questions the experience of time beyond the reductive approach required by the mechanisms of visual animation. It examines the embodiment of non-visible interactions and the tracing of continuous movement generated from correlating instantaneous moments. The principles driving the definition of form in this project have been applied to the SONIPACE project.

The visualizations in the Aionic Memoria Project are complex incorporating numerous NURBS surfaces that are difficult to retain in real-time applications. The SONISPACE research examines which aspects of complexity within space can be retained and still provide suitable vehicles for conveying information. This research is contributing to the design of systems that can be reconfigured dynamically and extend beyond conventional 3D arrangements of grids and boxes.

5 Sonification techniques for thematic and spatial navigation

As the development of SONISPACE is drawing from several sound based design practices, it is useful to consider the types of enterprises undertaken by professionals who generally describe their practice as sound design. These encompass sound reproduction system design and installation, software design for sound based applications, film and video sound track production, composition and arts based installation projects, auditory display, web and VR applications, soundscape studies, new musical instrument design, and architectural acoustic design.

We are finding that the system under development requires synthesising tools and techniques from several of these sub-disciplines. For example, whereas auditory display attempts to explicate informational relationships between data sets for the user via sonification, film sound design seeks to influence the emotional responses of the user to a set of thematic relationships. And similarly, although architectural acoustic design for places of assembly attempts to provide optimum performance of an acoustic environment for speech intelligibility, it can be further enhanced by spatial sound design techniques developed for arts based sound installation projects.

In the opening chapters of “Auditory Scene Analysis: The Perceptual Organisation of Sound, Bregman” (Bregman 1990) outlines several historical differences between auditory and visual perception. Briefly, “the goal of scene analysis is the recovery of separate descriptions of each separate thing in the environment.” He further explains how the early development of visual techniques to represent spatial relations between objects has tended to prejudice the visual perception over aural perception. To paraphrase Bregman, for several centuries western cultures have used projected geometry to describe distance cues among objects in space visually. Through the use of drawing and painting, accurate portrayals of these relationships have supported sophisticated thinking in the field of visual perception. “It was much easier to create a visual display with exactly specified properties than it was to shape sound in equally exact ways.” But in the absence of hearing deficiencies, the human auditory system is capable of precise spatial sound perception. Our research is investigating the use of these capabilities in scenarios such as memory recall of information presented using both simple and sophisticated spatial sound designs, and the use of spatial sound to avoid fatigue in listeners by varying the spatial location of information delivery points over time.

6 Conclusion

The principal aim of this research is to enhance our understanding of the consequences of extended multidimensional information delivery. It has already revealed some intriguing issues pertaining to the role of sound when closely integrated with visual components, and in relating cognitive understanding of information and navigation through information landscapes. Work continues with developing information sharing capabilities through the incorporation of animation (including physical movement as with Aegis), and making distinctions between the nature of time and its representation. As we proceed, the research reinforces some surprising conclusions about human factors and the nature of effective communication, not the least of which is that the medium can transcend the message. When the presentation framework is one based on rhetoric it can be enhanced by an information repository through which both presenter and audience have considerably more interactive engagement than in otherwise linear didactic presentation environments. The issues that remain to be resolved arising from our reported research in progress include the degree to the presenters of the future are prepared to customize their information pools *in acto* during their presentations, when we know that most today cannot even customize their PowerPoint™ templates beyond those that come in the box.

References

Bregman, A. (1990) “Auditory scene analysis: the perceptual organisation of sound”. Cambridge, Massachusetts: The MIT Press.

Bergson, H. Creative Evolution, (1911). Dover (1998), 361.

Bergson, H. Matter and Memory, (1896). Zone Books, MIT press.

Fear, B. Ed AD Architecture and Animation, Wiley Press.

Goulthorpe, M., Burry, M. and Dunlop, G. (2001) Aegis Hyposurface©: The Bordering of University and Practice, in Proceedings of the 21st, Buffalo (New York) 11-14 October 2001, pp. 344-349.

Jay, M. (1993) *Downcast Eyes: The denigration of vision in twentieth-century French thought.* University of California Press.

Kramer G., Walker, B., Bonebright, T., Cook, P. Flowers,J; Miner, N., Neuhoff, J. (1997) *Sonification Report:Status of the Field and Research Agenda,* ICAD 1997. (http://www.icad.org/websiteV2.0/References/nsf.html)

Levinson, P. (1997). *The Soft Edge: A Natural History and Future of the Information Revolution.* Routledge.

Lynn, G. (1998). *Animate Form*, Princeton Architectural Press.

More, G. (2001). Animate Techniques: Time and the technological acquiescence of animation, in AD Architecture and Animation, Wiley Press.

Potts, J. (1995). *Schizochronia: Time in Digital Sound. Source* http://www.soundculture.org/words.html

Roads, C. (1996). “The Computer Music Tutorial”. Cambridge, Massachusetts: The MIT Press. p 452.

Rodowick, R. N. (1996). *Gilles Deleuze’s Time Machine*, Duke University Press.

Zielinski, S. (1999). Audiovision: Cinema and Television as Entr’Actes in History, Amsterdam University Press.