Implementing Nonlinear Sound Strategies within Spatial Design: Learning sound and spatial design within a collaborative virtual environment.

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ABSTRACT

The integration of Collaborative Virtual Environments (CVE) into design curricula highlights shortcomings in the existing pedagogy of spatial design teaching. RMIT University’s Spatial Information Architecture Laboratory (SIAL) has utilised software developed by the University of Auckland from a commercial game engine to enable the teaching of spatial sound within an architectural design studio “Memory Games”. This paper reports on the outcomes of the design studio and discusses potential extensions of this approach for spatial design education, and for design and architectural practice.

KEYWORDS

Sound design, Architecture, Game engines, Spatial sound.

INTRODUCTION

The use of CVE offer an alternative learning environment to non interactive design media for both analogue (drawings, physical models) and or digital (rendered images, linear animation or sound recording). Even though sound is integral to ones perception of space the design of sound has generally stayed outside the pedagogy of spatial design curricular, choosing to remain within the domain of other creative disciplines, especially art, music, film, and media. Within a CVE sound elements and their design are integral to the overall spatial design concept. We use the phrase ‘nonlinear sound strategies’ to encompass the amalgam of sound creation, spatial arrangement of sources and triggers, and outputs activated by the indeterminate path of the navigating user. The term nonlinear suggests working with systems that exhibit an open-endedness and strategies is the ability to diagram or sketch the attributes of these systems and simultaneously register the effects of such designs through interactive experience.

The Memory Games studio examined the potential of the CVE for design generation and collaboration with equal emphasis on sound and spatial design. The studio’s central theme was the concept of ‘memory’ and its role in the collective and individual experience of the city. This theme was selected to stimulate issues of capturing a sense of ‘memory’ within the spaces of a CVE echoing Michael Roth’s statement “in modernity memory is the key to personal and collective identity.”[5] The work of artist Rachael Whiteread presented a physical precedent for manifesting qualities of memory into built form, yet these as do most architectural works that focus on memory, tend to become more about ‘memorial’ than ‘about memory’[1]. Rather than architectural precedents the studio considered temporal models more akin to Christopher Nolan’s film Momento, or the literature works of the likes of Calvino’s Invisible Cities.

The objective of the studio was for the students to (re)invent Melbourne’s CBD through its forgotten and interstitial laneways, allowing an active participant to pass through imagined landscapes of experience. To engage the fabric of Melbourne city each student chose a secret location from which they designed a portal to their imagined personal ‘memory space’. Akin to the experience of entering Narnia via the wardrobe, these portals could be scaleless, machinations of real and digital environments, slipping the participant from familiar to unfamiliar surroundings. The brief was open for interpretation and there were no requirements for outcomes other than the spaces within the CVE. Towards the end of the studio, the individual spaces, ported into a collective space from which an alternative reading of Melbourne’s CBD could be obtained, thereby taking the projects from the personal to the collective. The main issues dealt in the studio can be summarised as:

• The relationship between sound and visual texture and their role to evoke memory and furnish new narratives.

• Ideas of threshold and transition between physical and imaginary territories.

• The relationship between personal and collective memory.

• Relationships between past and present and the art of collective and self indulgence.

INTRODUCING STRINGCVE

The CVE software used for the SIAL architectural studio was StringCVE, an application based on the ‘Torque’ software development kit, which is a descendant of the ‘Tribes 2’ gaming engine. The University of Auckland is continuing to develop StringCVE for teaching and
educational research purposes. The initial impetus for the software development was to support architectural design, yet the aim of this development is to provide low cost desktop virtual environment solutions to facilitate collaborative design and critique of three dimensional data in real time.

Given the loaded and hackneyed use of the term ‘virtual’ some discussion of its meaning for the StringCVE project is required. For architectural and design education we are less interested in the use of digital graphics and audio as a representational tool in the 1:1 mapping sense (virtual reality) but rather the intent is to use such technology as an immersive environment for the fluid development of ideas. Virtual in this context is aligned with Sanford Kwinter’s re-definition of morphogenesis: Kwinter rejects the classical regime of direct relationship between the possible and the real in favour of a dynamic definition of morphogenesis where the emergence and evolution of form is based on the concept of a mutable and dynamic ‘virtual’ from which any number of ‘actuals’ can be extracted over time.

“The virtual is gathered, selected - let us say incarnated – it passes from one moment event (or complex) to emerge – differently, uniquely – within another. Indeed the actual does not resemble the virtual, as something preformed or pre-existing itself. The relation of the virtual to the actual is therefore not one of resemblance but rather of difference, innovation, or creation (every complex, or moment-event, is unique and new).” [4]

In this context the real time graphics and audio in the appropriated game environment are conceived as a temporal field where “moment event” is dependent on camera position and duration. Images mapped onto diverse geometry are combined with proximity triggered sound which can be viewed / heard from multiple perspectives. These works in progress can be ‘experienced’ from the first or third person viewpoint of gravity inflected or can be navigated in fly mode. As with all real time media duration comes into play: work can be accelerated through via ‘panned’ section or ‘zoomed’ plan to create montage and doppler infused sound; alternatively the gaze and movement can be more studied and visual / aural G-spots can be examined.

StringCVE is hence virtual (as outlined by Kwinter) in that multiple interpretations of the same content allow design permutations to unfold. The key to this unfolding is time: the placement in a real time environment where the designer observer can explore or accelerate; the time of pause, study and subsequent re interpretation; and the relevant temporal ease from which designer can switch from observer to editor in order to place alternate virtuals - the iterative time of designing.

While this is possible within other design software it is usually limited to the manipulation of graphic objects in a preview window. The equal emphasis given to spatialised sound for the Memory Games Studio allows real time manipulation of sound and image where there is no distinction between editing environment and the presentation output. The sound overlaps and colours the visual, triggering alternate interpretations of geometry and surface, simultaneously informing the raw sound sample and resulting in some cases where the layered visual and sound scapes operate as “abstract machines of stratification”.[3]

**SOUND IDEAS AND CONCEPTS PROMINENT IN THE STUDIO**

With an emphasis of sound and sonological understanding, the physical sites are mapped with a variety of acoustical and graphical textures. The use of proximity-triggered sound allows the design of dynamic soundscapes that can be used in the production of sonic narratives. Because the CVE maintains spatial sound relationships (examples given below), teaching exercises are undertaken in the ‘real-world’ as a precursor to students designing their own virtual acoustic environments. As an example of a ‘real-world’ exercise, one exercise involved a sound walk and fifteen minute perceptual exercise in the State Library sited opposite the University. Students were asked to take up individual listening locations in the main reading room, and on a single A4 sheet, note the location, relative loudness, identity and time at which various sound sources are heard. Students make a graphic ‘score’ of the results while listening, placing their own listening position as a point in the middle of the page. The exercise can be used to demonstrate complex relationships perceived in a sound environment, between a diversity of sound sources, their time and intensity, and spatial locations surrounding a listener.
The StringCVE environment becomes a soundscape laboratory, creating an immersive experiential learning context for students. Instead of presenting definitions, descriptions and linear recordings to explain sound concepts, students design their own virtual acoustic environments to test and explore their understanding of concepts. To complete a soundscape in the CVE, students were required to make stereo on-site recordings, to be combined with processed variations or other sound materials such as speech or rehearsed sound events. If these sound recordings were to be compiled onto a linear format such as CD, or video soundtrack, the pedagogical focus would most likely have concentrated on composition with sound to create a convincing experience of moving through the environment to accompanied visuals. In general sound designers still work in linear formats, the exception being those working in sound installation VR applications and games development.

In a non-linear environment, relationships between individual sounds can be explored over the need to create compositional relationships for the listener. In this respect, the experience of navigating a soundscape in a games environment is much closer to the listening experience of being in an ‘actual’ environment. The difference between linear and non-linear soundscapes is further exemplified when considering how temporal organisation is created. In a linear format, the temporal organisation of the material is predetermined by the sound designer. In a non-linear environment, the resulting soundscape is organised from the motion of the listener through the environment. As a listener is free to move through the environment, the sound designer creating a 3D soundscape must be aware of the potential way sounds will interact amongst themselves and be perceived by the listener.

TEACHING METHODS: ‘ACTUALITY’ VS SOUND EFFECTS

The initial six week stage of the studio, required students to learn the StringCVE modelling and texture mapping processes by making a realistic visual model of a chosen inner-city laneway. The exercise included the creation of an acoustic environment of the laneway. The use of actual recordings of spaces (actuality) was encouraged over the use of generic sound materials (for example sound effect CDs) for the following reasons.

The first was communicative impact. The teaching approach followed in the studio gave equal importance to sound and visual design. The exercise of students making audio recordings of their chosen laneway, produced unique complementary materials to the visual documentation and other impressions formed during their onsite explorations. The use of these recordings, as opposed to generic sound effects, revealed the communicative impact when original materials are the basis of both sound and visual design.

Secondly, maintaining a coherent acoustic character for the environment. Sound effects CDs or web archives usually contain several examples of generic environments and events, with descriptions such as, shopping mall with English speaking crowd, or high-heels on wooden floor. Unless each example is recorded in the same space, with similar microphone-source relationships, creating soundscapes from these materials tends to produce a ‘mishmash’ effect. Unique audio recordings of spaces known well, or easily visited, by individual students, proved to be an effective base on which to build further learning activities on sound propagation, aural perception and emotional influence of sound design.

Thirdly, establishing a sense of temporal consistency within the environment. Professional sound engineers will attempt to capture an event or environment in a continuous or short time span. One reason for this is to produce recordings where environmental factors such as air temperature and speed are stable, and do not adversely affect the acoustic image a recording. This presumes that some other event or physical condition (eg, quality of reverberation) in the space is the subject of the recording, and the intention is to create an accurate recording of this or other events.

Students were given rudimentary guidelines for planning and undertaking location recordings at different times of the day, along with the effect of choosing different microphone positions, and equipment operation for achieving successful sound field capture. Using a variety of recordings from different times of day, class discussion was structured to enhance students’ awareness of the changing events and conditions in their chosen laneway, captured with non-visual forms of representation. Some discrete examples include the aural experience of spaces filled with diverse language groups, the effect of traffic sounds, the presence or absence of music in a space, mixed use of spaces, the apprehensive quality of scurrying footsteps in a reverberant concrete arcade.

Several students produced intriguing design responses inspired by these and other events captured during onsite audio recording, which produced a stronger sense of temporality when navigating through their projects. These onsite activities also generated very personal memories for the students, from which most students based and developed their ideas both acoustically and visually.

SOUNDSCAPES AND ENVIRONMENTS

During the sound lectures for the course, students were introduced to acoustic ecology or soundscape ecology, defined by Barry Truax in his Handbook for Acoustic Ecology as:

“...the study of the effects of the acoustic environment, or soundscape, on the physical responses or behavioural characteristics of those living within it.”[6]

This web based resource and accompanying sound examples contain systematic definitions and explanations of studies in the acoustic environment. As a teaching resource, it is useful in developing the aural awareness of students whose education has been predominantly visual in nature. For example, the following environmental sound interactions (ambience, masking, density) will occur when a virtual environment is populated with sound: The below definitions are applicable to interactions of sounds in actual or virtual acoustic environments.

Ambience - “The background sound of an environment
in relation to which all foreground sounds are heard, such as the ‘silence’ of an empty room, conversation in a restaurant, or the stillness of a forest. Ambience is actually comprised of many small sounds, near and far, which generally are heard as a composite, not individually.” [6]

Masking - The effect one sound has on another by making it harder or impossible to hear.

Density - The number of sounding events in a given time frame.

Precedence effect - The psychoacoustic phenomenon whereby an acoustic signal arriving first at the ears suppresses the ability to hear any other signals, including echoes and reverberation, that arrive up to about 40 ms after the initial signal, provided that the delayed signals are not significantly louder than the initial signal. [6]

In the Handbook itself, these concepts are accompanied by linear audio recordings. By teaching these concepts in a CVE environment, students are not required to make a translation between linear (audio-recording) and non-linear formats that are mostly representational as opposed to experiential.

TEACHING MATERIALS AND NONLINEARITY

It could be argued that the choices made by a listener/viewer when confronted with a complex polyphonic orchestral composition, or the dense visual textures found in action painting, constitute unique pathways through a work, similar to those in a non-linear environment. As an example, sound lectures during Memory Games introduced preliminary ideas from Bregman on auditory streaming as a listening strategy in complex auditory situations.

But the choices made in either of the above scenarios are substantially unknown to others sharing the same listening and viewing experience. In a CVE, where the presence of an actual person is represented in the virtual space by an avatar, a shared, communal experience in a non-linear environment is possible. This sense of community is further enhanced in StringCVE as text messages can be sent and received through the environment.

The full potential of new learning environments combining virtual collocation and communication, with vivid aural and visual datascapes and based on non-linear forms of organization is still to be explored. Some qualities of these new educational spaces, might be found in the following quotes on arts practices and Some qualities of these new educational spaces, might be found in the following quotes on arts practices and the 'open-work':

Lev Monovich cites historical precedents to interactive computer art, as identified by Dinkla, that also claim openness as integral to their form:

A number of writers such as Söke Dinkla have argued that interactive computer art (1980s -) further develops ideas already contained in the new art of the 1960s (happenings, performances, installation): active participation of the audience, an artwork as a temporal process rather than as a fixed object, an artwork as an open system. [8]

And writing on the more contemporary practice of Hyperfiction, Annette Comte proposes communicative advantages of non-linear forms, and new relationships between author and reader:

The concept of a narrative structure that doesn’t conform to the standard predictable beginning, middle, and end, that doesn’t have the linear direction of the heroic journey or chronology of history, frees the writer to express and communicate complex ideas, values and attitudes that may have been previously repressed. [2]

The author/text/reader relationships that result from the connective synthesis of eye-to-screen have allowed texts to be organized in an immediate, interactive, non-linear fashion across interdisciplinary networks. This has provided a vehicle to reconfigure concepts of print-based narratives including the linearity of beginnings, middles and ends, metatative elements, parallel texts that can be read concurrently, the disruption of linear or historical time and the exploitation of intertextuality, allowing readers opportunities to construct individual stories within the written narrative. [2]

TECHNICAL ASPECTS OF SOUND DESIGN

The Memory Games studio was based on a ‘low-tech’ approach to audio production. The technical equipment included a (Sony TD10Pro DAT recorder and Sony minidisc), easily accessible software (Audacity, Audiomulch), and playback through an Extigy Sound Blaster card and a quadraphonic speaker array for final presentations. The pedagogical emphasis of the course was to examine how a games environment could produce a visual and aural experience of space, and not to develop high technical proficiency on software. Furthermore, as students were from architecture and design courses, and not sound design, the tools and techniques chosen for sound production were kept minimal and easily mastered.

Audiomulch (audiomulch.com.au) is a real-time sound design tool conceived and programmed by Ross Bencina. As a real-time environment, it provided accessible methods for students to enhance, transform, or generate new material for their projects. The second stage of the studio required a design response to produce a speculative space. Audiomulch was used to produce variations of sounds recorded from the actual laneways. In one project, a student transformed realistic visual and audio materials into gradually more decimated states, that formed stages of decay as the user navigated into a subterranean world, matching visual and audio decays inhabited by the objects of his personal memories.

Students were encouraged to keep file sizes at a
maximum of 5-7 seconds duration. This would help keep overall project data file to a size allowing reasonable download times for ftp transfer. Further project size reductions could be achieved through conversion to a lower sampling rate than the 441000 Hz used for the studio.

In the StringCVE environment a sound file is attached to an audio emitter which is placed in the 3D digital space. An editing mode in StringCVE supports click-and-drag editing of emitter locations. An audio profile associated with the emitter holds control information for the sound file such as proximity sensitivity, number of loops, and volume. The process of constructing an interactive soundscape in StringCVE is based around editing a source recording into mono files, assigning these to emitters and profiles, which are scattered throughout the virtual environment. Several student projects contained close to 200 such emitters producing an engaging immersive effect.

During the studio the StringCVE audio engine was modified to support Dolby 5.1 playback. Although students were not introduced to sound design techniques for multi-channel systems, their final projects were enhanced by the Dolby 5.1 sound. The final presentations used the traditional electroacoustic quadraphonic system of four speakers in a square configuration. It was found that the use of a centre channel tended to pull the audio image into the middle of the front speaker pair having an undesirable effect. Dramatic panning of sounds, improved localization and a sense of aural envelopment were much stronger over four speakers than two, or during headphone listening.

STUDIO OUTCOMES
At the end of the studio, the individual works resided in a series of collective spaces. These spaces contained varied readings of both Melbourne’s CBD and the central theme of the studio ‘memory’.

The work of Laura Harper recaptured the events from her chosen site, which at certain times of day becomes an urban ‘soup kitchen’. Her environments merge several parallel ‘mirrored’ spaces which give a confusing sense of déjà vu.

The work of Fooch Chi examined a graphical or iconographical representation of the CBD, replacing the city with text and symbols. He defined place by sound, allowing the city to be ‘reread’ literally as overlapping textual entities.

Beyond the projects the studio offered insights into the general issues of CVE and their use in teaching sound and spatial design.

• Spaces designed were very imaginative and varied however there remained some very traditional architectural spaces, rather than students exploring their ideas as abstract atmospheres.

• The emphasis on audio techniques within the studio developed a very critical approach to the use of sound, and there was very little use of sound purely for ‘effects’ sake.

• In some projects the spaces became minimal in design and texture which accentuated the role of audio within the space.

• The presentation and reviews gave insights into the difficulties of presenting individual experience within a collective audience scenario. The individual critics could roam, but the audience had a general sound and view from presenters point of view. Presenters also had the difficulty of ‘talking over’ the environments when presenting; some of best presentations were when they were walked through without commentary.

• The quantity and quality of the audio files created more substantial file sizes, limiting the distribution potentials of the CVE.

THE FUTURE OF SOUND AND SPACE IN CVE
The version of StringCVE used for the ‘Memory Games’ studio restricted design permutations to intuitive manipulation – real time placement / substitution / rotation / scaling – and the re reading of permutations by varying camera position and duration. Collaboration
was minimal being restricted to occasional multiplayer sessions where fellow students could interact within the CVE and potentially give each other alternative insight into design possibilities. A more recent studio undertaken at the University of Auckland and the London Architectural Association school of Architecture utilised a database version that enabled asynchronous collaboration via embedded chat forums. Such input throughout the duration of the design studio allows the text to inform the content both articulating and enabling design permutations. The linking of database to real time visual and sound environment also opens up the possibilities for an extended abstract machine: real time content substitution; parametric environments driven by user triggered events; the use of autonomous agents or flocking routines as generative tactics. We are less interested in developing next generation graphics or more acoustically correct sound algorithms. In this respect the criticism from some design critics of the ‘plastic’ or abstract quality of game engines is flawed and signifies a misinterpretation of the intent of such virtual environments. For the purpose of encouraging creative thinking in architectural and design students the machine is necessarily abstract.

An attractive aspect of the StringCVE environment is the possibility to rapid prototype concepts on a single PC. These prototypes can integrate a 3D model, with indicative soundscape, texture mapping and animations. These spaces need not be traditional architectural ones, but speculative or abstract in nature. As a StringCVE environment can be published as a stand-alone environment, it can be sent to remote locations via the web, and simultaneously explored by, for example, client and design team member, or used as a presentation environment during consultation, or post-construction phases of a project. For arts based projects, the environment can be projected as an installation, or used as a digital set as in machinima (see www.machinima.com). Again the integration of sound, textures and animations brings an added realism to the experience of these digital spaces.

CONCLUSION
Within the spatial design disciplines, elevated levels in the understanding of sound components are necessary to engage the full potentials of CVEs and their role in generating nonlinear narrative spaces. The actuality of creating and locating 3D sound is distinct from the efforts of traditional acoustic performance or installation. CVEs show promise for a number of sound based applications within an architectural and interior architecture program, including navigating proposed designs, ‘acoustic mock-ups’ of sound installations, comparative soundscape research and studies, digital audio archives of historical soundscapes or the creation of speculative acoustic environments.

The CVE application described above proved very effective in generating spatial awareness and understanding of sonic attributes. The nonlinear experience of synchronous reviewers creates a complex sense of the review process, putting emphasis of the reviewer to be willing to explore and interact with design, rather than assuming a conventional passive ‘critical distance’.

The convergence of digital spaces between themselves (movies and games environments), or of virtual and actual spaces (enhanced reality), will be substantially enhanced if designers are aware of the ways visual and sonic materials are organised in non-linear spaces. As CVE provide a low cost platform to render visual and spatial relationships found in the’ actual’ world, they are an attractive solution to educate students, whose professional practice will potentially involve designing hybrid digital-built environments, or emerging media spaces for cultural and informational applications.

REFERENCES
