Sound and Space: 
An Architect’s Investigation

Nicholas J. Murray
B.Arch.

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Sound and Space: An Architect’s Investigation

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Declaration

I certify that except where due acknowledgement has been made, the work is that of the author alone; the work has not been submitted previously, in whole or in part, to qualify for any other academic award; the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program; any editorial work, paid or unpaid, carried out by a third party is acknowledged; and, ethics procedures and guidelines have been followed.

Signed

Nicholas J. Murray
26th of March 2010
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Contents

Introduction 1

01 Spatial Prototypes 8
    Wayfinder 10
    The Birds and the Bees 22

02 Architecture and Aurality 36
    Soundscape 38
    Sound Art 41
    Architecture 44
    Auralisation 47

03 Accounting for Sound in an Architectural Context 54
    2006 Venice Biennale – Australian Pavilion Sound Design 56

04 Precedent and Typology 76
    Punt Road House 78

05 Re-evaluation 84
    Re-evaluation 85
    Melbourne State Theatre and Arts Centre Forecourt 87

06 Pedagogical Terrain 96

Conclusion 119

Bibliography 125
The author with full scale acoustic reflector prototypes, photograph by David Poulton.
Introduction

‘Design is a way of inquiring, a way of producing knowing and knowledge; this means it is a way of researching.’

If we can conceive of or comprehend sound in spatial terms, how can we use sound to design space?

Despite our visual predilection (the reverse is the case for some cultures), our aural experiences form a significant aspect of our spatial experiences and our apprehension of the world. Yet with the exception of high performance listening environments, our aural experiences of contemporary architecture are often a mere artefact of a myriad of other design decisions, usually programmatic or visual. Architectural projects that we might describe as having a specifically aural trajectory typically respond to programmatic impulses that drive such tendencies. Such is the case, for example, in concert halls, radio stations and recording studios.

If one can accept that sound is spatial and that an aspect of hearing is spatial comprehension, then surely it follows that designers of space, such as architects, would be intrigued to come to an understanding of sound and its significance to our experiences of our environments. Surely this knowledge of sound and spatial experience would then be brought to impact upon the designs that architects produce and surely these designs would only benefit from an invigorated, positive attitude to the design of sound in an architectural context. If we can conceive of or comprehend sound in spatial terms, how can it inform architectural practice?

I believe that the experiences of architecture could be significantly enriched if architects chose to modify their thinking to conceive of sound as potentially enabling, and thereby employed its qualities in a positive and constructive way in the design of space. I am interested in bringing this thinking about sound and space to bear on architecture because I believe that architectural practice is deficient in this regard. One of the things that has driven my thinking about sound and
space has been a desire to frame my projects in a way that architects might find productive. This strategy represents a desire on my behalf to engender positive change in the profession.

My own professional experiences as an architect in both academic and commercial practice attests to the general impoverishment of sound in architecture. Since 1993 I have worked in commercial architectural practices in Australia, London and Hong Kong. In the practices where I have been employed I have found it perplexing how rarely sound might be discussed in the context of an architectural project being undertaken. Admittedly, I am referring to the design of mostly non-high performance listening environments. When discussions of sound were entertained they were almost exclusively discussed in relation to ‘noise control’. This usually pertains to the desire to reduce unwanted sound transmission from say a toilet to a living room, or from one apartment to the next, or attempts at mechanical plant sound isolation. The method of noise control was generally one that relied purely on material specification. Sound was not spoken about in a way that communicated any understanding of its potential to be generative or positive. What was discussed, usually at contract documentation, or more commonly post-occupancy stage, were strategies that represented a desire to ameliorate the presence of sound, ignore its potential or to simply hope that if there was a perceived problem that it might go away or somehow rectify itself.

I recently worked on a residential project that employed open planning with polished concrete flooring, a flat concrete soffit ceiling and brick walls. I raised the issue of the potential reverberation and sound propagation through this volume with my employer, with a recommendation that the client should be made aware of what this space would probably sound like. My employer’s response was to assure me that the client ‘had a few rugs’. My observation was not intended as a negative critique of spatial quality; it was an observation of a likely acoustic outcome. Nonetheless this exchange reminded me of an account that appears in Reynar Banham’s The Architecture of the Well-tempered Environment:

‘More than one loyal supporter of the Bauhaus at that time is now, forty years later, prepared to admit that the glaring lighting and the ringing acoustics were distressing, and Phillip Johnson has told the author that he had difficulty in remaining in the Bauhaus buildings at Dessau for more than forty minutes. Where other interiors of the period survive, or have been restored, one may encounter these trying conditions, but in most cases the addition of carpeting, curtains, and light-fittings not visible in the early photographs have rendered these interiors easier to inhabit’.4

In my experience, the situation in academic practice is no different. I am not aware of an undergraduate course in architecture in Australia that has an acoustics component in its technology stream. That is not to say that students do not have access to acoustics or other sound modules

Introduction
via electives or postgraduate studies, but typically acoustics modules are not presented within the undergraduate streams.

While teaching in the School of Architecture and Design at RMIT University, which is something I have engaged in since 1997, it was not uncommon for me when critiquing architectural or interior design studios to ask a student about an aural concern. Any question that I might ask of a student about sound would typically illicit a reaction that could be described as an embarrassed silence, or a defence mounted on the student’s behalf by the tutor that sound was not part of the scope of the studio objectives. I should note that this defence was never intended to suggest that the student should not have considered sound; it was usually a simple acknowledgement that the tutor had not encouraged the student to explore this issue.

The handful of sound-based architecture and interior design studios that I have taught at RMIT University were characterised by an overwhelming eagerness on the behalf of students to develop an understanding of sound, but were limited by both the physical and conceptual means at the students’ disposal by which they could describe, communicate or evidence their aural propositions. Another limiting factor was a general deficiency in what I would describe as listening expertise. In contrast to my experiences in architectural practice, particularly the commercial variant, I discovered there was much to be learnt about sound and space from my adjacent practices as a professional recording and touring musician, sound designer and location sound recordist on film and television. Implicit in these practices is a negotiation of sound and architecture and their spatial relationship. The negotiation of this relationship was often expressed or legible in the decision of which room one might choose to record in. Or the addition, removal, or careful arrangement of baffles or screens which would be put to use to modify the acoustics of spaces, thus aiding the recording of voices or instruments. In home studios these baffles often took the form of bedding, mattresses or other items of furniture added to, removed from or arranged in a particular fashion to change the way spaces sounded. I note here that my musician colleagues and I found ourselves describing rooms as, among others, dark, bright, the big room or the small boxy room. These described our aural experience of these spaces and how we consequently understood them, rather than functioning as direct dimensional descriptions or statements to describe luminescent qualities. As a location sound recordist on films, I had to ensure that ‘wild lines’ were recorded in situ so that the acoustic artefacts of the performance space were embodied into the recordings that might be used for overdubbing. I had to record and assemble sufficient location audio to enable audio post-production representation of the space of dramatic performance. I make particular mention of these adjacent practices as I believe that they have been pivotal in allowing me to develop the conceptual thinking and skill set necessary to be able to undertake this particular research endeavour.
I undertook this PhD because I was interested in the question of how I could use sound in a spatial way, or make or shape sound that might have some positive spatial experience inherent in the act of its hearing, and what it might be or mean to do so. I had a hunch, so to speak, that there might be architectural, or more specifically, spatial possibilities for using sound to design space.

This PhD is undertaken in project mode. As such, the research is embodied in the projects that have been undertaken. The research is conducted by undertaking designs, in some cases making these designs, and then proceeding to review these designs and the manner in which they have been designed. This is part of an ongoing process of re-evaluation and reframing of my position in regard to this inquiry into sound and space. The description of this process is contained within this Appropriate Durable Record.

The Appropriate Durable Record of the research is structured in six chapters, an introduction and a conclusion. Where sound examples are referred to in the text they may be found on the audio disc that accompanies the Appropriate Durable Record.

Chapter 1, ‘Spatial Prototypes’, is an account of two designs I conceived for installation projects, Wayfinder and The Birds and the Bees. I explain how I understood my architectural and sound practices to be adjacent pursuits, and how by undertaking the Wayfinder project I came to understand that they might be concurrent. I observed that my architectural training was having a significant impact on my thinking about sound, and that this impact was manifest in the design and making of Wayfinder. I describe myself as working in the guise of sound artist or sound designer and how with The Birds and the Bees I attempt to approach the project in a guise that is more akin to that of an architect designing with sound. My exegesis is an account of how I designed and made a space where sound was pivotal to how that space was conceptualised, understood and experienced. My aim was to explore how I might design a space whereby the design of its aural aspects would constitute a significant aspect of its architectural composition. I end this chapter with a review of the project grouping, and make a particular observation that the projects’ lack of architectural program is a gap that I needed to contest. I conclude by describing the projects as spatial prototypes, or models, for conceptualising and designing space with sound.

Chapter 2, ‘Architecture and Aurality’, describes the difficulty in finding descriptions of aural experiences of architecture, and the embryonic nature of the domain. When sound is accounted for in relation to architecture its depiction is typically limited to quantifiable acoustic performance, not spatial potential. I observe that with the exclusion of acoustics, the major critical theory for sound and sonic comprehension resides in practices adjacent to architecture, such as sound art, soundscape studies, music and psycho-acoustics. However, none of these fields seem to adequately describe the research that I am undertaking. This chapter is essentially a review of people, practices and projects related to the research I am presenting here. It concludes with an explanation of an
acoustic modelling technique known as auralisation and a proposal for its use in the design of space with sound.

Chapter 3, ‘Accounting for Sound in an Architectural Context’, presents my design for the sound design of the Australian Pavilion at the 2006 Venice Architecture Biennale. I describe how I sought to address the problem of language in relation to accounting for the spatial experience of sound. I proposed that if others had already designated architectural descriptions of spaces or urban conditions, as was the case with the Biennale project, then perhaps I could identify aural scenarios that might correspond to these descriptions. My review of the project suggests that the real learning in the work did not so much reside in the proposition about language as in the empirical knowledge of sound and space I garnered in the process of undertaking the sound design of the Australian Pavilion. I argue that an empirical knowledge of acoustics may indeed be more useful to architects than a mathematical or scientific understanding of acoustics.

Chapter 4, ‘Precedent and Typology’, presents an overview of a design for a domestic residential project located in Punt Road, Richmond, that had particular acoustic requirements. I previously observed that the projects I had been doing had not had to contest architectural program. I also argued that as architects should be thinking about sound in a positive and generative way on any project I should be able to demonstrate this by undertaking any architectural brief. This chapter is in some respects more an essay on a gap in knowledge about sound in architectural context than an account of the design. In undertaking the design of the Punt Road project I realised that in attempting to bring this way of thinking about sound and space to bear upon a traditional architectural brief I had no way to of problematising sound in the context of the design of a domestic residence. This realisation leads me to conclude that there is a need for identifying precedent architectural works and typological classification as a way of enabling architectural design.

Chapter 5, ‘Re-evaluation’, describes a re-thinking of my projects, conclusions and disposition in relation to the question of designing sound for space. It represents a hinge point in my research, whereby having concluded the designs for and subsequently reviewed the Venice Biennale and Punt Road projects, I recognised that I was unsure how to best advance my research. I could build density into particular threads that I had already established, but I was unconvinced that doing so would actually advance the work I was doing. In short, I felt that rehashing territory I had already covered would be simply avoiding the issue at hand. I re-evaluated my position and in response proposed a number of guidelines about designing space with sound that I believed might be useful to adhere to and engaged in an electro-acoustic proposition for the Melbourne Arts Centre and State Theatre forecourt to examine these guidelines. The conclusion to the chapter gives a brief description of the design of this project and an account of the outcomes of these enabling shifts in thinking.
Chapter 6, ‘Pedagogical Terrain’, is an account of the design of an acoustic and electro-acoustic proposition for academic space. The effective development of this design draws on the findings of Chapter 5 where I adjusted my position in regards to designing with sound in an architectural context. The design represents an enabling proposal for designing space with sound that has significant architectural outcomes, such as the potential for flexible academic spaces that resist the orthodoxy for generic, partitioned pedagogical environments. The project demonstrates both how sound can define space and how it can be an enabling architectural strategy. The acoustic propositions are demonstrated via the construction of full-scale working prototypes. The major conclusions for the PhD are evidenced in this work.

In the conclusion of the Appropriate Durable Record I describe the contribution that this PhD makes in demonstrating the potential of applying an architect spatial sensibility to designing space with sound. I use sound to define space in a manner that is similar to the way an architect uses form and material to define space. The account of my designs is intended to enable my design works to be accessed as precedent projects for others wanting to design space with sound. In this way these works are a contribution to the field.
Notes


3 The term aural is used here because it refers to the act of hearing in its entirety. To use the term acoustic would possibly suggest a more restricted, scientific understanding of auditory experience.

Wayfinder. View looking into the shopfront space. Photograph by David Marx.
Spatial Prototypes

Introduction

In this chapter I would like to present an account of the design and execution of the two earliest projects I undertook as part of my research for this PhD. *Wayfinder*, a collaboration with visual artist Cate Consindine, was an installation work at Conical Gallery Fitzroy.

I had previously wondered about sound and architecture and considered how I might be able to intersect these apparently disparate disciplines. At the time of undertaking *Wayfinder* I understood sound and architecture as adjacent practices. As I was unable to conceptualise a way of negotiating sound within my understanding of architectural practice I had decided to pursue my sound practice through installation works. It seemed to me that there would be a certain freedom in embarking on this pursuit in an art context. Art projects have different types of constraints placed upon them when compared to architectural works. They do not have programmatic briefs, clients, and generally speaking, regulatory issues such as building codes and urban planning issues are not typically brought to bear upon them.

In reflection, I realised that I was working with sound in a spatial way on *Wayfinder*. I approached this work in the guise of a sound designer or even sound artist, not architect. Despite this, my architectural training, experiences and sensibilities had a significant impact on the final piece, whether or not I was acting consciously or intuitively. The process of reflecting on this project in many ways shaped the question of how I might design space with sound.

*The Birds and the Bees*, the second in this grouping of projects, was commissioned and curated by Hannah Matthews and installed at the Spare Room Gallery located at the rear of RMIT University’s Project Space Gallery.

This second project represents my first attempt at responding to the question of auditory spatiality in a consciously inquiring manner. When designing *The Birds and the Bees* I set about intentionally trying to make a space where sound was pivotal to how it was spatially conceptualised, understood,
and experienced. One of my aims was to explore how I might design a space whereby the design of its aural aspects might constitute a significant aspect of its architectural composition.

The chapter concludes with a reflection on the project grouping.

**Wayfinder**

**Background**

In the early months of 2003 visual artist Cate Consindine and I discussed the possibility of collaborating on an installation work. A late-night conversation about our experiences of sound and the city of Melbourne touched on our experiences of the city’s Audible Pedestrian Crossings (APCs). APCs are intended as an aid to non-sighted or visually impaired members of the community, and essentially function as a navigational device for crossing the road. In Melbourne they are typically, although not exclusively, found at pedestrian crossings and intersections in urban areas. They emit a mechanical sounding ‘tick’ and are activated by pressing the pedestrian crossing button.

Our conversation concluded with an agreement to make an installation piece. To that end we decided to locate a gallery space and begin responding to its conditions. I do not recall that we set out to make an installation that referenced APCs. It was our selection of gallery space and our consequent responses to its conditions that reminded me of our prior conversation about these auditory devices and the potential for a spatial understanding of their condition, and how this understanding might fold into this project.

We collaborated on all aspects of this project, however, while we discussed the audio content together, the research via the design and execution of this aspect of the project was entirely my own work, as is the consequent reflection and analysis of the project that I present in this document.

The final installation had a number of components which I will briefly describe. I will then give a full account of the design of the audio aspects of the project.

Refer to sound sample 01: a stereo field recording of an APC at the intersection of Cardigan and Queensberry streets, Carlton.
Project Description

Conical Gallery is located upstairs at 3 Rochester Street, Fitzroy. The existing gallery space inhabits a second storey of an early 20th century Victorian shopfront building. The shopfront itself faces Johnston Street, and entry to Conical is via the side of the building. The interior space of Conical is a single volume split into two halves. One enters into a low, white, plastered space. This space essentially consists of mute blank walls with the only features being the window to the eastern side and electrical conduit mounted to the ceiling. Next one moves into the second part of this volume, a brick Victorian shopfront with exposed ceiling and pyramidal roof structure with visible corrugated iron roofing. Layers of predominantly pale green paint accumulated over the lifetime of the building peel from the walls, giving the brick surface a variegated appearance. A striking aspect of this shopfront is a series of Victorian windows to the north-eastern sides of this space.

We immediately understood this single volume to be an actual and conceptual intersection between two types of spaces: that of the shopfront and that of the white plastered space. We set about amplifying this condition in a number of ways.

The first half of the volume was modified by building a timber stud frame and plastering over the existing east-facing window opening. The existing light fittings in this space had cubic covers made especially for them, which were attached to the ceiling. Excluding the polished timber floor this space was then repainted in fresh white paint to produce a pristine white volume. Two pairs of industrial ‘blinder’ floodlights, similar in intensity and configuration to semi-trailer headlights on hi-beam, were hung at the bulkhead intersection between this initial modern, low-ceiling, white space and the brick Victorian shopfront it proceeds into. The floodlights were shone back into the cubic white space giving it a harsh intensity. When viewed from the shopfront any inhabitant of the white cubic space was bathed in the harsh light projected the floodlights. However, when they moved towards the shopfront space and stood at the threshold between the two, their image was reduced to a silhouette, all detail diminished to an outline.
The second half of the volume, the shopfront, contained a six-speaker electro-acoustic array mounted just above the exposed ceiling joists. The speakers had black casing to reduce their visual impact. The only light sources here were reflected from the white cubic space, specks of sunlight that managed to penetrate the cracks in the old corrugated iron roof and the handful of period iron ventilation openings that sat over the window openings.

This speaker array reproduced a spatialised soundscape, the constituent sounds of which were recordings of APC ‘clackers’, which had been composed into a shifting sequence. This soundscape, by virtue of its source material, was familiar, implied certain behavioural responses, such as walking or waiting, yet was out of context, interiorised and had a sense of something not quite right about it. In a sense it defined a zone of intersection, but unlike the urban iterations of this configuration, one could occupy its territory at all times. This territory would shift, spin, slide past you and stop. As opposed to hearing the impulse response of the urban spaces that it would typically give rise to, in this instance the soundscape activated the space of the gallery, and was thus characterised by the sound of the materiality and volume of Conical.
The soundscape recalled an urban sound space, familiar yet displaced from street to room. While the familiar street configuration implied an ordered navigation of space, this reconfigured intersection was fluid. The auditory field expanded, contracted, shifted from beneath the listener and then spun at an increasing rate before returning to pause, at which point it was silent. The only sounds that could then be heard were the muffled street beyond and the sounds of the gallery’s occupation from within. One of its purposes was to reinvigorate the awareness of the external, urban sound space from whence it came.

The existing window openings in the shopfront were covered with large window replicas made from MDF sheeting with period window architrave surrounds. Using a split batten configuration they fitted over the existing windows and prevented light from spilling in through these apertures, as well as baffling the sound of the street outside. These window panels were abstractions of the existing windows. Where steel framing sections might once have formed a projecting grid on the surface of the glass, have in this case been rebated into the window replica surface. In this sense the window replicas are inversions of the existing windows.
The intention was that these window replicas would be painted in high gloss automotive two-pack enamel so that they might take on a mirror-like effect, whereby one could read their surface, but could also have a sense of looking beyond or into them. Understanding the acoustic field as a kind of morphing intersection, these window replicas were conceptualised as perceptual apertures to worlds beyond the intersection of the gallery. These worlds could simply be the real world, that is the world outside the gallery walls, or other worlds that might be imagined, dreamed, or otherwise conceptualised.

On Johnston Street, immediately in front of the gallery, was a pedestrian crossing, albeit a mute one, which any visitor to Conical would have to pass when leaving by the major access way to the gallery. The existence of this crossing offered an intriguing counterpoint to the designed experience within the gallery and was an important aspect of the work.

**Project Execution**

I had an intuitive awareness that the sense of intersecting space we had identified in the existing volume of the Conical Gallery could be responded to somehow by referencing the APCs that Cate and I had spoken of.

Initially I undertook a series of what I refer to as ‘sound walks’. These walks literally involved searching in and around the Melbourne city grid for examples of APCs that seemed to have some acoustic intrigue. For many years I had been aware of the APCs at the intersection of Exhibition and Bourke streets, Melbourne. This was the first site where I really noticed the evening transformation that the APCs were capable of undertaking. I will describe this transformation:
Late in the evening, as the sound of the traffic, industry, commerce and pedestrians diminish, these crossings become a spatial and sonic wonderland. This condition remains until the early hours of the morning which is punctuated by the return of industry, commerce, transport and their associated activities. The navigational aspects of the APCs, coupled with the zebra-striped road markings accompanying their installation imply a series of acoustic lines bounding a clearly defined territory. During the daytime hours their impulse is clearly heard, not so much because of their amplitude or volume, but because their frequency, in terms of pitch, and rhythm, in terms of time, cutting through the ‘noise’ of the city. In this condition they function effectively as navigational aids or acoustic beacons. However, as the daylight sounds of the city diminish, the echoes, reflections, beat cancellations and modulations that are completely indexical to the physical make-up of these intersections, that is, the building configuration, material, paving type, elevation and planting, can clearly be heard. What is more, at these times one can stand in the middle of these intersections and be engulfed by this swirling experience, as opposed to occupying the geographic edge. You can find yourself tuning into particular aspects of the sound: the impulse responses, an echo from a building facade, reflected in a way that is at first perplexing, but then begins to make sense as you start to understand how these APCs sonically interact with their locale.

I found an appealing asymmetry in the fact that these ordered navigational devices also exhibit a chaotic spatial aspect to their experience. The impulse and impulse response contain different information. Our experience of them depends on which particular aspects of the audible field we tune in to.

I set about analysing a number of APCs. This analysis was conducted in the form of a series of early morning location recording sessions at various sites around Melbourne. These sites focussed
mainly on the following locations, selected for their particularly legible night-time acoustic transformation:

1) The intersection of Cardigan and Queensberry streets, Carlton
2) The intersection of Gipps and Wellington streets, Fitzroy, a ‘T’ intersection
3) The intersection of Gisborne and Albert streets, East Melbourne
4) The intersection of Exhibition and Bourke streets, Melbourne

These location recording sessions typically took place between the hours of 1.00am and 5.00am. For a recording rig I used a TASCAM DA-P1 non-timecode portable DAT recorder and a pair of Sennheiser MKH40-P48 cardioid condenser microphones with Rycote shock mounts and windscreens. The microphones were handheld in the shock mounts in an ‘XY’ configuration to eliminate phase cancellation on the recordings. The wind shields were only used when required. I used a pair of Sennheiser HD-25 headphones for audio signal monitoring purposes. The aim of the recordings was to try to document the acoustic fields of these APCs, so that I might have material to listen to and analyse. The selection of recording apparatus was to suit this purpose.

A second round of recordings was undertaken that focussed on the actual sound of each APC device as a singular, ‘close-miked’ sound source. I used the same recording setup as the previous recordings. However, the microphone selection was altered to use a Sennheiser 416 hyper cardioid condenser microphone and Sennheiser MD-441 super cardioid dynamic microphone.

My analysis of the recordings and my experience gained whilst undertaking them revealed some intriguing aspects. Of the APC devices I recorded, I observed the following:

1) The devices do not pulse with the same beat.
2) The beat from an individual device could slowly vary and ‘slip’.
3) No two APCs sounded the same in terms of their timbre (tone), possibly due as much to the size and type of pole they were each mounted to as to the manner of their mounting.
4) There were general inconsistencies in the cycling of the sound throughout each intersection, that is, the variations outlined above determined that no two configurations of APC intersections are the same.
5) The corners of the intersections typically had two APC devices, thereby producing an ensemble effect of a singular ‘click-clack’ sound.

While undertaking analysis of these recordings, and in conjunction with listening to the APCs in situ, I observed that although my initial tendency had been to focus on the APC devices as if they were sound objects or sources, I became much more focussed on the spatialised field they seemed
to create. I became increasingly interested in the idea of taking the external spatialised field typical of one of these intersections – a field that was at once functional, navigational, familiar, and site specific – and displacing it into the interior condition of the Conical Gallery space. The paradox here was that in order to achieve this displacement I needed to relocate the auditory impulses of the APC devices rather than the field that resulted, and do it so that a new interiorised iteration of the spatialised field would result as a consequence of the acoustic profile of Conical Gallery. Blesser and Salter would describe the field I refer to as an example of sonic illumination.4

I took the second set of close-miked recordings of the APCs and trimmed the audio files down to single impulses, that is, ‘beeps or clicks’. These audio files were then assembled on different tracks of a digital multi-track audio editor, in this case Logic Audio Platinum, and I began experimenting with different arrangements. What I mean by arrangement here is the variations in the timings of the various APC ‘clicks’ and their location in space as a sound source. In this case it was the equivalent of a speaker location and pan position. One of the things I noticed is that even though the impulse of the APC clicks is very loud, when recorded with good levels I could hear a great deal of the space of the various intersections as the clicking sounds would decay. I used a sampler to alter the envelope of each of these sounds to hasten the rate of the decay of sound. Effectively I was
muting the reverberant tail on each sound, effectively removing the most legibly spatial artefacts from these recordings. This gave the recordings a disembowelled effect that I found appealing. I found myself describing the recordings as *de-spatialised*.

 REFER to sound sample 02: a 'close-miked' recording of an APC device. The site's ambient audio is evident in the decaying 'tail' on the recording.

 REFER to sound sample 03: The same recording in sound sample 02, post envelope shaping.

The *de-spatialised* sounds of the APCs I had previously referred to were finally composed into a polyrhythmic arrangement. In the process of developing this arrangement I set up a quad speaker array in my home studio and was concurrently experimenting with variations on positioning of sources. The initial electro-acoustic installation proposed four speakers configured in an approximate square to be mounted into the zone of the exposed ceiling joists of the gallery. I wanted to hear the presence of the APC units in the gallery, but did not want them to be visually referenced in order to heighten the sense the field that I was designing was a purely aural one. This quadrangle configuration obviously mimicked that of the APC intersections. As the audio design developed, this initial proposal expanded into a six-speaker system to accommodate the more sophisticated
panning manoeuvres implemented in the final piece. While the position of the speakers was static, I could still pan the source sounds anywhere within this speaker field.

While developing this work I began to subtly add artificial reverberation to each track. Having stripped the sounds of city from the APC recordings, I found myself attempting to artificially re-spatialise the audio into an approximation of what it might sound like when installed in the Conical Gallery shopfront space. I was acutely aware that the artificial reverberation would be removed when installed, and that the actual reverberation profile of the space of the Conical Gallery would replace it.

Pairs of de-spatialised APC sounds were then grouped at the corners of the quad speaker configuration, that is, eight source sounds in total, to construct a displaced APC. Each source sound had a Wait mode and a Walk mode.

The polyrhythm enabled the Walk mode sound sources to slowly slip in and out of sync with each other over a period of fifteen minutes. This polyrhythm gave the impression that the field was mobile, unless one listened sufficiently carefully to the differences in timbre to detect the fact that they were not mobile. The source locations were initially static, but after a number of minutes would start to move, that is, were panned through the speaker field. Essentially the sounds were slowly panned to the western edge of the speaker field so that the field gave the impression of having spatially contracted. The field would then expand slowly back to its initial configuration. There was a palpable sense that the field had moved out from underneath you and been consigned
to an edge of the space. At the conclusion of this expansion and contraction phase the ticking sounds would race similarly to the audible walk signal at one of the APC intersections. During this Walk mode the sound sources were panned in such a way that the entire sound field rotated progressively faster and faster in an anti-clockwise direction until the entire space seemed to whirl around one’s head. The field would abruptly cease spinning and was rendered silent for a few minutes. To maintain control over the perception of where the sources were emanating from, the speakers were pointed face down towards the floor of the gallery.

I had conceptualised the plan limits of the shopfront space to be the borders or edges that I referred to earlier, and conceived the domain within these limits, that is, standing in the middle of the shopfront space, to be the equivalent of standing in the middle of the intersection. By removing the visible evidence of the APC intersections the sense of spatiality was described purely by the auditory material that was retained. One could walk into the middle of the shopfront and experience the four corners of the quadrangle intersection. However, unlike the urban instances that are so familiar, the location of the sound sources for this installation were not static.

Refer to sound sample 05: Wayfinder auralised, modelled output of sound field. Warning: High attack signal present on recording. – I will discuss this modelling in chapter 2.
Reflection

I began Wayfinder with the aim of making an installation, whereby the sound design referenced APCs for their potential to communicate ideas about intersection, and ended up interrogating possibilities for sound and space. I approached this work in the guise of a sound designer or even a sound artist, not an architect. Despite this, my architectural training, experiences and sensibilities had a significant impact on the final piece, whether or not I was acting consciously or intuitively.

I observed that there was something spatial and architectural about the way I was thinking and designing. I was not intending the work to be architectural, rather, I considered myself to be working as an artist in the domain of a gallery space. The observation that I was acting architecturally was one that I made upon reflection.

This project was pivotal as it suggested a departure point from my sound practice as a musician, recording artist, location sound recordist, and sound designer. It suggested that there might be a way of working with sound in an architectural context that was not typical of the sound art installations I had become used to visiting or anecdotally heard others criticise. I had set up an auditory field that was a displaced APC. In retrospect I understood this field to be an urban sound space. I realised that the spatial experience of the designed, internal audio field was very much about identifying the existence of and highlighting the qualities of the urban sound space that it referenced.

The consistency of the general spatial configuration of the APCs’ aural conditions led me to want to classify them in terms of what an architect might refer to as typology or what a musician might refer to as a form, in the way they might understand a canon or fugue. I understood these auditory configurations as a sound–space type. In this sense their aural conditions have a consistency of arrangement and function, but each iteration has its own specificity, in the same way that opera houses, for example, have a generally consistent schema, but each has its own particularities.

The audio for Wayfinder was not responsive to inhabitation. By this I mean that it did not respond to the presence of people, other than the minor effect the presence of people had on the reverberant properties of Conical Gallery. It had no triggering or any other mechanical means to affect its electro-acoustic condition. It this sense it was a soundtrack, pre-composed, programmed and looped. This condition concurred with the APC model upon which it was based, but I found this observation troublesome, and identified it as something I wanted to negotiate in future projects.

Notwithstanding the apparent site specificity of the audio design of Wayfinder, its properties as an electro-acoustic work allowed for the possibility that the auditory layer of the project could be relocated to new sites, although with obviously different aural and spatial outcomes. The
sensibilities of the installation in its entirety would be different, but the mechanism by which the spatial sound field was manifest would operate in a similar way. I speculated that electro-acoustic works would always risk being perceived with some sense of impermanence due to the fact that the technical means by which they are made manifest are not constructed in the way, say, a barrel vault might be, but are installed, implying that they are overlaid onto, rather than being integral to a structure, and as such can be easily removed, or worse, switched off. I wondered whether an electro-acoustic work could be interwoven into a space in such a way that it meshed integrally into our spatial apprehension of that space so seamlessly as to defy this sense of impermanence.

The Birds and the Bees

Introduction

After reflecting on the way I worked on the Wayfinder project, I realised that there might be something potentially more architectural about the way I was working with sound. With The Birds and the Bees I set out quite specifically to try to use sound in a consciously spatial way. As I have stated previously, when designing The Birds and the Bees I set about intentionally trying to design and make a space where sound was pivotal to the way it was spatially conceptualised, understood and experienced. One of my aims was to explore how I might design a space where the design of its aural aspects might constitute a significant aspect of its architectural composition.

Background

‘The Birds and the Bees

Architects Melissa Bright, Shelley Freeman, Kirsten Grant, Nick Murray and Jonathan Podborsek and curator Hannah Mathews present a collaborative project involving five architects, one curator, a designer and a leftover space. Inspired by an exhibition of commissioned birdhouses designed by a number of prominent international architects and displayed in a public garden in Paris, the original aim of The Birds and the Bees was to explore the tendency of human beings to apply our rationales and disciplines to fantastical and ultimately intangible situations – in this instance, the tenets of architecture to a beehive or birdhouse. Not only does The Birds and the Bees examine the way humans behave, it also addresses a number of factors that arise from the parallels existing between the seemingly disparate lives of birds, bees and humans. The project has become a hybrid and explores many elements including social order and class structure, survival and production, biology and aesthetics, and most importantly the role of the home. Once existing as a leftover space, Spare Room is transformed into a newly configured architectural experience. Human perception is challenged as space is manipulated and perspective is morphed. What appears to be seemingly familiar is simultaneously disorientating.’

Spatial Prototypes
I was approached to collaborate with a number of architectural colleagues on an installation to be held at RMIT University’s Spare Room Gallery, located at the rear of the Project Space Gallery, 23–27 Cardigan Street, Carlton, in October 2003. Curated by Hannah Mathews, the exhibition was to be titled The Birds and the Bees. The initial premise for the project grew from Hannah’s interest in a history of architects who designed elaborate birdhouses, but most specifically by an exhibition she viewed in Paris of commissioned birdhouses by prominent architects.

‘The original aim of The Birds and the Bees was to explore the tendency of human beings to apply our rationales and disciplines to fantastical and ultimately intangible situations, in this instance, the tenets of architecture to a beehive or birdhouse’.6

The group’s initial thoughts were to work autonomously on a range of independent birdhouse designs, that is, architectural objects or miniatures that might inhabit the constrained space of the RMIT Spare Room Gallery. The Spare Room Gallery is essentially a remnant space that was possibly once a storage room at the rear of the Project Space Gallery.
It measures approximately 2 metres by 3.5 metres by 3.5 metres in height. The intention as that we would each respond to the concerns or issues expressed by Hannah in our own way, with our own filters and preconceptions, and produce our own designed responses. These would then be exhibited and displayed in such a way as to encourage a variety of critiques or responses that would enable dialogue between the various birdhouses.

My colleagues and I met weekly and engaged in round table debates about a range of issues that we felt were pertinent. We spoke about birds, bees, humans and the formal domestic living structures that each species engaged in. Privacy and shared territory was debated at length in relation to these formal structures. We discussed the history of birdhouses, architectural form and typology and our own nostalgia in relation to these. We also conversed at length about domestic aesthetics, decoration and the designs of Laura Ashley. The issue of domesticity and sexual politics also figured highly in these meetings. The constrained dimension of the gallery coupled with the valuable contestations of these weekly sessions soon led us to agree that our collaboration should not be one expressed in a curated collection, but in a singular response. Our response to the issues we had raised was a strategy that relied on subtle subversion. We assumed a collective position of questioning thoughtfulness rather than a rejection of what was familiar or even aspirational.

We collaborated on all visual aspects of this project, however, while we would discuss the audio content, the research via the design and execution of this aspect of the project, and indeed the impetus to even engage with aurality as an aspect of the design was entirely my own work, as were the consequent reflection and analysis of the project that I present in this document. Jonathon Podborsek and I constructed the enclosure. I designed, specified and installed all aural aspects of the work. The final installation had a number of components which I will describe briefly. I will then give a full account of the design of the aural aspects of the project.

Project Description

The final installed version of The Birds and the Bees took the form of a prismatic child’s cubby house with a gable roof, reminiscent of the type you find in toy catalogues or might observe drawn or painted on a child’s easel resplendent with the comfort communicated by the crooked chimney and the wisp of smoke from the open fireplace, which in Australia we are no longer even allowed to legally construct. The ‘ideal view’ of this form was distorted in a number of ways. The entrance to the cubby house was constructed hard up against the existing gallery entrance threshold. The entrance to the Spare Room was a standard door threshold approximately 800 millimetres in width by 2100 millimetres in height. We reduced this threshold condition further by constraining the dimensions of the entry onto The Birds and the Bees enclosure. This enabled us to curate the view of this cubby into one that was entirely interior. One could never see the form, despite the fact that it was legible and recognisable from its interior, and therefore familiar. The threshold
treatment did, however suggest the possibility that this form had an exterior, evidenced by the pink graphic treatment of the entranceway. The second primary shift was that the form was distorted so that even though the two gable ends were proportionally the same, one was smaller and repositioned asymmetrically to the plan centreline to give the interior an apparent perspective. The floor sloped gently upwards, and the ceilings raked down. While not as compositionally erudite as the perspective effect achieved by Borromini in his design of the gallery of Palazzo Spada, the outcome was nonetheless very effective. Unlike Palazzo Spada, you could view The Birds and the Bees perspective obliquely from the entry, rather than experiencing it only in axial view.

The installation was accessed via the larger Project Space Gallery. On approach to the entrance to the Spare Room Gallery one noticed a modified threshold condition, shrunken and sufficiently constrained to require visitors to duck their heads to enter. An outcome of having to duck down was that people would often pause and peer into the space before entering.

On entering the interior of The Birds and the Bees, one heard an unexpected sound. Instead of the quiet tap or pad of footsteps on the raised floor, each step made produced a large, loud, reverberant response, completely paradoxical to the sound one would expect from such a small, constrained space. The floor had been constructed to allow it to vibrate freely and had an electro-acoustic system designed to produce such a sound. Conceptually, I understood this effect spatially to be ‘dimensional inversion’. That is, the space looked small yet it sounded large.
Refer to sound sample 06: Location field recording from *The Birds and the Bees* installation.

The walls, which at first glance appeared to be lined in pink floral wallpaper reminiscent of a Laura Ashley design of flowers and bees, revealed on close inspection to be sexual motifs. Breasts, bums, penises and ejaculations replaced the chrysanthemums or other floral designs one might have otherwise expected. This wall treatment was extended to the floor, thus enveloping the interior in a soft pinkish hue. A single, bare, oversized incandescent light bulb illuminated the space.

The entire installation was conceived of as having a familiar, genial air. We relied on imbuing this familiarity with a sense of the uncanny.

**Project Execution**

My initial responses to designing the aural experience of this installation focussed on ideas that suggested adjacent spaces. I recalled a sequence in Wim Wender’s film, *Wings of Desire,* where the camera tracked through a number of apartments. In these apartments one witnessed people in various states of human emotion. Amongst an array of other emotions these might be happy, sad, lonely, reproachful or hopeful. This sequence resonated for me as it explored the human condition in regard to domestic relationships and therefore seemed to resonate with the themes of *The Birds and the Bees.*
I set about trying to produce a series of sound pieces to suggest that The Birds and the Bees enclosure might have spaces beyond it that could not be seen but could be heard. These sketches involved recording and editing a number of arrangements into rough sequences. These sequences used recordings from television sets, fragments of situation comedies, couples arguing or laughing, the news or a cooking program. I used recordings from talkback radio and various domestic sounds, such as a coffee pot gurgling, a boiling kettle, the sound of my garage door being remotely opened, water gurgling down a sink and the sound of rainwater trickling down a downpipe.

I proposed an electro-acoustic array of speakers on each of the four walls of The Birds and the Bees enclosure as well as the floor and ceiling. That is, six speakers in total which might then allow me to control where these sources might appear to come from, so that from within the interior of the cubby house one might hear the sounds as if they were coming from an apartment above, beside or below. To ensure that the sources were not visible they would need to be mounted on the rear of the installation. Any muffling effect this installation might have on the audio would only aid the intention that these sounds were coming from spaces beyond the immediate enclosure. The fact that there seemed to be an experiential schism between the entry threshold configuration and the fact that some of these implied spaces could not exist seemed to contribute to the sense of the uncanny that the work was imbued with. It was intended that playback would be on six-track digital multi-channel audio from a computer equipped with a multi-channel soundcard.
For another proposal I recorded foley footsteps. The potential for the footsteps idea was that I could arrange the six speakers on the ceiling and by panning the recordings from speaker to speaker I could make the footsteps move around the ceiling of the space as if someone was walking around in an apartment up above.

After experimenting for some with these ideas of adjacent spaces, and reflecting again about some of my aims post Wayfinder, I realised that there were a number of issues that were preventing me from achieving my aims for The Birds and the Bees project:

1) The manner of aural comprehension was acoustic communication not acoustic energy. The adjacent spaces where not so much heard as adjacent volumes that might be heard as reverberant, for example, but rather heard as media, which implied that other volumes existed.

2) The playback sounds were about other spaces, not the space of The Birds and the Bees enclosure. While they suggested possibilities for comprehension of the space of the enclosure, it was not the direct relationship that I was trying to establish between what was visible and what was audible.

3) The sound was static. By that I mean that it did not respond to inhabitation. It was a soundtrack that even if composed to last for two hours, to try to ensure a variation of experience for anyone inhabitant of the work, it would simply be repeated over and over again.

4) There was the possibility that the work could be understood merely as a soundtrack or soundscape and in that sense could be read merely as an overlay of media into the enclosure.
In order to address these issues I supposed that given the spatial distortion suggested by the small, tapered volume of *The Birds and the Bees*, and the compression and dimensional displacement implied by the various scale-distorting techniques, perhaps I could find an aural parallel to the visual experience of the volume. I wondered how I might be able to use sound to produce a dimensional, literally in terms of perceived size, and thus spatial effect that might interrupt aural and spatial expectations. Achieving this would heighten awareness of the impact of what we hear on how we apprehend and understand space. It would also serve as a developed strategy for how I could use sound in a spatial way.

Steen Eiler Rasmussen’s chapter on Hearing architecture⁹ includes an account of the acoustics of tunnels of Vienna’s sewage system in the motion picture *The Third Man*: ‘Here, architecture is certainly heard. Your ear receives the impact of both the length and the cylindrical form of the tunnel.’ If you are familiar with this sequence where Orson Welles’ character, Harry Lime, is chased through the sewers of Venice, you will notice that the sewer tunnels are rather more heard than seen. However, this reference is to a cinematic depiction of sound and space. From my own experience I had observed that one could hear how ‘large’ a building like a cathedral can sound, or how ‘small’ a space like a vocal booth in a recording studio can sound. In both these examples what is perceived visually corresponds to what is perceived aurally.

I was determined to design an aural condition that enabled a spatial experience where what one heard was contradictory to what one perceived visually. The floor of *The Birds and the Bees* enclosure was constructed of 18 millimetre thick MDF sheet. This sheet flooring was laid over pine joists that were sufficiently spaced to allow the flooring to move or vibrate relatively freely. Gravity, and the fact that the walls constrained movement, was all that held the floor in place.
fixed six acoustic guitar contact pickups to the underside of the MDF sheet flooring. These are effectively dynamic microphones designed to be mounted to instrument bodies and are sensitive to mechanical vibration. The signals from these contact pickups were each sent to a Behringer DI100 Active DI box. The signal from each DI box was then routed into a small mixing console and mixed down from the six inputs to one mono output channel at line level. This mono channel was then routed through a multi band graphic equaliser, a reverberation unit and finally the signal was fed into a powered 15 inch speaker. The speaker was mounted on a stand in the remnant space between the walls of the Spare Room Gallery and the linings of the installed enclosure of *The Birds and the Bees*. Access to the control of this electro-acoustic system was achieved by sliding the snugly fitted entry step to the installation vertically upwards to reveal the electrical system housed beneath the raised floor of the enclosure. Once installed I was quite astonished at the outcome when I tested the system.

When the enclosure was vacant no sound emanated from it. I had tuned the equaliser so that there was no audible high-frequency hiss from the system. The DI units helped with this potential problem by providing ‘ground lift’ to the signals from the floor pickups. I set the reverberation time on the digital reverb unit to a couple of seconds, and stepped into the enclosure. I was greeted with an instantaneous, loud, reverberant crash of my footfall on the floor of *The Birds and the Bees* enclosure. Despite the constrained dimension that I could see around me, what I could hear was a large cavern-like auditory response to my every footfall. The sound seemed to come from all sides and it was difficult to detect where any speaker could be hidden. I suspect that because the sound was reasonably low in frequency, coupled with the small space of the Spare Room Gallery, the sounds from the speaker were diffused fairly evenly around the gallery and therefore spread evenly around the enclosure. The spatial comprehension might not have been quite as compelling if the sounds had been of a high frequency nature, and consequently more directional, thus potentially revealing a speaker as the sound source. Instead, like reverberation in a cathedral the cavernous reverberation seemed to come from all sides.

Given my aims, it was important to me that this work relied on human presence to be ‘acoustically’ active and responsive to their inhabitation. It was important that *The Birds and the Bees* enclosure was not simply another space for the repeated playback of an audio loop of a soundscape, regardless of what that loop might communicate or augment in terms of spatial legibility or communication. The act of stepping into the enclosure rendered it active as an aural space.

An intriguing artefact of the electro-acoustic floor system was that by utilising the multi-band equaliser I was able to tune the enclosure to encourage certain resonant frequencies. This was something that I had not consciously considered in advance, and was only discovered in the process of making the enclosure and installing the floor system. I was able to find certain frequencies that the enclosure responded to which would feedback and ‘howl’. This could be controlled by
inhabitants of the enclosure who realised that the howl occurred when one stood still in particular locations, rather than by moving around. Once it started to howl pressing a foot elsewhere on the floor or taking entire steps seemed to modify the enclosure’s resonant response or vibrational characteristics and the howl would stop. To some extent the installation could be ‘played’ in this regard. I was also able to tune the system to prevent this phenomenon from occurring at all.

This initially disconcerting sound would startle some occupants possibly more than the spatial inversion suggested by the schism between what one saw and what one heard. I felt this aspect of the project was congruent with the general design strategy of presenting a space that was superficially comforting and familiar, but which then kept moving in and out of unfamiliar and disconcerting territories.

**Reflection**

The execution of *The Birds and the Bees* project demonstrated that it was possible to design a space where the aural aspects were a critical feature of the architectural composition. In achieving this aim I demonstrated that the problem of the tenuous relationship an electro-acoustic work might have to its site, by virtue of being installed as an overlay of auditory media, can be negated when comprehension of the spatiality of the site is predicated on hearing the electro-acoustic work.

It would be possible to re-use the technique of ‘augmented acoustics’ on another project, but the relationship between the visual aspect of *The Birds and the Bees* enclosure and the aural aspect of the enclosure was site specific and particular. There was no generic aspect to its design and execution.
The enclosure was responsive to occupation. Like a purely acoustic environment it was mute unless occupied or acted upon by some kind of impetus. However, the edges of the particular design technique I employed began to fray when one made sounds other than those accompanied by footfall. If one spoke or made other sounds that did not involve contact with the floor there was no accompanying reverberant response. The constructed enclosure was sufficiently ‘live’, like a musical instrument body, that a trace of artificial reverberation could be heard when one spoke, but the sense of seamlessness that naturally occurring acoustics demonstrate was not apparent. I am not sure if others noticed this characteristic, but I was certainly aware of it.

**Project Grouping**

I have grouped *Wayfinder* and *The Birds and the Bees* projects together and called them ‘spatial prototypes’. In the process of undertaking the design and review of these works that is precisely what they became for me within my own practice; that is, models for conceptualising and designing space with sound. I came to understand these projects as being like ‘personal precedents’ which said as much about the manner in which I started to work with sound in an art gallery context as they did about my attitude to the spatiality of sound. It is in making observations about this attitude that I recognised potential for architectural works.

As a consequence of this recognition of architectural potential a desire arose in me to contest architectural program with my auditory thinking. I recognise that an aspect of this desire was rooted in efforts on my behalf to locate my work in a larger domain. Were these works sound art? Were they soundscape? Or were they architectural follies of some sort? I understood them to be sound art works that as spatial prototypes have architectural potential. I recognised at the time that the manner of the thinking, design and execution of these works was heavily influenced by my architectural training and experience.

Both *Wayfinder* and *The Birds and the Bees* were designed for environments that were incredibly controlled. I wondered how either of these propositions, or the thinking behind them, might react to a classroom or a domestic environment? For example, if *The Birds and the Bees* had to contend with architecture program and I were to employ the same volumetric strategy I might use a far more subtle artificial reverberation. I am doubtful that I would tune the space to resonate at sympathetic frequencies. How might I apply the idea of augmented acoustics and the potential for perceived dimensional difference to a constrained architectural site?
A major aspect of the reflection of this project grouping resides in the propositional diagram above, which I understood to be either a scope diagram or a series of questions which I thought might frame future works in architectural contexts. These questions arose as a consequence of undertaking Wayfinder and The Birds and the Bees.
Notes

1 The use of the word ‘composed’ is not intended to imply any musical aspect to the work.

2 When we hear, we not only hear the direct sound source, that is, the ‘impulse’, we also hear the acoustic effect of the space in which that sound is made, that is, the ‘impulse response’. This impulse response contains all of the colourations and acoustic artefacts that environments add to or subtract from what we hear. This explains why clapping one’s hands in a concrete tunnel produces a very different sound to clapping one’s hands outside or in a cinema space. These terms are used by acousticians and acoustic engineers. I feel they are useful for what they suggest about the spatiality in what we hear.

3 I note that this site now has an entirely different acoustic space as a consequence of the demolition of the Southern Cross Hotel and the construction of the new building on this site.


5 Art Monthly Australia, number 164, October 2003.

6 Ibid.


8 Wim Wenders, Director, Wings of Desire, 1987. The sequence I refer to runs from 00:05:50 to 00:09:30.

Domain overview diagram. Nicholas Murray
Introduction

‘Thousands of visual artists, civil engineers, architectural historians, and social scientists have created a comprehensive symbolic language and an extensive literature for visual architecture, whose intellectual foundation draws on archaeology, engineering, history, sociology, anthropology, evolution, psychology and science. In contrast, even though aural architecture shares the same intellectual foundation, its language and literature are sparse, fragmented and embryonic’.¹

Attempting to identify the domain in which this research should be positioned is not as easy a task as it might appear. A survey of accounts of aural experience reveals how difficult it is to find descriptions of aural experiences of architecture. The major discourse that describes aural experience seems to reside in the adjacent fields of soundscape studies and sound art. With the exclusion of acoustics, the major critical theory for sound and sonic comprehension resides in practices adjacent to architecture, such as sound art, soundscape studies, music and psycho-acoustics.

In wanting to locate the domain for my research work I found myself looking more to the practices of soundscape studies and sound art.

This chapter is essentially a review of practices, projects and people whose work seems to share some common territory with the research I am presenting here. The chapter concludes with an explanation of an acoustic modelling technique known as ‘auralisation’.

Architecture and Aurality
Schafer considered that soundscape studies would unify all other branches of auditory investigation.

Schafer owes a debt to two musical predecessors, John Cage and Pierre Schaeffer. Cage’s 1952 composition, ‘4’33’, which requires the performing musician not to play their instrument for the duration of the work, elevated the sound of the environment to the status of music as environmental sounds are all that can be heard during any performance of the work. It was intended that the four minute and thirty-three second piece be anything but silent, and that consequently all sound could be considered musical. In treating the soundscape as a musical composition Schafer is really suggesting that our experience of the aural environment is one that should be composed or designed.

R. Murray Schafer’s ‘sound event’ is at once a development of and a reaction to Pierre Schaeffer’s sound object (l’objet sonore). In his Traité des objets musicaux, first published in 1966, Schaeffer reclassified the world of sounds into sound objects. Essentially he was interested in the material of sound and, using tape and other technologies, would isolate aspects of sound to use in his compositions. He was not interested in how we might understand sound in terms of semantics; only
in the sonic content of sounds as objects for his compositions. It was of no interest to Schaeffer that the sound of a note played on a violin came from a violin. The music he composed was described as ‘Musique concrete’. R. Murray Schafer recognised value in the idea of isolating particular sounds for investigation and research, but importantly, he was interested in precisely what the semiotic or referential qualities of these sounds were. Schafer’s sound event includes the referential aspects of a sound, its interactions within a particular context, and importantly a consideration of time.

In many ways the soundscape is historically treated as being pre- and post-industrial revolution. Schafer describes the post-industrial revolution as ‘lo-fi’, while the pre-industrial revolution soundscape is invariably described as ‘hi-fi’. The difference is that he considered a hi-fi soundscape as one where the background noise level is sufficiently low for discrete sounds to be clearly heard, whereas the background noise levels of a lo-fi soundscape is considered to be so high that one would have difficulty in discerning discrete sounds. Schafer exhibits a tendency towards nostalgia for the sound of a world that is long gone. The acoustic world that existed before the rise of the mechanised technologies of the industrial revolution is described in a far more meaningful and positive way than the lo-fi post-industrial revolution world that we occupy. However, he does state that he is against noise abatement:

‘Noise pollution results when man does not listen carefully. Noises are the sounds we have learnt to ignore. Noise pollution today is being resisted by noise abatement. This is a negative approach. We must seek a way to make environmental acoustics a positive study program. Which sounds do we want to preserve encourage or multiply? When we know this, the boring or destructive sounds will be conspicuous enough and we will know why we must eliminate them. Only a total appreciation of the acoustic environment can give us the resources for improving the orchestration of the world soundscape.’

The Handbook of Acoustic Ecology was prepared by Barry Truax, a colleague of R. Murray Schafer. The intention of the handbook was to assemble a collection of definitions of sound and acoustic terms to encompass all aspects of sound in the soundscape. Now an online resource, the idea was that the handbook would be a living text that could expand as the new field of soundscape studies developed. In combination with Truax’s other book, Acoustic Communication, the Handbook for Acoustic Ecology was effectively an endorsement of the ideas that Schafer had published only a year earlier. It is worthy of note that Truax felt that Schafer’s approach was descriptive and did not provide a coherent model for the analysis of the soundscape and historical trends. In Acoustic Communication, Truax develops Shafer’s propositions by offering a more technically analytical approach to the soundscape.
As proponents of soundscape studies and as analysts of acoustic ecology, Barry Truax and R. Murray Schafer have provided us with ways of conceptualising the sonic environment in relationship to listeners. As founding members of the World Forum for Acoustic Ecology, they have aimed to raise awareness and understandings about the acoustic environment. In presenting ways of trying to categorise, make sense of, or understand our acoustic environment, there is much to be gained from understanding their concepts of soundscape and sound event. However, a limiting factor of their research is that it is very difficult to translate their thinking into design stratagems.

Jean-Francois Augoyard and Henry Torgue, from the Centre de recherché sur l’espace sonore et l’environnement urbain (CRESSON) at the National School of Architecture of Grenoble, make the observation that

‘the application of the criteria of clarity and precision discredits a number of everyday urban situations impregnated with blurred and hazy (not to say uproarious) sound environments, which would belong to the ‘lo-fi’ category. We must therefore question whether, other than for the fields of aesthetic analysis, creation and conservation, the use of the term soundscape remains useful and pertinent.’

In questioning the concept of the soundscape and sound objects, Augoyard and Torgue suggest that an attitude to the acoustic environment that is more about an inclusive approach might be more pertinent. Rather than the purely qualitative approach to understanding the acoustic world subscribed to by Schafer and Truax, Augoyard and Torgue advocate an attitude that is both quantitative and qualitative. Rather than dividing disciplinary knowledge they assemble knowledge and describe the acoustic environment as ‘sonic effect’. An example of their approach is to examine the headings under which they describe the sonic effect called ‘cut-out’. The term is given various definitions under the following headings:
Despite the breadth of their descriptions, from a designer’s perspective it is difficult to know what to do with the knowledge communicated by Augoyard and Torgue. It is as if on the one hand there is the existence of an embryonic domain that is preoccupied with sound and space, while on the other hand there is an avoidance of design. It is as if an understanding exists amongst auditory theorists that the design of sound and space can only be advanced by the categorisation and definition of sounds, sound objects or sonic effects. I believe that this advancement will only occur by doing. That is, by making and accounting for designs for auditory space. This would give rise to a particularised understanding of sound in site specific contexts, rather than the generalised approach of soundscape.

Sound Art

The birth of sound art seems to roughly coincide with the creation of a number of auditory technologies. The most notable of these are were the inventions of the telephone and microphone by Alexander Graham Bell in 1876, the phonograph by Thomas Edison in 1877, and radio by Guglielmo Marconi in 1894. These inventions were significant because they enabled sound to be recorded, organised, edited, rearranged, reproduced and transmitted for the first time. In a sense, sound became material.

Douglas Kahn links the origins of sound art with modernism and the avante garde. He argues that ‘the literature on the arts of recorded and broadcast sound, and of conceptual, literary, and performative sound, is scant at all levels, from basic historical research to theoretical modellings’. He describes the early history of sound art via three prevailing figures that, while tied to the new technologies of radio and phonograph, pre-existed them and ‘were transformed by their adoption within a technological sphere’. These figures are vibration, inscription and transmission.

Kahn observes that only recently have auditory practitioners come to describe themselves as sound and sound installation artists, and that in the past there was no identifiable art practice outside that of music which actually dealt with aurality. Where auditory practices existed they seemed to ‘do so under other auspices: Marcel Duchamp was an antiretinal artist who focused on sound; Antonin Artaud was many things before he became involved in radio; Dziga Vertov took up film after his
attempts to found a phonographic “Laboratory of Hearing” were frustrated; Piet Mondrian found time to ruminate at length on Luigi Russolo’s noise music; William Burroughs was a writer who cut up audiotape; etc.¹⁷

Consequently, sound art is a ‘slippery’ domain that has only recently become more clearly defined. Within this domain there resides a strand of projects known as sound installation works. It is these that most easily resonate with the projects I am undertaking. Unlike the soundscape practitioner’s approach, which tends towards categorisation and definition of sounds, sound objects and sonic effects, sound installation works often describe potential and possibility for space and aurality, or are directly concerned with such issues.

Alvin Lucier’s 1969 sound piece I Am Sitting in a Room utilises the existence of a room’s resonant tendencies to enhance certain frequencies while diminishing others. The author recorded himself describing the process of sitting in a room and then replayed and re-recorded each preceding recording back into the same room over and over again until the room’s resonant frequencies eventually destroyed any semblance of speech on the recording. The original recording is rendered purely tonal and demonstrates the effect of location on what and how we hear. In this case the intersection of a recording technique and architecture formed the basis of an examination of sound and space. Lucier stated that ‘thinking of sound as measurable wavelengths, instead of as high or low musical notes, has changed my whole idea of music from a metaphor to a fact and, in a real way, has connected me to architecture’.¹⁸

La Monte Young and Marian Zazeela’s Dream House project (1962 – present) employs a series of over thirty sine wave generators that each emits a tone of constant frequency. Variations in the phase from one tone to the next can be heard as beat modulations and are relative to one’s position within the Dream House and dependent on the resonant frequencies of the specific location. Thus moving or even turning one’s head produces a perceptive variation in the sound field and a musical reconfiguration of the chord that the sine tones collectively describe. The experience of the work is entirely contingent upon the precise physical and psycho-acoustic relationship between one’s ears, the sound itself and the architectural environment within which the sound is contained, particularly in relation to its dimensional relationship to the wavelength of the sine tones.

Of particular intrigue to me is the work of architect and sound artist Bernhard Leitner. Leitner’s 1978 publication Ton:Raum Sound:Space describes a series of design investigations into sound and space. These early works are predicated on a range of propositions that Leitner makes at the beginning of the text. The most significant of these is that sound can define space and that sound can transform space.¹⁹ The designs described in Ton:Raum Sound:Space are contingent on psycho-acoustic experience of sound sources shifting in space.
Leitner’s works range from small-scale wearable works such as his ‘soundsuit’ to large-scale public projects such as Le Cylindre Sonore (1987) at Parc de la Villette in Paris. I find Leitner’s description of this particular work compelling, as it implies an attitude to the design of sound and space not dissimilar from my own: ‘The combined effect is the acoustic delineation of space and the physical massing of sound. Sound is no longer exclusively the instrument of musical expression; designed with precision, it becomes a building material in the creation of space.’

Brandon Labelle gives an account of a 1984 work that is typical of Leitner’s contemporary work:

‘Sound-Space consisted of a square room whose walls were covered in an acoustically absorbent material (a kind of membrane that holds sound rather than deflecting it), making environmental sounds somehow less imposing, hushed. Like Leitner’s work in general, Sound-Space confronts a viewer-listener with its physical alterations of space – we recognize the shift in space though psycho-acoustic disturbance. In this particular work, this shift is the absorption of sound – the room as a stifled space. Inside the walls forty-eight loudspeakers are mounted amplifying given frequencies. The frequencies seep into the quiet space and at the same time are absorbed back into the walls, creating a highly active and self-reflective (even self-consuming) public space.’

Labelle’s description of the physical alteration of space that is present in Leitner’s Sound-Space reminds me of my own experience of Joseph Beuys’ 1985 work Plight, on permanent display at the Pompidou Centre in Paris. The work consists of a room with walls that are lined in large rolls of grey felt. A locked piano is positioned in the middle of the room. The mute grey of the felt coincides with its material capacity to absorb sound. The threshold moment when one enters off the larger Pompidou galleries into the contained space of Plight is astonishing; sound seems to be sucked right out of the room. Initially, the spatial experience of this can be almost claustrophobic until one’s perception adjusts and the sound of one’s own breathing becomes acoustically elevated. The most compelling aspect of the work for me is a consequence of the fact that the rolls of felt do not extend to the floors or ceiling. The acoustic outcome of this is that each step one takes within the space of Plight is accompanied by the sound of a ricocheting echo of one’s footfall bouncing between the floors and ceiling. A space that seems initially acoustically mute, an understanding that is reinforced by the locked piano, is conversely rendered quite specifically active by human occupation and the acoustic specificities of its arrangement.

The works of these sound artists are indicative of a practice that finds itself commonly exploring the potential for sound in a spatial context. The liberation of these projects from having to contend with architectural constraints such as program and regulatory issues of planning and building codes, enables quite particular approaches to notions of sound and space. Like my own works, Wayfinder and The Birds and the Bees, these projects offer insights into auditory spatiality and exist as important precedents for designing space with sound.

Architecture and Aurality
Architecture

Sonification currently resides in architecture as a practice known as acoustics. As I previously noted, with the exclusion of acoustics the major critical theory for sound and sonic comprehension resides in practices adjacent to architecture, such as sound art, soundscape studies, music, psychoacoustics and other cultural histories. Discourse on sound and architecture is typically very limited, as the orthodoxy is to constrain the discourse to acoustics, which consequently focuses mainly on one of two things, the design of high-performance listening environments – that is, the control of sound – or environmental noise mitigation. A third aspect of this orthodoxy describes architecture and sound in regard to representational strategies, where notions of sound, commonly musical, are brought to bear as compositional strategies in an architectural sense. An often cited example of the compositional strategies I refer to is the monastery of Sainte-Marie de la Tourette, designed by Le Corbusier and Iannis Xenakis, where the window mullions in the loggia are analogous with a musical score.

Architectural works that have sought to be analogous with, to replicate or represent some aspect of a musical score or engage with transferences of musical notation or compositional strategies, are peculiar precisely for their lack of audibility. What was once audible, or was by implication aural, becomes ocular. Stephen Holl’s Stretto House is an intriguing contemporary example of this. Holl makes claims for transference of the compositional strategies of Béla Bartók’s *Music for Strings, Percussion and Celestra* into the architectural composition for his Stretto House.

‘Bartók’s composition is in four movements and has a distinct division in materiality between heavy (percussion) and light (strings). The Stretto House is formed in four sections, each consisting of two modes: heavy orthogonal masonry and light, curvilinear metal (the concrete block and metal structures of Texas vernacular). The plan is purely orthogonal; the section, curvilinear. The guest house is an inversion with the plan curvilinear and the section orthogonal, similar to the inversions of the subject in the first movement of Bartók’s score’.22

Holl’s description of the project goes so far as to exclude sound from architecture: ‘Where music has a materiality in instrumentation and sound, architecture attempts an analogue in space and light.’23 I understand that there is nothing in Holl’s description that communicates any attempt on his behalf to somehow sonify Bartók’s composition within the architecture he has designed, which probably suggests this was something he simply was not interested in doing. Nonetheless, it is telling that he has explicitly excluded aurality from an architectural design that has an apparent relationship to musical ideas.

A number of recently written acoustic histories have been published which, possibly as a consequence of the works of soundscape practitioners such as R. Murray Shafer, resist the
previously described orthodoxy and attempt to position architectural acoustics in relation to other cultural realms. Emily Thompson’s *Soundscape of Modernity* represents a critique of the acoustics of early twentieth-century America and its relationship to the culture of modernity. She tracks the transformation in auditory space that accompanied the rapid advancements in the science of acoustics following Wallace Sabine’s derivation of his reverberation formula. Thompson describes a lineage of projects from Boston Symphony Hall (1900) to Radio City Hall in New York city (1932). In doing so she describes a transformation in the auditory space of architecture from one that is acoustic (Boston Symphony Hall) to one that is electro-acoustic (Radio City Hall). Significant projects are described along the journey of this transformation, most notably St. Thomas Church in New York City (1913). The use of sound-absorbing Rumford tiles on the interior of the church demonstrated that a ‘Gothic-looking church need not be a Gothic sounding church’. The use of the Rumford tile represents the beginning of a decomposition in the traditional relationship between sound and constructed space, which is rendered fully breached with the deployment of the electro-acoustic technology in Radio City Hall. Thompson’s description of the acoustic design of the Philadelphia Saving Fund Building (PFSF) of 1932 is one where sound is understood as a critical aspect of the building’s aesthetic: ‘The building sounded as modern as it looked.’
There are other compelling accounts of sound in architectural contexts. Lewis Mumford describes the physical limits of London in the Middle Ages to be determined by the need to be within the sound of the Bow Bells. This understanding of urban limits is more extensively investigated by Alain Corbin whose 1998 study of bells in the countryside of nineteenth-century France includes an argument that the bells as soundmarks engendered civic cohesion and a sense of place that could be perceived by the inhabitants of particular locales. These inhabitants understood that the limits of a space were described by the sound of its bell.

Jonathon Mills has given an description of the ‘uguisu-bari’ in his text *Sound Design – Essays with Microtonal Tunings*:

‘The uguisu-bari or nightingale floor was commissioned in 1603 by the shogun Tokogawa Ieyasu as a surveillance system. Ieyasu feared assassination by stealth so he ordered his carpenters to design and install a floor which would produce sound with the application of the slightest pressure. The floor comprises an elaborate system of metallic wedges and sprung boards which rub together emitting a high pitched squeak. This rather beautiful sound is said to resemble the call of a nightingale in distress.’

In posing the question ‘Is there an acoustical tradition in Western architecture?’ Marc Crunelle describes a survey of acoustic spaces that exist outside the realm of spaces for performance and predate the conventional acceptance of the science of acoustics having its origins in the nineteenth century. His descriptions of the auditory aspects of spaces include the use of acoustic vases (resonators) in European churches dating from the Middle Ages and vaulted ceilings and whispering galleries used as architectural communication devices. Crunelle questions, but understandably is unable to answer, whether these devices were intentionally designed to acoustically respond as they do, or whether, upon discovery of their acoustic properties, these spaces were occupied in a way that exploited their acoustics. For example, the elliptical vault of a ceiling in a church in Lyon transmits sound in a way that enabled lepers to engage in the Christian sacrament of confession without coming into contact with the priest or minister.

Finally, Barry Blesser and Ruth Salter have attempted to gather the disparate attitudes and understandings of sound in spatial contexts and group them under a heading that privileges the auditory experience of architecture. They describe the auditory aspects of architectural space as ‘aural architecture’ and define it as ‘the properties of space that can be experienced by listening’.
Auralisation

Architecture has precedents and orthodoxies for representing light. The drawings of Claude Ledoux’s Cemetry of Chaux (1785), or Étienne-Loius Boullée’s sectional drawings of his Cenotaph for Newton (1784),31 which describes the daylight effect of artificial sun (when it is night-time) and the night effect of star patterns, a consequence of natural sunlight penetrating through apertures in the masonry sphere, can attest to this fact. And what is a three-dimensional computer visualisation or render, other than a representation of the effect of light on form? There is no architectural orthodoxy or convention for representing sound. However, there is a recently developed technique for predicting, and consequently sonically representing, the effect of space – in this instance materials and geometry – on sound. The technique is called ‘auralisation’ and I believe it should be adopted by architects as a way of representing sound in architectural environments, as well as a method of ‘acoustic sketching’.

Auralisation can be understood as the auditory equivalent of a three-dimensional computer visualisation or render. While rendering packages allow the modelling of the action of light on a surface or geometry, auralisation packages allow the modelling of the action of sound on surfaces and geometries. The two best-known commercial auralisation packages are CATT Acoustic and Odeon. Much of the acoustic modelling for my propositions has been undertaken using CATT Acoustic, and my description of auralisation will focus on that software.

The process of auralisation requires the definition of a three-dimensional geometry. This can usually be imported from another CAD package or defined in the auralisation modeller by co-ordinate point entry. An important aspect of the model is the acoustic definition of materials in terms of their absorption and reflection co-efficient. The effectiveness of the modeller is partially contingent upon having good quality, laboratory-tested material data. The material co-efficients are described in one-third octave bands that equate to a range of frequencies across the hearing spectrum. Data is interpolated from these frequency-based definitions.
Once the basic model is established source and receiver positions are located. These would usually be set up in some kind of meaningful scenario, such as on the stage of a modelled theatre, with a receiver positioned in a particular seating location. CATT Acoustic can calculate for multiple sources and receivers.

The sources must have their directivity defined. Different types of sound sources propagate sound in different ways. A human head, a violin, a bassoon, or electro-acoustic sources all have different directivity properties and these need to be carefully described. Most professional speaker manufacturers issue plots of the directivity of their speaker models for different frequency ranges. These can be plotted directly into the CATT Acoustic directivity module. I was able to accurately model the JBL Control 1 speakers that I used in the Wayfinder installation. In addition to directivity, which relates to the way that sounds propagates from a source, the direction that the source is facing must be noted. The receivers also require definition. Beyond the basic x, y and z co-ordinate specifications the receiver is typically modelled on a microphone array, or output type. For example, if one wanted to produce an auralisation intended for headphone playback they would model for a binaural receiver type.

CATT Acoustic works by ray-tracing sound from the source locations. The modeller literally traces a sphere of rays, treating the source as an origin for the rays. As the rays hit surfaces they are reflected or absorbed depending on the material definition of each particular surface. The rays also lose ‘energy’ as they expand out from the source. A limitation of the application is that unless a large number of rays are modelled the outcomes can be inaccurate because not enough modelled rays actually ‘hit’ the receiver.
The outcome of this phase of the acoustic modelling is the digital calculation of the impulse response (IR) for the modelled space. The IR is effectively the acoustic thumbprint of a space, and describes the acoustic response of a space to auditory input. It is effectively a measure of the way a room ‘colours’ sound, and can be used to ‘convolve’ anechoic audio material to sound as it would in other spaces. Anechoic sounds are sounds recorded in an anechoic chamber or ‘dead room’. An anechoic chamber theoretically reflects no sound back at a source, and is fully acoustically absorbent. In reality this can never be the case, but in practice such chambers are sufficiently sound absorbent to enable recordings that have little discernable acoustic colouration.

Once the IR has been calculated, it is convolved with anechoic material to produce a modelled prediction of what the anechoic material would sound like if was heard in the space that was being modelled.

For reasons that I will never be able to adequately explain, I was unable to produce a recording of the installed Wayfinder project. Consequently I investigated auralisation as a necessarily retrospective process of reproducing the auditory field of the installation. I modelled the six-speaker sound field to be decoded into the 5.1 format, although the versions presented here are stereo mixdowns. The three sound samples that follow give a sense of the possible outcomes of auralisation. The raw electro-acoustic material and the raw electro-acoustic material with an artificial reverberation effect are included here for purposes of comparison.

Refer to sound sample 07: Wayfinder raw audio material: literally what came out of the speakers. Warning: High attack signal present on recording.
We are still in the early days of the development of auralisation and acoustic modeling techniques, and they still have significant limitations. As with most new technologies these are being rapidly resolved as advances are made in the software. As the sophistication of the technique is developed the accuracy of the predicted auditory outcomes will improve. My approach to auralisation is that if the modelled outcome is 80 per cent accurate then it is sufficient to enable rapid testing of acoustic propositions. By not worrying too much about the absolute precision of the modelling, I believe auralisation has the potential to become the auditory equivalent of an architect’s sketch. Within certain limitations architects could easily use auralisation as a way of sketching acoustic ideas. We can now predict what the spheres of Ledoux and Boullée might have sounded like.
Notes


4 ibid., p.4.


10 ibid., p.xxv.


12 ibid., p.7.


17 ibid., p.2.


21 LaBelle, op. cit., p 25.

22 Martin, op. cit., p 57.

23 ibid., p 56.


25 ibid., p.216.


27 Blesser and Salter, op. cit., pp. 30, 68.


30 Blesser and Salter. op. cit., p 5.

Micro Macro City, Venice Architecture Biennale 2006. Australian Pavilion view from canal. Photograph by Nicholas Murray
Accounting for Sound in an Architectural Context

Introduction

In the previous chapter I wrote about the lack of adequate accounting of aural space in an architectural context. One of the reasons for this might be the insufficiency of the language we use to describe sound to account for its spatiality. I wondered if there may some value in trying to describe sound using architectural terminology.

This chapter gives an account of my design for the sound design of the Australian Pavilion for the 2006 Venice Architecture Biennale.

In seeking to address the problem of language in relation to space and sound, my proposition was simply that if others had already come up with architectural descriptions of spaces or urban conditions, then perhaps I could identify aural scenarios that might correspond to these descriptions. In a sense, I wondered whether I might be able to ‘reverse engineer’ accounts of sound and space.

The project was an investigation into an aspect of my research. It was about trying to establish aural understandings of, or finding acoustic evidence of certain prescribed architectural concepts and then presenting these as a soundscape which constituted one layer of a multi-layered exhibition.

When reflecting on the Venice Biennale project, which was essentially an acoustic survey, I observed that there was much to be learned from the process of undertaking the project, in regard to developing effective listening skills as well as building empirical knowledge of acoustic phenomena in relation to our environments, built and otherwise. I feel that this is particularly so for architects, when our formal training leaves much to be desired in regard to our understanding of sound.

As my contribution was limited to the design of the audio, I will limit my exegesis to a description of these aspects of the exhibition only.
2006 Venice Biennale – Australian Pavilion Sound Design

Background

I was commissioned to undertake the sound design of the Australian Pavilion for the 2006 Venice Architecture Biennale by the appointed Creative Directors of the Royal Australian Institute of Architects (RAIA), Shane Murray and Nigel Bertram.

The foreword to the catalogue for the 10th International Architecture Exhibition exhibit, otherwise known as the 2006 Venice Architecture Biennale, describes the exhibition as follows:

‘The Exhibition directed by Richard Burdett is entitled Cities, Architecture and Society, and focuses on the key themes currently faced by urban and meta-urban agglomerations with a population of over three or four million (the new global cities). The Exhibition analyses aspects that have become critical today: the interaction between city, architecture and inhabitants; the role of architects and architecture in the creation of democratic and sustainable urban contexts; the politics of intervention, and the actions of governing and developing.’

The Venice Architecture Biennale adheres to the following curatorial model: There is an overall exhibition proposition, which informs the main exhibitions held in the gallery spaces of the Venice Arsenale. Concurrently, within the confines of the Venice Giardini site, contributing countries hold exhibitions of their individual responses to the main exhibition themes in their own country-specific pavilions.

Murray and Bertram had identified that responding to the creative themes of the exhibition from an Australian perspective was problematic, simply because Australia did not have the large urban populations and densities of many of the other participating countries. The exhibition imperatives might apply more easily to an analysis of Sao Paulo than Melbourne or Adelaide. Consequently, Murray and Bertram’s response, an exhibition entitled ‘Micro Macro City’, identified eight ‘themes and symptoms’ that described a continuum of inter-relationships highlighting associations between understandings of urban, suburban and rural conditions. Each of themes and symptoms had a specific exemplar site evidencing Murray and Bertram’s critique.
The following extract is taken from Murray and Bertram’s initial proposal to the RAIA:

‘Micro Macro City

The Australian urban condition is understood in this proposal as a matrix of inter-relationships between urban cores, suburban sprawl, regional centers and rural hinterland. The conception of this field as a continuum of inhabitation across a range of densities and settlement types bypasses traditional distinctions between city and country, town and suburb, centre and periphery, metropolitan and non-metropolitan. Rather than separations, this idea of a dispersed urban continuum highlights connections and inter-relationships. Intangible workings of complex economic, demographic, social, governmental, environmental and cultural forces are revealed at certain precise moments within this framework. It is through the close study of such distilled environments that useful applied knowledge about our cities can emerge. We propose a series of highly-specific case studies of particular urban environments from a wide range of contexts. These micro-systems comprise theme (general condition) and symptom (specific urban configuration) which reveal and provoke latent potential within our broader urban situation. Significant works of architecture which understand and engage their urban field will be coupled with these micro-systems in a dynamic relationship.’

Accounting for Sound in an Architectural Context
**Shrinkage** rural reinvention and post-industrial diversification

Symptom: dramatic fall away of built density from main street intensity to vagueness of blocks behind. Localised compression of maintained public space to minimal dimensions.

**Expansion** suburban diversity and homogeneity

Symptom: large new housing estate edged to highway by repetition of large-scale commercial outlets shopping strip and service stations which form a de facto town centre.

**Interface** industrial and residential fringe

Symptom: new industry, big box retail, residential enclave and farm compete for the same peripheral space. Rethinking the potential of abrupt physical and functional adjacencies on a large scale.

**Overlap** multi-use mixed-zone pockets

Symptom: opportunistic reoccupation with a mixture of uses on formerly redundant industrial precincts. Multi-tasking urban space, small factories, living, production, storing and selling. Casual sharing and entwined ownership.

*Micro Macro City, 2006. Themes and symptoms table. Shane Murray and Nigel Bertram*
Absorption *satellite city expansion and regional sponges*

symptom: transit city redevelopment of historic core/station hub. New development targets previously ignored ambiguous and interstitial spaces.

Exchange *interactive and real public domain*

symptom: suburban shopping centre car park as authentic public domain and location of social, community and inter-cultural exchange.

Re-use *migration, renovation and regeneration*

symptom: proliferation of signage, new uses, colours, activities in urban fabric originally designed for other purposes. eg. Vietnamese commerce in old suburbs.

Over-supply *phenomenal precincts and the space of entertainment*

symptom: temporary and event-related occupations spilling outside site boundaries due to agglomerations of sub-cultural intensity and consumption; urban realm as event space.

*Micro Macro City, 2006. Themes and symptoms table. Shane Murray and Nigel Bertram*
The intention of the audio design was not to critique the themes and symptoms, but rather to inquire into the aural legibility of the conditions as described or defined by Murray and Bertram. Put simply, my goal was to attempt to identify and record audible evidence of the themes and symptoms, and re-present these recordings in the Australian Pavilion as part of the Micro Macro City exhibition. What the creative directors Murray and Bertram desired was location recordings that communicated the aural conditions of their selected sites.

**Exhibition Description**

The focus of the exhibition was an assemblage of irregularly shaped tables that displayed analytical drawings, photographs and models of selected architectural designs that seemed to respond to the conditions described by the themes and symptoms critique. In many ways, it was at these tables where the main body of critical content of the exhibition resided. Around the pavilion commissioned works which included large-format thematic photographs, film footage from the various example sites, a wall painting and my contribution, a spatialised aural environment, completed the ensemble of works. These commissioned works were intended to ‘immerse the visitor in a range of experiences, providing a qualitative and atmospheric understanding of the urban conditions presented.’

The spatialised aural environment consisted of a series of eight quadraphonic sound pieces which, in terms of content, were site-specific location recordings seeking to present the aurality of the themes and symptoms previously described. These recordings were played back from Dolby encoded 5.1 DVDs, which were also the source of film content reproduction. The fact that the sound and vision were being reproduced from the same DVD source meant that they were inevitably synchronised, something that I was opposed to as I did not want to risk the audio being potentially perceived as a soundtrack to the films. In retrospect, the synchronisation of sound and vision aided the audio in that the vision gave location context for the audio content. In watching the films one could see which location the sound might have originated from despite the fact that the content of the vision and the content of the audio were not the same. What one saw and what one heard were the same location, but seeing a car go past in one of the films was not accompanied by hearing a car go past.

The pavilion consists of an upper and lower space, each rectangular in plan, with a barrel-vaulted ceiling to the upstairs area and partial concave ceiling to the downstairs area. These coupled spaces are joined by an open staircase between the floor levels. There was one quadraphonic speaker array per level, with the basic specification for each quadraphonic system described as follows:
1 x Panasonic DVD-V5000 DVD player
1 x Yamaha RX-V359 Dolby surround pre-amplifier and decoder
2 x Stereo Crown XLS 802 power amplifiers
4 x JBL Control 25 passive speakers

A limitation of the sound system specification was that the system needed to be compact enough to be shipped to Venice from Melbourne. There was insufficient budget to finance the purchase of computers and soundcards for computerised, automated multi-channel playback or to employ other high-end multi-channel playback systems, hence the decision to reproduce the vision and audio from DVD. All cable runs and power requirements had to be resolved prior to shipping to ensure that the playback system was robust enough and could be easily deployed in the pavilion.
The upper level and lower level audio playback were identical in content. The audio for each level was programmed so that each one-minute audio piece had relatively long fades in and out, and a peak volume period of thirty seconds, followed by one minute of silence between each piece. Thus the entire loop of audio took sixteen minutes in total. As the pavilion was quite reverberant the level that was not active in terms of electro-acoustic playback was nonetheless active in acoustic terms. The work took advantage of the reverberant properties of the pavilion by allowing for two installations of the piece, one downstairs and one upstairs. These ran thirty seconds out of synchronisation. This produced the effect of a pendulum-like swing between electro-acoustic activation of each space, coupled with acoustic activation of the adjoining space. This pendulum effect was reminiscent of Bernard Lietner’s ‘Raum-Wiege’ or sound swing. Leitner’s project consisted of an arrangement of speakers mounted in a linear fashion on pairs of wings. As one walked through the sound swing, the sound sources would travel along the paths of the wings, thus producing a pendulum effect.

The spatialised aural environment consisted of critically selected recordings that evoked the conditions referred to previously, rather than curated constructions illustrating these conditions in more didactic terms. These recordings were details of a much larger documentary work. They described place as much as they described the themes and symptoms.
Project Execution

When I began working on *Micro Macro City* I had a number of different responses to the project brief. I will briefly outline these.

I was intrigued by the notion of ‘acoustic horizon’. It is a term that R. Murray Schafer first used and I suspect arose from the Vancouver soundscape project of the 1960s. Barry Truax’s *Handbook for Acoustic Ecology* describes *acoustic horizon* as follows:

‘The farthest distance in every direction from which sounds may be heard. Incoming sounds from distant sources define the outer limits over which acoustic communication may normally occur, and thus help to define the perceived geographical relationships between communities.’

My understanding of the concept of acoustic horizon is actually closer to that of Blesser and Salter. When I was examining the themes of the *Cities, Architecture and Society* exhibition and Murray and Bertram’s themes and symptoms, the notion of acoustic horizon, expansion and contraction, and the imperatives of *Micro Macro City* seemed to resonate quite strongly.

Australian urban centres demonstrate an aural tendency to perceptually expand and contract, which although not particular to the Australian context is nonetheless a feature of it more so than a densely populated twenty-four hour city that might be found in Asia, Africa or South America. This observation had obvious possibilities given the *Micro Macro City* themes and symptoms. This tendency is a outcome of what I would term a *dynamic acoustic horizon*. How far we can hear is a consequence of the immediate activity level our environments exhibit. For example, peak hour traffic in Melbourne dimensionally shrinks our aural environment because we cannot hear beyond the traffic confronting us. Driving rain can have a similar effect. As the city’s activity levels diminish a perceptually larger sonic field is experienced. Consequently one starts to hear a much more expansive environment. A pedestrian whispering is suddenly audible. One can hear a tram many blocks away, its sound shaped by our constructed environment. The apparently mundane, navigational audible pedestrian crossing (APC) becomes a swirling reverberant field for us to experience in a far more poetic and intrinsically spatial way. In some ways the night is the realm of real legible sonic activation of our city, as the din of the day recedes and gives rise to an audibility where the *ticking* of the APC is indexed, via diffusion, occlusion, reflection, attenuation and resonance to the construction of the urban acoustic field within which it is a pole. The field in this case is an activated engagement between the sonic matter of the APC device, and the reactive, that is to say, sound forming, impact of the geometry and material of our cities.

In late 1999 I travelled to New York City where I lived in Elizabeth Street on Manhattan Island for a period of four months. It was here that I experienced what was, for me, one of the most peculiar
urban acoustic phenomenons I had ever encountered. I have lived in cities all of my life. However, nothing really prepared me for how loud New York could be. I am not referring simply to noise, but more so the vast amount of auditory information one is exposed to. On the second or third week I awoke quite late and looked out the bedroom window at the rear of the block where I was staying and saw, to my excitement, that the tree outside was covered in snow. Growing up in Australia I had never seen snow, much less knew what it felt like, or more to the point the effect it could have on sound. I left the apartment and for the next few days walked the length and breadth of Manhattan in whispery quiet. The cars were stilled, industry had ground to a halt, and the snow seemed to have the acoustic affect of absorbing whatever sounds were present such that I did not hear echoes or reverberations as readily. The city was mute. An acoustic environment that I had sometimes previously struggled to hear was now speaking very loudly. Proximate sounds cut through the quiet. The intriguing thing about this experience was that despite the cessation of industry, and the expected expansion of the acoustic horizon, the absorptive qualities of the snow seemed to compress space as the city’s ability to reflect sound was negated. It was as if I was hearing mainly impulse audio as opposed to a combination of this impulse and the response that the city might typically offer up.

Additionally I was also interested in pursuing the notion of ‘sonic continuum’. This was really about proposing an aural representation of the continuum that the creative directors had described. Effectively, I imagined that I could undertake recordings staged along a series of conceptual paths or lines through or between the specific field of densities and settlement types alluded to in the initial proposal. I imagined that these recordings might then be interwoven in such a way that the roar of a city air-conditioner plant might morph into the sound of freeway traffic, which might then become the sound of a Massey Ferguson tractor. A recording of factory machinery could morph into a milking machine and then become a freshwater creek. In this way, I might be able to trace an audible line through the continuum of inter-relationships described by Murray and Bertram.

A third possibility, and the one that appealed most of all to the creative directors, was to simply undertake critically considered location recordings of the sites and present those recordings. The creative directors communicated a determination to avoid any constructed audio that might have a didactic aspect to it.

I embarked upon an aural survey of the sites that had been identified as being exemplar of the themes and symptoms. I hoped to assemble a range of recordings of each site that might give me options for pursuing the particular design trajectories I was interested in. I would usually pre-empt any recording expedition with a site visit to ‘get my ears around’ each locale. The only exception to this was my recordings of the Mallee town of Rainbow. The four-hour drive necessitated that I undertook recordings without a prior site visit. Often I returned to the sites numerous times,
varying my recording strategies or visiting at different times of day or night in the hope that different aural scenarios would be revealed.

The recording rig comprised of Sound Devices 722 and Sound Devices 744 hard disc recorders that could be crystal locked for synchronisation. For multi-channel recordings I used Sanken CS3 microphones super cardioid condenser microphones with Rycote shock mounts and windscreens. I used a microphone array stand for these recordings. For stereo recordings I used a pair of Schoeps MK41 condenser microphones with Rycote shock mounts and windscreens. The microphones were handheld in the shock mounts in an ‘XY’ configuration to eliminate phase cancellation on the recordings. As is my usual practice, wind shields were only used when conditions made it necessary to minimise sound colouration and phasing. For contact recordings I used a set of four Rebel acoustic guitar pickups in conjunction with a suite of Behringer DI100 Active DI boxes. I used a pair of Sennheiser HD-25 headphones for audio signal monitoring purposes. All multi-channel recordings were in quad format as opposed to 5.i as I did not want to privilege a ‘front’ or sense of direction to the recorded field, especially given the adjacent film playback that would accompany my audio work.

In the process of undertaking these field recordings I was reminded that there is a significant difference between how we hear and what a microphone records.

‘We can isolate an acoustic environment as a field of study just as we can study the characteristics of a given landscape. However it is less easy to formulate an exact impression of a soundscape than of a landscape. There is nothing in sonography corresponding to the instantaneous impression which photography can create. With a camera it is possible to catch the salient features of a visual panorama to create an impression that is immediately evident. The microphone does not operate this way. It samples details. It gives the close up but nothing corresponding to aerial photography.’

At each location I was listening for sounds that seemed to correspond to the architectural descriptions of the themes and symptoms. I would then attempt to record the sounds in a manner that might allow me to reproduce the aural evidence of these descriptions. The final selected recordings are details of a much larger documentary work. These recordings are described on the following pages.
Interface

EPPING

*industrial and residential fringe*

symptom: new industry, big box retail, residential enclave and farm compete for the same peripheral space. Rethinking the potential of abrupt physical and functional adjacencies on a large scale.

A multi-channel recording of the interface between Epping’s older residential housing stock and a new factory estate. The householder, displaying their sense of nationalism, had a flagpole bearing an Australian flag mounted in their front yard. A forklift can be heard through the open roller door of the reverberant factory next door. This contrasts with dry sound of the flag cable tapping against the flagpole in the breeze. The recording is punctuated by the sound of the resident returning home through their front gate. The traffic sounds on this suburban street are a combination of light trucks and cars, which give a sense of the locality.

Refer to sound sample 10: Location recording of interface between residential and industrial zone

Shrinkage

RAINBOW

*rural re-invention and post-industrial diversification*

symptom: dramatic fall-away of built density from main street intensity to vagueness of blocks behind. Localised compression of maintained public space to minimal dimensions.

A multi-channel contact microphone recording of a recently vacated tractor mechanic’s shed just behind the main street of the town of Rainbow. The shed cracks and groans in the afternoon sun and wind. The loss of utility of the vacated shed is audible in the recordings, but signs of life are evident in the dog and bird noises that can be heard. The faintest hum of transport can be heard in the distance.

Refer to sound sample 11: Contact microphone recording of shed at Rainbow.
Expansion

CAROLINE SPRINGS

suburban diversity and homogeneity

symptom: large, new housing estate edged to highway by repetition of large-scale commercial outlets shopping strip and service stations that form a de facto town centre.

A stereo sound walk from the ‘edge of the highway service station’ to the interior of the fast food restaurants and cafes of the Caroline Springs highway edge. The intention of this recording was to evidence the highway service edge as the de facto town centre. The apparently inhospitable roar of the highway gives way to children’s laughter and fast food café muzak. The critical moment in this recording is the transition between the exterior and interior spaces which effectively evidences the proximity of the highway to the community’s occupation of the highway shopping strip and fast food strip.

Refer to sound sample 12: Highway edge sound walk at Caroline Springs

Absorption

BALLARAT

satellite city expansion and regional sponges

symptom: transit city redevelopment of historic core/station hub. New development targets previously ignored ambiguous and interstitial spaces.

A multi-channel recording of the ‘Very Fast Train’ leaving the Ballarat Train Station, its passengers commuting to the urban centre of Melbourne for work or perhaps other appointments. Within one minute a goods train carrying freight from the rural town of Ararat passes through the same station, the sound of its horn providing an impulse that when heard against the level crossing “chiming” through one open end of the platform envelope, enables the listener to clearly hear the acoustic spatiality of this structure both physically and metaphorically.

Refer to sound sample 13: Multi-channel recording of Ballarat Train Station
Exchange

*interactive and real public domain*

Symptom: suburban shopping centre carpark as authentic public domain and location of social, community and intercultural exchange.

A stereo sound walk from the public domain of the external spaces into the internal spaces of the Karingal Hub Shopping Mall near Frankston. The recording attempts to document the space of the carpark as public domain, evidenced by the conversations of people at the ‘smoker’s bench’, contrasted with the interior space of the mall. I wanted to use another recording but was unsuccessful in managing to record it. I will describe the scenario: On a late-night visit to the mall I heard a group of teenage skateboarders skating in the truck-loading dock of the mall. Much to my disappointment, when I approached them with my multi-channel microphone array they fled. The sounds of their skateboards in the dock and the fact that their usage of such a space represented the idea that the carpark was the authentic public domain of the mall made me extremely disappointed not to be able to record them. I revisited Karingal Mall numerous times in the hope that this situation would represent itself, but one does not get to script occupation.

Refer to sound sample 14: Carpark to interior stereo sound walk at Karingal Mall
Re-use

migration, renovation and regeneration

symptom: proliferation of signage, new uses, colours, activities in urban fabric originally designed for other purposes, e.g. Vietnamese commerce in old suburbs.

A multi-channel recording at the entrance to one of the Vietnamese bric-a-brac stores around the Footscray market precinct. This particular shop was charged with the many sounds of its various novelty birds, electronic cuckoo clocks, animal toys and suchlike. This energised soundscape seemed to be typical of the site.

I tried to produce contact recordings of this location. The glass storefronts seemed to enable two different types of commercial domains; one that occurred within the store, and the transient, impromptu market-like stalls that would appear, sometimes for only an hour or two, on the outside of the store. This occurrence could be witnessed at the front or rear of the stores. I tried to use contact microphones attached to the glass of the storefronts, hoping to capture a recording that might embody this sense of re-use and reinvigoration, believing that the sound of the two commercial domains might become encrypted into the materiality of the glass storefront. My contact microphones were not sensitive enough in comparison to the mass of the glass. I suspect the use of modified record player cartridges might allow me to use the glass storefront interface to record the transactions on either side of the storefront and rear.

Refer to sound sample 15: Multi-channel location recording of Footscray bric-a-brac store
Overlap
multi-use mixed-zone pockets
Symptom: opportunistic reoccupation with a mixture of uses on formerly redundant industrial precincts. Multi-tasking urban space, small factories, living, production, storing and selling. Casual sharing and entwined ownership.

A stereo recording of a Middle Eastern grocery, located in a small Brunswick factory. The shop owner and a customer are trying to communicate about an item that the customer wants to purchase. The sound of the floor of the factory space next door can be heard being polished as part of its conversion into a mixed-use residential dwelling and shop.

Refer to sound sample 16: Stereo recording of interior of Middle Eastern Grocery in Brunswick

Over-supply
phenomenal precincts and the space of entertainment symptom: temporary and event-related occupations spilling outside site boundaries due to agglomerations of sub-cultural intensity and consumption; urban realm as event space.

A multi-channel recording at the front lawn of the State Library in Melbourne captures the multi-faceted use of this space. One can hear the plastic rubbish bin drum kit of a busker who often plays at the corner of the lawn. Some primary school children play soccer. The sound of the drums and that of the impromptu soccer game can be heard faintly echoing off the front of the library building indicating the size of the lawn and the distance to the façade. The bustle of the city’s trams, pedestrians and traffic continues for the entire duration of the recording.

Refer to sound sample 17: Multi-channel location recording at the State Library of Victoria Lawn
Reflection and Review

The comparative presentation of these aural works proposed an understanding based on interrelationships and connections rather than perceived separations. In the Mallee town of Rainbow, a dilapidated shed located just behind the main shopping street ‘groans’ and ‘cracks’ in the afternoon wind and sun. Its resonant materiality exposes its loss of utility, its only impulses being that of its own material condition, birds, and perhaps a dog barking in the distance. This may be understood comparatively to, say, the sounds of the Ballarat Train Station. One hears the overlap of the sounds of the rural goods train and the ‘Very Fast Train’, as well as the open space beyond the station suggested by the distant level crossing bells. The sound of the goods train horn provides an impulse that enables the listener to hear the acoustic space of the station.

The most useful aspect of undertaking this project was not the outcome of the work itself, that is, the installed exhibition, rather it was the process of undertaking the investigation into whether it was possible to find, identify or speculate on what the auditory evidence of the eight conditions described earlier might be, or whether such evidence might exist at all. I understood the value of listening and recording as acoustic surveying and that an outcome of this was the development of empirical knowledge of sound and acoustics.

Schafer states that ‘the first task of the acoustic designer is to learn how to listen’.10 His publication A Sound Education, 100 Exercises in Listening and Sound-Making," is primarily concerned with suggesting ways that we might learn to hear more effectively. My own undergraduate training limited my exposure to acoustics or sound design to a theatre design elective. The course, which had a practical basis culminating in a series of professional level public performances that the students worked on, was delivered by a lecturer with a fascination for Greek Tragedy and the purported acoustic effect of the masks worn by the ancient Greek thespians. I designed a mask that had a lightweight cardboard resonator which fixed firmly over the wearer’s mouth, and utilised a pair of tracing paper cones reminiscent of a gramophone horn to project sound.

While undertaking the recording for the Venice Biennale project I listened and listened, and recorded and dissected my recordings, and analysed the spaces and environments that I was investigating and observed. I had never up until commencing this particular work, spent such an intense period of time focussed on listening to spaces, and attempting to conceptualise their aural characteristics. I started to speculate that an empirical knowledge of acoustics may prove to be as useful for an architect as scientific or mathematical knowledge of the subject.
Emily Thompson has written about Dankmar Adler, who in partnership with Louis Sullivan undertook a number of successful theatre and auditorium commissions. ‘It is not apparent that the science of energy actually helped him to generate his designs’.12 According to Sullivan, Adler’s success in architectural acoustics was intuitive.

‘There is a feeling, perception, instinct, and that Mr. Adler had. Mr Adler had a grasp of the subject of acoustics which he could not have gained from study, for it was not in books. He must have gotten it by feeling’.

I suspect he developed it from listening and observing and by designing.

I encountered any number of acoustic and phenomenal effects when undertaking these recordings. I believe that these experiences become useful for designing space with sound. If one takes the time to listen suddenly possibilities for design arise. I will list a selection of these experiences as follows:
While undertaking the Brunswick recordings I came across a street which on one side had double-storey brick and concrete factories with undercrofts at the ground floor. Across the road from these were single-storey row houses with reasonably sized front gardens. As I walked down the street the sound of children playing in the neighbourhood activated the reverberant volume of the under-crofts, which could be clearly heard against the absorptive and diffuse qualities of the row houses and their gardens opposite. An observation such as this enables a rethinking of subdivision potentials, or how one might design the entry to an inner city dwelling, or the simple renovation of the veranda space of a dilapidated old Victorian terrace house.

Each of the houses I visited in the Caroline Springs housing development had a water feature in the area denoted on the developer’s house plans as ‘Al Fresco’ dining. The density of the subdivision, coupled with its proximity to the highway made me surmise that the purpose of the water features was to mask the proximity of neighbours and the highway just a few hundred metres away. The display houses, which had been constructed for sales purposes, had muzak piped through them further masking the auditory environment of the Caroline Springs housing development.
The apparent motion of the sound of the Brunswick train line level crossings as they systematically activate on the approach of a train is akin to hearing the acoustic breadth of Brunswick, imagined, constructed and heard.

When I was making the recordings of the Melbourne central business district I undertook a stereo sound walk where I travelled a path from the RMIT University Library across to Melbourne Central and then though the commercial interiors of Myer, David Jones and down Little Collins Street to Block Place and the Block Arcade. The sound walk then wound back up Collins Street before terminating in the interior of the Sportsgirl Centre. The most striking thing about the experience of this sound walk was the clear sense of threshold transitions and reverberation gradients. The most telling of these was the transition from Little Collins Street into Block Place, an open laneway that transitions into the covered Block Arcade. The gradual rise in the reverberation levels as one walks from Block Place into the covered arcade is astonishing. An experience like this suddenly activates possibilities in the ears of a designer for acoustically sequencing spaces, and consequently the manner of the materiality and volume of those spaces. The experience of the sound walk allowed me to make the observation that differences in acoustic profile from one space to the next actually enables hearing.
Notes


2 Shane Murray and Nigel Betram, extract from submission to the Royal Australian Institute of Architects (RAIA), 2006.

3 The creative directors’ terminology.

4 Shane Murray and Nigel Bertram, Micro Macro City, Australian Pavilion, 10th International Architecture Exhibition, La Biennale Di Venezia 2006, p.9.


13 ibid., p.32.
Precedent and Typology
Precedent and Typology

Introduction

In this chapter I will present an overview of the design of a domestic residential project, located in Punt Road, Richmond. I previously observed that the projects I had worked on did not have to contest architectural program. I also argued that architects should be thinking about sound in a positive and generative way on any project and that I should be able to demonstrate this by undertaking any architectural brief. In some respects this chapter is more an essay on a gap in knowledge about sound in an architectural context than an account of the design. In undertaking the design of the Punt Road project I realised that in attempting to bring this way of thinking about sound and space to bear upon a traditional architectural brief I had no way of ‘problematising’ sound in the context of the design of a domestic residence.

At the time of undertaking the Punt Road project I had assembled a schedule of possible project locations ranging from the intimate and the domestic to the institutional and the public. This appeared to be a moment that was luxurious with choice of where and how I might site future design investigations. I was aware that it was commonplace for architectural practices in Australia to begin by undertaking domestic residential projects. As these practices expand and develop further skills, reputations and expertise, such practices often start to win larger commercial or institutional commissions. It is common for these practices to develop an attitude or architectural posture which then informs the larger works they engage with. Indeed, these initial residential works are often prototypical of the later works of these practices. An example of this is the often cited comparison of Sir Roy Grounds’ own house to his design, in collaboration with Frederic Rhomberg and Robin Boyd, for the National Gallery of Victoria on St Kilda Road. On this basis I chose from among my schedule of possible projects, as luxurious as the collection seemed, and elected to undertake the design of a domestic project.
Punt Road House

Background

While in the part-time employment of a small architectural practice, I was engaged in the design of alterations and additions to an existing house at 395 Punt Road, Richmond. The practice was fully aware of my research. The clients were a professional couple with two young children. They had recently moved to Melbourne, and had purchased the property shortly after arriving. In addition to their domestic needs, which largely drove the client brief, one of the proprietors was a lawyer by day, and played drums at a semi-professional level in the evenings, necessitating the requirement for a sound-proof drum studio that would be suitable for rehearsal and recording. The site’s location on Punt Road, one of Melbourne busiest roads, meant that even with the significant double glazing installed by the previous owner the front rooms of the house were rendered virtually unusable as habitable rooms, and even less so if the double-glazed windows were opened for ventilation. This was due to the high noise levels that emanated from the six lanes of traffic constantly passing not more than 6 metres from the front door.

The house had a chequered history, including being used as an illegal abortion clinic. I mention this because it explains some of the modifications made to the house over the years, which consequently reduced its suitability as a domestic residence. The kitchen, for example, resembled a preparation room in a medical clinic.

The combination of the acoustic pressures of its location, coupled with the particular programmatic requirements of the client, led me to believe that the commission was a suitable site for examining some of my recent propositions. I proceeded in the belief that ‘surely this auditory concern for space could apply to any architectural brief or program’.

Project Description

The existing house was a two storey semi-detached Victorian style brick residence. It shared a boundary party wall with the adjoining property to the south. Typical of the period in which it was constructed the existing building had a single storey assembly of ad hoc additions attached at the rear of the structure. The internal walls were hard plaster on brickwork, with timber flooring throughout and plasterboard ceilings. The high ceilings in combination with these materials and structure meant that the existing rooms were quite reverberant. The effect of this was that any noise entering from outside was reinforced by the acoustic profile of the existing spaces. Similarly, any sound from a drum studio located within the existing house configuration would also be
reinforced, thus contributing to the likelihood of problems with noise egress for the neighbouring properties.

The basic project brief was as follows:

1) To render the front areas of the existing house habitable in terms of ventilation and noise.
2) To provide a sound proof drum studio, such that drums could be played at three o’clock in the morning without causing distress to the neighbours.
3) To provide a study or home office space for each client.
4) The parent’s bedroom was to have an en suite and walk-in robe.
5) A guest room that could be used a permanent third bedroom.
6) To provide a detached garage building with drum studio, possibly located at first floor level.
7) To provide a powered wave pool to enable lap swimming in a small pool.

The design went through a number of iterations, but the final sketch design described a reworking of the existing house, with the required program located in found space within the existing house envelope wherever possible. The additions at the rear of the house would be demolished and replaced with a link that formed a courtyard space, with a wave pool to the western side. The link connected into a two storey addition that included a garage and sound-isolated drum studio located on the first floor. The studio included a winch arm and hatch so that heavy musical equipment could be loaded to the first floor studio directly from the rear laneway by mechanical winch.

The rooms at the front of the house were to contain upgraded operable double glazing, making use of the deep window reveals to provide a 155 millimetre cavity. The existing period correct windows were to be resealed at the heads, jambs and sills to reduce sound penetration and leakage. The
The proposed window detailing would effectively triple glaze the openings. The existing wall vents were to be sealed. Ventilation was intended to be provided by acoustically damped mechanical means, powered from new roof-mounted solar panels. The ducting for this system would reside within the floor and ceiling joist cavities. The chimneys were also to be sealed to prevent them from being a source of sound penetration or egress.

The front fence was to be increased to the maximum height legally permissible, and the side fence and gate were to be upgraded to act as an acoustic buffer to the road noise from the external living spaces, and to reduce background sound pressure levels around the front of the house. All external doors were to be solid core acoustically rated doors with sprung Raven brand acoustic seals.

The interiors were to be carpeted where possible to reduce the reverberant reactivity of the spaces once sound had penetrated these volumes. This would also reduce footfall sounds throughout the house, something the clients had commented on in regards to the existing house.

The drum studio needed to achieve a differential noise reduction from as high as 110Db down to 45Db to match the ambient sound pressure levels at the rear of the site where the studio was to be located. An acoustic consultant was engaged to provide advice as the project was developed, particularly with regard to the drum studio. The consultant advised that after 10.00 pm it was a legal requirement that drums were inaudible from outside the building envelope, but advised that this was almost impossible to achieve in our site context. The final configuration of the studio relied on a core-filled concrete block cavity wall structure with ‘rockwool’ insulated stud frame and fire-rated plasterboard. The floor was to be a suspended concrete slab with plywood flooring on rubber pads. The ceiling was to be multiple layers of plasterboard with rockwool insulation, and the underside of the roof cladding was to incorporate a layer of Structaflor flooring material. The acoustic design of the studio structure was primarily concerned with minimising sound egress from the studio to outside. The qualities of the sound inside the studio were to be dealt with by specifying internal finishes that included acoustic absorption treatments. Entry into the studio was via an airlock space.

**Review and Reflection**

I began the Punt Road project with the aim of bringing architectural programmatic pressures to bear upon my research into sound and space. I imagined that I might find myself using the project as a location for investigating the manipulation of architectural form and materials to produce acoustic outcomes that aligned with my spatial conceptualisation of sound. When considering sound in an architectural context, acoustics has appeal as it implies outcomes predicated on materials and geometric arrangements.
The sketch design essentially evolved out of a process of space planning to accommodate the various requirements of the client and was developed into material and specification solutions for the perceived acoustic issues of the existing house. The clients were presented with various plans that described the house in a variety of potential configurations. The location of the drum studio was moved a number of times to work through different possibilities for its sound isolation. As its performance criteria were measured against background sound levels, the drum studio was at one point located on the ground floor at the front of the house. The advantage of this was that the background sound levels were significantly higher due to the traffic noise than at the rear of the site. This meant the required differential noise reduction was much less than if the studio was located at the rear of the site. By using the previously uninhabitable areas of the house this strategy liberated floor area in the planning of the new works. The problem with this solution was that delivery of music equipment to the studio was either from Punt Road, which would be virtually impossible due to the high volume of traffic, or that the equipment would need to be carried in from the rear of the site. This was deemed undesirable.

A proposition was made to include a lowered curved profile ceiling over the dining areas to act as a reflector to generate acoustic intensity around the dining table. This was an idea I had wanted to pursue for some time, and actually arose from my experiences of growing up in a large family. For many years my parents, siblings, their partners and children would crowd around an impossibly small table for family celebrations in the dining room of my parents’ home. These events were always raucous, intense, and often ‘well lubricated’. At the suggestion of my mother, who was possibly tired of being constantly elbowed as she ate, one of these gatherings was relocated to another part of the house where we could join together two tables, thereby allowing for much more expansive seating and a larger sense of space. At the conclusion of the meal we collectively revolted and insisted that for the next celebration we return to the former location and enjoy the intensity that the environment contributed. The technical execution of the curved ceiling was never explored or developed. It was intended that this aspect would be dealt with as the project moved into design development and construction phases.

What I encountered was the fact that I was unable to establish strategies for what I call ‘problematising’ the spatial possibilities for sound in regard to the project and its intended program. Whilst there may have been opportunities for designing with sound that I missed, the fact of the matter was that the acoustic imperatives that resided in the program, client brief and site were resistant to my sound and space thinking at the time. The actual design problem was a question of acoustic amenity for the occupants and their neighbours.

I asked myself a question: “What does one do when designing a house other than trying to warrant a high quality of space?” In this instance the problem of the traffic noise from Punt Road and the
amelioration of sound transmission into and out of the drum studio were considerable acoustic challenges that had the potential to impact in a negative way on the lives of the occupants of this house and their neighbours. I could have proposed a reworking of the front façade that filtered the road noise through small apertures, and in the process try to ‘aestheticise’ the traffic noise and the façade of the building, but the reality of the situation was that the clients simply understood the sound of the traffic as noise, and found its impact on the front rooms of the house untenable. This was the architectural brief for the design of a domestic space and drum studio in what was essentially an extreme acoustic environment, and the design did deal with these important acoustic imperatives, albeit in a somewhat orthodox way.

There are accepted ways of thinking about the design of high performance listening environments; these spaces have definable acoustic performance criteria that are meaningful in terms of their design, for example, reverberation time, speech intelligibility index, noise control and sound transmission. However, the thinking behind the way we design these high performance listening spaces does not readily translate to the acoustic design of other kinds of space.

The most important conclusion that came out of undertaking the Punt Road project was the necessity for establishing the precedents and typologies for this kind of design work. I believe that these precedents do indeed exist, but that what is missing are critical accounts of their auditory spatiality which are more than anecdotal descriptions. A full account of these precedents would need written language, but also documentation in the form of recordings and audio measurement in the same way that thousands of years of spatial history is described in ruins, models, drawings and photographs. I suspect establishment of the precedents and typologies will ultimately yield more possibilities for addressing the potential for auditory spatiality than yet another collection of terminology and definitions. I realise that the definitions to which I refer arise from a need to find ways of conceptualising and therefore describing our sonic environment, but I do not believe that they necessarily enable design.
Wayfinder, The Birds and the Bees, Punt Road House, Venice Architecture Biennale 2006 (clockwise from top left). Nicholas Murray
Re-evaluation

Introduction

Having concluded the designs for and subsequently reviewed the Venice Biennale and Punt Road projects, I recognised that I was unclear how to best to advance my research. I could build density into particular threads that I had already established, but I was unconvinced that doing so would actually advance the work I was doing. In short, I felt that rehashing territory I had already covered would simply avoid the issues at hand. In response to the direction that my research had taken I re-evaluated my position and proposed a number of guidelines that I believed might be useful to adhere to. To examine the potential of these guidelines I engaged in the design of an electro-acoustic proposition for the Melbourne State Theatre and Arts Centre forecourt. The design was not carried through to full resolution, and in many ways the project remains a sketch, however, I developed the project as far as I needed to, to enable a shift in the way I was designing and thinking.

This chapter describes the process of re-evaluation and the consequent shift in my research evidenced in the State Theatre and Arts Centre project, which is also described here. The re-evaluation constitutes a significant hinge point in my research.

Re-evaluation

After I designed and constructed Wayfinder, I reflected that I had established an inquiry into making space with sound and that it was indeed possible to make space with sound and understand sound spatially.

When designing The Birds and the Bees I set about intentionally trying to make a space where sound was pivotal to how that space was conceptualised understood, and experienced.

I observed that while both Wayfinder and The Birds and the Bees were effective examples of designing space with sound, they did not have to contest architectural program, and the sites
for these works were highly controlled environments. I also realised that when undertaking electro-acoustic works one is always adding sound to space, and subsequently recognised a desire to identify an acoustic mode of working. I believed that this acoustic mode would allow more scope for negotiating program than an electro acoustic-mode as it did not necessitate the addition of sound sources. As acoustic works are constructed, therefore having material and geometric configurations, there is an implied potential for generating architectural form.

In undertaking the Venice Biennale project I attempted to demonstrate that one approach to the problem of establishing descriptive language to account for our spatial experience of sound might be to find architectural descriptions of space and urban conditions and then assemble or identify sound that corresponds to these descriptions. Regardless of the success or failure of this strategy, the most significant outcome of this project was the realisation that there was considerable knowledge about aurality to be gained from undertaking such a project, and that the empirical knowledge of sound and space garnered in the process may indeed be more useful to architects than a mathematical or scientific understanding of acoustics. I also observed that despite the limitations of recording techniques for documenting acoustic space, there was at least potential now to collect, categorise, document, and most importantly, make available audio accounts of space in a way that was not readily achievable in the past. If I concur with Lawrence Harvey's assertion that ‘sound is its own best form of representation’, then perhaps the most effective way of accounting for spatial experiences of sound resides in a combination of critical description and audio recording as documentation.

The Punt Road house was a project which I had hoped might allow for an acoustic, that is, material and geometric, response to the question of sound and space. In attempting to bring my spatial sense of sound to bear upon a traditional architectural program and brief, I made the observation that I had no way of problematising sound in the context of a domestic residence. I identified that the lack of known precedents and typologies was a limiting factor in designing space with sound. I speculated that an account of precedents and typologies for this work would be enabling for the design. I recognised that the acoustic imperatives that resided in the Punt Road architectural program, client brief and site were resistant to my sound and space thinking at the time. The actual design problem was a question of acoustic amenity for the occupants and their neighbours, not the overlay of aural thinking that I had hoped to pursue.

I was aware at this point that what I seemed to be doing was trying to interpret what I do as architecture to differentiate my work from other sound design practices. My increasing preference for acoustics over electro-acoustics led to me conceiving of sound in an architectural way, that is, in a material way. It seemed that I was looking for ways to design volume, form and materiality to shape sound.
This material and formal understanding of architecture as a way of considering the space of sound had not been very useful or productive to my research thus far. Conversely, thinking about sound in a way that is informed by the spatial sensibilities of my architectural training and experience had been productive, as evidenced by Wayfinder and The Birds and the Bees. The main point here is that I stopped focussing on the space of sound and the potential of that investigation and began trying to make architecture from sound. The appeal of architectural form is that implicit in its geometric and material means resides acoustic potential. To make an analogy, I was focussed on the fact that bricks and mortar existed, rather than on what I might want to build, and how I might best construct the things that I wanted to build.

In response to this re-evaluation I set up the following guidelines that I felt I needed to respond to, and then set about developing a project intended to work quickly through these issues:

1) Space, not acoustics

2) Architecture as immaterial vs. architecture as material/geometric/visual/acoustic

3) Architecture as visible is the orthodoxy

4) Standing by the principle that sound is spatial

5) Program (could be how things are related)

To examine the potential of these guidelines, I proposed a design for an electro-acoustic proposition for the State Theatre and Arts Centre forecourt.

**Melbourne State Theatre and Arts Centre Forecourt**

*Background*

The concept of *acoustic horizon* has resonated throughout my research since Wayfinder. The concept has reappeared consistently throughout the research program that I have followed. I am reminded of my observation of the night-time activation of the Audible Pedestrian Crossings I described in chapter 1 and how this activation was predicated on *acoustic horizon* as a phenomenon. The expansion and contraction of an acoustic horizon is, in my experience, a very difficult auditory phenomenon to record. Our ears are very effective at filtering sounds in a way that microphones and recording equipment cannot. However, it is possible to make comparisons between different
sites that have contrasting horizon conditions in order to better understand it. The expansive acoustic horizon of the town of Rainbow sits in stark contrast to the comparatively compressed acoustic horizon in the vicinity of the State Theatre and Arts Centre site.

Refer to sound sample 18: Stereo field recording from top of Rainbow silo

Refer to sound sample 19: Stereo field recording from State Theatre and Arts Centre site

Despite the dense acoustic environment of State Theatre and Arts Centre site, there is a very dynamic acoustic horizon. The traffic and trams of St Kilda Road are the site’s major source of high sound pressure level, but their activity levels vary considerably over the day. The acoustic horizon seems to expand and contract rapidly due to the persistent variation in traffic volume. I suspect this has something to do with the lack of building mass on the eastern side of the site. This side of the site opens onto Queen Victoria Gardens. My experiences at the site over a twenty-four hour period can attest to multiple short periods of high intensity of sound, interspersed with contrasting short periods of low intensity sound, and consequent acoustic expansion. Fruit bats can be heard in the Royal Botanic Gardens, the rattle of flag cables on St Kilda Road become more pronounced. The whir of derailleur gears on an approaching bicycle can be heard from quite a distance away. The sound of a coxless four can be faintly heard rowing on the Yarra River. The city still hums in the background throughout, but it does not seem to dominate except at peak times. Even the traffic in the Alexander Road underpass seems not to be too obtrusive. This is possibly because it is sunken 7 or 8 metres below the site. And then the moment is gone – some cars drive up St Kilda Road and the horizon shrinks only to expand again a few moments, or sometimes a half hour or more later.
Having studied the site and heard the rapidly pulsing acoustic horizon I reconsidered my thoughts on program, and rather than searching for architectural understandings, wondered what might happen if I started to consider sound as programmatic. I came to the conclusion that the variable acoustic horizon I had identified could be conceived of as the ‘acoustic program’ of the site, and understood this concept as a set of interrelationships. The traffic is the major noise source at the site. The paradox is that this noise becomes critical to the spatial understanding of how this site manifests in acoustic terms. This apparently simple shift in thinking seemed incredibly enabling as it allowed me to rethink other previous attitudes and positions. I wondered what might happen if I intersected a modulating auditory field with the modulating acoustic horizon that the State Theatre and Arts Centre site exhibited.

**Project Description**

I proposed a dense modulating sound field dispersed across the lawn of the space between the Melbourne Arts Centre and the State Theatre, and out to St Kilda Road. When localised sound pressures are high the acoustic horizon shrinks. Conversely, when the localised sound pressures diminish, the acoustic horizon expands. I proposed to interweave the modulating field with this site and design the field so that it expands and contracts across the site.
The project was to have an array of speakers dispersed through the site in an expanding series of concentric quadrangles. The sound sources would initially emanate from the north-west corner of the site and gradually be panned through a speaker array to produce a slowly expanding field. The slow expansion, rise and fall, or opening and closing of the proposed electro-acoustic territory would then intersect the expanding and contracting acoustic field of St Kilda Road traffic, the main source of environmental noise in the location.

The critical aspect of the proposition would be matching the variations in the relative sound pressure levels of the modulating field to the variations in the ambient sound pressure levels of the existing site. To be effective the relationship between the existing sounds and the overlaid sound field would also need to be compared through spectral data and frequency analysis.
Why a modulating field? The idea of the field goes back to the Wayfinder project, but in returning to the basic problem of making space with sound, I had been experimenting with making low frequency sine wave tones. Because of the dimensional differences in their waveforms the tones create sound pressure gaps and intensities. The gaps and intensities correspond to nodes and anti-nodes in the wavefront. The sound pressure gaps are perceived as drops in volume, and intensities are perceived as volume increases, which would equate to peaks and troughs in sound pressure levels. The anti-nodes are experienced as ‘space’ partly as a consequence of the frequency range of the sine waves. The frequencies vary from 100Hz to 125Hz, which correspond to a wavelength dimension of 2.75 metres and 3.44 metres. These wavelengths are sufficiently long to allow us to hear their dimension and thus to walk into, through, and out of an anti-node. The nodes are perceived more as if they were ‘mass’. In addition, as the waves are heard to oscillate and ‘beat’, a consequence of phase-shifting, the experience of the field will be that it slowly moves through and past you. This strategy was intended to generate another type of sound space. It was similar to Wayfinder in that it was a field, yet rather than relying on enclosing the listener within a territory which was then shifted this proposition relied on a modulating field that seemed to be mobile. In this proposition, despite the fact that the entire field does slowly expand and contract via a dispersed speaker array, the perception that pockets of space might be opening and closing or expanding and contracting is really a consequence of the interaction between the dimensional and phase variations of sine waves. One’s position in space relative to where the soundwaves emanate from would create drastically different spatial experiences. The experience and perception of the nodes and anti-nodes would be contingent upon the intersection with the existing acoustic horizon condition. The existing field and the applied field are brought into a relationship whereby the conditions of one are heightened by the actions of the other.

I demonstrated the effectiveness of the modulating sound field in a presentation I made at the June 2006 Graduate Research Conference at RMIT University.

Refer to sound sample 20: Study for modulating sound field number 1. Warning, the frequencies in this file are such that it may damage speakers if played at very high volume. The beat modulating effect will not be heard with headphones as the sound waves cannot interact.

Refer to sound sample 21: Study for modulating sound field number 2. Warning, the frequencies in this file are such that it may damage speakers if played at very high volume. The beat modulating effect will not be heard with headphones as the sound waves cannot interact.
Re-evaluation
Expansion of modulating sound field (opposite), Contraction of modulating sound field (above). Nicholas Murray
I had previously examined the possibility of installing a similar sine wave field into a smoke lobby of a lift foyer. The dimensions of such a lobby would lend themselves to the establishment of a standing sound wave that could be tuned to the lobby’s resonant frequency. When a person was in the lobby and waiting for the lift they would be able to experience node or anti-node within the sound field. The moment that a lift or lobby door opens the resonant frequency of the space would alter and the sound field would shift accordingly. Who can imagine the effect the presence of other people might have? I recently came across a similar project to this by Bill Viola. *Hallway Nodes* dates from 1972. Viola proposed two speakers, one at either end of a 22-foot-long hallway. By reproducing a 50 hertz tone from each speaker, the sound waves would cancel each other out to an extent where sound pressure would be at its minimum. Viola states that ‘this creates varying densities of “resonance” in the space -or- nodal points, which (at this frequency) will be “felt” as much as heard’.²

I was also aware of La Monte Young’s works with light artist Marian Zazeela, particularly their *Dream House* project,³ which utilised sine wave generators to produce an oscillating field. Douglas Khan, in comparing Young’s work to that of Allan Kaprow, describes the immersive aspects of Young’s work as having ‘the main features of being inside a sound, when the sound itself defines space.’⁴
Reflection

The purpose of the Melbourne Arts Centre and State Theatre forecourt project was to examine the enabling potential in the guidelines that I had set up. An important aspect of the project was the reframing of how program could be understood. By adhering to the principles provided by the guidelines, I undertook a project that was about using the immateriality of sound to design space, to contest the material and geometric preference for sound that I had been pursuing. The intention was not to negate the idea that geometric and material resolutions were appropriate for responding to ideas about sound; it was about refocussing my attention to the space of sound itself. This project was about restating my proposition and then finding an appropriate form for its resolution rather than knowing what the resolution was in advance and trying to find a proposition that fit.

Notes

1 Lawrence Harvey, personal communication, 22nd November 2009.


3 Ibid. p.29.

Elliptical reflector, ray-tracing diagram. Nicholas Murray
Pedagogical Terrain

Introduction

In this chapter I would like to give an account of the design of an acoustic and electro-acoustic proposition for academic space. The effective development of this design draws on the findings of chapter 5 where I adjusted my position in regards to designing with sound in an architectural context. The design represents an enabling proposal for designing sound with space that has significant architectural outcomes, such as the potential for flexible academic spaces that resist the orthodoxy for generic, partitioned pedagogical environments. The project demonstrates both how sound can define space and also how it can be an enabling architectural strategy.

The chapter includes a description of the development of full-scale working prototypes. The prototypes were constructed to demonstrate the acoustic principle that the proposition is contingent upon. The major conclusions for the PhD are evidenced in this project.

Background

I had been discussing the problem of designing pedagogical space with Adrian Stanic of Lyons Architects. Lyons had recently been awarded the commission to design a new campus building for RMIT University near the corner of Swanston Street and A’Beckett Street, on the site of the open carpark space behind the Oxford Scholar Hotel.

The problem, as we understood it, was a tension between the inclination of property services management groups for maximising spatial flexibility and the desires of architects and designers for high-quality environments that enriched spatial experience. The contemporary architectural paradigm for maximum flexibility is a multi-storey office building. Flexible and with an air of efficiency, these spaces constitute a blank canvas that could be fitted out and partitioned as property services saw fit. The spaces could then be repartitioned every five to ten years depending on the changing requirements of academic program. This approach is not necessarily fulfilling in
terms of what an architect’s desires might be or what an inhabitant’s spatial experience might be, or what the pedagogical possibilities of that type of space might be. Lyons were proposing teaching spaces that could be fitted out so that with the use of large sliding partitions they could become either a large lecture theatre or smaller tutorial rooms.

Adrian postulated that it would be fantastic to be able to have ‘endless’ un-partitioned space that could be completely flexible, thereby allowing for multiple pedagogical scenarios. I mused that the planning of these spaces could be more akin to the field of potential program that the plans of Toyo Ito or Rem Koolhaas and OMA imply. But in terms of pedagogical models for teaching, such a proposition is fraught with acoustic difficulties. How could a lecture be delivered in this environment while a tutorial is being conducted only a few metres away? Adrian’s suggestion was that everyone could be wearing headphones, which I objected to because that would limit our acoustic experience of space to being electro-acoustic.

In thinking about my conversation with Adrian I wondered what it would entail to design spaces of acoustic intensity, how that might be achieved, and whether acoustic intensities could be used to define space where walls did not exist. I wondered if the acoustic intensities I imagined might also enable ways of dealing with the pedagogical imperatives that academic spaces need to fulfil. I recalled an experience I had in one of the subterranean spaces of the New York Natural Science and History Museum. The space had a domed ceiling. When I walked under the dome, the sense of space was profound, and was sensed aurally. I suspect that the domed ceiling was most likely parabolic and was focusing the sound underneath the dome around the vicinity of my ears, thus producing an acoustic intensity. The dome was part of a larger room, and was supported on four columns. Despite the lack of walls, walking out from under the dome had the aural experience of walking into another space.

I also remembered the parabolic speaker reflectors used at the Melbourne Visitors Centre at Federation Square. The speakers are mounted at the focal point of acrylic parabolic reflectors. They are aimed back into the reflectors, which, as a consequence of their parabolic geometry, are able to focus the resulting reflections into a reasonably controlled ‘beam’ of sound. The speakers are mounted on the ceiling and the effect is that you can barely hear the sound coming from them until you are under the reflectors. They work more effectively at higher frequencies and are useful for the controlled electro-acoustic delivery of speech. I found myself thinking about the parabolic speaker reflectors in the context of wondering what it might mean to be engaged in a tutorial or attending a lecture. I was considering what the various pedagogical guises any proposition I make would have to respond to.

I was also aware of a number of other instances of the use of acoustic reflectors, such as the Hythe Sound Mirrors. The mirrors were pre-radar concrete-formed parabolic listening devices.
that were intended to act as an early detection system for German aircraft attack on the United Kingdom. ‘The Mirrors were used to collect the sound of bombers off the coast and relayed them to a listener who sat below in a concrete room with a pair of headphones.’ Le Corbusier’s League of Nations competition entry of 1927 was the result of collaboration with the acoustic engineer, Gustave Lyon.

‘They designed an auditorium with a roof composed of double-plated glass arranged in parabolic sections. Their intent was to allow the form of the room to direct and disperse reflected sound throughout the body of the hall.’

**Project Execution**

I had experienced how certain geometries act as acoustic reflectors, and how in doing so they can describe spaces of acoustic intensity. I speculated that proposing a field of acoustic intensities might be a way of designing space for a range of pedagogical modes, such as lecture mode or tutorial mode, for example. Space could be described by sound and liberate the architecture from resorting to the orthodoxy of generic, partitioned pedagogical environments.

I took Lyons Architects seating and table layouts and started to map out how big or small a dome might need to be to accommodate the various seating layout types. I was quite conscious that
the proposition needed to operate acoustically at the scale of a table. I did not modify the Lyons table layouts. I have tried to make the proposal of acoustic intensities work back into the Lyons layouts. I established that a domed reflector, whether part of the architecture or deployable, would need to be in the vicinity of 3 to 3.5 metres to be able to accommodate all of the various Lyons seating arrangements. Based on some preliminary geometric analysis, I established both parabolic and elliptical cross-section options for the domes and set about acoustically analysing the likely outcomes using CATT Acoustic modelling software. I also undertook basic sectional analysis to verify sightlines limitations.

I carefully modelled the propositions for the domes in CATT Acoustic. However, I was unable to generate either data or auralised output that I would describe as meaningful or particularly conclusive in any way. Perhaps if I was a fully trained acoustic engineer some of the data I generated might have meant more to me, but as an architect the results did not tell me what I wanted to know about the geometries I was designing. A part of the problem is that CATT Acoustic depends on angles of incidence and reflection which can easily be calculated for a flat surface, but once that surface is curved the modeller fails. The only way to model a curved surface at this stage of CATT Acoustic’s development is to construct faceted versions of curved surfaces. The question is how faceted do the surfaces need to be to be accurate?

To get around the problem of curved surfaces modelling and wanting to maximise accuracy, I modelled quite densely faceted meshes. I had completed some low mesh density preliminary studies, but the low mesh density meant that the described geometries only barely resembled the parabolic and elliptical geometries I was investigating. What I learnt was that the modelling
Auralisation was typically a relatively quick exercise, but the density of the meshes I was working with resulted in an elaborate scripting exercise in material definitions. Every surface in a CATT Acoustic model requires a material definition that describes acoustic performance. If that surface is floating in space, like a canopy of domes or an acoustic reflector would be, then the backside of each surface requires material definition as well as the front to ensure that the program understands which side is reflective, thus doubling the number of required surface definitions. An additional factor here is that errors can occur when traced rays (these represent sound propagation) hit the edges of faces. The program can often get confused as to whether the ray should reflect as if hitting a surface, diffuse as if bouncing off at an angle, similar to light hitting a roughened surface, or simply to pass through and ‘leak’ out of the model. If one is modelling a simple, enclosed cubic volume, there are six faces and twelve edges to define the geometry. Relative to the number of rays that are traced this gives quite a high degree of accuracy. Once one starts to attempt modelling highly complex geometries, and by necessity using lots of faces to describe these geometries, the modelling accuracy starts to unravel quite quickly. The technique that I had hoped to use to produce some quick acoustic sketching had lost the expediency that had previously made it appealing. The prior appeal of the acoustic modelling had been its equivalency to grabbing a roll of yellow trace and a pencil, and then quickly sketching ideas.

I recalled reading Emily Thompson’s description of Pierre Patte’s 1782 design for an elliptical theatre,1 and British architect George Saunders’ analysis of the focussing properties of various curves. His 1790 analysis used the technique of ray-tracing to dissect the properties of a range of curved profiles, including an ellipse.4
I made the decision to cease acoustic modelling, and proposed a far more rudimentary way of working. I undertook a series of two-dimensional ray-trace drawing investigations into different reflector configurations as a way of establishing how sound might respond to the geometries I proposed and how I might be able to use these geometries to generate particular acoustic intensities. Intensity would be visible as a convergence of rays equating to an acoustic focussing effect.

I notionally located a series of source and receiver positions as well as a speaker that could be hung from the domes or mounted on the table. I started the ray-tracing analysis by working with the parabolic and elliptical reflectors with a view to trying to reflect an electro-acoustic sound source down to the zone of a table. I then questioned what might happen when someone sitting beneath the reflectors started speaking? I undertook this analysis through further ray-tracing.

I was attempting to establish how sound might bounce off and be focussed or alternatively dispersed by the geometric forms. I was attempting to map a zone of acoustic intensity that might allow for communication between people talking across a table, people sitting back, a person who walks up to the table edge and talks over your shoulder or leans over to view a laptop screen. What I observed through undertaking this analysis was the amount of spill from the parabolic form. It functions well as a focussing device when the source is located at the focal point of the geometry but when the source is in other locations the spill becomes a concern. I started to conduct ray-trace analysis of the other primary geometry I was investigating – the ellipse. A surprising feature
of the elliptical reflectors was that the ‘spill’, that is, the dispersed sound, was far less than with a parabolic reflector, but also the plotted intensity in the vicinity of the tables seemed to be increased. What I was trying to establish with this analysis was geometry that was a best match for two modes, that is, acoustic and electro-acoustic. This would allow a dual operation or a way of simply flipping between modes, one which would function acoustically, describing space and aiding acoustic communication across the table, and the other which would function electro-acoustically and allow delivery of sound into the acoustic intensity in a controlled manner.

I examined other geometries, such as flat ceilings, composite geometries of parabolas and ellipses. My ray-tracing investigation established evidence that the elliptical reflector proposition was sound. I concluded that despite the evidence that the ray-tracing offered, I could not model or ray-trace experience. Even if the reflector’s acoustic performance was as I suspected, the experience of being in their sound field might be unsettling in some way. That is not to say that it would be a bad experience; it just might not sound as one might expect it to or be familiar with.

I have noticed a tendency in my more acoustically minded friends to take on quite odd acoustic challenges and rather than assuming the position that the acoustics of a space are a problem, seek some positive acoustic aspect about them. In a presentation that I gave at the June 2006 Graduate Research Conference at RMIT University, Ranulph Glanville contested the idea of ‘bad acoustics’, by relating a tale about St Paul’s Cathedral in London. Apart from its famed whispering gallery, this building has been described as having bad acoustics due to its echoes and reverberation. His story was an account of a mass that he had attended at the cathedral. The mass was sung by a particularly skilled cantor who paced his phrasing with the echoes, thereby producing a marvellous effect, where his sung prayer was reinforced by the echoes. The bad acoustics became an enabling device for his prayer. The properties of the elliptical reflector that I was pursuing would normally be considered ‘bad’ acoustics. I proposed to use these bad acoustics in an enabling way.

The final geometric proposition was a series of ellipse-shaped reflectors. I initially investigated ellipses because they have dual focal points. If a sound source is located at one focal point, a consequence of the geometry of the ellipse is that it will reflect all sound waves back to the other focal point. If one considers this property in section, the geometry lends itself to an obvious solution to dealing with the problem of people sitting across a table from each other and trying to converse when there might be a reasonably high background level of sound. The ray-tracing investigations indicated that the ellipse form best served the acoustic imperatives of the proposal.
Ray-tracing analysis of reflector profiles. Nicholas Murray
Ray-tracing analysis of reflector profiles. Nicholas Murray
**Pedagogical Modes**

The final resolution of the elliptical reflectors described a 3.5 metre diameter elliptical dome. The height of the dome structure was 825 millimetres. The proposal included a speaker mounted on the central axis of the ellipse pointing back up into the canopy. The canopy would then reflect sound back down to the tables below it. It is possible to position the speaker so that any sound emanating from it that is reflected back from the ellipse can actually be focussed inwards, effectively giving it a tapering reflection. This equates to a tighter controlled reflection of sound.

The various pedagogical modes would be as follows:

When in *lecture mode* any of the domes may be switched on, that is, the speaker is switched on. The lecturer stands at a podium or lectern as they typically would in a lecture theatre space and they speak into a microphone. A designed artefact of the geometric arrangement of speaker and elliptical profile means that one experiences a concentrated electro-acoustic zone under these domes. There would be spillage to other zones and adjacent spaces but it would be attenuated quite sharply as a consequence of the focussing characteristics of the dome. People seated around the tables would be hearing the lecture as an electro-acoustic zone focussed around their table.

In *tutorial mode* the tutor merely walks away from the lectern and once they are beneath the domes there is a net gain in acoustic amplitude as a consequence of the elliptical profile. One would experience a heightened acoustic effect of space in this mode. When this occurs I consider the domes to be functioning in acoustic mode. It is necessary for the domes to have a dual function modality to allow for acoustic and electro-acoustic possibilities. My experience of spaces of acoustic intensity is that one has a tendency to talk quietly. Rather than project one’s voice to fill a room we do the opposite, which is to lower the volume of our voice as we become aware of the sense of loudness of our speech. A consequence of this is that the overall sound pressure level should theoretically drop as people lower their voices – no one shouts in a cathedral! This has an obvious benefit for the notion that the domes might be arrayed throughout a free-plan academic space, because the overall sound pressure level should drop relatively as a consequence of these intensities.
Elliptical reflector pedagogical modes diagram. Nicholas Murray
In peer conversation mode the proposal relies once more on the acoustic action of the dome, but is limited in that it requires a person to walk to another acoustic zone to be able to speak to someone at another table. You may be able to speak to the adjacent table, but yelling across the room might be problematic. There is nothing to stop you from simply walking into another zone of acoustic intensity.

In composite mode tutorials and lectures might occur concurrently or adjacently. The different acoustic and electro-acoustic properties of the domes would enable such variations in pedagogical delivery. A number of tables might be operating in lecture mode, while the next dome could have the speaker turned off, but obviously the acoustic functionality remains passive, so a tutorial or discussion among scholars might be occurring here. The lecturer is free to walk back and forth between the lectern and individual dome groupings.

All of the modes referred to previously could be occurring simultaneously and dynamically. There might be students leaving or joining a lecture, a table of students chatting quietly among themselves, while students at the table next to them are intently listening to a lecture delivered electro-acoustically. A student might move to speak to someone at another table; the tutor might decide to leave the lectern and speak to a student about, say, what their latest design proposition might be. I have isolated these modes to simplify their description, but I understand them to be a single constant dynamic mechanism that enables these various pedagogical conditions.
Elliptical reflector pedagogical modes diagram. Nicholas Murray
I had previously presented some of the development work for this proposition at RMIT University graduate research conferences. Despite presentations of the CATT Acoustic modelling and the ray-trace drawings, my peers were generally sceptical about the acoustic outcomes that I described. I could show a diagram of a CATT Acoustic sound pressure level plot showing a reasonable hot spot of concentrated increase in sound pressure level under the domes, but this would still be greeted with the question of whether the dome had acoustic efficacy.

Earlier in this chapter I described some inadequacies of the acoustic modelling package. In addition to the issues relating to modelling curved surfaces, I discovered that CATT Acoustic is not as effective for the auralisation of small-scale spaces, such as the area under one of the elliptical domes, because the innate errors of the auralisation technique became proportionally larger. At a larger scale, say when modelling a concert hall, these errors diminish proportionally so that outcomes of modelling are much more effective. While the impulse response calculations remain quite good, the auralisation becomes unreliable. I found myself recalling Mies van der Rohe’s use of large and full-scale detail models\(^5\) for his curtain walls and most notably the full-scale wood and canvas model of Mies’ design for the Kroller-Muller house.\(^6\) I thought to myself that the domes I was designing were actually domestic scale in their dimension, so why not just build or prototype them? I had reached a point where I believed the only way I could test whether or not the acoustic principles described by the ray-tracing diagrams actually worked, or allow anyone the experience of the auditory space I described, was to construct a full-scale prototype.

The first prototype was an elliptical arch. It measured 1200 millimetres wide and was constructed of 9 millimetre bending ply on a 12 millimetre CNC routed MDF frame. The assembly slotted

\(^5\) Mies van der Rohe, full-scale mock-up of Kroller-Muller House, Franz Schulze.
together and was suspended on a 90 x 45 millimetre timber stud frame to elevate it into position. By constructing the prototype I was able to demonstrate that there was a distinct increase in the perceived levels of someone’s speech, provided that the listener and the person speaking were located at the focal points of the ellipse. There was the sense that the speaker’s voice had significantly increased in volume.
Having completed the initial prototype, and feeling confident in what I had learnt from the demonstrable acoustic outcomes, I elected to launch straight into the full-scale dome prototype. I made a faceted, ten-sided, 3.5 metre diameter plywood dome. Constructed from 9 millimeter bending plywood, the dome was three dimensionally modelled, and CNC routing profiles were calculated directly from the model. I had the 9 millimeter bending plywood CNC routed by Stephen Mellars at Join by Join in Ringwood. The routing included cutting holes that would enable me to cable-tie the dome assembly together. The suspension system was an assembly of truck ratchet tie-downs, passing through a simple block and tackle. When it was first constructed the prototype deformed considerably when it was winched into position. The lack of any perimeter ring beam in conjunction with the cable-tie fixing technique meant that the form was too flexible. I cut a rough ring beam from MDF sheet to reinforce the structure. The ring beam also served to provide hanging points for the suspension system. As the intention of the prototype was to test the acoustics of the dome, I did not concern myself too much with its aesthetics. It was intended, after all, to be a working prototype.
Upon completion of the dome construction, I suspended it from the workshop roof structure and walked beneath it. The spatial and acoustic effects were profound. There was a distinct sense when one walked under the dome of having entered a ‘spatial zone’. There is a sense of a blurry edge, but one hears and understands immediately that the acoustic effect is what is describing space. When people were positioned at the focal points and engaged in conversation there was a two to three times increase in gain of speech transmission. The intensity of the focussing effect tended to taper when one was at the 90 degree position relative to the person speaking, but the effect was still apparent. The prototype achieved demonstrable acoustic and spatial outcomes. The most important consequence of the prototype construction was the possibility it presented to experience the conditions I had been trying to emulate through acoustic modelling. The experience of space is perhaps more telling than any benefits the dome might allow for acoustic communication.

Refer to sound sample 22: Recording of dome focal points. A 3 inch speaker is placed at one of the dome’s focal points to replicate the directivity of a human voice. The recording is of a soundwalk moving from 6 metres away to the focal point directly opposite the sound source. Despite the noisy environment a sharp increase in volume is heard as the microphones move under the dome’s elliptical canopy.

Refer to sound sample 23: Recording of dome focal points. Same speaker and audio source configuration as sound sample 22. The microphones are moved from the dome edge into and out of the focal point directly opposite the sound source. The focussing effect of the dome can be clearly heard on the recording.
RMIT Swanston and A’Beckett Academic Building. Level 12 proposed floor plan, Lyons Architects.

RMIT Swanston and A’Beckett Academic Building. Level 12 proposed floor plan with field of elliptical domes.

Nicholas Murray

Pedagogical Terrain
Refer to sound sample 24: Recording of dome loudspeaker. A soundwalk from 6 metres away moving to the underside of the dome. A sharp increase in the volume of the 'lecture' audio playback is heard as the microphones move under the dome’s elliptical canopy.

Refer to sound sample 25: Recording of dome loudspeaker. The microphones are moved from outside the dome edge to the underside of the dome and back again. The focusing effect of the dome on the electro-acoustic sound source of the speaker is evidenced by significant variations in the volume of the 'lecture' audio playback as the microphone position is altered.

The dome proposition is not about blocking out background sound. It acknowledges that there would be noise in the open-plan structures I am proposing. Rather than cancelling this noise, by enabling acoustic intensity the dome elevates the sound that occurs in the space beneath it and localises this sound by maintaining its reflections within the acoustic intensity that the dome describes. Similarly, the electro-acoustic delivery of lectures through the ‘near field’ speaker system is controlled because of the dome’s reflective acoustic properties.
The potential of this proposal amounts to the difference between having a fully partitioned academic building versus the possibility of having endlessly dynamic modes of teaching that occur in an open domain. Teaching and learning would be liberated from the pedagogical constraints implicit in the generic, partitioned pedagogical environments we are used to experiencing.

**Reflection**

This project constituted a significant milestone in my research. The design represented an enabling proposal for designing sound with space that has significant architectural outcomes. The project demonstrates both how sound can define space and be an enabling architectural strategy. That the acoustic propositions have been demonstrated via the construction of full-scale working prototypes is a considerable achievement that allows one to experience space through sound. The issue of the representation and acoustic testing of the proposal are dealt with simultaneously. I believe that prototyping was ultimately the only way of evaluating the proposal.

Early on in my research I identified my interest in developing propositions that had acoustic tendencies. Acoustic spaces are passive yet react to occupation, whereby they respond to their occupation. Because they do not require sound to be added, acoustic propositions can more easily intersect architectural program than electro-acoustic works.

My interest in materials and geometry are resident in this work, but are merely the means by which space is achieved. The focus of this design was always the space of sound, not the design of geometric and material outcomes.

I had previously argued for the value of auralisation packages such as CATT Acoustic as a way of generating the acoustic equivalent of an architectural thumbnail sketch. My position has now been modified such that I am now convinced that one should build a prototype when an acoustic proposition is small scale. When designing for a larger volume auralisation becomes really useful as a design tool. I am not discounting the technique; it is more that I have learnt its best usage in terms of how I believe this kind of work can be developed.
Notes


3 Ibid, pp.20–21.


Conclusion

This Appropriate Durable Record is an account of a sequence of design projects that comprise the major research activity of this PhD. The account describes the formation of the design inquiry for each project and the manner and process of their design. Most importantly, a reflective process is evident.

In designing Wayfinder, I became aware that my previously-held belief in the adjacency of my sound design and architectural practices was a falsehood. By undertaking the design of Wayfinder and reflecting on the design of that project I was able to observe that my sound design and architectural practices were, in fact, very much intertwined. I concluded that my architectural training, experiences and consequent expertise had made a significant impact on the outcome of my design for Wayfinder. I reflected that I had established an inquiry into making space with sound and that it was indeed possible to make space with sound and understand sound spatially.

In recognising that I was intuitively applying an architect’s spatial sensibilities to designing with sound, I undertook The Birds and the Bees. My specific aim was to explore how I might design a space that exhibited aural characteristics as a significant aspect of that space’s architectural composition. I designed a space where what one heard had a direct impact on the apprehension of the volumetric scale of space. A result of this process was that I could conclude that I do not so much think about sound in terms of an ‘event’, rather I think about using sound to define space in the same way that an architect thinks about form and materials to define space.

These two spatial projects framed an inquiry into locating a domain for the research. A survey of accounts of aural experience reveals that it is difficult to find descriptions of aural experiences of architecture. When sound is accounted for in relation to architecture its depiction is typically limited to quantifiable acoustic performance, not spatial potential. I observed that with the exclusion of acoustics the major critical theory for sound and sonic comprehension resides in practices adjacent to architecture, such as sound art, soundscape studies, music and psycho-acoustics.
From this inquiry I concluded that the lack of accounting for sound in a way that concurred with an architectural sense of spatiality was a gap in knowledge. I claim that this gap is a partial explanation for the lack of knowledge of precedent projects that exhibit the auditory thinking I have previously described.

In undertaking the Venice Biennale project I demonstrated that one approach to the problem of establishing descriptive language to account for our spatial experience of sound might be to find architectural descriptions of space and urban conditions and then assemble or identify sound that corresponds to these descriptions. I observed that the most significant outcome of this project was the realisation that there was considerable knowledge of aurality to be gained from undertaking such a project, and that the empirical knowledge of sound and space garnered in the process may indeed be more useful to architects than a mathematical or scientific understanding of acoustics.

I also observed that prior to the advent of the ability to electrically reproduce sound there was no way to produce audio recordings of space for documentation purposes. Despite the limitations of recording techniques for documenting acoustic space, there is at least potential now to collect, categorise, document, and most importantly, make available, audio accounts of space in a way that has not been readily achievable in the past. I conclude that accounting for spatial experiences of sound resides in a combination of critical description and audio recording as documentation.

The Punt Road house was a project which I hoped might allow for an acoustic, that is, material and geometric, response to the question of sound and space. In attempting to bring my spatial sense of sound to bear upon a traditional architectural program and brief, I made the observation that I had no way of problematising sound in the context of a domestic residence. I identified that the lack of known precedents and typologies were limiting factors in designing space with sound. I speculated that an account of precedents and typologies for this work would be enabling for the design.

The knowledge generated by undertaking these first four projects allowed me to re-evaluate my thinking in regard to the research. I concluded that the material and formal understanding of architecture as a way of considering the space of sound had not been very useful or productive to my research. Conversely, thinking about sound in a way that is informed by the spatial sensibilities of my architectural training and experience was productive, as evidenced by Wayfinder and The Birds and the Bees. I observed that I had ceased to focus on the space of sound and had begun trying to make architectural form for sound. I acknowledge that this occurred because the appeal of architectural form is that implicit in its geometric and material means resides acoustic potential.

These reflections and critique liberated my design strategies such that I was able to respond to a set of newly formed design guidelines by designing an electro-acoustic proposition for the Melbourne State Theatre and Arts Centre forecourt. The project demonstrated an understanding of auditory space that was dimensional. The project offered a critique of a specific condition of ‘noise’, whereby the noise became the means of defining the auditory spatiality of the site,
thus conceptually redefining the site’s aural condition. A consequence of the design was that the question of architectural program was modified to become a question of auditory program.

The final project was for the design of an acoustic and electro-acoustic proposition for the academic spaces of the proposed RMIT University Swanston and A’Beckett Academic Building. The effective development of this design was dependent on the conceptual adjustments I made after reviewing the Venice Biennale and Punt Road house projects. The design represents an enabling proposal for designing space with sound and has significant architectural outcomes. These outcomes include an auditory solution to the problem of designing open-plan environments and demonstrates the potential for flexible academic spaces that resist the orthodoxy for generic, partitioned pedagogical environments. The execution of the project demonstrates both how sound can define space, and be an enabling architectural strategy. A major contribution to the research is in the form of the fully realised acoustic prototypes that demonstrate the acoustic and electro-acoustic propositions.

In summary, the contribution that this PhD makes is in demonstrating the enormous potential in applying an architectural spatial sensibility to designing space with sound. I use sound to define space in a manner that is similar to the way an architect uses form and material to define space. The difficulty in locating a clearly definable domain for this work is a consequence of the absence of the account of design works of the type I have presented throughout this Appropriate Durable Record. Blesser and Salter describe the domain as ‘sparse, fragmented, and embryonic’. The account of my designs is intended to enable my works to be accessed as precedent projects for others wanting to design space with sound. In this way these works are a contribution to the field.

The major conclusions for the PhD are evidenced in the design projects I have described, and can be summarised as follows:

1) To design acoustic space it is more useful to focus on the space of sound. Architectural form and materiality shapes sound and contextualises design and acoustic experience.

2) Auralisation as an acoustic modelling technique is valuable to architects in that it enables the ability to rapidly sketch acoustic propositions by defining three-dimensional form, materials, sound sources and receivers in a computer model. Audio output can be generated to enable speculative hearing. Auralisation does not equate to aural experience. In addition, auralisation is only accurate and therefore effective for large-scale volumes. It is more useful to engage in rapid prototyping of acoustic propositions when they are small scale. Auralisation does provide useful mappings which translate visually and thus have a representational function that can aid in the communication of spatial scenarios.
3) One cannot model ‘experience’. However, prototyping allows for auditory spatial experience where auralisation does not.

4) My project and literature review concluded that outside the arena of high performance listening environments there are few intentionally designed instances of acoustic space. I would now offer that such spaces do exist, but what is missing is the account of our spatial experiences of these environments or an account of the manner in which they were designed. Critical rather than anecdotal descriptions of our acoustic experiences would be a more effective way of addressing and identifying precedents and acoustic typologies. I conclude that accounting for spatial experiences of sound resides in a combination of critical description and audio recording as documentation.

5) Electro-acoustic works are contingent upon the addition of sound. This aspect of electro-acoustic works contributes to difficulties with negotiating particular architectural programs.

6) Acoustic scenarios are usually categorised as being concerned with acoustic communication or acoustic energy. The dome proposition demonstrates that it is possible to design multivalent scenarios that can inhabit both of these acoustic imperatives, rather than having to categorise designs as being one or the other.

When I began this PhD I asked: ‘If we can conceive of or comprehend sound in spatial terms, how can we use sound to design space?’ I would now contend that the assembly of design projects described within this Appropriate Durable Record demonstrates how we might conceive of and comprehend sound in spatial terms and represents valuable precedent works for informing how we can design space with sound.
Notes


