Painting with Sound: Exploring Transformational Aspects of Studio Production Processes, within the framework of Acousmatic Music Practice

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Abstract
This Thesis investigates a series of transformative studio production processes used in the creation of Acousmatic music from fixed media sourced on a research trip to the Huế peninsula in Vietnam. It also looks at a history of the graphical arrange page in a Digital Audio Workstation and relates to the graphical metaphors in the depiction of the sound objects used in the graphical arrange page to Denis Smally’s Spectromorphological analytic framework.

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1. Introduction

This document discusses the relationship between graphical metaphor in the way Digital Audio Workstation software depicts sound objects and Smalley’s Spectromorphological framework as applied to acousmatic music practice.

The research presented in this document – and in the portfolio that accompanies it – is concerned with how metaphors of abstraction and composition from the cannon of Musique Concrète mix with theories and concepts of mathematical representations in experimental music composition. These metaphors and concepts form what we see, accept, intuitively understand, engage with and manipulate as a metaphorical, graphical language concept, in the basic workflow of the arrange page of most Digital Audio Workstations. For the purpose of this document a digital audio workstation (DAW) is defined as a computer based system with or without external hardware running a software application with the purpose of the recording, editing and mixing of fixed media (audio files) used in the production of audio mixes for music, film/video or online media.

Acousmatic music is a form of fixed media electroacoustic music that is composed for presentation using only speakers, and exists solely as audio recordings. The word acousmatic comes from the Greek akousmatikoi, a term that describes teacher / philosopher Pythagoras’ teaching technique of having his pupils listen in silence while he delivered his lecture from behind a screen. French composer Pierre Schaeffer coined the term “acousmatique” to describe the process of listening to a composition behind a screen of loudspeakers, the source of which remained unseen (Schaeffer, 1966).

This music is part of a compositional tradition that dates back to the introduction of Musique Concrète by Schaeffer and his contemporaries in late post war 1940s Paris. Musique Concrète (Schaeffer 1952) is an experimental form of composition that involves cut up, abstraction and assemblage techniques. These can be viewed as forms of edit and montage appropriated from 1920’s Soviet montage theory (Eisenstein 1949) a cinema style that relies heavily on editing of fixed media.

Subsequent artists including influential British music producer and composer Brian Eno further developed the traditions assisted by emerging music graphical editing technologies that embody the use of graphical sound object metaphors used in the arrange page of a DAW.

(Sean Albiez, David Pattie, 2016)
The graphically representative metaphors used in Digital Audio Workstations (DAW) to visualize sound objects’ temporal morphologies can be quantified and explained through the use of New Zealander Denis Smalley’s concepts of Spectromorphology and structuring processes (Smalley, 1997). In the late 1980’s Smalley theorized an analytical framework which describes sound-shapes. Spectromorphology views electroacoustic and acousmatic music as comprised of sound spectrums with temporal morphologies, defining aspects of their energy-motion and quantifying sonic sound spectrums within sound objects as they manifest over time.

This project explores these ideas through the acousmatic studio practice presented in the portfolio of works. Here the compositions are comprised solely of sound objects, transformations of the fixed media collected. When placed on a time line in a DAW in relation to each other the graphical representations depict the arrangement of the works. The temporal morphology of these objects has been altered in the time line using these graphical representations of the Onsets, Continuants, Transitions and Terminations which delineate the energy–motion trajectory inherent in the sound objects. This in part is where the acousmatic composer exercises his or her compositional choice, the choice of one morphology over another.

The creation of the portfolio of works that accompanies this research took me to the Vietnamese ancient former imperial capital city of Huế and to the peninsula in Thừa Thiên–Huế Province to photograph temples, tombs, ancient bells and calligraphy and make sound recordings. These recordings included the acoustic ambience of various locations, environmental sound sources, traditional Vietnamese instruments being played, and recordings of the Vietnamese ceremonial court music Nhã nhạc, which has been performed in Vietnam since the Trần dynasty of the 13th century. The reason for choosing Huế Vietnam as the site for the collection of fixed media utilised in the research is two fold. Firstly, from a New Zealand composers personal stand point, the pictographic detail of the art, complexity of the architecture and general cultural otherworldliness of the ancient imperial capital was creatively stimulating. Secondly, the simplicity of certain aspects of the instrumentation and arrangement of both Nhã Nhạc music and the Buddhist practice of bell ringing and chanting makes it possible for more extreme acousmatic production transformations to be performed on the fixed media collected.

In the portfolio I have explored transformational production techniques in acousmatic studio practice, using the fixed media collected in Huế Vietnam. Through the study of acousmatic composer’s work and writings such as Denis Smalley, Bernard Parmegiani and Iannis Xenakis I can assert that emphasis on timbral manipulation and rhythmic complexity is a stylistic footprint of acousmatic music.
The portfolio involves complex evolving textures, polyrhythms embodied in sound objects developed out of field recordings, recorded and synthesized sounds, and in some cases photographs. These were transformationally processed by software and used as gesture in the works presented.

These sound objects were then temporally arranged in the graphical arrange page of Avid Protools Digital Audio Workstation Software, utilising Smally's spectromorphological concepts of motion and growth to create the acousmatic works presented.

This research examines, in part, how sound design elements mixed with the musical sensibilities of the composer are realized into acousmatic compositional works, mediated through the graphical metaphors of the Digital Audio Workstation arrangement page. This highlights the providence of these metaphors, and the value of Smally's spectromorphological framework, which provides a quantitative analytical way of describing the motion and growth that these metaphors depict.

Structure of the Thesis

Section one of this thesis starts with a broad overview of the relationship between graphical metaphor in DAW software and Smalley’s Spectromorphological framework as applied to the acousmatic music practice in the portfolio created from the fixed media collected in Huế Vietnam.

Section two discusses and analyses a history of the Digital Audio Workstation, focusing on the germination and evolution of the graphical metaphors depicting sound objects. This discussion pays particular attention to Xenakis’s symbolic music flow chart (Xenakis, 1963), and UPIC (Unité Polyagogique Informatique CEMAMu) system.

Section three chronicles a research trip to collect fixed media in Thừa Thiên Huế province, Vietnam. This section provides a short history of Huế city, and explores aspects of the Imperial fortress palace in Huế. It also discusses royal Vietnamese Nhã nhạc music, and looks at the seaside tombs of Thuan An and An Bang in relation to fixed media collected.

Section four discusses and analyses gesture in Acousmatic music, sound objects, and graphic morphological gestures as seen through Smalley’s Spectromorphology framework. The section then delves into specific ways in which software transformations were used as gesture in examples from the portfolio, collectively relating these examples back to concepts in graphical composition.

Sections five and six comprise of a short summary and references.
2. The Digital Audio Workstation: a short history

2.1. Foreword

In order to understand the importance of the rise of the Digital Audio Workstation in music production, which in turn normalized the graphical arrangement of sound objects on a time line in computer software, we might first explore some history. This history of ideas can be viewed through the lens of a few key moments in the Silicon Valley technology research and technology production industries.

The democratizing effects of computer based Digital Audio Workstation technology – and its effect on the recording studio sector within the musical economy – cannot be understated. A detailed discussion of these effects is beyond the scope of this project, partly as this theme has already been explored in some detail by other scholars (Goodwin, Theberge 1997, Moorefield 2010, Leyshon 2009).

In totality this Digital Audio Workstation software technology makes it possible, (with the use of software based instruments, and 3rd party audio processing plugins), for complete music productions to be planned, worked on and realized within the digital space that exists behind the non-reflective plastic of the computer screen. This project focuses on the role that the Graphical User Interface (GUI) plays, exploring the basic metaphors used in the graphical representations of sound objects, their relation to each other, and to the overall time line in the Edit/Arrange page of all contemporary Digital Audio Workstation software.

The act of edit montage, transformation and arrangement as compositional practice has its roots in the tape and electronic music of the last three quarters of a century, in particular in the form of Musique Concrete pioneered by French composer and theorist Pierre Schaeffer in the 1940's. These roots of montage-based composition in Musique Concrete inform my acousmatic practice, which is also influenced by the relationship between graphical metaphor in sound objects depicted in the time line of a DAW, as per Smalley's concept of Spectromorphology. Later in this document (in section four) I explore this relationship between my acousmatic music practice and these metaphors about graphical representation of sound objects, making extensive reference to Smalley’s Spectromorphological analytical framework.
2.2. ANS synthesizer – visual score to sound via light

The first significant development in the prehistory of the DAW graphic user interface’s depiction of organized sound objects in a time line is the Russian ANS synthesizer.

In 1967, the Experimental Electronic Music studio was opened in Moscow's Scriabin museum. The main attraction in the studio was the first Soviet-made synthesizer (ANS) developed by the engineer Evgeny Murzin (1914–1970). The name of this synthesizer was an acronym for the initials of composer Alexander Nikolayevich Scriabin.

In this studio, Soviet electronic composers such as Edison Denisov, Sofia Gubaibulina, Eduard Artemiev, Stanislav Kreychi and others worked and experimented in the electronic music field for many years. As places to perform electronic music did not exist in the Soviet Union, most of the electronic sound tracks of this era can be heard as scores in movies, documentaries, scientific and educational films. Some of the aforementioned composers scored electronic soundtracks for dozens of Soviet films during the 1970's. (Stanislav, 1997)

In 1938 Murzin invented a design for composers based on synthesizing complex musical sounds from a limited number of pure tones; this proposed system was to perform music without musicians or musical instruments. The technological basis of his invention was the method of photo-optic sound recording used in cinematography, which made it possible to obtain a visible image of a sound wave, while synthesizing a sound from an artificially drawn sound wave.

The technology of the ANS musical synthesizing instrument utilises a unique and creative interface, a photo electronic light to sound process, where the composer draws the score for the piece being performed on a glass screen covered in a black mastic substrate, which, when scraped away, creates a visual arrangement, which is then played back by the ANS via a vertical bank of twenty photo optical cells.

The non-drying mastic allows for correction of the score, portions could be smeared over, and missing sounds could be added. The ANS is fully polyphonic and will generate all of its possible 720 microtones (discrete pitches), spanning 10 octaves simultaneously, when the glass plate with the visual arrangement inscribed on it is then scanned left or right, the Y-axis, representing pitch, transcribes the drawing directly into pitches, while the X-axis, representing durations of sound events, can be controlled by the scan speed and is adjustable down to zero, in other words the speed at which the score scans in the X-axis is a means of controlling duration whereas the vertical axis of the arrangement in the Y-axis, bottom for low pitch, top for high pitches, is a means to denote the pitches of those sound events.
The significance of the ANS synthesizer’s development lies in the creation of a graphically representative score. Here we see the shape, form and energy-motion of sound objects being literally drawn onto a graphic user interface. In the prehistory of DAW GUI’s this was the first time these concepts were not only theorized but also made to function in an all-in-one music synthesizing instrument. The ANS synthesizer’s graphic compositional interface, and the underlying concepts of graphical representation of fixed media, both inform and are crucial to my acousmatic music practice.

Fig 1. ANS Synthesizer at the Glinka Museum Moscow
Fig 2. ANS synthesizer's music score examples from the release Coil-ANS
2.3. Iannis Xenakis’s temporal flow chart and UPIC

Greek-French composer, music theorist and architect Iannis Xenakis theorized the concept of symbolic music and the sound object metaphors used in the graphical representation within a temporal flow chart (1963). This is the founding concept behind the graphical editing workflow of all modern computer based music production Digital Audio Workstation software.

Interestingly his groundbreaking book *Formalized Music: Thought and Mathematics in Composition* (Xenakis, 1971) contains the complete program code for one of Xenakis’s early computer music compositional programs, known as GENDY. The stochastic music program was written in FORTRAN IV computer language to be run on the room-sized IBM System/360 mainframe Computer in circa 1962 like this one at Stanford University Electronics Lab.

Fig 3. IBM 360 mainframe at Stanford University Electronics Lab 1962

Xenakis’s Symbolic Music concepts are based around the idea of having graphical shapes that define what he calls ‘the logic underlying musical composition.’ These are displayed on a ‘temporal flow chart’ depicting the graphical arrangement of a composition, encompassing ‘sonic events which are not endless’ as graphical objects on a two dimensional time line that represented the totality of the composition.

(Xenakis, 1971
This temporal flow chart shows the sonic events as discreet visual blocks, with the duration of the events represented by the length of the blocks. The arrangement of this solo piano piece HERMA is represented by the visual relationship between the sonic event blocks, as read left to right.

It is remarkable that in the 1960’s, Xenakis imagined such a simple graphical metaphorical device that could represent the complex interaction between sonic events that in its totality embodied an arrangement. Furthermore, this system involves little use of language, relying mostly on mathematical symbols representing sonic/musical events, and their durations, hybridizations, subsets and interrelationships. The display of this information on a timeline permits the representation of the motion and momentum of the composition.
Later Xenakis developed and completed in 1977 the computer-assisted composition tool UPIC at the Centre d'Etudes de Mathématique et Automatique Musicales (CEMAMu) in Paris. This was an even more physical graphical interface design for composition, where sound objects/events are drawn onto a digitizing tablet linked to a computer. Objects/events can then be organized, composed and played back by the system.

This functioned in exactly the same style as the ANS musical synthesizing instrument, with the X-axis representing time, and the Y-axis representing pitch. The graphical objects/events within the compositions can be transposed, reversed, inverted, and processed by a number of algorithmic transformations, including the stretching of the duration of the events from a few seconds to an hour in the organization and arrangement of the composition.

Fig 6. The first page of the graphical score of Mycenae-Alpha, the first work realized by Xenakis with computer-assisted composition tool UPIC in 1977
In the compositional studio production practice of this research, the fixed media pieces presented in the portfolio use Xenakis’s temporal flow chart technique in their composition and arrangement. This is where the score is embodied in a graphically representative form as sound objects with an energy–motion trajectory presented as morphological strings depicted in the time line of a DAW. The graphical score of the temporal flow chart is fixed to the work itself, the definition of Schaeffer’s Musique Concrète (Schaeffer 1952). In other words, the metaphoric representation of the sound objects are directly linked to the sound files depicted by the graphical representations. This composition (City of Ghosts Part 1 – HUE KIET 42) was made by placing sound object in relation to sound object using only the graphic representations first, which were then evaluated by listening together in playback the relevant section(s). Only then were changes made to the temporal relationships incrementally between the objects, which when played back together embody the composition.

In section 4.4. Sound Objects and Morphological Gestures, we will examine morphological strings in greater detail.
2.4. Lucasfilm SoundDroid – Multi Track Digital Work Station

SoundDroid is an early Digital Audio Workstation designed by a team of engineers led by James A. Moorer at Lucasfilm, the production company owned by Star Wars writer/director George Lucas. Between 1980 and 1987, while researching at Lucasfilm Droid Works, Moorer designed the Audio Signal Processor, (ASP) the technology upon which SoundDroid was based. (Moorer, 1982).

The SoundDroid system was a ground breaking, all-in-one digital audio workstation that for the first time enabled non-linear editing capability. This permitted instantaneous editing, playback and mixing of sound file ‘objects’ created in a time line linked to a time coded picture playback, for use in motion picture soundtrack creation. SoundDroid was a hard-disk-based, non-linear audio editor developed on the Audio Signal Processor (ASP), a large-scale digital signal processor for real–time, multichannel equalization and audio mixing. Only one prototype was ever built, and it was never commercialized. Lucasfilm started assembling a computer division right after the first Star Wars film as an in-house project to build a range of digital tools for filmmaking.

The audio project that became SoundDroid was undertaken in close collaboration with the post-production division, Sprocket Systems, and later released as part of a joint venture called The Droid Works. Droid Works was a complete system, with a hard-disk-based, nonlinear audio editor, and included a shuttle wheel, touch-sensitive displays, moving faders and programs for sound synthesis, digital reverberation, recording, editing and mixing. The SoundDroid was the beginnings of what is commonly referred to as the “DAW revolution.”

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1 Moorer later co-Founded the Stanford University Group for Computer Research in Music and Acoustics in California, and was also a researcher and scientific advisor to IRCAM in Paris. He was thus aware of Iannis Xenakis’ compositional work, and utilized stochastic mathematical functions, set theory and game theory in his work and theories of symbolic music. Moorer was also particularly interested in the idea of the temporal flow chart.
Fig 8. The SoundDroid work surface, incorporating eight motorized level control faders, a touch sensitive display, and multifunction soft keys.

Fig 9. SoundDroid, Cue sheet page incorporating graphical vertical audio waveform representations of the sound objects in a time line.
2.5. Digidesign Sound-Tools 1.2 - Wave Form Editor

In 1988, Digidesign released Sound-Tools Digital Recording and Editing system for the Apple Mac II personal computer. This was a hybrid system, utilising accelerated DSP on a card hosted inside a Mac II computer, (which provided the computing power for the algorithms doing the actual audio processing), and software running on the Mac II computer itself (which ran the program giving the user a Graphical User Interface with which to control the actions of the audio DSP card). This gave the user direct to hard disk recording/playback with 16-bit linear digital resolution, waveform editing and digital signal processing.

The system is comprised of the **AD IN** stereo analogue-to-digital converter in a stand-alone box, a Sound Accelerator card for the computer that contains the stereo digital-to-analogue converter, a Motorola 56001 Digital Signal Processor (DSP) chip, and the Sound Designer II or Sound Tools software, which controls the recording, editing, and playback functions, and provides the visual waveform editor. Audio editing and arrangement is achieved by highlighting a section of the waveform by pointing, clicking, and dragging the mouse in standard GUI fashion. This is where the modern iteration of a graphical representation of the waveform of a sound object was born and the now standard Cut, Copy, Paste, Clear and Undo functional commands first appear.

![Fig 10. Digidesign Sound-Tools Waveform Editing Display](image)

**Fig 10. Digidesign Sound-Tools Waveform Editing Display**
2.6. Protools Digital Audio Workstation (DAW) software

AVID Pro Tools is a mature Digital Audio Workstation software platform that continues in development since its introduction in 1991.

In 1994, with the introduction of the Pro Tools III, the system became an integrated all in one digital studio.

In its most basic form Pro Tools III was a two card system hosted inside an Apple Power Macintosh computer running the ProTools Graphic User Interface software.

This system would allow 16 tracks of audio to be recorded, edited and processed simultaneously, then mixed down to a stereo mix file. The basic editing tools in the software (Cut, Copy, Paste, Fade and Crossfade) allow and are informed by the very same edit and montage techniques used by the Musique concrète composers of the 1940's in their work using magnetic tape.

There are other DAW software packages, most notably Apple Logic Pro, which started life in 1993 as a Music Instrument Digital Interface (MIDI) computer based software pattern and track sequencer, Emagic Notator Logic. Audio recording tracks and audio editing were added to logic in the late 1990's.

Protools DAW software to this day has two basic work environments; The Edit page and the Mix page.

Most of the metaphors used in the graphical representations of sound objects, are present in the Edit page of version 3.4 of Pro Tools GUI software circa 1995.

This graphical Edit page, is where compositions are organized, wherein each sound object is placed in the time line in relation to others. This is also where sound objects can be edited and montaged, then reformed into new shapes, typologies and trajectories.
Fig 12. Digidesign Pro Tools Version 3.4 Edit page

2.7. Conclusion and Foreword

Even at this early stage of Digital Audio Workstation development in the 1990’s, the basic metaphors underpinning the graphical presentation of sound objects (Digital computer files) on a timeline were clear, present and useable.

The sonographic representation of sound objects - the ways in which visual data in a DAW, is tied, fixed together with the sound objects themselves, (i.e. the actual recorded digital sound files), is pivotal in informing my practice. This bond between representation and reality means that when the composer creates using the representative depiction of the sound object, they are effectively creating/using the actual fixed media. This is the essence of acousmatic music practice, as initially defined by Schaeffer (Schaeffer 1966).

How this historic evolution of visual audio data metaphors relates to the works presented is that the works themselves were written and produced entirely in the time line of a DAW, all of the temporal artistic decisions were made utilising these graphical representations which, when seen in totality, embody the score of the works depicted.

In the next section I will detail the creative input for my studio based research practice in acousmatic music composition, in the form of the raw cultural and fixed multimedia data that I collected during a research trip to the Thừa Thiên-Huế (the Huế peninsula) in Vietnam.
3. City of Ghosts: Thùa Thiên Huế Vietnam

3.1. Introduction to a fixed media research trip

For the studio practice portion of my research (presented in the accompanying portfolio), I composed an album of acousmatic music. Thematically, this album explores the abstracted idea of a sense of place. The place chosen was Thùa Thiên Huế province, Vietnam, and in particular the 2800-year-old settlement Huế and the Huế peninsula, which are collectively known as the ‘City of Ghosts’.

The research trip to the Thùa Thiên Huế province Vietnam was a fixed media acquisition and cultural project to gather the raw fixed media from which the sound objects in my compositions would be created. This section explores the media, and its geographical, cultural and historical contexts.
3.2. A very short history of Thừa Thiên Huế, Vietnam

The ‘Thừa Thiên-Huế Province in Vietnam dates back approximately 3000 years. Huế city itself, a Unesco World Heritage site, was the imperial capital of Vietnam from 1802 through to 1945 under the last of the five emperors to rule Vietnam in the Nguyễn dynasty. During this time Vietnamese culture, art, cuisine and architecture flourished in the walled fortress palace, in the Imperial City of Huế.

Vietnamese revolutionary leader Ho Chi Minh declared independence from the French influenced Nguyễn dynastic rule in 1945, removing capital status from Huế, and announcing the creation of the Democratic Republic of Vietnam. This effectively split the country in two. During the first Indochina War, between 1946 and 1954, French forces attempted and ultimately failed to assert their power to return the country to (French-backed) dynastic rule. During the subsequent Vietnam War, Huế city again became embattled. During the Tet Offensive of 1968 the city suffered considerable damage to its historic architecture due to American military bombing. The city’s reputation also suffered due to a massacre of thousands of civilians in Huế committed by the communist forces. North and South Vietnam were reunified in 1975 at the end of the Vietnam War, moving the capital to Hanoi in the north.
3.3. The Imperial City of Huế

The Imperial City (Kinh thành Huế) is a fortress palace in the city of Huế, seat of power of the Nguyễn emporial Dynasty and former imperial capital of Vietnam. In the city’s heyday in the 18th and 19th centuries, the Imperial palace contained many pavilions, gardens, residences and reception rooms in a sprawling opulent complex within an impenetrable walled enclosure surrounded completely by a moat. Only a handful of the over one hundred and sixty historic structures in the Imperial City survived bombing during the War years (1955 – 1975). Restoration and preservation is ongoing, with the Vietnamese government announcing in April 2016 an ongoing commitment to funding the project through to 2030.

Two sites are of particular artistic interest to me in the context of my acousmatic music studio production practice. The first is the recently restored Royal Theatre Duyet Thi Duong, considered the oldest theatre in Vietnam, and the second is the Co Ha Water garden in the imperial city’s grounds. In the exhibition section of the Royal Theatre Duyet Thi Duong, I was able to play and record instruments including a huge ceremonial drum and gong, take photographs of ancient music scores, many examples of traditional Vietnamese instruments, theatrical masks and performance costumes. In the Theatre itself I filmed, recorded and photographed a performance of Nhã Nhạc music, Royal dance and Tuồng. (Traditional Theatrical Art)

Some of this media would end up being transformed into sound objects, and was subsequently used in my compositions, some informing and enlightening the artistic intent of the works themselves. Using this transformed fixed media the project seeks to express a sense of place abstracted through the lens of acousmatic music practice.

Fig 15. Ceremonial Gong and Drum in the citadels restored Royal Theatre
The Cơ Hạ water Garden was one of five royal gardens inside the Huế royal citadel. Completed in 1837, this garden was largely destroyed in the first and second Indochina wars, and is still undergoing careful restoration. The contemplative water garden contains many paths weaving through installations of over four hundred impossibly detailed miniature bonsai landscapes, leading to bridges over arcing waterways to various structures and shrines.

This place has such a strong residual energy of the artistry from the Nguyễn dynasty that I immediately envisioned cascading rivers of shimmering harmonic sound, mixed with an incoming storm front and random rhythmic patterns created by rain droplets on the surface of slowly moving water. Here I made audio recordings of a passing thunderstorm and water movement as it sloshed through many of the garden’s waterways. I also photographed architectural aspects of the garden, including pagodas and various bonsai installations, paying particular attention to photographing the many artworks and calligraphy poems scattered through the various pagodas. One of these would be transformed back in the studio into rivers of tones utilizing a virtual software model of Russian synthesizer the ANS.

Fig 16. Cơ Hạ water Garden Pagoda & Calligraphy poems detail
3.4. Nhã nhãc: the royal court ceremonial music of Huế

Nhã nhãc is a form of Vietnamese royal court music recognized in 2005 by UNESCO as a Masterpiece of the Oral and Intangible Heritage of Humanity. Performed for Vietnamese emperors in the 13th century Trần dynasty through to the Nguyễn dynasty in Huế at the end of the 20th century, Nhã nhãc is still performed in the restored Royal Theatre in the Citadel palace of Huế.

The meaning of the term ‘Nhã nhãc’ is literally elegant ceremonial music which is played for the emperors and their guests during religious holidays and official receptions.

The largest influence upon Nhã nhãc music is imperial Chinese Ming dynasty court music, dating from the 276 years between 1368 and 1644. Interestingly in the Ming dynasty, a small group of scholars were preoccupied with the acoustic principles of music especially related to investigations in mathematics and numerology. Astronomer mathematician and musicologist Zhu Zaiyu (1536-ca.1610) is credited with the development of the equal-tempered scale of twelve pitches.

My interest in Nhã nhãc music in turn spurred my interest in Huế, the city that became the most important line of inquiry in finding creative threads for my works. Although we are looking at the city through the frame of acousmatic music production practices there are much bigger shadows cast across this prefecture of Vietnam than I would ever be able to perceive or render. It could be that looking at this place though the lexicon of its music is one way of understanding a small part of what it is.

Fig 17. Nhã nhãc performance in the restored Royal Theatre
Some of the exhibits in the museum of Nhã nhạc in the Royal Theatre

Fig 18. Nhac Cuong (song texts) - Nhac Pho (music score)

Fig 19. Phach Mot (wood planks) Tam Am (three gong) Thanh La (bronze gong)

Fig 20. An Nhac Cung Dinh (royal court music orchestra)
3.5. City of Ghosts: The Giant tombs of Thuận An and An Bang

On the Huế peninsular lie the seaside villages of Thuan An and An Bang, where local fishermen are taking the Buddhist Confucianism practice of ancestor worship to a very opulent and detailed higher form. They do so under the watchful eye of the local communist prefecture authorities, who quietly discourage the practice.

Between the giant Thuan An estuary – where wooden fishing fleets reside, and the vast South China Sea, is a thin and almost impossibly long dune laden white sand spit.

Here kilometre after kilometre of Tombs are scattered across the highest point of the spit, so as to not be washed away in either a flood from the Perfume River that intersects Huế and empties into the estuary, or in a one in a hundred-year cataclysmic storm sea event. A strange and hauntingly beautiful array of Tombs – some yet to receive the intended inhabitant – reach towards the heavens, with ever increasingly tall ornate structures, some over eight meters high, in the hope that good fortune will possibly be favoured by the gods on those who cultivate respect towards their ancestors.

I felt that one way to attempt to understand this ritualization of death – the bizarre yet important spectacle of hectare after hectare of tombs – was with a creative act. I took a stereo field recorder and created a Soundwalk (a walk with a focus on listening to the environment). At midnight on the full moon of March, I walked, barefoot through the surf, at the isthmus, where the sand and waves meet at Thuan An beach, in an attempt to capture an essence of the Ghosts of the long dead as they escaped their tombs … into the dark water.

The Soundwalk is the main feature of the work *THUAN AN* presented in the portfolio.
Fig 21. A detailed tomb in the white sand dunes of Thuan An

Fig 22. Kilometre after Kilometre of Tombs at An Bang
3.6. Fixed Media Collected used in the works presented

**Performance Video recordings:**
45min Nhã nhạc performance at the Royal Theatre.
35min private commissioned Nhã nhạc performance in Hue.

**Found Media:**
Video CD of Nhã nhạc bought from a Dong Ba Market trader.

**Field Audio recordings:**
Hue Streets at night (Keit 42)
Thuan An beach: waves in moonlight Soundwalk
Thuan An tropical thunder storm
Thuan An street life and roadside vendors
An Bang motorcycle journeys
An Bang wind through the Tombs
Hue Taxi journeys
Vietnamese royal ceremonial Gong, Drum & instruments
Cô Hạt water Garden thunder storm

**Photographs:**
Architectural aspects and calligraphy poems in the Citadel water garden
Elaborate Tombs and Tomb detail in An Bang and Thuan An
Instruments in the museum of Nhã nhạc in the Royal Theatre
4 Analysis:
exploring aspects of
Spectromorphology in Acousmatic
Music Production

4.1. Introduction to the portfolio production

In the portfolio of this research project I have explored transformational production techniques in acousmatic practice, utilising the media collected on the research trip in Huế Vietnam detailed in section 3. The emphasis on timbral manipulation and rhythmic complexity is a stylistic footprint of this acousmatic music.

The portfolio involves complex evolving textures, polyrhythms embodied in sound objects developed out of field recordings, recorded and synthesized sounds, and in some cases photographs. These were transformationally processed by software and used as gesture in the acousmatic works presented.

What follows here is a detailed examination of the main software tools used in the composition and studio production of the works in the portfolio.

Specific examples of sound objects used in the works presented will be discussed and in these examples, transformational production processes will be applied altering the spectrographic, morphological and temporal characteristics of the sound objects.

This section also relates these processes to the earlier discussion of graphical metaphors and Digital Audio Workstations, and an analysis of these graphical metaphors utilising Denis Smalley's Spectromorphology framework.
4.2. Gesture in Acousmatic music

Influential British music producer and composer Brian Eno experimented with innovative studio production techniques that were influenced by the building blocks of painting, particularly minimalist painting practice. Eno’s work is inspired by the art theory concepts of Line, Shape, Direction, Size, Texture, Colour, Balance, Gradation, Repetition, Contrast and Harmony. Eric Tamm states:

As Eno himself has pointed out, his musical work is so heavily dependent on technology that it could not have existed in any previous age. When he speaks of himself in terms of being a painter with sound, or a constructor of sonic landscapes, he is being more than metaphorical: for in a very real sense, magnetic tape is his canvas, and he applies his sound-substances to that canvas, mixes them, blends them, and determines their shape, in a specific “painterly” way …

(Tamm, 1988)

This is a process where the transformative nature of production techniques is used as gesture: this can be described as a sound object in electroacoustic and acousmatic music. The gesture may here be defined as the process whereby a sound object is manipulated via a transformational or acousmatic process and applied in space, in relation to other sound objects.

The nature of these processes – the choice of one sound over another, and how these different sonic objects are then reconfigured within the mix – defines the nature of the composition and/or our response to it. Thus, gesture may be considered the site where the acousmatic composer/producer makes his or her mark. With its roots in the Cut & Paste ethic of the early tape experimentalists of Musique Concrète, selecting, editing, refining and/or manipulating gesture in groups of sound objects is the basis of composition in acousmatic music when practiced in studio based production of this music. An effective way to define aspects of the motion and growth of these gestures is through the use of the Spectromorphology analytical framework.
4.3. Spectromorphology

Denis Smalley (born 1946 in Nelson, New Zealand) is a theorist and composer, and his extensive discography of electroacoustic and acousmatic music reaches back to the late seventies. Smalley coined the term Spectromorphology to describe his creation of a descriptive analytical framework for explaining sound-shapes. Spectromorphology views electroacoustic and acousmatic music as comprised of sound spectrums, and explores their manipulation over time. (Smalley, 1986).

In his 1997 article Smalley defines Spectromorphology as:

*The two parts of the term refer to the interaction between sound spectra (spectro-) and the ways they change and are shaped through time (-morphology). The spectro- cannot exist without the -morphology and vice versa: some- thing has to be shaped, and a shape must have sonic content.*

(Smalley, 1997)

The framework encompasses language that helps to explain the sonic content and structural relations in electroacoustic music production, utilizing the types of morphology outlined in Pierre Schaeffer’s *Treatise on Musical Objects* (1966). Smalley’s diagnostic framework strives to describe the components of the sound spectrum and how they are shaped through time. It gives us a way to begin to describe gesture in electroacoustic and acousmatic music, and allows us to explore how the listener may perceive some aspects of the morphology and spatiality of those gestures.

The gestures described in Spectromorphology are for the most part created by audio editing and processing transformations. This is, in other words, a studio based production practice where a data set exists, a transformative production technique is applied, manipulated, and the resulting output is the composition in fixed media (recording).
4.4. Sound Objects and Morphological Gestures

In section 2 we examined a history of the graphical sound object metaphors used in the arrange page of Digital Audio Workstations. This included discussion of how Iannis Xenakis’ symbolic music temporal flow chart was put into practice in the Digital space. This adaptation is one way of representing sound objects in a time line in a simple, clear way and of depicting the relationship of one object or group of objects to another.

Smalley’s Spectromorphology framework, in part, encompasses metaphors of the trajectory of sound objects in relation to their individual and collective morphology i.e. form, structure and their specific structural features over time. This relates to sound objects depicted graphically and how concepts of gesture relate to graphical metaphors in the visual representations of the sound objects and their arrangements in a DAW.

Spectromorphology provides a vocabulary for describing the basic gesture unit of acousmatic music – the sound object. The energy–motion trajectory of a sound-object, is three linked temporal phases, these are Onsets (Attack), Continuants (Sustain) and Terminations (Release).

The graphic visual metaphor used in the depiction of a sound object and its energy–motion in a Digital Audio Workstation reflects these same metaphors.

Fig 23. DAW Graphic Waveform 1

Onset (attack) Continuant (sustain) Termination (release)

The metaphors of motion and growth are appropriate ways of considering a time-based art like electro- acoustic music. (Smalley, 1997: p.115)
This delineation of energy–motion trajectory, which Smalley terms “structuring processes” (1997) can describe groupings of sound objects arranged into gestures of longer forms, referred to as “morphological strings” (Smalley 1986). Smalley refers to the point at which the continuant phases of sound objects meet and overlap as the “transition.”

The image above depicts a graphical representation of a morphological string, represented in a DAWs graphical arrange page.

Fig 24. DAW Graphic Waveform 2

The above waveform shows a complex internal morphology, depicted in a simple, clear and understandable way through the use of graphical metaphor within the DAW GUI. The geometric shapes and curves provide a visual metaphor of the trajectory of the sound objects, allowing easy recognition of the energy-motion of the objects. This in turn allows for very precise editing and layout of individual sound objects in the time line of a Digital Audio Workstation. This is an intuitive way to depict the relationship of complex properties of one object to another, for example, the relative volume between two objects or the temporal relationships between two or more sound objects.

This is the value of the idea of using simple geometry in graphical metaphors depicting sound objects in the time line, because it allows for immediate pattern recognition, and can convey very complex inter-behavioural relationships and morphological trajectories.
4.5. Examples:
Software transformations creating Sound Objects used on the works presented

The empirical component of this project explores a range of spectral, textural and transformative studio production techniques used to build sound objects and gestures in my studio based acousmatic music practice. Below I discuss specific examples of Spectrographic/Morphological/Temporal transformations applied to the fixed media collected in Huế Vietnam. This discussion focuses on the use of software tools in the creation of sound objects for the compositions.

IRCAM Lab TS

One of the key pieces of software used in the creation of sound objects in the works is IRCAM Lab TS, primarily because of its unique ability to allow sounds to be stretched to the point at which you can almost hear between the vibrating air molecules. This ability gives the composer an extreme level of creative abstraction in the temporal morphologies of sound objects, is fundamental to the creation of my works and why we will look at this technology in detail.²

IRCAM Lab TS is a standalone Spectral Transposition and Stretching application that allows a sound file to be slowed down by a factor of up to 1000%, transposed and or formant shifted by up two + or two - octaves, and filtered with spectral filters. These use a variable phase vocoder algorithm to allow the extraction or depletion of the Transient (Onset), Sinus (Continuant) and Noise components of the sound being processed.

I used IRCAM Lab TS in the construction of a sound object for the THUAN AN composition. In this instance, I took a recording of a wind chime bell tree from Huế Vietnam, and transposed this down in pitch by two octaves.

² IRCAM, is a world leading music research institute in Paris, (Institute for Research and Coordination in Acoustics and Music), funded by the French Ministry of Culture for research into avant garde electro-acoustical art music, technology and software. Founded by composer and conductor Pierre Boulez in 1977, IRCAM pioneered many advancements in tools and technologies used in the creation of electro-acoustical music, including FM synthesis and the Max/MSP graphical programming environment
I also slowed the recording down by a factor of 8.00x so the 1.08 min recording became 9.04 min, effectively elongating each tine hit event of each bell into a long sustained note. This created a totally transformed sound object, with a radically altered temporal dimension: The Onset, Continuant and Termination of each of the bell hits having been stretched by a factor of 8.

The downward transposition of the spectral formant of the bell’s sound has the perceived effect of making the bells sound dramatically physically larger (the formant being the pitch of the inherent acoustic resonance of a sound). The Noise component of the sound object was also reduced to 0%. This process reduces and concentrates the pitches present in the sound object to a shifting cluster of pure tones.

Fig 25. IRCAM Lab TS sonographic image of the wind chime bell audio file

This wind chime bell sound object created utilising the extreme temporal morphological abilities of IRCAM Lab TS represents a form of creative abstraction. The sound was thus transformed from a collection of bell tine hits into long blurs of hyper elongated harmonic sound.

To use spectromorphological terms, the wind chime bell sound object’s onset, continuant, transition and termination have been stretched into a completely new temporal energy-motion.

This energy-motion is depicted in the graphic visual metaphor of the sound object in the DAW, which then allows the acousmatic composer (me) to edit and place the transformed sound object in the time line of the composition in relation to others.
Virtual ANS synthesizer

The Freeware Virtual ANS is a software simulation of the unique Russian ANS synthesizer designed and built by engineer Evgeny Murzin in the 1940’s. Prolific Russian software coder Alexander Zolotov programmed the simulation of this iconic Soviet electronic musical instrument. This software instrument creates shifting fields of microtonal and spectral sound utilizing a sonogram based visual interface with a host of spectrum based graphic editing tools. The visual data in the synthesizer’s editing/playback interface is transformed into pure tones via a Virtual Analogue sound engine with an unlimited number of sine wave tone generators.

A unique and inspiring feature of this software instrument is the ability to load a photograph into the graphic editing interface of the synthesizer. Not unlike photographic editing software, this image can then be edited with tools including scale adjustment. Adjustments in size on the X axis affect sound events in time, and adjustments on the Y axis affect in pitch. One can also Cut, Copy, Paste or Crop selections of the image.

In the work CO HA GARDENS, a calligraphy poem photographed in the recently restored Co Ha Water Gardens of the Hue citadel is extracted from the image, and loaded into the sonographic interface of the Virtual ANS. I then adjusted Contrast and Invert Effect functions to turn the black ink calligraphy brush worked figures into high contrast text. I then laid the text on its side, chose a Beats Per Minute Vs Pixel Per Beat scale (in this case 125 Beats Per Minute at 16 Pixels Per Beat). This sets the parameters of the speed of playback. I then chose an Octave range – in this case 4 Octaves starting at C1 – this sets parameters on the Y axis of the image which in turn dictate the pitch of tones in playback.

The pulse and rhythm in the gesture of the calligraphy artist’s hand, is transformed into a morphological string of pure tones by the Virtual ANS software synthesizer. This use of software creates a direct link to the fixed media of the sound object. Once again the created sound object’s energy–motion, when depicted through visual metaphor in the graphical representation in the DAW, allows the acousmatic composer to place the sound object in the time line, in relation to others. This sound organization is one of the founding principles of acousmatic music compositional practice.
Fig 26. Huế imperial city Co Ha Water Garden poem

Fig 27. Virtual ANS synthesizer edit/playback displaying Co Ha Garden Poem
GRM tools FreqWarp

GRM tools FreqWarp spectral transformation software audio plugin has the lineage of over fifty years of cutting-edge research into software sound transformation algorithms by INA/GRM.³

The spectral transformation function offered by the software allows the user to rearrange the spectral frequency component of a sound by transposing the frequency spectrums of that sound to another area (either higher or lower), or a combination of both based on a transfer curve drawn into the graphical interface.

In this example, a sound object from the composition HUE KIET 42, (Fig 28) there is no transfer curve. Whatever sound goes into the plugin comes out with the same spectral content except that the smooth function is engaged and set to 96%.

FreqWarp splits audio into 4096 spectral bands, and uses a granular crossfade algorithm to achieve the spectral transposition, if the transfer curve is equal to zero, the granular crossfades continue but are unnoticed. If the smooth function is engaged, the granular crossfade algorithm starts to overlap groups of the gains of the 4096 spectral bands, the effect of which is to blur the spectral frequency component of the sound in the timeline. Unlike reverberation, this spectral resynthesis contains all of the information in the original sound but its morphologies are stretched and smoothed creating a spectral blur.

³ In 1951 Composer Pierre Schaeffer formed GRM studio in Paris (Groupe de Recherches Musicales) which later incorporated with INA (Office de Radio Television Francaise) in 1974 to form INA / GRM.
These Spectrographic/Morphological transformations of sound objects via software illustrate, in part, the notion of studio based production techniques as compositional gesture in certain types of music. They also reinforce the idea of the studio as compositional tool and/or a digital musical instrument or environment.

The choice of using IRCAM Labs and INA/GRM software were not arbitrary in the creation of the works. Both these institutions were germinated in the research, of the early practitioners of the edit montage and abstraction techniques of Musique Concrète and Acousmatic music practice in Paris of the 1950’s and 1970’s through to today. The temporal/morphological transformations possible with these tools allow for sonic abstractions in the outer limits of creative sound design. As such these software tools have a creative history and specific design operation principles that both inform and inspire the creation of these types of musics. To reference and explore in part these early composers’ concepts in the field of these musics, in particular Pierre Schaeffer, by using these tools was essential to the core creative purpose of the submitted works.
4.5.1  
Audio Examples of Software Transformations

Software Transformation Audio Examples

IRCAM Lab TS Example

Example A: Wind Chime Bell – unprocessed
Example B: Wind Chime Bell – IRCAM Lab TS Transformation

Virtual ANS synthesizer Example

Example C: see Fig 26. / Fig 27. (page 39)
Example D: Co Ha Garden Poem – ANS synthesizer Transformation

IRCAM Lab TS / GRM tools FreqWarp Example

Example E: City of Ghosts Vocal – unprocessed
Example F: City of Ghosts Vocal Slowed – IRCAM Lab TS Transformation
Example G: City of Ghosts Vocal – GRM FreqWarp Transformation
4.6. – Graphical Composition in a Digital Audio Workstation

The acousmatic composer is working with metaphoric graphical representations of sound objects in the use of the arrange page of a Digital Audio Workstation. These images are, however, sonographic representations of the actual recorded sounds embodied in the sound objects themselves. In other words, when the composer cuts the representative depiction of the sound object in half the digital sound file is being cut in half.

The Spectromorphological concepts of the trajectory of the energy-motion of the sound objects form direct relationships to the metaphors used in the graphical representations.

This direct relationship between visual metaphors used in the graphical representations of sound objects and the energy-motion flow and order of the sound objects, i.e. their relationship in one to another, to which the visual metaphors refer, represents both the totality of the compositional work, and the depiction of it simultaneously.

Acousmatic music practices highlight the interactive relationship between the act of production and composition: the ways in which they inform each other, and their shared Spectromorphological traits including trajectory, energy, texture and spatiality.

This is a practice where the transformative nature of production techniques is used as artistic gesture. To reiterate, gesture is the process whereby a sound object is manipulated via a transformational or acousmatic process and applied in space, in relation to other sound objects. Selecting, refining and/or manipulating gestures forms the basis of composition when practiced in a studio production.

When acousmatic music is composed in the arrange page of a Digital Audio Workstation the selection, editing, transformation and refinement that is created and manipulated in the time line with the metaphoric graphically representative sound objects in their collective totality can be both the compositional graphical score and the acousmatic work when played back through speakers.
It is the metaphoric representation of the sound objects being directly linked to the Digitally recorded sound files depicted by the graphical representations in the sound objects stored on the computer that leads to this duality of meaning and function. The work displayed in the time line is both the concrete and the representative composition.

In the works presented in the portfolio, Xenakis’s temporal flow chart technique is used in their composition and arrangement. Placing sound object in relation to sound object using only the graphic representations first, then evaluating by listening in playback and then making incremental changes to the temporal relationships, between one objects energy–motion trajectory and that of another sound-object. (Fig 29. / Fig 30.)

Although at first this temporal flow chart technique seems somewhat counter intuitive and perhaps backwards to how a DAW is usually used to produce music in studio production practice, montage based Musique Concrète and Acousmatic musics focus on form, texture and space rather than tempo and melody. This makes this technique of production creatively fruitful, sometimes allowing for interesting unforeseen combinations and juxtapositions to arise.

Montage in general is an art derived from these disparate combinations and juxtapositions where separate elements perceived together create interest and meaning in a composition. Graphical composition techniques and software based transformational production processes lend them selves well to the studio production of Acousmatic music, a music where the shape and texture of sound is highlighted and presented as music.

The graphical composition in a DAW of the presented work CITY OF GHOSTS can be deemed artistically and technically successful. Using this temporal flow chart montage technique has created works that are evocative and representative of the cultural subject material yet abstract in nature. The collected fixed media being transformed through studio production processes and presented in the acousmatic works with an atmospheric and cinematic music production style.
Fig 29. *CITY OF GHOSTS* detail of temporal flow chart showing energy–motion trajectory / complex morphological strings of sound objects in the DAW

Fig 30. *CITY OF GHOSTS* detail of the same section in Fig 29. showing Frequency–motion trajectory of complex morphological strings
5. Summary

An important aspect of this research is addressed by the following questions.

Is acousmatic music practice like painting with sound? If so, is the Digital Audio Workstation the canvas and brush?

I would argue that this is the case.

This project uses the graphic representations in a DAW as the medium of the works presented in the portfolio. In a similar process to a collage using paper, I have edited, cut and shaped the sound objects using the graphical shape of those sound objects as depicted. Only then have I listened to the results and made my decision if the transformation of the objects has been artistically successful. The compositional arrangements are made using only the graphic representations of sound objects first, which when listened to together embody the composition. Because of this process in my acousmatic studio practice the graphic representations and the sound objects are fixed together.

This practice is the act of artistic abstraction and composition of sound forms to create and/or enhance a cultural meaning or expression, utilizing the synesthetic lexicons of form, texture, colour, movement and space. Acousmatic music is a free form of creative expression. It is an almost borderless, four-dimensional universe of weird and wonderful textures, morphologies and spaces. It is one in which visual metaphors abound due to the lack of a predetermined musical score in the conventional Western music notation tradition, tempos or even actual musical notes. It is also a musical practice in which the composition exists in a concrete or fixed form. Due to the inherently experimental and freeform nature of this music, even conventions that have come to define acousmatic music are sometimes not observed by its practitioners.

It takes then the true inspiration of someone like Denis Smalley to plant an analytical tree, to give us something to help each other describe what we are doing or thinking about our Art or the Art of others, but also a place from which to let our own descriptive and or creative ideas take root and grow.

For that Mr Smalley, I and others, will be forever grateful.
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The four Acousmatic/Ambient works presented in this portfolio consist of fixed media collected on a research trip to the Huế peninsula in Vietnam. Location recordings, sound-walks, digital abstractions of recorded instruments and photographs are used in landscapes of sound, created to evoke an abstracted emotional sense of a particular place. What follows is a short playful description of each work, with a few accompanying photographs.

**Track 1. Hue Kiet 42**
Overlapping field recordings of an alley, Kiet 42 in central Hue city … vendors ride cycles & scooters selling hot soup at night while dogs bark, inhabitants burn rubbish in tin cans on the street outside their front doors, temple bells and gongs mix with ceremonial drums in a shrine under a tree.
Track 2. City of Ghosts
Field recordings of An Bang … on the Huế peninsula, wind wiping through kilometer after kilometer of tombs structures … rustling leaves and twigs … morph in and out of a plague of digital insects, that swarm in twisting fractured ghostly clouds through drifting elongated pitch shifted temple bells … the sound of an airbus A340 aircraft’s electronic nervous system quietly singing to itself traveling 913 km per hour 11,000 meters in the sky hums in the background.
Track 3. Co Ha Gardens

Monks chant & ring bells as a thunder storm brews above Huế’s Imperial Palace Co Ha water gardens … traditional Vietnamese instruments from the Royal Theatre Museum are abstracted into impossibly long harmonic clouds that sparkle in the darkening light. Water falls from a concrete sky, splashing on the titled roof of a pagoda, then runs into the over looking pond.
Track 4. Thuan An
The March full-moon lights the surf at midnight of Thuan An beach … temple bells chime randomly in the warm wind. Surf in front … sand hills with tomb after tomb behind, tiny spirits gather and swarm in the waves as they touch the isthmus of the shore.