The analysis of composition techniques in utp_: Synthetic composition for electroacoustic ensembles

Kynan Tan
Edith Cowan University

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Honours Dissertation

Bachelor of Music (Honours)

The analysis of composition techniques in utp_: synthetic composition for electroacoustic ensembles

Submitted 4th November 2010

Kynan Tan

Bachelor of Music: Music Technology

Western Australian Academy of Performing Arts
Edith Cowan University
USE OF THESIS

The Use of Thesis statement is not included in this version of the thesis.
Abstract

This thesis attempts to analyse and describe a number of spectrally oriented composition techniques for composing music for electroacoustic ensemble. These techniques aim to achieve a synthetic approach to combining electronic and acoustic sound sources in live performance. To achieve this, an in-depth analysis of utp_ (2008) by Alva Noto and Ryuichi Sakamoto in collaboration with Ensemble Modern is conducted. utp_ utilises a large acoustic ensemble, live electronic processing, pre-recorded electronic sound and video projections in performance.

The discussion also queries the possible problems of electroacoustic performance, and examines ways to resolve the most prevalent issues. This involves a discussion of the materials of electroacoustic works, timbral differences in acoustic and electronic sounds and liveness in electroacoustic music performance. The analysis involves using spectral and score analysis to identify composition techniques. The final section describes the way these composition techniques are applied in my own work for electroacoustic ensemble, lucidity.
Declaration

I certify that this thesis does not, to the best of my knowledge and belief:

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Many thanks to the incredible and generous performers who helped create and develop my work, Ben Hamblin, Lindsay Vickery, Tristen Parr, Lyndon Blue, Stina Thomas, Christopher de Groot, Callum Moncreiff and James Paul, this project would not have been possible without your assistance.
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Introduction

_utp_ is a collaborative multimedia work between the artists Alva Noto (aka Carsten Nicolai, b. 1965, Germany), Ryuichi Sakamoto (b. 1952, Japan) and contemporary music ensemble Ensemble Modern (formed 1980, Germany). The work creates unique sound spectra and textures through the combination and juxtaposition of electronics and acoustic instrumentation, utilizing an ensemble of eleven acoustic instruments, live processing, pre-recorded sound, video synchronisation and video projections. The _utp_ CD package contains the audio recording, full score booklet, additional materials booklet (containing diagrams, reviews, pictures and liner notes) and DVD (containing video of the performance and workshops).

This thesis aims to define and describe techniques for the combination of electronic and acoustic sounds, through structural and spectral analysis of the work _utp_. Selected composition techniques will then be transformed and absorbed into my own compositional style in my work _lucidity_. It is the goal of this thesis to identify ways in which acoustic and electronic sound sources can be synthetically combined.

Definitions and Terms

The term composition refers to both the process and the product of organising materials in order to create music.¹ This is achieved through any means, such as the notation of parts, constructing improvisation directions, computer programming and specification of recording and amplification techniques. Improvisation is defined as any performer decisions at the point of performance.² I will be using the term electroacoustic to describe any music that employs electronic and acoustic sound sources in a live performance.³ The term texture is used to describe the layering of sound timbres and the combination of multiple sound sources at any given moment.⁴ The term spectra refers to the visualisation of overtones present at any given moment.

While both texture and spectra refer to the overall sound quality at any given time, texture accounts for the perception of sound, while spectra refers to the scientific

³ This term is primarily used to describe live applications in the writings of Karlheinz Stockhausen. This spelling of electroacoustic has been adopted rather than any other permutation due to its exclusive use in these writings, see Karlheinz Stockhausen and Jerome Koll, "Electroacoustic Performance Practice," Perspectives of New Music 34, no. 1 (1996).
analysis and empirical data present. Synthetic composition is a term that has been used by many composers, musicians and writers that alludes to the combination of musical parts to create a new, greater substance. Synaesthesia refers to the neurological condition in which cross linking of senses occurs. This is thought to allow for metaphorical thought due to forming abstract connections between the senses, e.g. hearing and vision.

1. Electroacoustic Music


Electroacoustic music can be seen as forming a “metagene” of electronic music, which as defined by Joanna Demers, encompasses institutional electroacoustic works that derive themselves from academia and trace a lineage back to Edgar Varèse (b. 1883, France) and Karlheinz Stockhausen (b. 1928, Germany). This is largely due to the development of many compositions in or around academic institutions such as the Institute de Recherche et Coordination Acoustique/Musique (IRCAM, France) and the Groupe de Recherches Musicales (GRM, France). At these government subsidised institutions technological developments are paired with creative uses, forging the path of music technology. Stockhausen and Varèse were among the first composers to call for the use of electronic sound in their music, using electronics in performance along with acoustic instruments as early as 1955 with Varèse’s Deserts for orchestra and tape, and Stockhausen’s Kontakte (1958-60) for electronic sounds with optional piano and percussion.

Early experiments involved the use of pre-recorded tape sounds that would be played back through loudspeakers in a concert setting, in addition to the instrumental sound. In the case of Deserts, the orchestra would not sound at any time the tape was playing, but was composed to demonstrate similar musical elements in the electronic and acoustic sounds. Tape music flourished with musique concrète led by Pierre Shaeffer (b. 1920, France), music that explores ‘the sound object’ through the recording and manipulation of found sounds and acousmatic playback over loudspeakers. Iannis Xenakis (b. 1922, Greece) is credited with developing the first granular synthesis techniques at this time, by splicing pre-recorded tape into short samples and then layering them into thick, continuous sound, as used in works such as Concret PH

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9 Ibid.
10 Ibid., 142.
12 Ibid., 67-68.
13 Ibid., 338.
The manipulations and editing of recorded sounds that occurred during this time opened a new world of possibilities for composers, as changing sounds with reverb, compression, overdrive, ring modulation and filters became a part of electronic music language. At the same time, the Elektronische Musik school in Germany, led by Stockhausen, created sounds using synthesis techniques and tape manipulations. The generation of sound using synthesis and the manipulation of pre-recorded material forms the basis of electronic music’s ability to create almost any sound imaginable, and to bring to fruition Varèse’s call to “compose with the sounds themselves and not composing only with sounds”.

During the mid-1960s, Stockhausen developed several works for live instruments and live electronic manipulations. These include Mixtur (1964) for orchestra and four ring modulators, Mikrophonie I (1964) for tam-tam and filters, and Mikrophonie II (1965) for twelve singers, four ring modulators, hammond organ and tape. These early works utilise live performers on electronics that manipulate the timbre of the live instruments and were some of the earliest works to involve the live combination of acoustic instruments and electronics. Stockhausen also used electronic instruments in live concert performances such as the hammond organ, the use of electronic instruments being heavily popularised by rock and blues bands during the mid-1960s. Up to this point in history, most of the areas of electroacoustic composition have already been developed. Stockhausen later explains in a lecture in 1991 that the techniques of electroacoustic performance practice form six key areas: recording technique, amplification technique, transformation technique, pre-formed music technique, adoption of electronic musical instruments and finally, the combination of all electroacoustic possibilities. Here he outlines how understanding, experimentation and creativity using these techniques can lead to a “liberated music” or a “synthesis” of all the aspects of electroacoustic performance practice. utp_ makes use of all of these areas of electroacoustic music.

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14 Ibid., 340-41.
16 Holmes, Electronic and Experimental Music: Technology, Music, and Culture, 351.
Computers in Music

Microprocessor chips and sound cards became readily available in the early 1970s and have grown to the point today where computers influence all genres of music, far beyond its original home in academia. This evolution of digital technology has had a strong effect on electronic and electroacoustic music. As technology has developed and personal computers and laptops have become commonplace they have become the preferred choice of electronic music device. Today, anyone with a desktop or laptop computer has access to a digital audio workstation. Software programming environments such as Max/MSP provide a modular, real-time environment for sound synthesis, sound processing and programming, effectively fulfilling the roles of multiple analog devices with a single program. It is now much easier to be able to incorporate all areas of electroacoustic music into a single composition than anytime in the past.

With this development in technology, the roles of digital processes in music have significantly expanded. In his book *Electronic and Experimental Music* (2008), Thom Holmes defines some of these roles as: computer composition and scoring, computer synthesis of sounds and computer sampling of audio input. Perhaps most importantly, the development of computer hardware and software has enabled composers of electronic music to be able to create unique programs for specific purposes. The power of these machines also allows extremely complex calculations to be made in real-time, enabling the performers to treat the computer as an instrument and direct the device in real-time to perform musical applications.

*utp_* draws from academic electroacoustic music, but is also informed by many other areas of music, in particular ‘glitch’, or microsound, and electronica. As time has progressed, more and more performers and composers have used the combination of electronic and acoustic sound sources in their music, and many have made these transformations in real-time during live performances. Examples of this can be seen in live performances by the band Radiohead (formed 1985, UK) who perform live

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19 This thesis will not discuss the specific programming or implementation of digital materials but assumes the capabilities of common processes to be implemented using one or more of the available software platforms.
electronic manipulations to vocals and instruments. Other artists such as Christian Fennesz (b. 1962, Austria) have taken the exploration of acoustic and electronics in combination as their primary impetus. Fennesz uses computer processing of guitar sounds to create washes of noise and manipulated sounds that greatly extend the instrument. Some artists have also used the inherent sounds and functions of digital devices as the audio material of their work such as Ryoji Ikeda (b. 1966, Japan) whose compositions consist of digital glitches, white noise and rapid mechanical rhythms. The openness of electronic music today has allowed for the incorporation of techniques generally used only in electronica to become used in electroacoustic music. utp_ takes influence from music created both inside and outside of academia, and uses the sounds of digital glitches, pulsing rhythms and washes of white noise in combination with classical orchestration, synergistically combining areas of electronic and acoustic sound.

1.1.1. Liveness and Successful Electroacoustic Works

Denis Smalley (b. 1946, New Zealand) states that electronic music has the capability to access “all sounds, a bewildering sonic array ranging from the real to the surreal and beyond”, and that this surreal world of sound often disconnects listeners from the physical act of sound making, and can remove the traditional frame of performance. According to Demers, much electronic music, and in particular acousmatic music, blocks the natural connection of sound to source by signifying sound objects that are detached from their origins. However, electroacoustic performances generally involve live performers playing acoustic instruments in addition to electronic sound and/or live manipulations. These performances involve both the sonic and the gestural, the combination of senses can provide a logical, transparent relationship between source and result. The advantage of these electroacoustic performances over acousmatic or solely electronic performances is that it places emphasis on the liveness of the performers, while also creating sounds that are “extending and transforming traditional sounds in well-nigh visionary ways”.

25 Ibid.
Liveness is used here to denote the live performance interaction between electronics and acoustic performers. In some listening scenarios, audiences are immediately deterred by playback of recordings that have been created prior to performance. Yet on the other end of the spectrum, John Croft (b. 1971, UK) explains that performances that rely heavily on manipulation of a musical motif played live and then manipulated by electronic means display a one-to-one relationship that is “tedious”, the technology bringing “the procedure into the foreground”.

Theorists such as Croft argue for “aesthetic liveness” or a situation in which, as Croft states, “aesthetically meaningful differences in the input sound are mapped to aesthetically meaningful differences in the output sound”. This includes the use of prerecorded or predetermined sound, as long as it creates this meaningful difference. The treatment of liveness in works for electroacoustic ensemble requires that not only the individual instruments be treated as extended instruments, but that the entirety of sound of the acoustic instruments is extended via manipulation or playback. From the analysis of \textit{utp}_, I identified that the live combination of electronics and acoustic sounds successfully achieves liveness when:

1) the electronic manipulations avoid obvious procedures of recording and playback to form a time-based relationship with the live acoustic sounds (either no delay between recording and playback or sounds played back at a later time)

2) the sound of the ensemble is augmented, i.e. altered in real-time (the electronics able to change the spectra of acoustic sound and output immediately)

3) the electronic sounds create meaningful difference in the timbral relationships to the acoustic sound (in particular predetermined sound needed to make direct timbral connections or distinctions when combined with the acoustic sources)

In \textit{utp}_ the multiple layers of manipulation and pre-recorded sound create coherent relationships with the acoustic sounds. The pre-recorded electronic sounds either maintain an electronic identity with sine tones, computer glitches or low frequency sound, or provide similar timbres to the acoustic sounds, such as manipulated pre-recorded ensemble sounds. \textit{utp}_ utilises manipulations that extend the instruments’

\footnotesize
29 Ibid.: 61.
30 Ibid.
31 Ibid.
spectra in real time, or create complex layering and repetitions via sampling. The electronics augment the acoustic sounds whilst creating their own identity, generating sounds that cause complex interplay with the acoustic sounds, and allowing the entirety of the sound to remain the focus.

1.2. Analysis of Electroacoustic Music

1.2.1. Spectral Analysis History and Uses

Spectral analysis refers to the analysis and deconstruction of spectrogram images. These images display the amplitude of each frequency present in a recorded sound, mapped to time. On each spectrogram, time forms the x-axis, frequency the y-axis, and amplitude is shown by depth of colour, or the z-axis. Robert Cogan (b. 1930, USA) first described spectrograms as a tool for musical analysis in 1984, with his book *New Images of Musical Sound*. Cogan uses spectrograms to illustrate the ways that different styles of music performance utilise the frequency spectrum, from the performance techniques of singers such as Billie Holiday (b. 1915, USA), the rich orchestration found in compositions by Alban Berg (b. 1885, Austria) and the shifting densities of electronic music works by composers such as Jean-Claude Risset (b. 1938, France).

1.2.2. Viewing Spectrograms

Spectrograms contain a significant amount of information, but in order to be used as an analysis tool their shapes must be “interpreted and reduced to perceptual essentials”.

Cogan describes five main areas revealed by spectrograms:

1) Sound waves (clearly illustrated contours of melodies or changing pitches)

2) Musical space (defining the human hearing range and viewing how musical material occupies this space)

3) Musical time (duration represented horizontally, displays the time scales of music and illustrates musical form)

4) Spectra (the complexity and richness of musical tone, timbre and texture displayed in vertical patterns and structures)

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32 Also known as sonograms or spectrum photos. Here spectrogram is used due to its use in the Sonic Visualiser software used to create the images seen in this paper.


5) Register (sounds occurring in different octave frequency bands appear to be of different qualities, in particular low frequency sounds require greater amplitude to achieve the same perceived volume)

An understanding of the frequency makeup of sounds is essential in analysing spectrograms. While spectrograms arbitrarily show the amplitude content at each frequency, the human ear and brain are able to reduce an enormous amount of information into single events, e.g. a single tone heard from a musical instrument consists of multiple harmonics but is grouped together and heard as a single sound. The intensity, number and frequency of harmonics account for the difference in tone or timbre between different sounds,\textsuperscript{35} and therefore different instruments. Figure 1 illustrates the visual representation of a range of timbres, from the computer-generated extremes of sine waves (all energy at a single frequency) and white noise (equal amount of all frequencies). Exact replication of these sounds is only possible with electronics, although acoustic instruments can share some of their timbral characteristics.

1.2.3. Sonic Properties

The timbre, tone or quality\textsuperscript{36} of individual sounds can be characterised by the oppositions of sonic properties that make up the overall characteristic of the sound. In \textit{New Images of Musical Sound}, Cogan uses a table of oppositions, which lists thirteen different properties of sound, each ranging from low to high energy. The properties that Cogan discusses can be seen in Figure 2.

\textsuperscript{36} Ibid., 24.
Cogan analyses the spectrograms with this table of properties and uses it as a comprehensive framework for describing sound. Cogan uses this table to show that what is perceived as a heightened intensity in sound can be described as the movement of multiple properties from low to high energy. I will use four of the sonic properties described by Cogan in my analysis:

1) grave/acute: indicates the majority of frequency content, grave refers to the lower portion of the frequency spectrum, while acute refers to the upper.

2) narrow/wide: the distance between outer spectral elements. A more widely spread band will tend to be of more irregular shape and sound noise-like.

3) sparse/rich: the total amount of frequencies present.

4) no-attack/attack: attack refers to a noticeable difference in the onset and continuation of spectral elements.

This provides a method of categorising individual sounds from instruments according to defined properties, and then comparing these properties to other sounds.

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Footnotes:
38 Ibid., 135.
The somewhat fixed overtone structure of acoustic instruments compared to the near-limitless potential of electronic sound means that the two will not always cover the same sonic territory, but within the inevitable overlap lay many interesting effects when manipulating sonic properties. The above four properties are used to identify a continuum of sonic properties for acoustic and electronic sound sources as a way of negotiating the timbral differences found in each.

I believe that spectrograms are particularly important in the analysis of electroacoustic music, (an area which Cogan does not cover) due to their ability to illustrate the differences and similarities in timbre between electronic and acoustic sounds. This means they can be used to show how pre-recorded and manipulated sound interacts with acoustic sources in time, a concept termed “spectromorphology”.

1.2.4. Spectrally Informed Synthetic Composition

“Synthetic composition” is a term coined by Tristan Murail (b. 1947, France) in his paper The Revolution of Complex Sounds, in which Murail calls for a new method of composition that uses “new organizing principles that do not exclude one or more categories a priori, but integrate the totality of sonic phenomena”. Murail here speaks of the integration of complex techniques into the language of music. These techniques are often derived from electronic techniques; echo, loops, reverberation, inharmonic and harmonic spectra, and the integration of complex sounds and noise. Murail’s explanation of synthetic composition as a theory of organisation places varieties of sounds into a complex whole. This provides an approach for the combination acoustic
and electronic sounds. The aim here is the results, the sound spectra and sonic textures created, rather than a hierarchical, pre-determined organisation. This has proved a large influence upon the study of utp_ and the creation of my own work, lucidity.

Spectrograms and audio frequency spectrums have been used in Western Music since the French spectral school. Murail and Gérard Grisey (b. 1946, France) use spectrograms of recorded sounds to identify the partials and overtone structure, and then use these overtone ratios to influence structural properties, or as notated parts for acoustic instruments. Perhaps the clearest example of this technique is Grisey’s Partiels (1975), which reconstructs the overtones of a trombone note, from the double bass upward, beginning low and muted and moving to bright and dissonant in the upper tones. This method of composition pays close attention to the fundamental nature of sound and its construction on a microscopic level, rather than imposed sets of rules as in traditional harmony and counterpoint. This ties the harmonic make-up of the pieces in with the scientific logic of sound synthesis and helps to tie together the electronic and acoustic sounds.

During the composition process of creating lucidity, spectrograms and frequency spectrum visualisers were used as a tool to identify the sound’s spectra. This helped to visualise and identify the relationships between acoustic and electronic sounds. Use of spectral analysis assured the implementation of the composition techniques described in the 2nd and 3rd chapters.
Chapter Two

2. *utp_*

2.2. Background

*utp_* is an audio/visual work developed by Alva Noto and Ryuichi Sakamoto in collaboration with Ensemble Modern, for the 400th anniversary of the city of Mannheim. The work builds upon Alva Noto and Ryuichi Sakamoto’s previous electroacoustic recorded works *Vrioon* (2002), *Insen* (2005) and *Revep* (2005) that feature compositions of electronics and piano. The artists describe their work as a “synergetic mixture of electronic and natural sounds”. Their approach is expanded by working with the acoustic instrumentation of Ensemble Modern. The formal structure of the work is derived from a rasterised city map of Mannheim, built in the seventeenth century as an ‘ideal city’.

Composed for a large ensemble of instruments, prerecorded electronics, live sound processing and visuals, the work takes on an unusual form, described by the artists as “having no model”. The musicians view a display screen with a timer and the projected visuals in addition to a musical score.

2.2.1. Background of Involved Artists

The involved artists in this work cover significant territory and an understanding of these backgrounds helps to explain how they arrive at such a synergistic work. Alva Noto is the performing name used by German sound and visual artist Carsten Nicolai. Nicolai has released an extensive discography on his own label *raster-noton*, his music is generally categorised as ‘glitch’. Nicolai’s recorded works feature, on the most part, minimal rhythmic structures applied to computer tones, he has stated that his music is more informed by scientific and mathematic processes than by musical logic. Ryuichi Sakamoto is a composer who has won numerous awards for film scores and instrumental music. He gained significant popularity in Japan in the late 1970s with the synth-pop group Yellow Magic Orchestra, but has since gained a reputation for his work with film scores and his use of electronics in his composition. The main

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44 Ibid.
performers in utp, Ensemble Modern, are one of the world’s leading contemporary music ensembles. The group regularly invites composers to form co-operative ventures – resulting in collaborations with such artists as Frank Zappa (b. 1940, USA), Anthony Braxton (b. 1945, USA) and György Ligeti (b. 1923, Hungary).

2.2.2. Structural Map and Layout of Work

utp_ is arranged into twelve sections, each given a title that refers to the focus of sound used in that section (attack, grains, particle) or the structural direction or movement (transition, broken line, plateaux). The work is composed to be 72 minutes in length, the exact size of an audio CD. From this overall length, the city map of Mannheim is used to allocate amounts of time to each section, creating a distinctive fixed structure.

Noto and Sakamoto, UtP Dvd Material.
Figure 3 - Diagram of street plan of the inner city of Mannheim, showing the city layout from which the *utp* structure is derived, from *utp* additional materials booklet, p. 9.

The blocks in the Mannheim city plan are allocated letters and numbers. These are tallied and allocated to each section; there are 144 sections across twelve letters. Therefore each block equals thirty seconds of musical time, for example, there are five A blocks so the A section in *utp* has a set duration of 2:30, section B has seven blocks and a duration of 3:50 and so on. This method of structure means that the overall timing of the work is fixed and takes on an architectural form, locked in to specific durations.
2.2.3. Notations

Most notations used in *utp* allow the performers to choose some aspect of their playing within a controlled texture. The use of instructions and very few tempo-based notations allows each section to explore a particular texture by restricting the range of sounds, while still allowing the performers some amount of rhythmic, dynamic or melodic freedom. All notations used throughout *utp* create specific sonic textures by using combinations of the following:

1) **tone sets or performer choices**: sets of notes are provided to the performers to choose from. These range from tonal to chromatic, hinting at specific harmonic chords without stating them fully.

2) **written performance instructions**: instructions for the performer to utilise particular sounds. These also call for improvising random rhythms, referencing the parts of other players or the electronic sound.

3) **graphic notation**: notations that fall outside of traditional nomenclature, all symbols reference a particular sound. These are used when players are asked to play unusual sounds (e.g. grain like sounds) or for electronic parts that evoke a particular symbolic notation.

4) **proportional notation**: ranges of dynamics, lengths or articulations that notes are to be performed within. Some examples include “mop-up”, “each note must be played very long” and “with very slow attack”.
play these notes with Bartók pizzicato or arco détaché in any octave with non-repetitive rhythm

Figure 5 - Score excerpt of *attack/transition*, showing combination of tone set, written instructions and graphic notation, from *utp* score booklet, p. 2.

The electronics use similar notational tools but are generally more descriptive of the sounds that are created. Volumes, triggers of sound and descriptions of what each sound is are shown, but rarely are frequency or rhythm articulated.
2.3. Composition Techniques

From the analysis and study of utp_, I identified a number of spectrally informed composition and synchronisation techniques. These are broken down into four areas, each of which will be described in detail: 1) continuum of sonic properties, 2) utilisation of the frequency spectrum, 3) augmentation of instrumental sound and 4) video scoring and synchronisation.

2.3.1. Continuum of Sonic Properties

Opposing sonic properties can reveal the similarities or differences found in individual sounds and this information is used as a method of contrasting acoustic or electronic sounds. The combination of acoustic and electronic sounds can be used to reinforce a particular texture, or to draw the sound together in subtle ways. For example, a col legno battuto string sound produces irregular, noisy spectra that is wide, diffuse and rich. Its spectrogram shows that this tone has many partials, each at weak strengths, which cover a large number of frequencies of varying ratios from the fundamental. This sound could be contrasted with electronically generated white noise, where the spectra share similar properties.
Figure 8 – Spectrogram of *attack/transition*, showing the use of white noise and noisy string techniques in combination at 0:30-3:30. Total duration 0:00-7:24.

Although the electronic sound is able to create white noise to a much more exact degree, the combination of the two sounds contrast each other and prove to be an engaging combination, making the electronic and acoustic sounds difficult to distinguish aurally.
Figure 9 - Spectrogram of particle 1, showing a wide, diffuse and rich spectra created by noisy acoustic instrument techniques. Duration 0:00-7:00

Figure 10 - Score excerpt from particle 1, showing instructions for each performer to find a short particle of noise and repeat, with a crescendo towards a peak at 4:30, from utp_score booklet, p.6.

In particle 1, acoustic instruments are instructed to play noisy particles of sound to create an overall texture of noise, which spans a full frequency spectrum at its peak, similar to electronically created white noise.

2.3.2. Utilisation of the Full Range of the Frequency Spectrum

The capabilities of electronic sound extend to the far reaches of the frequency spectrum and are often far more complex than acoustic instruments are capable of. Electronically generated sounds can intermingle with acoustic tones to create psychoacoustic and timbral effects, including the interference of tones at similar frequencies to create beat frequencies, or the augmentation of timbre via electronic manipulation of the live sound. By using widely spread frequencies to cover almost all
the hearing range, or by focusing closely on a very specific frequency range, complex musical effects can be created that place the electronic and acoustic sounds in close interplay.

One clear example of widening can be found in *broken line 1* where the electronic repeated rhythmic elements are placed below and above the acoustic instruments' frequency range, featuring prominently at both below 50Hz and above 10kHz. As can be seen in Figure 11, the instrumental sounds operate between 180-3500Hz, while the electronic sound dominates the frequencies above and below this range. Electronic bass pulses and glitches fill the frequency range between 20-120Hz and high pitched synthesised chime sounds create clearly defined rhythms in the range of 10-18kHz. This use of the frequency spectrum creates a sense of space within the texture. Elements of electronic and acoustic sounds each operate in their own frequency domain: each being heard as individual parts. The perceived result is that of sounds moving in separate directions, their evolution not directly linked to one another. This further enhances the polytextural aspect of the music by allowing repetitive pulsing parts to continue below and above the frequency range of the developing instrumental part.

Figure 11 - Spectrogram of *broken line 1*, showing electronic sounds operating below 120Hz and above 10kHz. Duration 0:00-6:29.
2.3.3. Augmentation of Instrumental Sounds

As previously discussed, digital processing allows for the real-time manipulation of sounds in a way that can alter the perception of the instrument’s sonic output. The augmentation or alteration of sounds proves to be a key composition technique in combining electronic and acoustic tools in that it allows the sound to seem acoustic and electronic simultaneously.

One example of this can be found in *attack/transition* where the string instruments are playing in short stabs of *col legno, arco détaché* or Bartók pizzicato\(^{50}\). Some of these sounds are processed by the computer to add a significant reverb tail, greatly altering their role in the current sound world from being a short sound with a sharp dynamic to becoming a longer held tone. This also makes the texture more layered by increasing the amount of sounds that are heard concurrently.

![Figure 12 – Spectrogram, detail of excerpt from *attack/transition*, showing two short string pizzicato sounds followed by a clearer, bowed tone that has been augmented with reverb (just before 1:10). Duration 1:06 to 1:15.](image)

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\(^{50}\) Or snap pizzicato, “The string is plucked straight up from the fingerboard, between two fingers, so that it snaps back sharply” from Kurt Stone, *Music Notation in the Twentieth Century: A Practical Guidebook*, 1st ed. (New York: W. W. Norton, 1980), 312.
In the spectrogram, two sharp string attacks are followed by a string sound with added reverb processing, forming longer durations in the harmonic overtones and creating electronic sound derived from acoustic source.

2.3.4. **Video Scoring and Synchronisation**

The use of digital displays and video scoring allows the performers in *utp*_ to successfully synchronise long passages of electronic sound, silence or abstract rhythm, without a regular pulse. The displays also allow the performers to respond to the intensity, shape and colour of visuals through their own playing. The use of polytexture in *utp*_ provides a means of combining pre-recorded material with live instruments in a way that does not require the performers to follow exact cues or bars. Examples of this can be found in the sections *broken line 1* and *broken line 2*, where the electronics follow repetitive rhythmic patterns while the instruments are instructed to play extended notes, followed by pauses or at “[their] own tempo, differing from others”. The resulting effect of this is that the instruments move in different trajectories to the electronics, contrasting precise, mechanical rhythms with more emotive, individual performance.

![Figure 13 - Score excerpt from *broken line 2*, showing instruction to ‘play at your own tempo, different from others’, contrasting the electronic pulse, from *utp*_ score booklet, p. 18.](image-url)
One key moment that illustrates the need for digital scoring occurs in transition where the players are instructed to play held notes from a given pitch set. At a particular time all instruments decrescendo to silence for 5 seconds. This acts as a bridging transition point and occurs at almost exactly halfway through the section. During this time the acoustic instruments decrescendo and stop, the electronic processing fades and silence is reached, just before moving into another foray of polyphonic, unsynchronised extended notes.
The use of a digital timer display here is essential because it provides exact timing of the sections (necessary for pre-recorded or synthesised parts), allowing the performers to pre-empt the silence and accounts for the electronic processing time periods.
Chapter Three

3. lucidity

3.1. Instrumentation and Format

The electronic and acoustic sound sources and techniques employed in _utp_, are expanded upon in my own work _lucidity_, a new forty-six minute composition for electroacoustic ensemble. The score and audio recording are at Appendix A and B.

_{lucidity}_ is composed for an electroacoustic ensemble consisting of clarinet, bass clarinet, cello, double bass, prepared rhodes piano/electric organ, and vibraphone/drum kit, and two computer performers controlling sound manipulation (processing) and sound generation/playback (synthesis). Each acoustic instrument’s sound is captured via microphone and routed into the processing computer, which also takes sounds generated from the ‘synthesis’ computer. The processing computer uses custom built software that is capable of routing sounds through combinations of manipulations, granular synthesis, sampling and panning modules. There is a visual component that is projected onto, behind or above the performers, that creates slowly moving abstract colour images related to each section.

Each performer is able to see a computer monitor (display) used to show a parameter information graph, notational information, video scoring, and a timer. These computers are synchronised via a wireless network to maintain consistent timing.

![Screenshot of display program during senn showing timer, parameter information graph, video scoring and notational information.](image-url)

Figure 16 – Screenshot of display program during _senn_ showing timer, parameter information graph, video scoring and notational information.
The players are provided with printed scores that include most of the notations, directions and timing of changes, to be read from the displays. *lucidity* employs tone sets, written instructions, graphic notation and proportional notation as used in *utp_*, but uses the display screens and video in a different way by displaying graphical and randomly generated notations.

While being performed as one continuous work, *lucidity* can be divided into eight sections that each explore a specific set of techniques. While I will not be discussing the work in its entirety, I will draw attention to specific sections that directly illustrate techniques derived from *utp_*.

![Figure 17 - Composition timeline of lucidity showing section lengths and order](image)

### 3.2. Specific Examples of Composition Techniques

#### 3.2.1. Continuum of Sonic Properties

In *lucidity* I attempt to emphasise the sonic properties of acoustic and electronic sounds, either by combining sounds of both sources with very similar timbres, or, with extremely different timbres. *senn* illustrates this by combining electronic and acoustic sounds that both have noise-like properties. In *senn*, the ensemble follows a video score that directs the players as to the overall density. Performers are given several instructions as to the types of sound to create in this section such as slap tongue, key clicks, Bartók pizzicato, *arco détaché*, friction and scrapes, but must match their sound to the current density shown in the video. The synthesis computer provides a pulsing synthesised electronic rhythm and uses a granular synthesis engine to create a dense, textural mass by re-sampling pre-recorded percussion sounds. The sonic properties of this electronic sound are acute, wide and rich spectra, with distinct attack. The performers are asked to emulate this electronic sound, directly contrasting the sonic properties of their playing with that of the electronics.

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51 For larger version, see Appendix A, p. iv.
Figure 18 – Score excerpt from senn, showing technique suggestions for interpreting video score.¹²

Figure 19 – Spectrogram of senn. The two peaks that cover a broad frequency range show the noise-like properties of the acoustic instruments. Duration 0:00-5:00.

¹² For full score see Appendix A, p. 2.
The acoustic instrument and electronic sound create noise-like spectra. The spectrogram exhibits vertical lines rather than parallel horizontal lines, demonstrating how the instrumental sound is difficult to distinguish from the electronic sound aurally. This creates timbre generated from both the acoustic instruments and electronics with predominantly noise-like sonic properties.

The extremes of different timbres between electronic and acoustic sounds are exploited in melody. All acoustic instruments are provided with a single pitch class at a time via the display. They are instructed to play each note within a 20 second window, beginning the note in the first 3 seconds and ending in the last 5 seconds, using a very gradual envelope and maintaining warm, clear tone. This creates chords consisting of a single pitch class played by each instrument simultaneously. Throughout melody the purity and alignment of the acoustic tones is contrasted with the electronic playback that produces electronic ‘crackling’ sounds occurring in random rhythmic patterns, and a static white noise mass, forming a textural backdrop. These are generated from manipulated recordings of bells, synthesised tones and white noise. The acoustic sounds produce narrow and sparse spectra, with no-attack. The electronic sound produces grave, wide and rich spectra with attack.

![Figure 20 – Excerpt of melody score, 0:00-3:00. Notation showing how instruments are given single pitches to play over extended periods.](image)

![Figure 21 – Excerpt of melody score, synthesis part, 0:00-5:00. Notation showing volume levels of dense electronic sound added gradually over the duration.](image)

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53 For full score see Appendix A, p. 7.
Figure 22 – Spectrogram of *melody*, showing the contrast of parallel instrument spectra and dense electronic playback. Duration 0:00-5:02.

The resulting spectrogram shows two distinct patterns: the vertical alignment of parallel horizontal frequencies created by the acoustic instruments, and the dense, textural backdrop of the electronics. The instruments retain the stable properties of held notes, while the electronic parts are scattered and noisy. The use of different timbres creates an obvious foreground and background. This creates a polytextural distancing between parts, another example of complex spectra.

3.2.2. Utilisation of the Full Range of the Frequency Spectrum

*spectralisis* is the most texturally complex section of *lucidity*. The acoustic instrumentalists improvise using one of seven techniques modules and one of four tone sets. The main sound source of *spectralisis* is rapid, dense granular playback from both the processing and synthesis computers generating a thick texture of moving sound. The sounds processed are captured from the live ensemble, pre-recorded and synthesised parts. The granular engine is able to play back the sounds in displaced octaves up to two octaves above or below the original sound, while maintaining the same constant playback rate. This granular engine also re-records itself as the section progresses,
further processing its own output. Together with the octave displacement, frequency ranges are pushed in outwards directions throughout the section.

Figure 23 – Spectrogram of *spectralisis*, showing use of all frequency range at most complex point (approx. 4:30-6:30). Duration 0:00-8:26.

*spectralisis* comprises of a conglomerate mass of sound that gradually spreads out to occupy most of the audible frequency spectrum, making particular use of low frequency sound through electronic means, with high amplitudes at low frequencies around 36-90Hz, while also reaching the frequency range above 10kHz. The instructions for the acoustic instruments are choose from one of the seven available technique modules, using pitch classes from the current tone set.

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54 For full score see Appendix A, p. 8.
Figure 25 – Instrumental technique modules from *spectralisis*. Performers choose one technique at a time with accompanying notes from the tone sets shown in Figure 26.

Figure 26 – Tone sets used in *spectralisis*. The number of notes reduces from all available pitch classes to three pitch classes over the duration.\(^{55}\)

\(^{55}\) For full score see Appendix A, p. 8.
As *spectralisis* progresses the tone sets become more restrictive. The first tone set contains all twelve pitch classes (plus any increments between pitches) while the final set contains only three pitch classes. This gradual narrowing of frequencies creates a refinement of spectra in the final decrescendo, creating an interesting texture due to the contrast of the electronic sound operating on such a wide frequency berth, against the instruments provide penetrating, sporadic bursts of sound. The acoustic sound is also constantly being recorded and combined with previous sounds to construct an ever-thickening sound texture. A thick, dense texture of electronic and acoustic sound using the extremes of the audible frequency spectrum is a characteristic of *spectralisis*. The way that I have utilised the frequency spectrum allows the electronics to occupy frequency ranges above and below the range of acoustic instruments. This creates textures that are extremely thick and complex, generating unusual spectra that incorporate a wide range of acoustic and electronic sounds.

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56 For larger version see, Appendix A, p. 8.
3.2.3. Augmentation of Instrumental Sounds

*lucidity* uses augmentation of sound spectra in real-time using combinations of audio manipulations. In *spectra*, instruments perform trills or extended tones using tone sets while the processing computer uses spectral filter, overdrive and reverb manipulations to alter the original sound of the instruments significantly before playing them back through the loudspeakers. This spectral filter consists of splitting the signal into 16 frequency bands and applying delays of varying feedback, delay times and gain to each.

![Figure 28 – Example spectrogram showing a singular cello note being passed through various augmentations, each note lasts for 4 seconds with short gaps in between. Duration 0:00-0:20.](image)

The four discrete parts of the spectrogram show the cello note firstly with no manipulation, then with spectral filter, then with spectral filter and overdrive, and finally with spectral filter, overdrive and reverb combined. The spectrogram shows increased richness, width and density of the spectra. In the application of reverb, the sound has become smudged in the lower frequencies and has a significant reverb tail, increasing the duration of the note.
These manipulations are used extensively in *spectra* when the ensemble’s individual sounds are processed. The signal path follows the same pattern as exhibited in Figure 28 and the resulting sound is passed through randomised panning to separate the sound from the ensemble. This results in an increased density of the ensemble sound that would not be possible from the acoustic ensemble alone.

Figure 29 – Spectrogram of *spectra*, showing a high level of density and textural richness. 
Duration 0:00-4:32
The notations given for the double bass, organ and vibraphone provide tone sets with instructions on how to improvise with those tone sets, each player performing asynchronously from each other. Instructions given to the processing performer are to use “spectral filter, overdrive and reverb, random panning of signals, player controls the rate of change”\(^{58}\). The processing computer layers additional augmented sound, creating a complex and rich musical texture of acoustic sound and electronic augmentations of this original sound. \textit{spectra} uses augmented acoustic sounds to create texture derived from only the acoustic sources and manipulations of this, creating an extended ensemble. The resulting sound texture utilises the liveness of the acoustic performers but extends the sound dramatically creating a surreal and enhanced sound spectra of augmented vertical patterns.

### 3.2.4. Video Scoring and Synchronisation

The parameter information graph takes the form of a function graph that is scrolled across by a ‘slider’. The x-axis represents time, while the y-axis represents a variable specific to that particular section. Throughout \textit{lucidity}, this refers to the density,

\(^{57}\) As seen in Figure 30, for full score see Appendix A p. 1.

\(^{58}\) \textit{spectra} score, see Appendix A p. 1.
volume of each instrument, or overall volume. During merr, performers read the overall volume from the parameter graph displayed in Figure 31, while improvising around tone sets or modular passages. This allows the players to visualise the overall texture and improvise accordingly, reaching a climax after 260 seconds and then suddenly reducing to a sparse texture. The spectrogram from the resulting performance shows the direct connection and exact timing achieved with the parameter graph.

Figure 31 - Parameter graph for merr, showing the overall density. The yellow line scrolls across as the piece progresses, providing performers with visual representation of the density parameter, from display program.

Figure 32 - Spectrogram of merr showing the direct correlation between the parameter graph and resulting sound. Duration 0:00-5:58
Video Scoring

The use of video scoring provides synchronised graphic notation to the performers. In senn the players read from a video display that shows visual noise of changing densities.

![Video Score of senn](image)

**Figure 33 – Still images from the video score of senn, showing the changing densities in the visual noise used to direct performers.**

The performers are instructed to “follow the...intensity graph and video score and use sounds that emulate the synthesised electronics...attempt to maintain the density and rate inferred by the video”\(^{59}\). Each instrument grouping is also provided with specific instructions. The electronics are not heard until well after the instruments begin to play their noise-like sounds, asking players to refer to their memory of the electronic sound.

The video gradually changes from completely white to being filled with rapidly changing black spots and lines, increasing or decreasing in density over the duration. The result of using video scoring in this controlled manner is that the ensemble is able to visualise the overall density of sound and match this with their playing at the time. The video display provides a synchronised method of controlling the ensemble and results in a tightly controlled texture that can be controlled either rapidly or gradually. It also provides a synaesthetic connection to the sounds they are to produce that proves effective in asking instruments to create noise-like sounds. The resulting sound is a tightly controlled grouping of sounds that maintained noise-like sonic properties.

Random Note Generation

During canon notational information is read from the display screen. The interface that the performers read is shown in Figure 35. The computer chooses the duration of each note randomly, making the parts move out of phase and overlap to

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\(^{59}\) see Appendix A, p. 2.
create harmony. The pitches are derived from a remapping of tones transcribed from bell spectrograms.

![Figure 34](image)

*Figure 34 - Score excerpt from canon, showing the 15 note melody derived from bell spectrograms.*

The computer program selects the next note from the melody and assigns a random duration, within the parameters of 5-7 seconds. Through randomised probability, the percussive or struck instruments whose sounds decay rapidly are more likely to receive times closer to the minimum 5 seconds, while the string instruments which are able to sustain their sound indefinitely are more likely to receive the maximum 7 seconds. This allows the instruments with decaying sounds to play their note shortly after the previous has dissipated, enhancing the overlapping texture.

![Figure 35](image)

*Figure 35 - Screenshot of display screen, partial example of interface for randomised notes, showing the interface for each instrument to read their current pitch class, next pitch class, direction to the next note and a graphical representation of the note length.*

To begin, the notes are close together and maintain the same melodic contour with slight rhythmic delay. After some amount of notes, the notes will move out of vertical alignment and begin overlapping with each other, as demonstrated in Figure 36. This creates dissonant and dense chords as different parts play their sounds at the specified times, creating a constantly shifting and dense harmonic sound mass. Randomised note information generated by the computer allows the control of the ensemble to move from tightly synchronised to asynchronous performance between parts. This creates a gradual movement from a simple texture to a complex, overlapping harmony as the parts slowly move out of phase.

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60 For full score, see Appendix A, p. 3.
Figure 36 - Spectrogram of *canon*, showing the overlapping texture. Duration 0:00–4:00.
Conclusion and Outcomes

Through an overview of the evolution of electroacoustic music and the approaches to its composition, I have been able to create an entomology to discuss electroacoustic music in a more complete way. The analytical methods I applied in my examination of utp and lucidity visualise and describe the sounds of these electroacoustic works, and identify a range of composition techniques that may be applied in new works. I believe my work lucidity integrates these techniques successfully and merges sound sources into a singular, synthetic compositional approach.

While the area of electroacoustic music has been developing alongside electronic technologies over the past seventy years, I believe a greater understanding is still needed for works to be created that completely integrate electronic and acoustic sound sources. I hope that this research can provide some insights into the compositional practice in these works and aid the development of future works for electroacoustic ensembles.
Selected Texts


Mabury, Brett, and Edith Cowan University. Faculty of Education and Arts. Western Australian Academy of Performing Arts. *An Investigation into the Spectral Music Idiom and Its Association with Visual Imagery, Particularly That of Film and Video*, 2006. microform.


**Selected Scores, Discography and Multimedia**


---., 1999. sound recording.

---., 2000. sound recording.

Appendix A – *lucidity* full score

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lucidity

for electroacoustic ensemble: acoustic instruments, computer processing, sound synthesis and video projections

kynan tan
2010
performance notes

Locality is a work for medium sized electroacoustic ensemble, comprised of acoustic instruments, electronic instruments, computer sound processing, sound synthesis and visual projections. The work was created through the study of exemplar works in the field, but also through workshop sessions spread over a period of six months during 2010. These workshop sessions allowed testing of various notations, trying out electronic music techniques, recording the ensemble, as well as building an ensemble identity and cohesion.

Synchronisation between performers, electronics and visual projections is achieved via a network of computers that are triggered by the master computer at the beginning of the performance. Once all computers begin, each has a self-contained engine that will allow it to continue until the end of the performance. The synchronisation is then checked at regular intervals to maintain timing synchronicity. The networked computers include the playback and synthesis computer, the visual projection computer and several display computers which provide players with score triggers, randomly generated material and parameter graphs.

The work was composed with specific limitations and for a particular performance venue, this was for a specific length work to be performed in an acoustically designed music auditorium, as such, the technical specifications, stage arrangements and amplification systems were specific to that venue, and may be altered for subsequent performances.

Locality is a continuous, 46 minute work that comprises of eight sections. The time length is fixed due to the synchronisation of display screens. Video and some pre-recorded sound elements, if the work is to be performed, the length of each section, the order and the number of sections performed can be altered as long as all parts remain synchronised.

The score consists of one page per section, plus an appendix of the live transcriptions used in quasi: the transcriptions are derived from spectrograms of electronically modified bell samples. The notation is precise and requires further detail than the texture-oriented scores to the eight major sections.

player specifications

For best results, the players involved in the performance of the work should have an understanding of improvisation, electronic music, amplification and recording technique. A number of parts in the work require players to adjust their sound in contrast with electronic parts. Players are also required to improvise using a specific method of playing or sound set.

score + rotations

Instrumentation / score order
visuals
special effects
bass clarinet
cello
double bass
prepared rhodes piano / organ
vibraphone / drum kit

Note: markings in the electronics parts of the score are to provide a symbolic representation of the sound only: they do not provide exact timing or parameter control. The combination of the written instructions plus the programming information and audio recording are necessary to reach the sonic result. Generally speaking, note heads represent a pitched sound or group of sounds that are being sampled; changes between different notehead symbols represent changes in sounds. Other symbols are used to suggest a particular pattern, movement or lifetime of sound.

Square brackets = groupings of instruments that follow the order and the number of sections performed as well as guidance on how to interpret various notations and perform the work are provided here.

Structure
spectra (4.5"
zone (2.7"
canon (4"
im (6")
luminaire (5.5"
quad (7"
melody (5"
specials (8"

Each section of the work is given a specific name, while the work fits together as a whole, sections may be played individually, the name of each section attempts to describe either the features of that piece, a synaesthetic connection between the spectra of the work and a non-functional word, or, a reference to a music technique which has been recontextualised in this setting.

The score consists of one page per section, plus an appendix of the live transcriptions used in quasi: the transcriptions are derived from spectrograms of electronically modified bell samples. The notation is precise and requires further detail than the texture-oriented scores to the eight major sections.

Specific Notations

![Specific Notations](image1.png)

Playing "in waves" = refers to following an envelope pattern for a specific technique or expression, beginning with very little, moving to loud, out or fast and then returning to very little. This can refer to translo or vibrato rate/width in combination with volume.

Line and arrow = this symbol indicates the extent of the timeframe for the material that it leads from.

- Filled in note head = this generally refers to a pitch class given in a tone set that is to be treated with the given instructions.

- Open note head = this refers to a note that is to be held for extended periods.

Time markings = always appear in seconds (format: XXX).

Tone sets = the tone sets provided allow the performers to choose from one or more of the notes and apply various instrumental techniques to these: at some points these are written in ascending order, other times notes are given in irregular orders to ask the players to make sure they are treating the set randomly.

Note brackets within tone sets = these are to be played on a less frequent basis, or in the case of the improvisatory 'solos' in men as a leading tone / ornament.

Parameter graphs = parameter graphs that are displayed on screen are scroll through, allowing the performers to see the current density, volume, rate etc, accurately and in real-time.
compression which, when pushed to the extremes, results in
a noticeable loss of quality. However, other software
may be used if it provides the same functionality.

performing with the actual ondes martenot instrument
would also be acceptable, but was not possible for this performance.

processing
the maxMSP patch used for the live performance contains many self
built modules that are linked together through a matrix system which allows for any combination of control signals. The modules that are necessary to perform this work are explained below.

compressor: control-compressor, control-gain,
reverb: control-reverb time,
overdrive: control-gain, control-preset adjusting

the original performance was achieved using the following equipment:

speakers: 2 powered PA speakers
foldback: foldback monitors provided electronic elements
mixer: 8 channel mixer providing signal path into laptops, 8 channel mixer providing laptop outputs to speakers and foldback inputs = 8 instrument microphones = 2 synthesis inputs = 2 processing inputs

preparations to rhodes piano
prepared using gaffa tape, the middle portion of the keyboard range should be left untouched, in the lower and upper portions tape should be applied to the keyboard to alter the sound to become more percussive and reduce the decay time.
section title: | duration min: | duration sec: |
---|---|---|
spectra | 4.5 | 270 |
senn | 5 | 300 |
canon | 4 | 240 |
merr | 6 | 360 |
luminaire | 6.5 | 390 |
quasi | 7 | 420 |
melody | 5 | 300 |
spectralis | 3 | 240 |

**Composition Timeline**

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<thead>
<tr>
<th>Section</th>
<th>Duration Min</th>
<th>Duration Sec</th>
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<td>300</td>
</tr>
<tr>
<td>Spectralis</td>
<td>3</td>
<td>240</td>
</tr>
</tbody>
</table>

*For more information please see www.kynantan.com or email contact@kynantan.com*
all instruments (except rhodes): follow display for intensity graph and video score, use sounds that emulate the electronic granular noise, some suggestions are provided. attempt to maintain the density and rate inferred by the video. images on the score are a guide only.

display: timer, parameter, notes.

clarinet

bass clarinet

cello

double bass

drum kit

rhodes

synthesis

processing

kynan tan
Visuals: real notes from display, the pitch class, direction and a graphic for note length are provided. Each note lasts between 3-7 seconds. Maintain consistent volume and warm clear tone, changing register if necessary. Use normal attack parts should move out of phase. Repeat until no further note information is provided.

Clarinets: tenor, baritone, bass clarinet.

Cello, double bass.

Rhodes, vibraphone.

Ondes.

Begin recording and looping ensemble sounds.

Add more grains, non-linear looping and polyphony.

就这么不期而然地转到了下一段。
all instruments: choose one note from the set and play for 4-10
with smooth envelope, then choose a note different to the one you just played
and play after a 2-3' break between notes, keep tone as clear as possible
you may change register to keep tone warm and clear

[display: timer]

visuals

clarinet

bass clarinet

cello

double bass

rhodes

vibraphone


osida

processing

begin recording post-processed sound, and playing
back sounds in non-linear loops, overall sound should still be sparse
all instruments: where the markers A, B, C, D and E appear, refer
to the separate scores for each module, the start time for each is marked
here, however the pre-roll, notes and timing are shown on the digital display

[ display: timer, notes ]

clarinet

bass clarinet

cello

double bass

rhodes

vibraphones

synthesis

processing

impulse: begin by adding these notes:

| display: timer, notes |

--

quasi

kyan tan
all instruments: each note has a 20 second window. you must begin your note in the first 3 seconds, and end in the last 5 seconds. use a very gradual envelope for each sound. maintain a warm clear tone, changing register if necessary. notes and timing will be displayed on screen.

visuals

melody

clarinet

bass clarinet

cello

double bass

organ

vibraphone

ondes

synthesis

processing

special delay, pitch shifting: 1 or 2 octaves and newly applied to live sound in changing parameters: shifting and partials

second sound not played, pluck played back in final seconds
**All instruments:** each player chooses a technique and a note from the current tone set, then plays that pitch with the chosen technique. The tone sets vary as the piece progresses but the techniques do not. Laptop processing will capture sounds played from instruments and electronics to re-create new textures.

For each technique, choose your own dynamic based on the overall density and intensity of sound at the time. The parameter graph on the display gives suggestion as to the dynamic level throughout the piece.

**Visuals:**

- choose a pitch and any pitches and any instruments between pitches may be used.
- multi piano or piano string preset.
- 10-15% short, staccato notes.
- string staccato notes.
- 10-15% harmonic.
- scattered, textured improvisation using brushes, bundled wood or wooden sticks.

**Synthesis processing:**

- electronic should use a 'freeze' granular synthesis engine that re-records input and output constantly. You may use live sound, pre-recorded or synthesised material. Follow the overall density graph to guide the output of granular through overdubbing, filters or reverb before re-recording. Performer may change granular playback octaves, grain size, density and rate at will. Become very dense, filling the frequency spectrum; fade out gradually.
A - first modulation, x3 timing (longer) and reverse
B, modulation three, twice as long, forward

transcription B

clarinet

bass clarinet

cello

double bass

organ

vibraphone

free, rapid string vibrato, increasing in width, and rapid tremolo with varied rate

slow, wide vibrato
C - first modulation, short time frame

transcription C

**clarinet**

**bass clarinet**

**cello**

**double bass**

**organ**

**vibraphone**
transcription D

D, bell two, forwards and normal speed

clarinet

bass clarinet

cello

double bass

organ

vibraphone

kynan tan

D
clarinet

bass clarinet

cello

double bass

organ

vibraphone

note: reverse
E, transcription number two, held very long and reverse
breath when necessary, clarinets to try to stagger breathing times

transcription E
Appendix B – *lucidity* audio recording

Live performance recorded on the 13th October 2010  
Music Auditorium, Western Australian Academy of Performing Arts

Recorded by Bob White and Charlie Daly  
Mastered by Kynan Tan

8 sections // 46.5 minutes

1. spectra 4:32  
2. senn 5:00  
3. canon 4:00  
4. merr 5:58  
5. luminaire 6:32  
6. quasi 7:01  
7. melody 5:02  
8. spectralisis 8:26

Musicians:  
Ben Hamblin / Clarinet  
Lindsay Vickery / Bass Clarinet  
Tristen Parr / Cello  
Lyndon Blue / Double Bass  
Christopher de Groot / Prepared Rhodes Piano, Organ  
Callum Moncreiff / Vibraphone, Drum Kit  
James Paul / Synthesis Computer  
Kynan Tan / Processing Computer
Appendix C – Spectrograms of *utp_* and *lucidity*

Full-page colour spectrograms created using Sonic Visualiser software.

*utp_* by Alva Noto and Ryuichi Sakamoto

1. attack / transition 7:24  
2. grains 6:24  
3. particle 1 6:40  
4. transition 3:32  
5. broken line 1 6:32  
6. plateaux 1 8:07  
7. silence 6:51  
8. particle 2 7:00  
9. broken line 2 6:29  
10. plateaux 2 / end 12:59

*lucidity* by Kynan Tan

11. spectra 4:32  
12. senn 5:00  
13. canon 4:00  
14. merr 5:58  
15. luminaire 6:32  
16. quasi 7:01  
17. melody 5:02  
18. spectralisis 8:26