Time in Music : Strategies for Engagement

Thesis submitted for the title of PhD in Composition

Edward Kelly 2002

Contents.

Audio CD Contents:

Track	Title	Date	Composer(s)	Time
1.	**Batista! (Lament)**	1998	Edward Kelly	8’24”
2.	**Block Groove**	1999	Edward Kelly/Nicholas Melia	8’58”
3.	**Fright Fiction Simulator**	1999	Edward Kelly/David Casal	3’31”
4.	**Particle Foil**	2000	Edward Kelly	8’57”
5.	**Inside-Out (Stereo Mix)**	2000	Edward Kelly	10’19”
6.	**Entanglement**	2001	Edward Kelly*	8’06”
7.	**Thermal Inversion**	2002	Edward Kelly*	8’01”
Total Time:				ca. 56’16”

* Percussion by Simon Limbrick, live electronics by Edward Kelly.

DVD Contents:

“Sonimation” – a series of films commissioned by the Sonic Arts Network of Great Britain.

Includes:	**Escape**	2001	James Padley/Edward Kelly	3’24”

CDROM Contents:

PD software and externals (Linux):

Pd-0.37-0.linux.tar.gz

ggee-0.24.tgz

zexy-linux-1.1.tgz

xsample-0.2.4.tgz

motex_1_1_3.tar.gz

externs folder and sample .pdrc file (in case compilation and configuration of the above is unsuccessful.

PD patches (with above externals):

- **Thermos-flask-filter-player.pd**
- **pm-demo.pd**
- **pm-dur-test.pd**
- **pitches-xpose.pd**

MAX/MSP application (MacOS 9.2):

- **Entanglement Instant Remix v2** for Apple Power PC G3 or higher.
- "Joliet" extension (for reading the CD with full file name compatibility).

Audiomulch (Windows):

- Software and VST plugins
- **Process-Time.amh** patch and samples

Accompanying Materials:

Scores:

• **Continuum**	1997-2000	vln, vla, vc, cb, pft: 2 movements.	Ca. 10'
• **Cold Fusion**	1999	percussion quartet	ca. 8'
• **Entanglement**	2001	solo percussion	ca. 8'
• **Perspectives**	2000-2002	vln, vc, cb, pft, perc, hp, hn	ca. 6'+
• **Thermal Inversion**	2002	solo percussion	ca. 8'

Territorial Pitch Maps:

- **Cold Fusion** – the first territorial pitch map.
- **Perspectives –** territorial pitch map before and after composition.
- **Thermal Inversion** – the first to use "charm quarks"

Acknowledgements.

I would like to thank Simon Waters, for patiently guiding me through my own fog of ideas, absorbing my angst, giving me opportunities for my work to be performed, and teaching me only what and when I cannot teach myself, Micheal Alcorn for proof-reading my work and making suggestions, David Chadd for his continuous support and understanding, Simon Limbrick, for having the guts and the skill to perform work others deemed “unperformable”, and for making room for my work in concert schedules and festivals, Love Mangs for allowing me to work at the EMS studio in Stockholm (and the students of EMS for an excellent concert on their return visit), John Bowers for putting me in interesting musical situations and introducing me to new ways of thinking about performance, Phil Archer, Shigeto Wada, Stefan Edwards and all who played at or supported **Wired** events (we’ll be back!), Suzie Hannah, Phil Hallet, Darryl Biggs and all at the Sonic Arts Network of Great Britain for presenting opportunities too good to miss out on, Alison Gilliam for encouraging me through times of distress and for her faith in me, Ian Dearden, Javier Alvarez, Howard Burrell and all at the University of Hertfordshire for encouraging me to do this in the first instance, Elise Chohan for making me laugh a lot, Jana Dugal and Mike Rowland, for your hospitality and enthusiasm, My Parents, Bernard Benoliel and the AHRB (finally) for supporting me through this work, Ann Kelly, Peter Perou and Grant Newman for always being interested, and for helping me finish this thesis whilst bereft of accommodation, Jonathan Impett for guiding me to interesting research material and Nicholas Melia and David Casal for being such great collaborators.

My time at the University of East Anglia was rich in new experiences and full of creativity thanks to these people, and it is to them I dedicate this work.

Time in Music : Strategies for Engagement

Introduction

I do not compose only one kind of music, but a repertoire of different forms and styles of music. Each discipline I have engaged with in the course of my studies has been practised as a different approach to a musical problem - namely how to compose music that significantly alters the listener's perception of time. It is apparent through study of the literature on the subject that time itself is not experienced, rather that our experiences of events, processes and phenomena are what give time form and structure to us. As Clifton states:

> "The words "past," "present" and "future" express relationships between objects or events, and people. These words exist and have meaning because people are in the world. It is the experience of objects, events, and other people which is in constant flux…It is events, as lived through by people, which define time."[i]

Clock time (for the purposes of music analysis and criticism) can be seen as an arbitrary mechanical or electronic standard rate of change, useful for measurement, comparison and synchronisation purposes. Since time is perceived in and through music without reference to any external measurement of time's passing, clock time has little relevance to our perception of music unless extra-musical references are made to it in the music itself. So-called "real" time is a misnomer, since we are unable to perceive any form of time that may exist outside of our conscious experience (of time as an ordering principle of experiences, events and information) (Clifton p. 51). If we view time as a continuum of relative events then we are in a better position to understand musical time, as an engagement by the listener of experiences of time in its various forms through music. Objective time is evidenced by the ticking of a clock since we experience one "tick" as coming after a previous tick and we *anticipate* the next tick, or in a sequence of numbers counting up on a digital or analogue display. Clock time is an arbitrary construct, an imposition of mechanical or physical processes onto our experience of time as a sequence of

events, invented for the purpose of synchronising social behaviour(s). Conversely music is perceived in and through time as distinct experiences. Humans are pattern-seeking animals and so we seek information in the steady stream of events that we perceive via our senses. How we perceive time in music is largely dependant on how we "chunk"[ii] information successions presented to us, and how we relate the resultant patterns of information with each other and with external experiences or events. Concepts such as chunking are useful to the composer or music software engineer in understanding the perception of music, since they deal with information as a quantifiable flux of related entities rather than a continuous stream of parametric variation based on some arbitrary scientific unit (e.g. hertz). In order to understand, analyse and synthesise music that does not rely on a set of proscriptive tools for its expression (notation), one has to invent meaningful abstractions that encompass multiple attributes of its phenomenology (its behaviour through time), based on observations of sound through listening. Conversely if one is to compose music that is to fully exploit the psychological implications raised by concepts such as chunking through proscriptive means (e.g. by creating musical scores), there is often a need to tailor one's proscriptive methods (the tools of musical notation) to conceptions of music, rather than confining ones conception of music to that which is available through standardised (traditional) means.

My aim in composing each of the pieces presented here has been to investigate compositional devices for the manipulation of musical time; that is the time we experience in and through music. This document will serve to clarify issues of compositional practice and the beliefs and intuitions that have caused me to explore a specific realm of musical activity. My portfolio consists of a diverse mix of tape music, scores, software and film, some of which has been realised in sound and some of which (instrumental compositions) has remained unperformed at the time of writing. It is my conviction that to understand composition one must explore a rich variety of aesthetic and philosophical approaches to music, and that experience gained in one field of music will reinforce and enrich techniques and ideas for another musical activity. Each composition is approached as a coherent entity in and of itself. A work's governing principles and formalisms do not need to bear witness to other works' procedures in order to establish a coherence of its own. Each piece possesses its own unique approach to a common area of research; compositional strategies for the material engagement with musical time, as perceived by the listener in its

multiple forms, although these may be grouped in certain ways according to the methods and the material from which they are composed. In fact the process of composition with live electronic processing as an element results in general purpose tools (such as **Entanglement** and **Thermos Flask**), and these may find uses in other compositions and performances. Figure 1 shows a map of how some of the concepts in my music relate to one another.

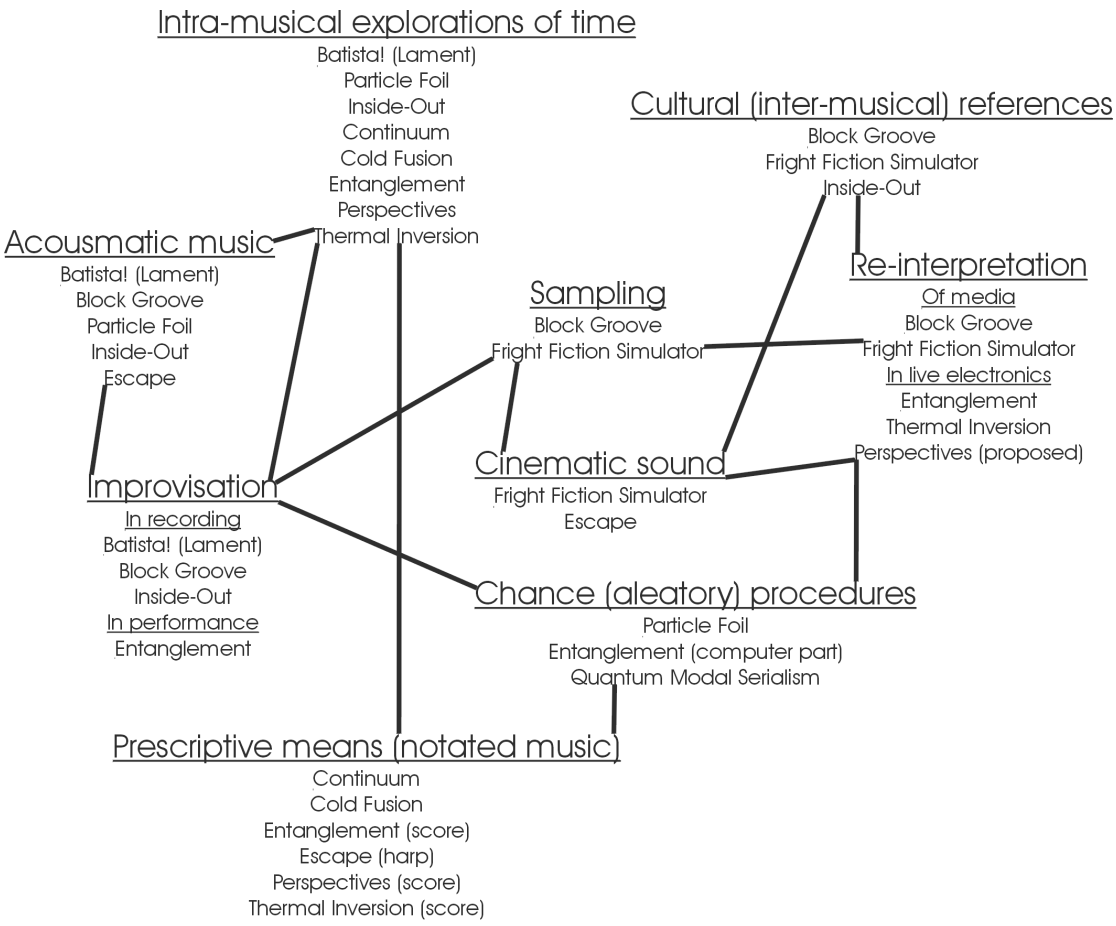

Figure 1. A conceptual map of related themes and common procedures expressed in and through the accompanying portfolio.

The connections within this diagram are intended to show areas of common ground between its concepts and techniques. I would hesitate to put any piece of music into one category alone, since music is a multi-dimensional art form. This diagram represents only one set of attributes of music and its processes, and is in some sense arbitrary since no definition of music is

mutually exclusive. There is always a sense in which a piece of music or a process of composition will share characteristics with multiple other forms of composition. In some sense it is the order of the processes involved in composition and their territories that defines a work, rather than any one process or material. Thus a proscriptive approach to composition will usually involve some degree of improvisation for example, and it is the time scale of and the order in which the processes of conception/inception/realisation happen that determines the nature and substance of a work. It would be easy to make connections between every point on the map and every other, and to relate them conceptually. Here I have shown close relationships between cultural and musical areas of activity, rather than to relate every point to every other point. It is a concise overview of my portfolio with respect to some of the conceptual areas explore therein.

The structure of this thesis is more rationally ordered according to the media of musical realisation, although where live electronics are concerned this area is inextricably intertwined with my instrumental composition activities.

I began to compose electroacoustic tape music for two reasons. I was aware that the complexity and long composition times of my instrumental scores meant that many of the ideas realised within them would remain unheard and untested for some considerable time. Whilst this satisfied an intellectual desire to create new forms and techniques for manipulating material schematically (on a theoretical level), the need for experience of one's own music remained unsatisfied by this. A musical need (for *feedback* in the compositional process) led the composer to seek new modes of expression, which is why the work presented here explores a common theme (musical time) through a variety of different media.

The second reason to engage with electroacoustic music was in reaction to the work of others. My experiences of working with field recordings had left me dissatisfied, as had my experiences of much acousmatic music. Much of it seemed to me to imply that the sonorous materials' origins and their referential symbolism(s) were more important than the act of composition. The frustration caused by difficulties in isolating and evaluating individual events from field recordings was acting as a barrier to musical clarity. The aurally interesting elements contained within a field recording are often of interest because of their extra-musical context, but

in isolating concrete attributes of such a recording one frequently has to strip away such symbolism by making the sounds less recognisable as components of a scene. This renders the recording more *musically* useful as a set of sonic units or *objets sonores,* yet less so as a set of referential units or symbols. The interest in a field recording for me often lies within the relationship between its significant elements and its musical identity (if it possesses a clear example of one). A field recording is a concretion (of a particular time and place) in which individual sonic identities (potentially musical components) exist. Attempt to extract one from the other and the scene, or the musicality is obscured from the listener. Faced with this, coupled with a desire to use the highest quality materials in a piece, one inevitably has to accept that in dealing with field recordings one must either accept that spurious events and phenomenon are vital to the symbolic integrity of the recording (at the expense of the *clarity* of the concrete musical attributes one may wish to isolate and use) or that the musicality of the recording is more important than the preservation of its semiotic meaning (and hence sacrifice its symbolic meaning as a document of a certain time and place). The former response to this problem is represented in the final section of **Particle Foil** where a microphone has been placed outside the window and the signal is processed in performance (realisation) time. The latter is represented in **Fright Fiction Simulator** where an auditory scene (excerpts from the soundtrack to the film **Predator**) has been de-constructed into a set of musical building blocks with which the piece is improvised in performance time.

The third response to this compromise was to approach the act of recording as a controlled, scientific process with spurious events and coincidences happening by improvisation rather than by accident - a performance occasion. My desire to create tape pieces at this point drew from the notion that a composer must compose, and that it is not enough for a composer to suppose that by capturing sound on a recording medium one is creating a work of art. The idea that by recording sound one is elevating it to the status of art is an illusion. It is a result of living in a consumerist society where recording and mass reproduction have become synonymous, and where we are led to believe that what constitutes music is that it becomes commercially available as recordings (usually by those who have a vested interest in making us believe so). The invention of recording historically led to mass reproduction. The combined forces of marketing and globalisation within the music industry have resulted in a highly developed, fashion-oriented

notion of genre. Although this may be seen as a logistical convenience – that recorded music is categorised in order to make it easier for the consumer to find what he or she wants, the illusion that music has validity by conforming to conventions of instrumentation, style and presentation is frequently encouraged by record companies in order to try to secure a market. In order to distance myself from this illusion I set about composing using improvised materials recorded under controlled conditions, with un-conventional instruments (springs, metallic objects, an Indian ektara) or uses of instruments (such as a short-scale bass guitar played with chopsticks). I aspired to compose music free from everyday experiences of sound and referential symbolism. This material that was performed (improvised) using conventional instruments and found objects was processed and combined to create a study of musical time, articulation and context: **Batista! (Lament)** (Edward Kelly, 1998).

Part 1. Electroacoustic Tape Music

Audio CD Contents:

1. **Batista! (Lament)** ***1998, Edward Kelly***
2. **Block Groove** ***1999, Edward Kelly, Nicholas Melia***
3. **Fright Fiction Simulator** ***1999, Edward Kelly, David Casal***
4. **Particle Foil** ***2000, Edward Kelly***
1. **Inside-Out (Stereo Mix)** ***2000, Edward Kelly***

CDROM contents:

- Example Audiomulch patch: **Process-Time** demonstrating mixing and automation processes used in **Particle Foil**.

Chapter 1.1. Process- and Structure-Oriented Models of Acousmatic Composing with Respect to Batista! (Lament)

1.1.1. The Process of Composing

It is useful to look at musical activities according to their modes of contrivance, i.e. according to the process of getting from the inception of music to its eventual dissemination through mass distribution or performance, installation or broadcast. This allows us to discuss music as a set of dynamic processes or activities, which may be combined in various ways. As such the DJ and the tape music composer can be seen to share aspects of technique and decision making in pursuing what may be quite different aesthetic or ideological objectives. Musical activity can thus be seen according to shared experiences that inform musical decisions within the context of the *modus operandi* of a given situation or compositional process. More importantly for the composer, musical production can be seen as a process employing a combination of strategies and tactics for the production and combination of materials. This allows one to think about the ways in which different procedures may be combined to contrive new approaches to composition and performance of music. Thus in creating a work one may gain control of the process of music making by viewing it as a combination of smaller processes. This allows one to experiment with the currency of one's compositions in terms of its micro-structural properties and their use in larger formal units. This approach is not limited to one mode or genre of musical activity but is applicable to all forms of sonic art.

Much of my electroacoustic music relies on the balance between decisions taken before the compositional process and decisions taken after the recordings have been made. I make this distinction because the working methods for each situation have quite different implications. Decisions taken at the time of recording are improvisational and are treated as such, or else they may be contrived attempts to gather together a set of building blocks (samples) in order to construct an instrument (patch) on which music may be played. In order to express a depth and variety of ideas in the finished article, I decided that the material itself must possess potential for

further musical development. Thus the recording was improvised as a piece of music rather than treated as an instrument-building exercise. This results in recordings with multiple possibilities of expression in terms of micro- and macro-structural units.

The process of improvisation can be likened to the way in which graffiti builds up on a wall favoured by street artists. Motifs and phrases are built upon the framework of what has gone before, yet they may be haphazardly applied so that the new material gradually (or suddenly) obscures or alters past events by its boldness or detail. Each theme is applied to a montage of previous material. Changes to past events in this context are made only by amendment, and thus by continual re-contextualisation from the point of view of present perception. Nothing is removed from the fabric of the work as it goes along, yet everything is replaced eventually, or rather it is altered by what happens subsequently to past endeavours. What happens after a recording has been made (either through tape manipulation and analogue processing or through digital technology) is as if the paint was always wet and we had a chisel to work the stone of the wall. Paint may be smeared, the new mixed with the old and chunks carved away from the fabric of the piece, yet we have not the means to add anything new to the wall. We must be content with assembling fragments of it upon the ground, creating holes within the canvas of the material (the material becomes the canvas by inversion of the process) or blending colours within the established palette. Anything done to a recording once it has been made will almost certainly affect the physicality of the sound. Improvisation during the recording process ensures that the material will contain sophisticated articulations and musical relationships. This presents the composer with the possibility of interplay between diverse sound sources recorded by improvisation, and with personalised material with which to work instead of lifeless laboratory recordings, but without compromising the subtleties of acoustic sound in order to arrive at structured material. This is not mutually exclusive to digital manipulation however; rather it is complimentary to such means since it provides the composer with musically rich material with which to work. Memory in improvisation and in listening to music, affects what we play or how we hear subsequent music respectively. Thus a recording can only be added to, just as an experience of a piece of music is

cumulative, and as graffiti on a wall is a process of aggregation so an improvisation can be seen as a process of re-defining the past by acting in the present.

The subtleties of acoustic sound are such that it cannot be replicated inside a computer without the aid of physical modelling software such as **Modalys**. Whilst new developments in synthesis have resulted in performance-time physical modelling synthesizers (such as the Yamaha VL series of synthesizers), these devices offer only a limited range of models and do not yet provide the user with a complete flexibility of design so that one could not construct a steel spring using such devices for example. Such instruments are designed to reproduce the timbre and nuances of traditional instruments, excluding many possibilities of improper use of instruments (e.g. hitting a guitar with a drumstick) and the sonic possibilities of found objects. There is another reason for recording acoustically that would be the same regardless of whether low-latency physical modelling were available, and that is to do with how the shape of a physical object influences the way it is played. As an example of what I am talking about, the car suspension springs used in **Batista! (Lament)** would never have conveyed the musical characteristics they did if it were not for their shape, more precisely the interaction with that shape as it was played. Similarly the washing-machine flywheel on which the material for **Inside-Out** was performed, would never have yielded such a diverse repertoire of articulations, were it not for the potential for interactions its five-spoked shape afforded. Relegating the playing of such a sonorous object to a MIDI keyboard or some other interface drastically reduces the possibilities available to the performer. A hands-on approach is preferable – as is the case with a majority of compositional concerns.

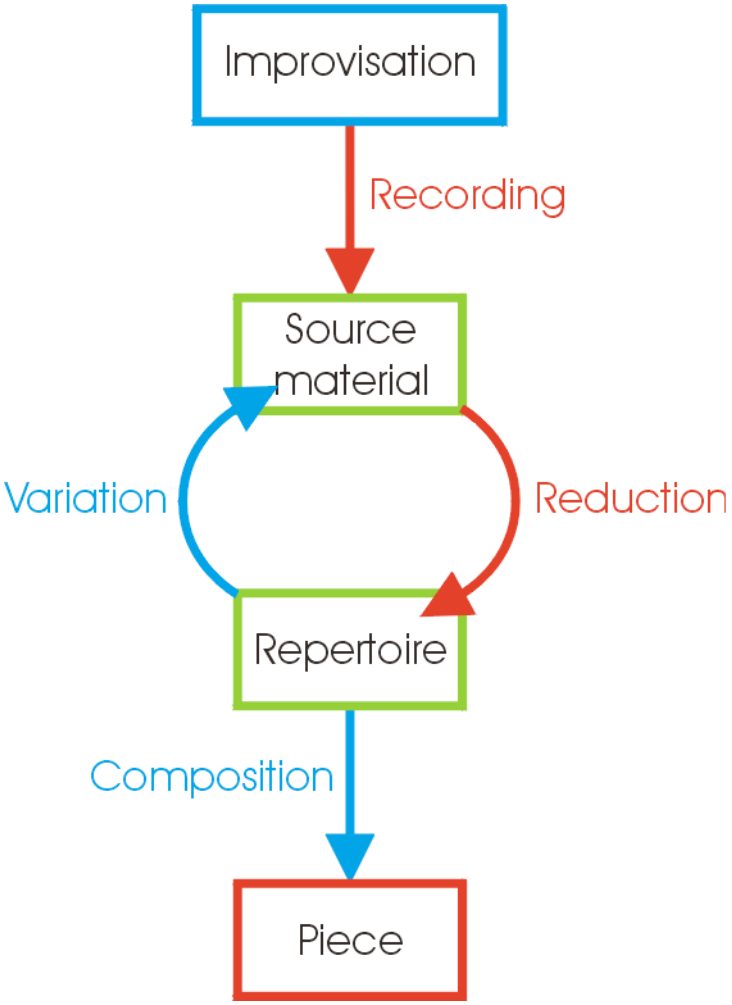

Figure 2. A process-oriented model of acousmatic composition.

The process of music production used for the composition of **Batista!** is a process that begins with improvisation and leads to composition. In between these two processes lies a process of reduction and variation. Material is selected on the basis of aesthetic merit (preference or suitability) over other material that is deemed unsatisfactory, and successful candidate material is manipulated to produce variants. This process may be recursive since not all variants may be satisfactory to the composer, and a further process of reduction and variation may take place.

This process is illustrated in figure 2. This model illustrates how a piece is composed according to the reductive (red) or constructive (blue) processes involved. Pools of material are represented as boxes, with transition states shown in green. Improvisation is a dynamic,

constructive activity. In improvising one explores the possibilities of a situation. In an improvisation one is continually aware of how motive arises and develops from physical gesture. At the same time one is continually re-interpreting what has gone before, re-framing the memories of past musical gestures. It is a profoundly constructive occupation and hence is labelled in blue. The act of recording such a performance is selective. A recording is like a photograph of a scene in that the act of recording eliminates all other realisations of itself by its inception. Once a recording has been made it becomes a static representation of a dynamic event. The process of recording is reductive since it selects only one possibility (e.g. the position of a microphone within a room) at the expense of all other possibilities (e.g. all possible positions of a microphone within a room). In contrast to the act of recording a performance or scene, the process of composition is constructive. Originals and variants are combined so that musical relationships are established between the materials. Possibilities afforded by the material (and enhanced by variation) are explored in reference to other material in the context of the work. The whole becomes greater than the sum of its parts as detail and structure is revealed by juxtaposition and comparison with other material. The piece of music itself is a final reduction of possibilities, a single fixed realisation of musical structure.

1.1.2. A Structured Information Based Approach to Composition

In looking at how information is stored and transmitted during the process of composing a piece one can gain valuable insight into how compositional techniques may be hybridised and combined. Musical information can be categorised as literal or schematic (abstract or abstracted) information. In computer music the waveform display of a sound-editing program is literal information. It represents changes in air pressure by drawing a line that centres on equilibrium. The sonogram display of **Cool Edit Pro** (CEP with which **Batista!**, **Inside-Out** and sound elements of my other tape pieces were made) represents abstracted spectral information. The benefits of working with a sonogram as opposed to a waveform display are that one can use this abstracted information to inform compositional decisions and DSP techniques. One technique that I use that is based on sonographic information is to use the spectrum of one moment of a sample to

design filters for processing other samples. One could abstract this information more accurately using the noise retention facility of CEP, or convolve sounds with a small slice of the spectrum. However the approach I have developed is more musically useful for two reasons. Convolution affects the temporal envelope of the sound file in question whereas the filter (being specifically a filter and not some other process co-opted to do the job of a filter) preserves the temporal profile more accurately. The second reason to approach the task in this way (of spectral imposition to create hybrid samples) and perhaps a more persuasive one, is that in constructing a filter one has the power to discard information and to generalize - unlike either convolution or FFT-based noise retention (also available within CEP). In figures 3 and 4 is shown just such a filter based on a recording of a detached piano hammer bowing a piano string longitudinally.

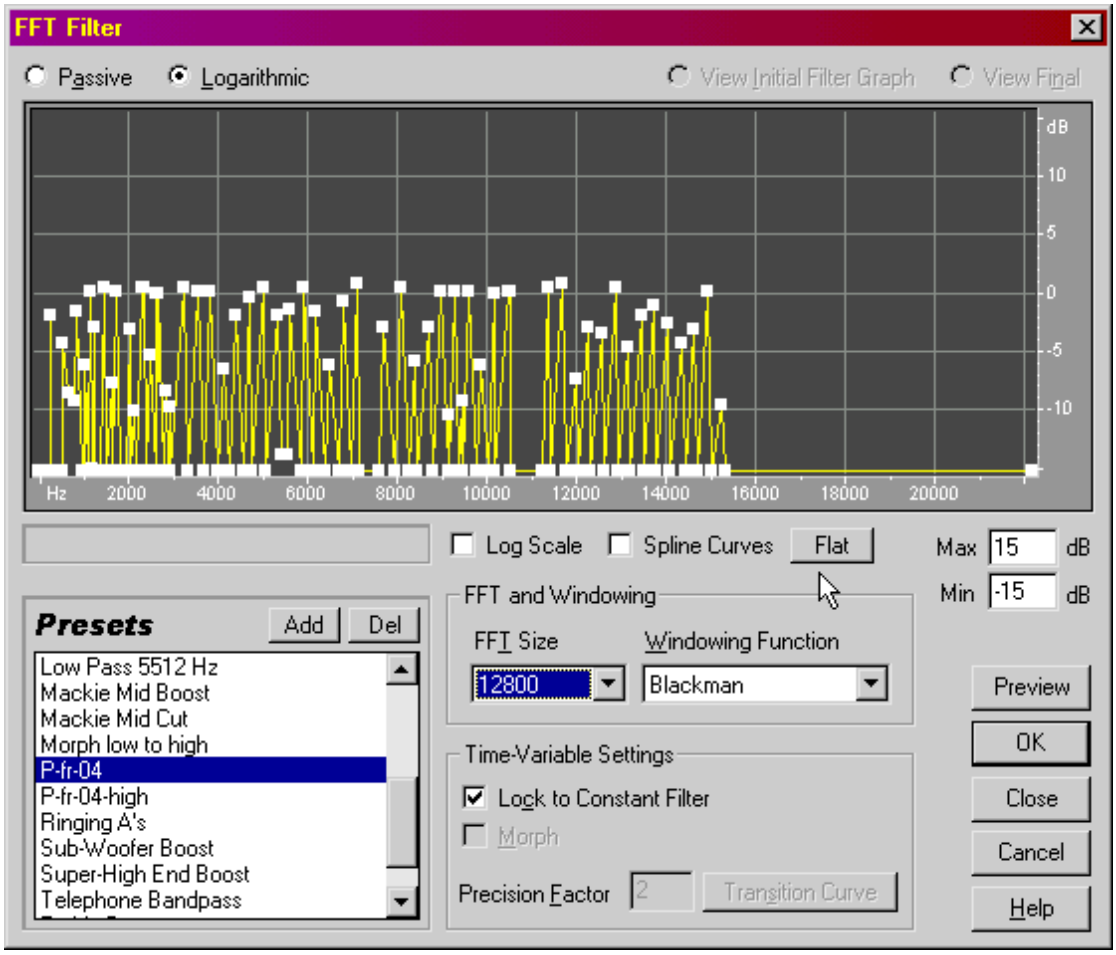

Figure 3: A filter based on the sonogram of a “bowed” piano string.

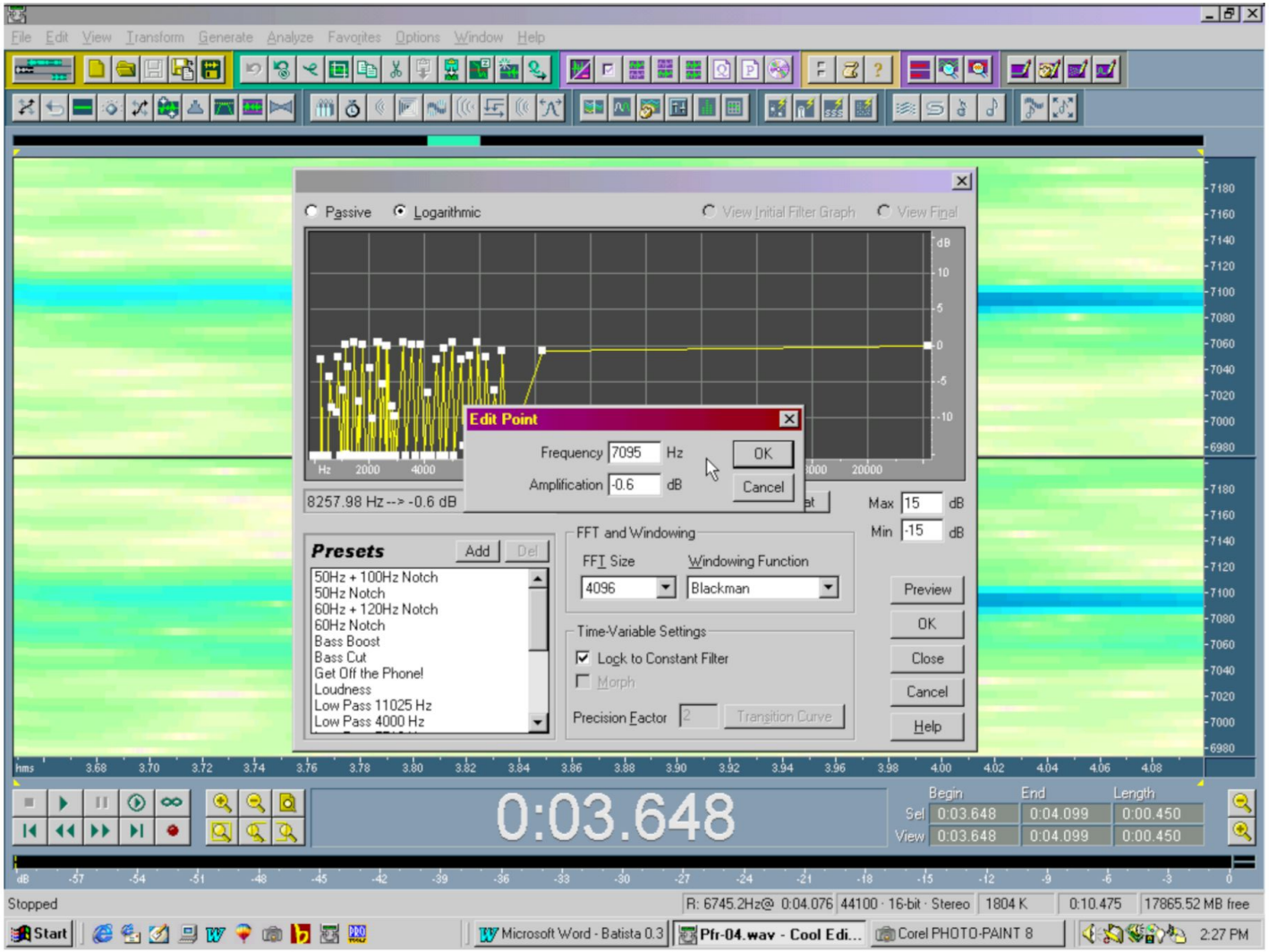

Figure 4: Building an FFT filter from a sonogram display.

Much of the information abstracted from the sound file represented in the sonogram display is discarded when building the point-based filter shown in figure 3, and only the strongest partials are mapped to points on the filter graph. The placement of points is not 100% accurate, but this does not matter since in practise when many points are mapped the individual errors cancel each other out (due to the harmonic coherence of physically vibrating objects). A limitation of the software with regards to this facility is that one is only allowed a certain number of points on the graph. If one is making a filter from a sound spectrum of some complexity one can make a second filter for the upper partials of the spectrum. The resultant sound file from such a filter is then mixed with the resultant of the lower-partials' filter.

The point of this is to impose the most significant spectral features of a portion of sound (using the FFT filter) onto a sound file, whilst preserving the temporal profile of that sound file. In choosing which features of a spectrum to model one is making a compositional decision that condenses the information according to its spectral properties. The filter is a generalisation of the sound spectrum on which it is based. It is therefore an abstraction, a *schematic* representation of a sound file's spectral content averaged over time (in that only features that are deemed significant are preserved). Here we are taking a musical aspect of one sample - a selective set of information *about* a sound file - and using it as a compositional *tool*. In this way one can use the transient features of one sound file to articulate the spectral content of another, without producing any unwanted smearing or artefacts. Examples of this occur at 1'53" (with pitch-shifting as explained later in this document) and 8'04" in **Inside-Out**. Unfortunately this technique does not allow for temporal morphing of the filter according to the spectro-morphological development of the source material. It is confined to static spectra since the morph carried out by CEP is a linear interpolation between one profile and another and does not follow a sample's spectral profile.

Why use this technique? Csound now provides access to FFT bins (individual frequency bands) of phase-vocoder analysis files (which it did not when **Batista!** was composed), but this technique lacks selectivity in that all partials of the source material are used, rather than only those chosen by making compositional decisions based on the intensity of partials displayed in the sonogram as lines. Recent interest in **PD**[iii] has uncovered possibilities that may lead to a low-latency, performance-time spectral filter derived from input using FFTs. Csound *was* used for

cyclic phase-vocoding (see below), and **Direct Csound**[iv] (a real-time version of Csound) could be used to implement a performance-time spectral filter from source material, but the composer became interested in building filters manually from sonograms in CEP because of the speed at which the filter could be constructed, the ease of use and most importantly, the potential for mediation of the information. In other words, to do something my self, where I have access to information and so can form qualitative judgements about the information and hence be *selective* in my choice of information, is nearly always preferable to delegation of a compositional task to a machine, unless the *quantity* of information is too great for a human mind to hold and process. Abstractions of information are tools we humans use to simplify such complex information and make it available to us for use, and in some cases the computer is invaluable here, such as in the representation of sound files as sonographs.

1.1.3. The FFT f/t paradox

Fourier transforms are mathematical algorithms used to analyse the spectral content of a waveform. Fourier transforms are time-window based algorithms. Fourier analysis is carried out on finite portions of a signal. The larger the window is the lower the minimum frequency the Fourier transform can measure the energy of and the higher the frequency resolution, but large window sizes result in temporal smearing of the spectral information - since the output of a Fourier transform is an average (over the time of the window) of the energies in each frequency band. Fourier transforms hence have an inversely proportional relationship between frequency resolution and temporal resolution. DFTs (discrete Fourier transforms) are used in digital signal processing. DFTs carry out Fourier analyses upon time-windows at discrete points along a waveform. The DFT (and its inverse process) is a pragmatic implementation of the Fourier transform that *interpolates* between frames of spectral data. This results in temporal smearing of the spectral components of the signal when it is re-synthesised, proportional to the window size of the analysis. This means that when one goes to use such an algorithm one must decide which information is more structurally important to the work, spectral accuracy and stability or temporal accuracy and attack transients. Constructing fixed filters is one application of DFTs for which transient

information of the source spectrum is unimportant. The articulation of such filters will result in output that is smeared, and so precise temporal properties of the input will be modified. The resultant smearing occurs to all of the sound file being processed however, thus the *relative* temporal relationships within the sound file will still be manifest in some way, although individual details in the internal structure of the sound stream may disappear. This smearing of the temporal properties (coupled with further smearing by the use of a pitch-shift effect with feedback) is used effectively in the first section of **Inside-Out**, where a complex network of pulses is filtered so that we hear the *contours* of the rhythms rather than their details, as articulation of a spectral filter.

1.1.4. Hybrid Sonorities in *Batista! (Lament)*

There is another kind of rhythmic structure in **Batista!** apart from that which is improvised, and that is temporal structure that has been imposed on the material. In much of my electroacoustic music there is a preoccupation with rhythmic multiplicity and complex temporal structures. In **Batista!** a conscious effort was made to record only material with attack transients and clearly defined articulations improvised at source. During the composition ideas from my instrumental compositional technique were applied to acousmatic compositional practices. Clearly there are many procedures and techniques in electroacoustic music composition that have no correlation in the physical world, often where the purpose of a technique has been subverted. For example, it could be argued that convolution is essentially a way of simulating reverberant spaces - a purpose for which it is rarely used by electroacoustic composers who frequently use it to create hybrid sound elements. More importantly there are parameters available for manipulation in the virtual domain (such as the illusion of spatial depth induced by artificial reverberation) that are rarely if ever utilised as compositional tools in acoustic music performance. One simply cannot play a sound in reverse in the physical world!

Batista! (Lament) represents an attempt to define musical structures that are musical in the sense they share attributes with instrumental scores by means that are particular to the digital domain. One must bear in mind when analysing **Batista!** that it is a result of experimental composition in that many of its constituent structural relationships are the result of exploring

possibilities that are conceived as musical principles apart from the material such as metric modulation, polytonality and the periodicity continuum (rhythm-pitch-timbre).

1.1.5. Imposed vs. Inherited Structure

Batista! (Lament) is a study in temporal articulation. Rhythm is a subject that is treated in much modern tape composition often as a purely descriptive term. It is rarely discussed in contemporary electroacoustic music literature and from hearings of much acousmatic music it appears that many composers would see any imposition of rhythm upon a source recording as interfering with the "natural" articulations therein. Recordings are only ever natural in the sense that they are representations of one aspect of natural events. If one is a symbolist, a composer of modern, literal program music (otherwise known as soundscape composition) then one is likely to be more concerned with pseudo-realistic representations of scene than with rhythm as a compositional device (cf. The work of Hildegard Westerkamp for example).

A recording is not natural in the sense that it is a deliberate intervention by man upon whatever (and as importantly whenever) its source may be, and thus it is synthetic (made by man). In many tape works where literal playback is used one senses that the temporal continuity of a field recording is sacrosanct to the composer of such a work. To interfere with the internal structure of such recordings would seem to be in some way corrupting nature, but a recording of an aural scene is a corruption of its terms and conditions of engagement anyway. A recording is context-independent. It can be taken anywhere on this earth and played back in any context where the necessary equipment is available. If taken back to the location of it's recording and played it becomes an intrusion, irrelevant to the time at hand. Southwark tube station on June 21st 1995 will have no bearing on Southwark tube station on February 18th 1997 except that it is the same space with the same conventions of activity. Now a recording of such a place will be relevant to those who know Southwark in the audience at the CBSO concert hall on May 15th 2001, but this is arbitrary and meaningless. The audience was not at Southwark at this time or if they were then unless something unusual happened there at that time, it becomes meaningless. There is the sense

of place as an aesthetic concern however. Not all field recordings are bad, merely they are schematic, representative and exclusive.

As human beings we filter information all of the time. Selective listening allows us to listen to one voice amongst many, or to pick out a bassoon line in an orchestration of a piece of music. A microphone does not have this ability and so when we take a recording of a particular sound or scene we record the vibrations of every air particle that hits the diaphragm rather than what we hear - that is a subjective, selective impression of the aural panorama. When we listen to a piece of soundscape composition we are hearing a subjective fictionalisation of a scene in sound since the composer of such pieces will strive to make the piece as *representative* as possible of the aural scene he or she is trying to convey. Of course what is actually being presented in a soundscape *composition* that uses such a recording, is usually a representation of how the scene was heard, rather than a literal impression of all air particle vibrations at a particular point in space and time. From the point of view of a listener we are hearing one persons tastes and decisions as much as if we were listening to a piece of Schumann's chamber music or a Haydn symphony, as well as a product of its cultural-historical context. Luc Ferrari realised this, as did Pierre Schaeffer. It is evident from Schaeffer's background in sound engineering for radio and television programmes that he was aware of the fictional implications of recorded sound. The term *concrete* means literally "made up of diverse substances". What Schaeffer aspired to was the creation of a music of diverse substances where musical attributes are abstracted from recordings he made of trains, everyday objects and other sources from the traditionally non-musical world, as well as the world of music and musical objects/instruments etc.. Luc Ferrari's ambition for *Presque Rien* was "to tell stories" by the condensation of recorded time by editing. This is a recognition of the subjectivity - and the symbolic nature - of soundscape composition. The distinction should be made at this point between music that is *symbolic* - i.e. that where natural or found sound is intended to convey a sense of its location or source, and music that is *acousmatic* - i.e. that where sound is intended to be heard for its aesthetic qualities and concrete attributes apart from its location or origin. It is the acousmatic use of sound as musical rather than symbolic material that I have sought to manipulate in my electroacoustic compositions. In some cases (especially **Block Groove**, **Fright Fiction Simulator** and **Particle Foil**) the symbols and symbolic content inherent

to particular sound sources are a decisive factor in the inception and interpretation of a work. Nevertheless what interests me is a musical constriction and re-negotiation of the materials, with symbolic meanings and metaphors occurring as by-products of the interaction between the nature of the source and the process of composition.

1.1.6. Imposition of temporal structure

Imposition of temporal structure upon recordings was realised in a variety of ways thus:

1. Complex tremolo. Low frequency amplitude modulation is applied to a sound file more than once. If the modulation is applied at two different frequencies, a combination pulse will result with a complex rhythmic pattern. In **Batista!** the modulations are applied with dynamically changing frequencies. The resultant articulations are dynamic (as opposed to static) in that the relationships between the single pulses are not locked into one pattern of phasing, rather the relationship between phase patterns changes over time as well. This can be heard at 0'27" in **Batista!**.

2. Cyclic phase vocoding. This technique relies on the separation of analysis and synthesis in Csound's phase vocoding implementation. In this technique, the time-point envelope used to read the analysis file is made up from a combination of a line and a cyclic waveform (see figures 5a and 5b below). In practise this has to be clipped so that it does not try to read before the start or after the end of the analysis. Cyclic phase vocoding is the temporal modulation of a spectral profile. It can be heard in the second movement of **Batista!** starting at 1'53" and ending at 2'25". The re-synthesis (of certain bell spectra at this point) cycles forwards and backwards along the attack phase of the spectral profile of a bell. One can hear the linear component of the temporal envelope as gradual change in the rhythmic phasing of the cyclic pulse since the wave crosses the attack point of the file repeatedly. The point at which the sine wave crosses the attack portion of the pvanal analysis file is varied by the linear component of the envelope (in the case of the sound file ending at 2'27" a single, triangle-wave attack/decay envelope). I am not aware of any other composer using this technique. It allows one to dynamically impose rhythmic modulations on a

sound file without altering its spectral integrity and as such can be viewed as the reverse of the filter building exercise explained above.

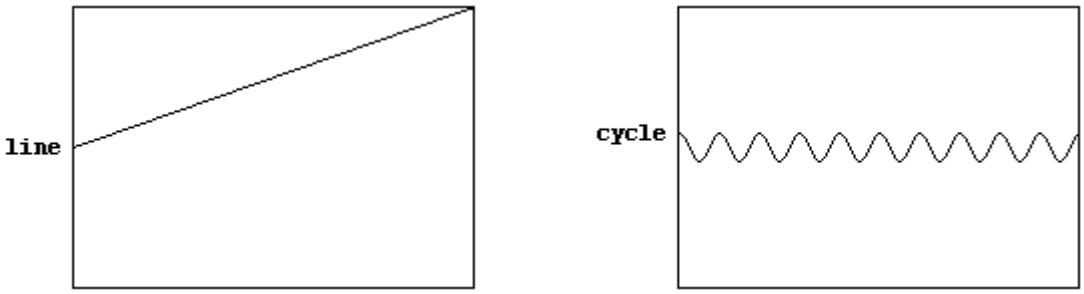

Figure 5a. The line and the cyclic waveform are combined to produce figure 5b (below) that is used to re-synthesise analysis frames from a pvoc analysis file.

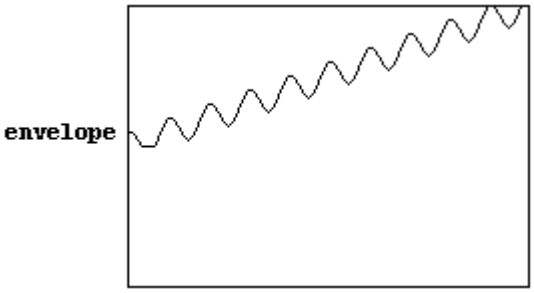

Figure 5b. The envelope is clipped so that the pvoc opcode does not attempt to access analysis frames before the start or after the end of the file.

3. **Metric modulation** and **time stretching** are linked in that the latter is used in part to accomplish the former. In **Batista!** and **Inside-Out** there are two different approaches to this. In **Batista!** it is a repetitive or looped sound, or an iterative (see below) pulse that undergoes this treatment. In **Inside-Out** the 'gapper' - an effect that inserts chunks of silence into a sound file, the "gaps" of a specific length and at regular intervals - is used. The material is "gapped", metrically modulated and then undergoes the spectral filter procedure explained above. All three processes can be heard in the work at the section starting at 1'36" and ending at 2'25" (as well as the Hyperprism™ granular pitch-shifting algorithm explained below). To metrically modulate a pulse the metrical ratios are translated into compression or expansion settings for a time stretch

algorithm. The algorithm used in these cases is the one provided with CEP - an iterative (windowing) time stretch algorithm that attempts to take attack transients into consideration when performing its action. The ratios used are integer ratios (5:4, 7:5, 9:4 etc) and are often applied to longer or shorter numbers of pulses than would make a complete tuplet (e.g. the ratio 5:4 applied to 6 pulses making a figure of six 5^{th} notes in traditional notation). This avoids the periodicity of complete tuplets interfering with the metric modulation. This process is carried out on more than one channel of sound (2 in **Batista!** at 6'17", 2 at 1'36" and then 8 at 7'34" in **Inside-Out**) so that the result is a complex counterpoint of metric relationships. This is one type of pulse network.

4. **Rapid accelerandi** and **deccelerandi** are used in **Batista!** These are iterations of the same or similar sound materials in a rapidly decelerating (e.g. at 3'19") or accelerating (e.g. at 7'00") figure. This is a separate approach from the discrete metric modulation techniques described above and below since the tempo is altered in a linear fashion rather than in steps according to integer ratios.

Another way in which metric modulation is used can be heard from 1'55" in **Batista!**. A repetitive ostinato (of bass guitar harmonics in **Batista!**) is initiated and gradually re-arranged. Metric modulations of sections of this motif are played together with the regular pulse and compete for the listener's attention. The modulations of the original are mixed with the original in such a way so that they lead the ear of the listener away from or towards the regular pulse. In this way the listener hears a polyphonic passage with various "routes" through it. Texture is established but not arbitrary texture. Instead of some random process (such as much granular synthesis) a musical process is used to build the texture from a simple ostinato figure. In the section of **Batista!** mentioned above the ear is continually drawn away from the time stretched bell spectra and cyclic phase vocoding towards the dynamically shifting texture. The ear is drawn back to the cyclic bell spectra that is underpinned by a reduction of the pulse network to a single iterated attack that crosses the threshold from rhythm to pitch and back again using…

5. **Pitch curves.** Pitch curves are used in **Batista!** and **Inside-Out** to transform rhythmic material and, specifically to modulate it into pitched material and back into rhythm. Curves (or envelopes) are applied to a single pulse in **Batista!** and a filtered pulse network in **Inside-Out** (from 2'25" until 3'39"). This is a free approach to rhythmic modulation in contrast to the

mathematical precision of pulse network construction. It is especially effective when a complex pitch envelope is applied to a pulse network of the first kind since we hear discrete pulses that interact rhythmically whilst following the gestural profiles of the pitch curves, rather than a solid line. The illusion created by the individual pulses of sound is that each gesture resembles the playing of notes. Each pulse is perceived as a single element of a single gesture whereas if we apply the same pitch envelope to a linear sound (as opposed to a pulse network) we hear continuity of line. In this case we hear a single sound with complex pitch modulations whereas in the case of the pulse network we hear a series of discrete gestures. An example of the type of pitch envelope discussed here is shown in figure 6.

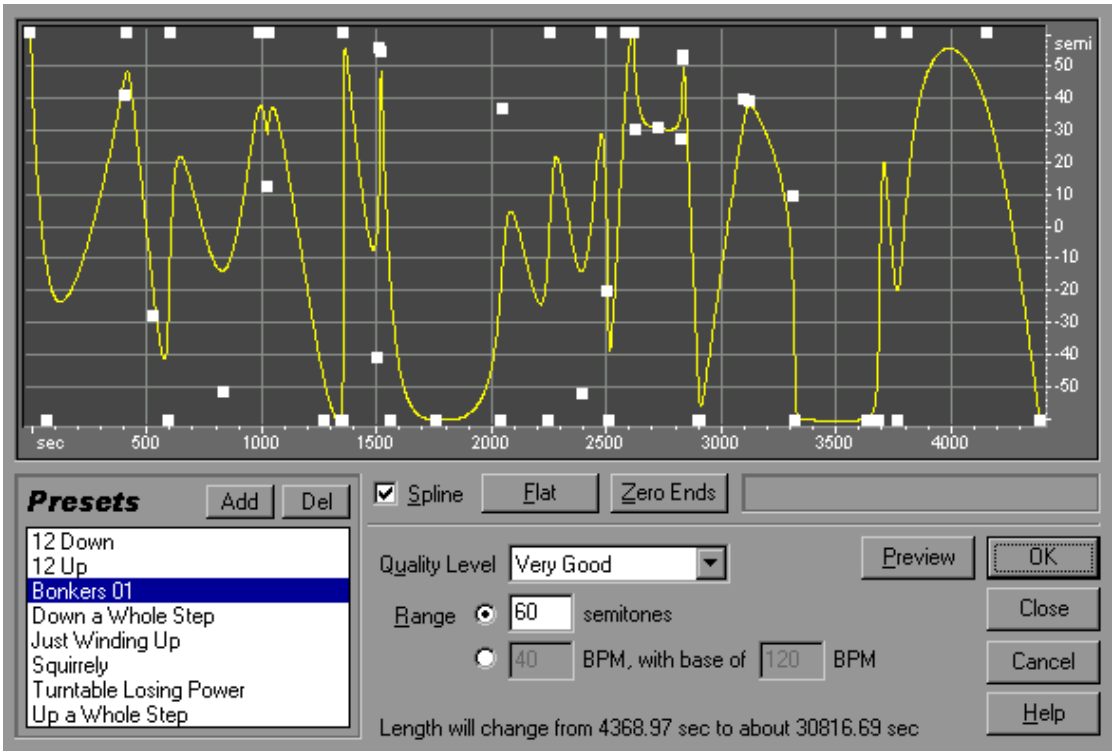

Figure 6. A pitch envelope of the kind used in **Inside-Out**.

6. **Spectral smearing** techniques were employed in the composition of **Batista!**. The creation of spectrally static textures with internal motion acts as a counterpoint to the rhythmic and temporal progressions of **Batista!**. There is a process I have developed in order to create sounds with fixed spectra but with internal motion (amplitude variation) between the partials of the sound

- using recorded material. Firstly the sound file is amplitude modulated with sine tones at moving frequencies. This process is carried out firstly with frequencies moving upwards through time and then with frequencies moving downward. A filter is then applied based on the spectrum of the original sound (as detailed above). The resultant sound file has a similar spectral content and temporal profile as the original, but the spectro-morphology of the sound is changed completely. Convolution is also used in **Batista!**

7. **Altered retrograde** is where a recording is played simultaneously with a reversed version of itself that has been altered. This can be heard from 4'32" to 5'03" in **Batista!** where a passage played on the [Indian string drum] is heard with a reverberated and then reversed version of itself. The symmetry of this technique is skewed by the alteration of the retrograde version, also by the temporal directedness of concurrent musical processes. An altered retrograde can be heard as an 'echo' of its forward original also, either before or after the original. Conversely an altered original can be heard as an 'echo' of its retrograde. This can be heard at 6'05" (with 6'10") and at 7'46" (with 7'58") in **Batista!**.

These are techniques that investigate temporal parameters creatively with respect to their relationships with other musical parameters such as pitch and timbre. There is an active engagement with rhythm in the construction and composition of each work discussed in the present article. This is in contrast to passive engagement - where articulations within a single recording are allowed to run their course unmediated by the composer, or where rhythm is subjugated to a minor role in maintaining a regular, cyclic notion of time with little or no deviation from fixed patterns (as is the case in much pop music). Concretions of elements (from improvised recordings) are treated as multiples (see below) and possess their own internal structure, but since they are improvised in the original recording there is an active engagement with rhythm rather than a passive one that pervades the entire piece.

1.1.7. Definitions of a "mix".

A typical club DJ mixes pre-recorded music with other pre-recorded music to integrate it into his or her set piece. This concept of mixing musics is not new, The Marriage of Figaro by Mozart contains examples of this as does the work of Charles Ives. In The Marriage of Figaro, the orchestra is at one point divided up into two ensembles, each of which plays in a different tempo (one in triplet rhythms, the other in duplet rhythms). Each ensemble has its own separate identity, and the combination of the two pieces of music is used to symbolise the contrary purposes of the characters of the Opera. Much of Charles Ives's work mixes musics by incorporating hymn tunes and brass band music into orchestral works. The combination of different brass band music in the second movement of Ives' **Three Places in New England** is an example of how pieces are mixed together in his music in contrasting relationships. In the piece by Mozart the musics denote forces of opposition at work, whereas it is clear that Ives intended for the music he composed to be heard as a whole. As Ives quotes his father as saying:

"If the mind can understand one key, why can't it understand another key with it?"[v]

The combination of entirely different marching band pieces was an experiment conducted on a number of occasions by George Ives, Charles Ives' father, and his influence on his son's musical development is well documented. Thus we can conclude that the forces of opposition in Ives' music are intentional. Nevertheless, the separate pieces played together work against each other, as forces of opposition.

The modern club disc jockey (DJ) entertains the audience with recorded music that is integrated harmoniously (or more precisely according to aesthetic commonalities). This is both a process of reduction (similar tempi, harmonic consistence etc.) in that the music is mixed according to common elements, and a process of construction in that pre-formed ideas (recordings) are re-contextualised by their relationships to other music.

1.1.8. Creative Recording in *Batista! (Lament)*

An important factor in the composition of **Batista! (Lament)** is that it was made with mostly pre-formed material. That is to say that the material already contained degrees of musical

structure before the process of composition began. The material for my electroacoustic tape music always comes from the act of performing upon instruments or objects rather than recording them in a more scientific, objectified manner. The reasons for this are as follows: The emphasis on improvisation as opposed to observation is important, since it is this approach that gives the material for a piece its own set of musicalities from which complex polystylistic textures may emerge. In other words, I want to make music in every stage of the process of achieving a finished composition from a handful or more of source recordings. When recordings of a sound source are made in the manner of an improvisation the composer can build a rich set of articulations of the source before the editing process has begun. A lot of the character of an acousmatic piece may depend on the recording conditions for its source material. Subtle inflections in timbre and style can be readily played if one treats the recording session as music and plays accordingly. Inflections that may be overlooked were the recording session treated as an instrument-building exercise. Although recordings may be manipulated and transformed once a recording has been made, the nature of these manipulations is always highly dependant on the characteristics of the source material and how it was created. If a characteristic of an object is not recorded then it remains unavailable for transformation and investigation, and since the acoustic domain is the highest-resolution environment we have available to us it is worth exploiting it fully. Detailed material may be constructed in the digital domain, yet there is no physical interaction of sounds and vibrating objects in this environment. For example, a sampled piano instrument may be made from high-quality multisamples, may indeed be very convincing, yet the effect of one piano string upon another is never reproduced by such an instrument as it is played. If the source material for a piece is imbued with musicality at the moment of recording, the acoustic properties of an object or instrument may be exploited and material may possess a rich vocabulary of sound.

1.1.9. Concurrent Work.

Batista! (Lament) was composed whilst work was ongoing on **Continuum**, the most complex of my scored works to date. In many ways the process of composing in more than one medium at a time is highly productive, since experience gained in one medium is applied to the

other. **Continuum** (see chapter 2.2 for a detailed account of this work) is a piece for strings and piano that explores polyrhythmic structures that are interleaved, in that one tuplet is interrupted by another. Although this technique was conceived in the instrumental medium, **Batista! (Lament)** and **Inside-Out** explore musical ideas derived from this technique.

I was well aware when composing **Continuum** that the piece may never be played, yet my conviction that it is an important work of art is still strong and will remain so. I wanted to explore ideas of complex rhythm in both instrumental and electroacoustic idioms, the former to devise new formal approaches to rhythm and harmony, and the latter to explore free rhythmic expression coupled with complex rhythmic and timbral manipulations of sound recordings made possible by computer software. **Continuum** took three years to compose a piece that at best will only ever be heard as an approximation by performers. It is a work to be played and the composer wishes it to remain so at the present time (rather than a fictional construction of how it *would* sound), however **Batista! (Lament)** is a complete realisation in sound of material that makes use of the same rhythmic ideas. **Continuum** is as much as a work of conceptual art about instrumental composition as it is a piece of music to be played - although this perspective will change once a performance has been achieved. I needed to balance the rigorous compositional activity that went into **Continuum** with work in a more responsive medium, to compose in a way that would allow me feedback between the fruits of my labours and my aspirations and affectations concerning them. In composing complex polyrhythmic instrumental music I had to forego the process of aesthetic evaluation of my work in compositional time since it was unlikely the piece would be performed until long after its completion. I set about making a tape piece to express formal procedures that had become the tools of my instrumental composition directly, in sound, and freely, yet the work had to succeed or fail (and so the materials had to be selected) on the basis of its sonic aesthetic qualities regardless of formalistic concerns. An added advantage of computer composition is that the potential for accurate temporal detail many times more complex than that which is possible for an instrumental performer. And so I composed **Batista! (Lament)**, which was premiered in October 1998 at the University of East Anglia and has since been performed at the ISCM festival in Sao Paulo, Brazil in August 2000.

The stereo (in **Batista!**) and 8-channel (in **Inside-Out**) polyrhythmic sections demonstrate the principle of the interrupted tuplet admirably. Structurally these sections consist of streams of incomplete tuplets (4 quintuplets, 5 septuplets etc.) based on a master pulse that is present in the original material (a single regular pulse rhythm). Comments from instrumentalists that "you cannot have an incomplete tuplet" and "this passage is impossible" motivated me to pursue the composition of electroacoustic music: incomplete tuplets *are* possible – they exist in my tape music!

1.1.10. Combination Form in Batista! (Lament)

Technically **Batista!** Is a piece written in the acousmatic tradition. It is composed from recordings made in the summer of 1998 of contrabass, amplified and prepared bass guitars, Ektara and various found metallic objects. The material performed on these was deliberately rhythmic and often explicitly polyrhythmic (as are my instrumental compositions). My intention was to compose music using material that was already music in the sense that it had been performed, to imbue the material with a musical character apart from its sources' inherent morphological properties. The phrases and actions performed on these objects and instruments form micro-structural units out of which the macro-structure is made. This is what I mean when I state that this piece is an example of combination form (my own terminology). Each section or element contains its own musical logic and can be described according to rhythmic, harmonic or timbral definitions and processes but it is by a combination of these (often disparate) materials that the overall structure of the piece is defined.

Although my aspirations were to create a piece entirely from instrumental sound or instrumental uses of found objects, one very small piece of conceptual 'leakage' occurred during the selection of materials to use. In order to get a feel for the acoustic qualities of the performance space, I had made a sound with my body, using my thumb and my cheeks to produce a percussive sound to test the reverberation of the room. Although this was never intended to be used as a source, it became integral to the structure of the work. It is a sound that may be recognised by many, a sound often made by or for children's amusement. It represents the only non-instrumental

source in the piece. This makes the distinction between sounds made apart from- and sounds made with the human body. There is an important psychological difference between the two. Human sounds are personal, they are made by somebody for somebody (even if it is the same somebody). There is a degree of psychological separation one has from non-natural sound (that made by humans for its own sake away from the body) that is breached by human utterance.

1.1.11. A Structural Typology

There are four primary structural archetypes in **Batista!** There is the singular sound event, the structural complex, the iterative stream and the linear contour. These can be defined thus:

1. The singular is an isolated sound event. It could be an attack/decay structure or a pitched note. It may be played forwards or in reverse but it remains a singular structural item.
2. The multiple is an autonomous structure with its own internal structure and articulation. It may consist of more than one significant sound event or it may be an extension of articulation, as with many kinds of ornament on plucked instruments.
3. The iterative is any structure that consists of repetition of a sound event or structural process (such as tremolo) whether it is simple (a single meter) or complex (metric modulations, complex tremolo and similar structural effects).
4. The linear is a sound structure that slides in pitch or timbre without corresponding attack-based articulation.

As with any structural typology there are overlaps between the definitions of types. These are shown in figure 7a. Structure and pulse combine in ostinati for instance, and linear gestures may possess non-discrete musical structure. The structural, the iterative and the linear all overlap significantly. The singular as a compositional object exists only in overlap with the linear (e.g. pitch slides on the fretless bass guitar) but if we adjust the model to represent how a sound element is perceived in the context of a musical work rather than how we use it to compose then we must make the singular a subset of each of the other three sets (figure 7b), since we perceive each smallest perceptual unit (whatever that might be) as a member of a perceptual group or hierarchy,

the entire work being the highest level (highest resolution) of form presented to the listener.

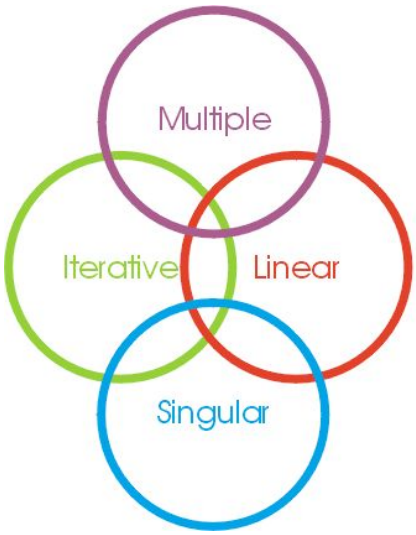

Figure 7a. Formal units in Batista!

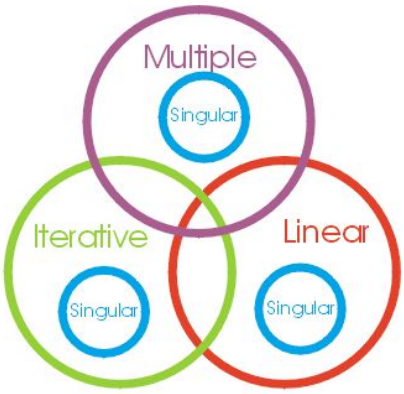

Figure 7b. Perceptual Model

There are various terms and conditions that are taken for granted by these definitions. A sound event is defined as a perceptual object after Schaeffer[vi]. This will inevitably contain its own spectro-morphological profile (Smalley 1986) and hence its own internal structure. It is how we perceive this internal structure on which the model is based. This is on one level instinctive (or habitual, depending on whether the perception is due to innate ability or learned behaviour) and on another level a result of conscious effort by the listener. It is worth bearing in mind that we are looking at this model in the context of a piece made under quite precisely controlled conditions. Aside from the small amount of conceptual "leakage" mentioned earlier we are dealing with a

piece that is made from material, which was played to be intentionally musical in the traditional sense (although highly experimental).

So far we have discussed the process of composing electroacoustic music in terms of its micro-structural properties. This is a bottom-up approach to analysis. In order to see how this typology of musical structure functions within the larger formal scope of a work, a top-down approach is appropriate.

1.1.12. Form and Partitioning in *Batista! (Lament)*

A scientific examination of how the human brain hears musical relationships as coherent or not is outside the scope of this document, but suffice to say that a listener's understanding of music is to do with the acquisition of skills rather than an innate ability of music. Any analysis of perception here is based in part on experiential observation and listening, but takes for granted a cultured audience with a sophisticated understanding and experience of music. Practically this would be a naïve assumption to make, but it is necessary in order to discuss music in terms of the *perception* of musical structure. It is relevant to talk of the untrained ear as not perceiving the structural subtleties of sophisticated musical discourse, and so such considerations can be disregarded.

When one hears an individual structural element in a piece of music it is as though one's perception of it is filtered by its relationships with the work as a whole and smaller structural groupings thereof. We hear individual elements according to their function within a piece of music that is defined by its relationship with other elements of a work. We recognise musical works as consisting of sections or movements with coherent internal structure. Discontinuities are heard as new sections or movements with the potential for new musical relationships and contexts. Emilios Cambouropolous (Cambouropolous 1997) calls this the Proximity Rule of segmentation. The Proximity Rule states that:

> …amongst three successive objects that form different intervals between them a boundary may be introduced on the larger interval. i.e., those two objects will tend to form a group that are closer together (or more similar to each other).[vii]

The work done by Cambouropolous and others is concerned with melody as a sequence of discrete pitches but it can be extended to consider other musical parameters such as intensity, spatial depth and timbre. Discontinuities in music happen in all dimensions of musical articulation. We perceive things as being different from other things according to degrees of scale, but also according to differences between expressed attributes. For example on might hear a passage of

reverberant tones as a single musical entity, but if it is followed by a dry percussive attack we hear another entity distinct from the first in pitch (or pitched-ness), spatial depth, duration and timbre. This forms a sectional boundary as we hear discontinuities in many attributes of the sound, what we actually perceived is a different expression in sound - a different sonority and by metaphor a different *instrument*.

In the context of a work like **Batista!** these discontinuities are often underpinned by other musical processes that are continuous regardless of discontinuities within other streams of musical information. Kramer calls this embedding of temporal structures "multiply directed linear time" (Kramer 1988). Simultaneous musical processes evolve independently in **Batista!** whereas individual events between improvised multiples occur synchronously and are heard as contiguous gestures, as connections between disparate streams of musical information. Just as in conventional polyrhythm there are moments of synchronisation but in this case there is a free musical development between the points of synchronisation in each layer of the music independently of the other layers (without deliberate mathematical relation of metre or tempi). A clear example of this occurs from 2'54" in **Batista!**.

Discontinuities occur on every structural level of **Batista!** and the highest level (global) discontinuities announce the commencement of a new set of musical structures and processes. Largely in **Batista!** these are changes of timbre or phenomenon (expression of sound through time). In analysing a complex musical work we can examine its micro-structural properties, yet if we are to discover how such a work is perceived in terms of its form we must also look at which processes drive fundamental structural changes within a piece in the context of the work as a whole. We need to focus on that that is perceived as musical difference in a work. This implies that there are some sections of a work that are contiguous and consist of some kind of musical "sameness". We perceive time-structured music as having coherent sections that consist of the same or related musical substance throughout. Often the unification of a particular section of music relies on the working out of dynamic musical processes. Though these processes result in change throughout the time of the section of music in question we still perceive sections of music as individual perceptual items (the exposition of a classical sonata for example).

There are dualities of static material/dynamic process and dynamic material/static process that exist in **Batista!**. If we look in greater detail at the structural elements of **Batista!** we find that static materials (such as the re-iteration of a single attack) are governed by dynamic processes imposed on them. On a perceptual level this material is static since it is literally repetitive. The imposition of a dynamic process on such material is perceived as an *evolution* of a static structure. An example of this is combination of dynamic and static processes in its simplest form can be seen in the gradual timbral change imposed on the steady rhythmic pulse from 2'21.333" to 2'45.668". Here we see how a dynamic (moving) timbral and spatial change in static (repetitive or stable) material can facilitate a duality of motion and stasis. In fact what we are confronting when we listen to such a change is a basic human need to resolve the information we receive via our senses into patterns of structured information. Thus we perceive two levels of structure in this passage, the dynamic trajectory of the timbral change and the static repetition of the metric pulse.

The structural types discussed earlier are transcended by certain impositions of structure. An example of this is the speeding up of the pulse at the end of the passage in question until it becomes perceived as a linearity, which in turn leads to a singular (percussive "pop" sound) upon which is imposed a linear timbral change. This is an example of how the definitions between types of material are blurred by the interaction of processes that cause the material to transcend perceptual boundaries (e.g. rhythm + timbre to pitch + duration + timbre).

In order to understand how material functions within the typology model discussed earlier it is useful to view it as a three-dimensional model of perception as in figure 8.

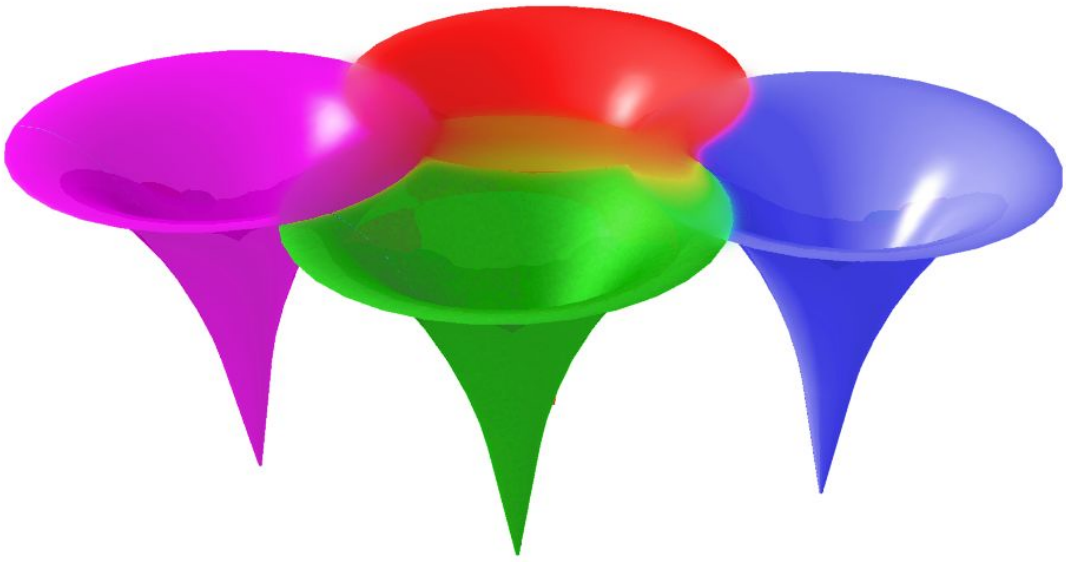

Figure 8. A three-dimensional model of the perceptual categorisations of Figure 7a. The identification of a sonic entity has to overcome a kind of 'perceptual gravity' in order to move from one category to another. The blurred boundaries between the categories of distinction are similar to the perceptual "grey zones" of Stockhausen[viii].

Processes transcend the model by moving from one perceptual category to another. The boundaries between categories of material are blurred, but once a stream of audio information (sound) has crossed the boundary between two perceptual types it quickly becomes the new type to us. It is as though a material at one edge between two perceptual categories has to overcome a perceptual 'inertia' or 'gravity' to become perceived as a member of a different category of sound. There is an ambiguous area between the perceptual types that stretches our brain's ability to categorise sound, just as (as Stockhausen makes us aware – see footnote) there is a blurred perceptual distinction between pitch and rhythm or between duration and form. An arresting moment such as the rhythm-to-pitch transition discussed earlier heightens our awareness as we are challenged to confront ambiguity and to comprehend the boundaries between areas of perception. The transition mentioned happens too fast for our perception to switch quickly between modes of listening and thus creates tension in the listener. The percussive attack puts an end to the process and we are left dissatisfied - and ready for the musical engagement of the next section of music

that relies on interplay rather than focusing on one aspect of sound. The complex and discontinuous (interrupted) nature of the proceeding section is in high contrast to the continuous pulse of the previous passage. It is as though the listeners attention is focused by the detail and monotony of previous articulations, primed for a musically complex discourse by presenting the listener with perceptually ambiguous materials.

1.1.13. The Illusion of Causality in Acousmatic Music.

Acousmatic music is an illusory art form. Since it does not have any players it affords the composer a mode of music in which interplay between sound elements is wholly predetermined, and is analogous to film in this respect. The disembodiment of sound from source alters the way in which the music is perceived as divorced from physical human activity. In an orchestral or ensemble performance the listener is presented with clear relationships between cause and effect embodied in the relationship between physical gestures of the performers and the resultant sound sensations. Such causal relationships are enhanced and confirmed by a learned awareness of musical instruments and sound production techniques employed during performance(s). The removal of such an unambiguous relationship between the cause of a sound and its effect on the listener greatly enhances the potential for causal relationships to be perceived as an integral component to the fabric of the music. In **Batista! (Lament)** and **Inside-Out** this perceived causality is reinforced by using performed material as source material, since one's own sense of what to play next is continually active during the recording process. The acousmatic is an appropriate metaphor for disembodiment from source but in its original use (after Pythagoras) it is by its very nature illusory. The lectures delivered by Pythagoras from behind a screen were intended to be perceived as a disembodied voice somehow separated from its origins. This is a perceptual trick played on the audience; Pythagoras was directly responsible for the content and delivery of his lectures and so no real separation *in time* existed between source (cause) and speech (effect). In acousmatic music this illusion is taken one step beyond its original manifestation in terms of separation. The invention of recording allows one to take an accurate representation of the effect (sound translated into electricity, magnetic polarisation and digital switch positions; binary

1s and 0s) and separate it in time *and* space from its cause. This removes one aspect of the perception of music from the listener - one no longer has an obvious perceptual anchor for the sound (a performer in the context of music or any event in the wider context of human experience). In separating the material from its origins we are liberating a crucial aspect of how we perceive sound from its reliance on visual cues from physical objects excited and gestures enacted in physical space. Our basic need to find patterns of information in sensory input causes us to perceive sound elements in a work as being connected, also since we understand that a musical "work" is a thing made up of related events (in western musical tradition). Since we are lacking a credible source to which to attribute the sensations we experience to in acousmatic music, we can in some instances perceive the sounds themselves as causes for future sound events to occur. We seek source information in the material itself but also we perceive tension and release in an acousmatic work as cause and effect. It can be suggested that a lack of visual or environmental cues enhances this perception. We can deduce from this that acousmatic music relies on illusion for its potency since it is our search for information (pattern) coupled with our ability to imagine extensions of, and perceive associations between events within the sensations of sound we hear when the music is played to us (source and completion, cause and effect). The illusion that an attack or other feature of a sound is caused by another is created by the composer often as a simple juxtaposition, but it is perceived as though one sound were a direct consequence of another. There are many instances of the illusion of cause and effect in **Batista!**. Examples occur at 0'45.609", 0'55.504", 2'45.545", 3'13.862", 4'26.751", 5'00.785" and so on. Illusory causal relationships are a defining feature of **Batista!** and pervade the work throughout.

Analysis of a musical work in terms of this illusory causality is an approach to understanding sensations of tension and release in acousmatic music that is analogous to a discussion of cadential forms. Often an instance of cause/effect relationships coincides with a pitch cadence in **Batista!**. From 0'08" to 0'30" there is a clear I-V-I pitch progression that is heard as a series of cause/effect relationships. The rhythmic progression at 0'14.5" connects a series of attacks that are easily recognisable as a plucked string with another more ambiguous attack. The listener's sense of pitch before this change occurs is based on temporally smeared and spatially diffuse spectra with a pitch of F natural. There is spectral similarity between this and the attack that

immediately follows the plucked attacks at 0’14.5”, but this attack is connected rhythmically with the plucked attacks. The perceived rhythmic connection between the plucked attacks and the following attack makes it appear that the plucked attacks cause the nature of the pitch base to change from a linear diffuse spectrum to a singular attack. This effect is heightened by the change in pitch to C natural - the fifth degree of the mode established previously of F Lydian mode. Similarly, the sweeping pitch that dominates from 0’24” to 0’27” is heard as being connected to the attack that follows, as well as the change in pitch back to F forming a perfect cadence.

It is important to note that this has been accomplished by experiment, by design but not by deliberation or pre-conceptualisation. When one sound event is perceived as being caused by the theoretical source of another it is because the composer heard it that way by searching for it, not because of any actual “cause of sound”. The illusion of cause and effect in electroacoustic tape music is a purely perceptual one. The physical means of production of sound in the performance of acousmatic music is relegated in its importance by negation, in that all sound events emanate from loudspeakers. This frees a massive part of the listener’s perceptual capacity, image processing functions for example. The imagination of the listener is vital to the perception of music that presents no extra-musical cues to the listener. Effectual relationships such as these are functions of “gesture”, which in electroacoustic tape music is analogous to music’s *trajectory* over time.

Chapter 1.2. Block Groove : Authenticity and Context

1.2.1. Conception.

In the modern world copies of musical 'originals' can be freely purchased as CDs or vinyl discs, but these are the products of commercial exploitation of art rather than the substance of artistic creation. Copies of works of art on CD or in print or on my wall are reminders of what art works look like, sound like and say. Artists such as Andy Warhol and Marcel Duchamps and John Cage parenthesised this relationship between art works and consumers by re-contextualising objects from everyday life as fetish objects (Duchamps' **Fountain**) or motifs from well known operas as archetypes of opera itself (Cage's **Aria**) or by presenting commercial images as mass produced 'objets d'art' (Warhol's **Campbell's Soup Cans**). In the work of these artists one is forced to confront ones own consumption of icons and symbols (or patterns and motifs) as objects of *fetish*.

One can categorise musical activity on the basis of mass reproduction, with the singular experience of a concert of improvised music at one pole and the superficial media frenzy of "Pop Idol" at another. In between the two we find instrumental composition, tape music and rock concerts. Still we are talking about music whose authorship is defined (although at the extreme commercial end of the spectrum there is a more ambiguous relationship between performers, composers and the audience), but the activity of the modern DJ in both programming and performing a selection of other peoples' music(s) is more difficult to define in such terms. The DJ re-contextualises the objects of fetish (recordings) one with another but remains one or more stages removed from the creation of original material. The DJ takes responsibility for the selection of music to play but not for the composition of the music itself, and for the manner in which the playback is executed and mixed. These are compositional decisions and in some aspects of its realisation, a DJ mix *is* a composition. The DJ is to some extent a composer (from the French word 'compositeur' meaning "one who puts things together" or "one who connects that which was previously unconnected"), or to borrow from the French language, a *bricoleur*. The DJ stands outside of the compositional process in that his materials are ready-made music, yet the process of

mixing involves compositional decisions regarding what to play and how to integrate it into a seamless mix of music. A DJs compositional decision making is typically subservient to the music he plays. For the most part in modern club culture, the DJ is entrusted with the role of keeping the audience on the dance floor. Beat-mixing (the process of matching one record's tempo to another by lining up the beats, pioneered by Larry Levan in New York in the late 1970s) is a technique favoured by DJs throughout the western world in order to keep the music flowing. If a DJ is also concerned with only a narrow range of styles of music (as is often the case) then his compositional decisions are already restricted. In many clubs one will hear one tempo and one style of music for the whole night. In this situation the DJ is an executor, whose compositional powers are all but negated by his role in keeping the music consistent. **Block Groove** (Edward Kelly/Nicholas Melia, 1999) inverts this situation. In **Block Groove** the material and the compositional process are in dialogue. The relationship of material to compositional process varies section by section. In some sections there is a clear imposition of structure on the material as well as clear references to club music styles or genres (the third and fourth movements of the work). In others, most notably the opening section of the piece, there is an interplay between material and process that is reminiscent of switching between radio stations, and in doing so switching between musical contexts and cultures. The concept of a re-mix is taken to an absolute where the work is a re-mix of every source-work, yet none of the individual pieces cited is what **Block Groove** is a re-mix *of*. It is a mix in the sense that Cage's **Williams Mix** is, except that the sources for **Block Groove** are culturally encoded in a musical way rather than a theatrical way. It throws the concept of 'original material' into question in the same way as the **Williams Mix** in that culturally archetypal materials are considered as common property in both pieces. There follows a technical and musical analysis of **Block Groove**.

1.2.2. Inception and Technique.

Block Groove was composed by Edward Kelly and Nicholas Melia in the winter of 1998-99. It is composed largely from samples taken from commercial vinyl and shellac records using a variety of extended playing techniques. The samples were taken using Technics SL1210MK2

phonographs that were used to play records that had been doctored in some way, records at the wrong speed, RPM sampling (see below) and to play the contact between the stylus and the groove in an improvisational fashion (as though the point of interface were a musical instrument). The following is a summary of techniques used and a discussion of their implications, as well as a musical analysis and a discussion of how **Block Groove** relates to sampling culture and the history of commercial exploitation of recorded music. A parallel discussion about the process of collaboration with another composer will develop, with particular reference to the interpenetration of ideas that pervades a successful collaborative project.

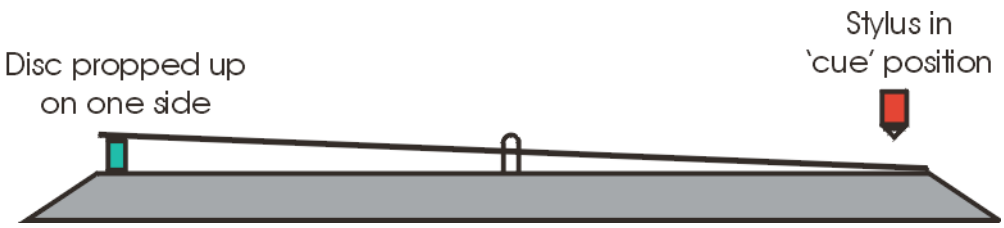

Figure 9. RPM sampling set-up.

RPM sampling (Revolutions-Per-Minute sampling) was first explored by the composer in multiple record-player experiments from 1988 to 1990. The technique is to take a vinyl or shellac disc and prop up one side of it on the turntable so that the record is tilted (see figure 9). The cue arm is also propped up (usually with modelling clay) so that it touches the raised portion of the record but not the portion that is flush to the turntable (see fig. 1). When the turntable is spun, arbitrary sections of the record are played periodically as the record touches the stylus suspended above it. The separate sound entities that result may be repetitive or non-repetitive (in material, but are likely to be repetitive in periodic structure). High quality modern gramophones tend to be more sensitive and finely balanced, and so repetition is usually only achieved by careful fine-tuning of the system - since the interaction with even a small portion of the spiral groove of a record will move the needle along somewhat. Older decks tend to produce more repetition with this method since the mechanisms are usually much stiffer and heavier than in more recent models. Note that this does not work with linear tracking systems as there is no physical access to the stylus or turntable in such systems.

One of the delights of this method of random sampling is its inherent unpredictability. Even on an inexpensive gramophone there is no way to predict which way the stylus will travel as the record's surface drops away from it. The more finely balanced record deck will move both according to the spiral of the groove and according to the groove itself, although it is far more likely that defects in the playing surface will influence the direction of the needle than the groove itself. Since the record is set on a slope, the needle drifts into the groove (often with a click if the groove is not aligned with the stylus) and then the groove drops away. During the approach phase there is often a gradual increase in fidelity, and vice-versa for the receding phase. The result is a series of slices of the record of equal length an equal length of time apart (both of which are altered by moving the stylus closer to and further away from the record). The beauty of this is that one can never predict how the structure of the recorded material will be disrupted by this process, or how the internal structure of each slice will be affected when it is arbitrarily framed by silence and noise brackets - the increase and decrease in fidelity at the start and end of each section mentioned above.

Issues of context in **Block Groove** are epitomised by this technique. Each slice of sound is usually quite short - enough to contain only a notional echo of the piece of music it is taken from. Since the samples are taken arbitrarily there is no specific intent to steal 'a significant part' of the music on the disc. There is no attempt to edit material according to perceived structure either. Each recording made in this way owes its character as much to the recording *process* (RPM sampling) as it does to the commercial *product* from which it is taken and the musical structure of each recording is a hybrid of the *material* and the *method*. These recordings invariably inherit aspects of the cultural norms and production traditions that went into the making of the records. What one obtains after a number of different records from different musical traditions are played in this way is a set of cultural 'snapshots' or distillations of production techniques and musical styles. Since one is taking the finished article of a process of aspiration and technical convention as raw material to begin with this should come as no surprise, but in combining these fragments of music into a new piece of music their characteristic cultural aspects become more starkly apparent. For example, 400ms of British pop music from 1986 may have no meaning by itself, but when it is juxtaposed with 300ms of 1950's European Avant-Garde instrumental music each fragment is

thrown into bold relief by its relationships with the other. Thus the (sonorous) theatricality of such a juxtaposition is one of a contrast of styles, production values and orchestration. The cultural contrasts between the music-s one has sampled become apparent through their juxtaposition.

Noise is a major feature of mechanical recording techniques. Vinyl, shellac and especially acetate recordings become scratched, dusty and generally degrade in audio fidelity as time wears on. **Block Groove** is as much a piece about this process of degradation of the media of mechanical recording (vinyl, shellac etc.) as it is about cultural and stylistic contrast. It is a work on the culture of recording that subverts commercial recording by transcending its materials - vinyl and shellac records. In composing **Block Groove** the surface noise and stylus artefacts were considered to be as important as the sound that the records were manufactured to distribute. The process of record being played again and again and its cumulative effects are under investigation in this work. The process by which the records got to the composers of this piece is as important to the work as the intent with which a stylus was placed upon a record (or dropped, scraped, bounced and thrown upon the disc). The composers of this piece in engaging with the process of making it, are engaging in some way with all of the cultures from which the musics emerged and all of the people who ever played, stored, moved or dropped the recordings of the music - of which remains only surface noise, a stream of cracks in the sound caused by individual events in time. Each record's history is intertwined with the history of the material recorded on it, and this dual temporal relationship is embodied in one experience of sound when the record is played. The fact that the piece exists as a contrivance on CD format is an end to this process, but perhaps this piece of music should be pressed onto virgin vinyl at some point, to be played on the very machines that gave rise to it! That would create a work that continually becomes more representative of its sources as it is played, and yet the process of playing such a record would gradually obfuscate the surface noise inherent to the source material. Thus a vinyl realisation of **Block Groove** would possess its own history, compounding the temporal duality of musical/physical history with its own physical (un)development. Christian Marclay's **Record Without a Cover** explores a similar theme to this, although it is not available on CD.

Cutting, melting and eroding the records gave rise to a number of different effects, most notably (in **Block Groove**) the loop of Beethoven piano sonata that runs through the second

section of the work. Many techniques were developed as the work neared completion (and performance) and so were not included in the piece, however a performance by myself and Nicholas was executed at a concert at the University of East Anglia in March 2000. One of the techniques developed at this time is the technique of scraping the plastic from the record with a curved scalpel whilst playing the record (and hence removing the musical material and exposing the medium's physicality). Other techniques include cutting rhythms into the record, baking the records in the oven so that they become deformed, and burning the vinyl with a cigarette lighter to create ridges, which cause the needle to jump around erratically.

1.2.3. Formal (Perceptual) Analysis of *Block Groove*.

Block Groove is in five movements with no pauses. The boundaries between the movements are largely blurred and indistinct. Nevertheless five distinct formal entities can be located within the work.

The music of the first section arises from the relationship between the imposition of new material on more established material and the assimilation of such material into the fabric of the work. By imposition I mean that new material is introduced suddenly without any clear indications earlier in the piece as to why it occurs. The regular noise-burst running through the first section acts as a reference point for this material analogous to a pedal note in orchestral composition. As the section progresses there is more and more interplay between the fragments of music taken from the discs and the surface noise theme. The material is *assimilated* into the fabric of the work. The piece consists of three streams of hereby referred to as original source, surface noise and psycho-acoustic sound. At the start of the piece the music is heard as RPM sampled fragments of original source that interrupts a repeated surface noise attack. As the piece progresses the interplay between original source and surface noise intensifies, becoming more rapid, so that it is heard in places as a single collage of materials rather than two streams of material that interact. The audience's awareness of how music sounds from vinyl is important here as it will affect the way in which the music is perceived. An audience that only has experience of compact discs will have a different interpretation of the work (this is discussed in greater detail below). Surface noise is usually

accepted as unwanted artefacts created by wear and tear on a record. Once it has been recognised as such the listener will likely expect it to be relatively constant throughout the duration of the work, due to prior knowledge of how an old record sounds. Thus the listener is presented with a new listening situation when (s)he identifies interplay between material stored (original source) and that which constitutes a by-product of the means of storage (surface noise). In fact the intensity of the initial attack would already alert an audience to the deliberate use of surface noise, as would a typical (multiple-speaker diffusion) performance situation for the work. In order to devise a performance situation where the use of surface noise is not initially interpreted as a deliberate compositional device, a vinyl disc could be made of the piece as mentioned above.

It is necessary at this point to put **Block Groove** into a historical context, and to discuss its implications for future listening. For a listener who grew up with no contact with vinyl records, **Block Groove** may possess a different set of meanings (or a dearth of them). Those who grew up with CDs may be unaware of surface noise, or may have a different awareness of such phenomena. In sampling culture (see Waters 1996) record crackle has become a compositional device. The line between *medium* and *material/message* has become blurred since the invention of the sampler. In present times it is not unusual to hear a piece of pop music with a surface noise sample woven into its structure. Since the introduction of the compact disc, the use of surface noise as a compositional device has been used selectively by pop music composers to introduce sonic "imperfections" into music on a format that is for most listeners a perfect reproduction of the "original" piece of music. The contrivance of imperfection is notional in this case, since the imperfections are in fact an accurate impression of what surface noise sounds like. This is a truly acousmatic use of sound since the apparent source of the sound (if we are to identify the CD itself with this role) belies its origins. **Block Groove** is a piece of music about the process of musical reproduction. Were it presented as a vinyl or shellac disc it would become a self-referential artwork, but since it is presented on CD it is an acousmatic piece divorced from the origins of its source(s).

The impression of records jumping is distorted in the first section. The cuts and glitches are not regular as with a record. Sections of material are repeated erratically and re-iterated after the climax at 1'44". This prepares the listener for the second section, which is based around a skipping record. The loop of Beethoven piano music (a 33+1/3RPM disc played at 45RPM) acts as

a resolution to the chaotic development of the first section due to its stability and consistency. Taken from a record that has been deliberately scratched, the (true) impression of a jumping record is heightened by the inconsistency with which the stylus jumps back three grooves instead of one. Another jumping record is combined with the first setting up a polyrhythm at the ratio of 33+1/3 to 45. The combination of stasis (stuck records) and continual shifting of meter creates tension in the music, already created by the first loop, which continually gets stuck on the V chord of a perfect cadence. The high frequencies added by Mr Melia create a sense of pressure on the listener that one is conscious of only as it is removed. Samples of free jazz and sped up laughter, together with reverberated surface-noise patterns are composed into the fabric of the jumping records/high frequency to heighten this effect.

The nature of collaboration between two composers is that it requires that two separate approaches be combined in one piece. Consequently, the piece often becomes a hybrid of disparate ideas, and **Block Groove** is no exception to this. Whereas my own approach was concerned with arbitrary sampling techniques, and consequences of the interaction between original source and surface noise in recordings and players that were altered in some way, Nick's approach was much more clearly concerned with the physicality of surface noise and high frequencies combined. It seems appropriate to speculate that the reason why the piece works is due to the opposition of our two approaches to the material. Whereas Nick's approach appears concerned with the physical surface noise, stylus interaction and high frequencies, my own approach was concerned with random sampling of recordings, and the juxtaposition of fragments exhibiting extreme differences in musical style and production. The (ordered) periodicity inherent to a rotation based playback mechanism coupled with the arbitrary (chaotic) selection of material fascinated me, whereas Nick appeared to be far more concerned with irregular, aperiodic noise and visceral, barely audible frequencies. The contrast between these two approaches to the composition of **Block Groove** resulted in a musical tension to the work, in which its power as a piece of music to hold the attention of an audience resides.

The theatricality of the free jazz ensemble is heightened by its gradual drifting in and out of the fabric of the music. The tension in this section is taken to an extreme that renders it absurd. There is a musical sense of humour at work here, punctuated by the occasional burst of audience

laughter. The 15830Hz tone is at such a high level as to make the rest of the audio spectrum seem distant without much use of reverberation effects. The reverberation that is used is that of a small room and is only noticeable on the artefacts that are not part of the original source material. The second section of **Block Groove** is an example of what Trevor Wishart calls a surreal sonic landscape (Wishart 1981[ix]). The foreground artefacts are heard as existing in an acoustically live environment (in a room). That which we expect to be reverberant is the piano, since pianos are typically heard in large concert spaces, whereas here such reverberations are masked by surface noise. Conversely the listener familiar with vinyl expects surface artefacts to be dry and transient. The expectation for the music is that it should develop structurally (for someone familiar with this style of piano music). In this section of the piece however, the music is based around a repetitive stasis that is only *emphasised* by the intrusion of free jazz. The artefacts are reverberated instead of the piano. They are few in number and so the listener senses the repetition of individual samples (unlike real crackle, where every spike is different) but with a developing *musical* structure independent from the stasis of the loops. In this way the normal rules of vinyl piano recordings are inverted, and the landscape of the work becomes *surreal*..

The emphasis on by-products of vinyl recordings becomes more dominant as the piece progresses. The chaotic development of the clicks in the second part of **Block Groove** is replaced by a more structured musical statement in the third section. As the loops from the second section come to a halt there is a residue of sound that links to the third section. As though the record were finished and all that remains is our neighbours' music and a faulty TV set (or other malfunctioning electrical equipment) exuding in the very high frequency range (>16000Hz). The transitions between movements 2 to 3 and 3 to 4 are as though the act of changing the record for another is enacted. The short snatch of piano between movements 3 and 4 is as though the piece were a compilation of original sources (in the commercial sense of the word *compilation*). The stylus is mistakenly placed on a track that one does not wish to play - a situation that may cause an inexperienced DJ to panic and drop the stylus of the other deck (as a potential theatrical interpretation of this moment in the work). The piano functions as an echo of the earlier section - an echo of music unheard due to the record sticking on one section of the groove (second movement). The run-out groove of a record is implied at the end of each section and then finally

realised at the end of the piece, which is made entirely from run-out grooves. The end of each section is a metaphor for these, but the final (5th) movement of **Block Groove** is literally the end of the record(s).

The third and fourth movements of the piece are representations of musical styles emanating from sampling culture constructed from the detritus of sampling from records. Musical material is replaced by artefacts cumulatively through the work - movement 4 is made from clicks, scratches and bumps assembled as 'breakbeats', a term that can trace its origins directly back to the advent of the modern DJ[x]. The music of the third and fourth sections is stylistically akin to 'Trip Hop' and 'Drum and Bass' respectively - two styles of music made possible by the invention of the sampler and renowned for their use of samples taken directly from vinyl. The style dubbed 'Trip Hop' (much to the chagrin of some of its progenitors), which emanated from Bristol in the early 1990s, is arguably the musical genre where sampling vinyl crackle became a routine production technique - something that has only happened in pop music at least since the compact disc became the default medium for the dissemination of music. Examples of this can be found on 'Protection' by Massive Attack (1996). 'Dummy' by Portishead (1996) goes one step further in that the beats were pressed onto vinyl in order to be played by a DJ as part of the band.

In my experience as a DJ I execute compositional decisions in deciding which pieces will sound good (or inspire people to dance) when mixed with others I choose, and in the execution of technique (cross-fades, scratching, cuts, stalls etc.). **Block Groove** addresses the relationship between composition and mixing as a process of construction and reinterpretation. Deeper questions arise from this process as a discussion of influence and the relationship between the music of ones own creation and the world of Music, which exists apart from the listener. Such questions concerning experiences of sound, their temporal relationships and the social conventions by which these relationships are defined are central to my music and contribute to an argument for a holistic approach to style as a set of symbiotic techniques - symbiotic in the sense that each individual procedure in the compositional repertoire or concrete attribute of a piece of music is dependent on another, separate technique or attribute to bring about its realisation in works of music. This will form the basis of a discussion of combination form in music with reference to my work over the past four and a half years and in the works of other composers and theorists.

There is a figural narrative contained within and between the five movements of **Block Groove**. It is a narrative that relies on the balance between time enfolded[xi] in the "musical" material, in the surface noise and the influence of the high frequency sounds. It is also a narrative of musical styles that reflects heavily on what has come to be known as "sampling culture."[xii] Another form of narrative exists within **Fright Fiction Simulator**, and that is a condensed narrative or schematic narrative.

Chapter 1.3. Landscape, Metaphor and Combination Form.

1.3.1. Fright Fiction Simulator: Schematic Narrative

Fright Fiction Simulator (FFS) is an edited version of a 20 minute improvisation by Edward Kelly and David Casal. All of the material for **FFS** was taken from the soundtrack to the film **Predator** (dir. John McTiernan 1987) where an alien creature hunts soldiers in the Vietnam jungle for sport. The fictional time of the film was condensed and re-ordered by taking short (ca. 1"-30") samples of both the sound effects in the film and the musical soundtrack. These were treated and processed freely by both participants, never so much as to render them unrecognisable, then each person mapped the samples onto individual MIDI keys. Filtering and one use of reverb were the only effects used. The coherence of the piece was partly ensured by the nature of the source material - i.e. both players' materials came from the same source, and that the source was a highly stylised entity to begin with.

Within **FFS** certain narrative features of the source (such as the re-creation of a jungle environment within the film) are retained, whereas the order of events is arranged with the logic of a piece of music rather than that of a story. The piece happens as though it were a re-creation of a violent incident, yet without any sense of why or how events led up to or away from this event. The work is discontinuous, both in the sense that it contains sudden edits and in the sense that it is not grounded in any specific fiction. Individual sound events happen *schematically*, that is they happen as an indication of a specific *type* of occurrence rather than a unique set of circumstances. It is an arbitrary battle in an arbitrary jungle, with an arbitrary soundtrack from an arbitrary film. The fact that we know what film the samples are taken from is because we have read the program notes, not because it is explicit or implicit in the material itself - although a knowledge of the film would effect recognition in a listener. An enhancement of meaning in this piece is a result of the fact that it is made from samples of a fictional (manufactured) soundscape. When we hear the elements indicative of "jungle" we are in fact hearing residues of what the original sound artist who worked on the movie made as his impression of what a jungle soundscape "sounds like". In

this way are the materials are schematic also, as *representations* of sonic archetypes and environments.

Luc Ferrari has composed pieces with condensed narrative such as *Presque Rien*, but in this piece the materials are taken from a genuine documentary recording. In this case the narrative is a schema of the time embodied by the recording, as well as the place at which it was made. I would like to argue that both pieces are fictionalisations of material, regardless of the nature of the sources. In *Presque Rien*, Ferrari manages to tell the story of what happened on the beach, on the day on which the recording was made. Although the events actually happened in the order in which they are presented, the intervening material was removed, and so the timescale and hence the pace of the recording is distorted in the piece. The piece is a *schematic* representation of what happened on a particular day. The contrast between *Presque Rien* and **Fright Fiction Simulator** is that **FFS** uses a fictional story to portray a fictional event, whereas *Presque Rien* uses a documentary recording to portray a time and place as a story. I would posit that both of these pieces are *soundscapes* in the tradition of Hildegard Westerkamp or Gilles Gobeil; acoustic ecologists and composers of 'cinema for the ear' alike make pieces that are schematic in that their semiotic content is integral to the conception of the works. The use of materials to *suggest* environments or scenarios is what I mean when I say a piece is constructed schematically. Fictional time - the time of stories - is the time of these musical forms.

1.3.2. Trajectory and Structure

The term "trajectory" is used here to mean the directedness explicit in or implied by a sequence of musical elements or structures. A typology of trajectories is not what this article aims to produce. What is aimed at is a complimentary way of defining musical structure, complimentary to a typology of structural forms as formulated earlier. In order to describe a piece of music one can form typologies of parametric classification, but these do not give any clues as to how the music is perceived other than on a fundamentally visceral level. Trajectories are motions within music. Some trajectories are definable (and measurable) in terms of parametric change (accellerando, pitch change etc). These I will call simple trajectories since they are motions based

on singular parametric changes. Another way of defining trajectory is that it is the *effect* the music as a set of functional relationships has on the listener's sense of *motion* and *anticipation*. These I shall call compound trajectories, since it is the sum of all the simple trajectories that make up the musical fabric of a work that defines its overall trajectory.

Particle Foil (2000) represents a different approach to musical time than that of **Batista! (Lament)** or **Inside-Out**. It was composed using a piece of software called Audiomulch[xiii] that lends itself to audio-loop-and-process based composition, and a piece of software called Fasttracker II that is much more deterministic in its approach (as it is a sample-sequencer program). The musical fabric of the first section of **Particle Foil** consists of the gradual accretion of layers of musical material, each of which consists of a looped sample of a different length from the other layers. The trajectories of each layer of musical material are defined by a chain of digital effects and processing algorithms with continuously changing parameters through which the looped samples are transformed in performance time. The aim was to compose a piece where processes rather than source material were used to define musical structure, but it does not continue like this throughout the work. This is an example of what Kramer calls "nondirected linear time" (Kramer 1988[xiv]) analogous to a dream-like consciousness in which events are linked in time but not related. The repetitious nature of each layer of the source material hints at vertical time - a sense of timelessness found in compositions that approach music as a single extended event. The digital signal processing (DSP) paths follow separate trajectories that are also repetitious in that they are modulated by low frequency oscillators (LFOs), which are also set at rates at which their peaks and troughs will not coincide with other LFOs' peaks and troughs quickly or often. The stereo spatialiser (SSPAT) object[1] in Audiomulch is used to create more

[1] From the Audiomulch help files: "SSpat is a stereo spatialiser, allowing the projection of a moving mono source signal into a virtual plane lying behind a pair of stereo speakers. The path along which the source travels may be specified, along with various parameters effecting the apparent dimensions of the virtual plane. A reverb send is provided to allow a more realistic room simulation to be achieved. The reverb send is a delayed version of the input, amplitude scaled relative to its distance from the rear of the virtual plane." AudioMulch Help ® 1997-2003 Ross Bencina. In fact the reverb output is only delayed with respect to Doppler shift. When Doppler

complex trajectories of motion both in stereo space and in timbre-space. This object pans the input around a three point trajectory. The left and right outputs are a stereo representation of the motion of the object in front of the listener with optional doppler shift and scaling according to the virtual distance from

Figure 10a: Stereo spatialiser object.

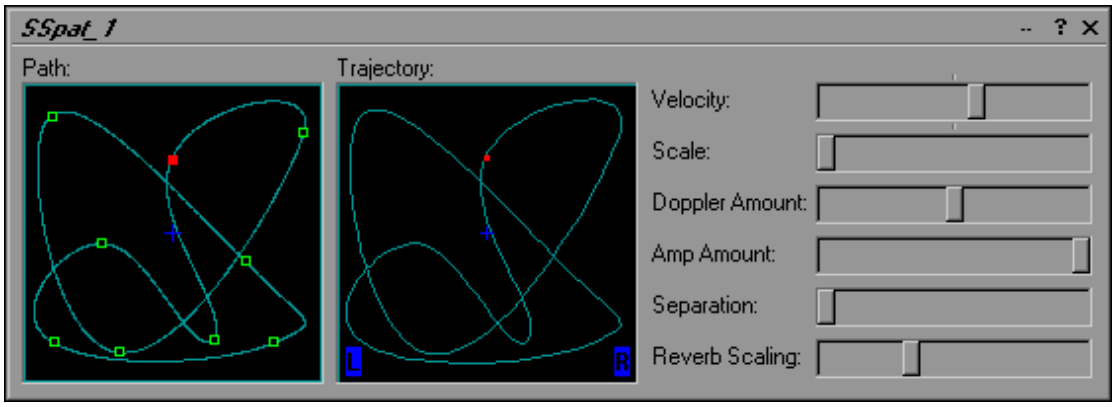

Figure 10b: Stereo spatialiser parameter window.

the listener. The third output allows one to connect a reverberation unit to the spatialiser in order to simulate spatial depth. The left and right outputs and the reverb output can be used to pan between separate DSP paths to create complex trajectories in timbre space by varying the input levels to different effect paths. In **Particle Foil** the front (left and right) channels are sent as a stereo pair to the mixer whilst the rear (reverb) channel is connected to a separate DSP path. The trajectory in this case incorporates both a spatial dimension and a timbre-space dimension of motion, which is enhanced by other trajectories further along the DSP chain to which the rear channel is connected.

The techniques used to create the first and final sections of **Particle Foil** are demonstrated in the **Audiomulch** piece **Process Time** on the accompanying CDROM. You will need to put the

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Amount is set to zero there is no delay between the front (left and right) channels and the rear channel, and the unit can be used as a three-way automated panning device.

VST plugins from the CDROM into the VSTPlugins folder in the Audiomulch source directory before the patch will work.

The sense of a lack of direction in the first section of **Particle Foil** is compounded by its delicacy. The entire piece is composed at quite a low level of intensity relative to the maximum possible amplitude. This directionless quality encourages the listener to perceive the work as analogous to landscape rather than narrative, where sonic entities occur circumstantially, without reference to other activity within the piece. I would argue that the first section of the piece is heard as a form of overlapped-moment time since structural development is arbitrary and contains no meaningful relationships. Kramer's non-directed linear time[xv] is another definition of this kind of musical form. Relationships are heard as chance occurrences in this section, temporal ordering contains no significance and so we hear the music as though it were a natural process rather than an intended sequence of events. This becomes even more relevant as the music progresses to the second section of the piece beginning at 3'18.237", where a composed musical form is introduced into the piece. The contrast between this, linear expression of time and the previous non-linear expression causes a shift in the way in which the work is perceived. The listener's perception shifts from one way of listening (moment time) to another (linear time) very quickly. The listener's relationship to the music is altered by this. If the piece had continued with structure as a set of coincident processes we would find ourselves listening more and more to the inner details of the sound world. As the linear musical structure is initiated our memory of the previous moments is in stark contrast to it. The experience of a static sound world seems contrary to the continual timbral and spatial motion of the music, but it is the principle of continual steady change in which we sense a stasis of process such as that which we experience when we listen to the sound of waves breaking against a shoreline.

The subsequent forward motion of the piece is, if we are to assume that the previous section of music is heard as static, analogous to an island of directed time in a sound-world with motion but no direction. We hear a motif at 3'42.387" that is repeated later at 4'30.780" in altered form. The music here is clearly sequenced in some way (using Fasttracker II in fact.) Here the music possesses a sense of directedness, of past, present and future, and a sense that sound follows other sound in some functional relation rather than an arbitrary one. We can *follow* the second

section of **Particle Foil**, whereas the first and final sections *coexist* with the listener. By switching from one conception of music (as a set of dynamic processes applied to static or repetitive material) to another (as a set of static musical relationships constructed from dynamic material), we can manipulate the listener's mode of perception and hence his sense of time, principally the appropriate *mode of listening* employed by the listener.

The notion that the listener can be manipulated is perhaps an exaggeration. Listeners are autonomous, and so one may choose (or expect) to hear the piece as if it were linear throughout. This strategy for interpreting the work may result in frustration however, since there are little or no functional relationships between the materials, and the work does not "go anywhere" for a period of time. As with all music, a piece that requires a distinct listening strategy on the part of the listener does not guarantee that the listener will oblige, but it can thwart the more familiar listening strategies of a listener, and so encourage the search for new modes of appreciation. Perception of the temporalities discussed in this thesis is contingent on the listeners' perceptual skills, but it is also dependent on how they are influenced, affirmed or denied by different forms of music. Music listening is an open relation of passive observance and dynamic interpretation[xvi] and as such, the way in which the two modes of perception are combined cannot be guaranteed to take one form or another. Critical perception of a piece of music thus entails a certain amount of co-operation on the part of the listener, but I am arguing that musical form and structure can have a direct influence in the process, i.e. that the relationship between an audience's perception of music and the composer's intention is a *reciprocal* one.

At 4'46.892" in **Particle Foil** a new source of sound is introduced. A microphone was hung from the window of the flat in which I lived and the sound of the street below was processed in performance time. The incidental nature of this technique and the acceptance of whatever may happen outside as musical material reinforces the transition from linear time back to moment time once again. The material here is dynamic but arbitrary. Outside on the street on a quiet summer's day there is no intentional performance or compositional activity going on. The only sound that is picked up by the microphone in this situation is incidental and beyond compositional control. The sense of scene is reinforced by this arbitrary source material and the music returns to overlapped-moment form for the rest of the piece, the moment form aspect being further reinforced by the

happenstance nature of the ambient activity. By this point the listener is aware (if the piece has been successful in its purpose) of moment time as being a principle compositional device in the work. A return to moment form is not the same as when it is first heard as such though, since one has the memory of forward motion and linear time and thus one experiences a sense that one has travelled from one place (relationship with the music) to another. Although the formal structure of the music of the third section is very similar to that of the first, the material is different. The listener has travelled from one musical landscape to another via a musical process. This constitutes an example of what I call *combination form*.

In one sense the *piece* of music begins at 3'42" and ends at 4'46", but the *other* music in **Particle Foil** starts at the beginning, stops at 3'42" for a while and starts again at 4'46". Alternatively one could state that the music starts, begins, ends and then stops, or that the first and last sections of the piece are an extended beginning and ending respectively, for a piece of music that lasts 64 seconds. This is combination form, since different sections of the music exhibit alternative formal properties.

Looking again at **Batista!** It is clear that different movements of the work exhibit different characteristics. The second movement of the work is structurally very different from the first, and while the first movement is heard as a multiply-directed linear progression (after Kramer), the second exhibits properties associated with vertical time. The multiple-linearities of the first movement are heard in contrast to a soft ostinato - cyclic entities can be thought of as static forms (in vertical time) and are heard in contrast with the multiply-directed linear progressions mentioned earlier. Again in the second movement we hear repetition and elaboration of cyclic musical structures (the cyclic-phase-vocoded bell and the bass harmonic ostinato) as a fundamental structural device. Repetition in the first movement of **Batista!** is used in conjunction with other strategies. One hears a soft, pulsing ostinato from 0'26.885 to 1'06.992" that is simplified in figure 11.

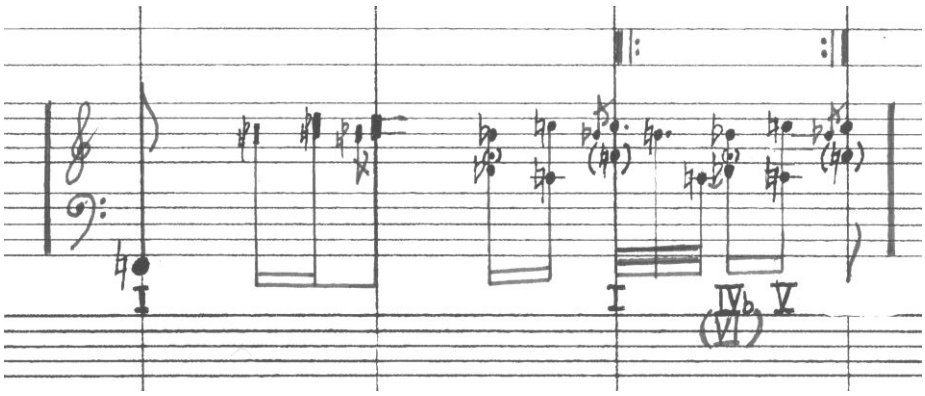

Figure 11. Tonality and rhythm of the soft ostinato in the first movement of **Batista! (Lament)** (simplified).

Repetition here can be viewed as a static element in the music. The motif is asymmetrical in time, implying forward motion, yet the circular (repetitive) nature of the motif causes it to "go nowhere" new. The phrase is continually becoming itself, since its motion results in no new material being generated. This is not the case with the repetition of the bass harmonic ostinato in the second movement. There is an implied forward motion in this section since the ostinato is made from attack based sound elements rather than the linear motion of filtered partials. The ostinato in the first movement is both linear (in its motion) and iterative (in its near literal repetition of material - not a perfect repetition due to the subtle timbral reduction that occurs throughout the passage). Harmonically it moves through a I-IV-V-I progression in F minor in each cycle (see figure). The bass harmonic ostinato is an iterative structure that begins on a D and quickly establishes itself as being in the key of G. The V-I cadence continues to be heard as the start of the motif - D is heard as the strong beat in a four note succession. The continual harmonic tension and resolution in this motif implies forward motion, but its ceaseless repetition and subsequent de-construction into a polyrhythmic texture frustrate and defeat the sense of motion implied by the V-I iteration. If one listens to this section one begins to hear tension and release in the polyrhythmic changes, since one is aware very quickly of what the pattern contains in terms of notes and timbre one seeks new information elsewhere.

I have heard this section as mostly consistent of phase-vocoded bells - my hearing mechanisms have tired of the repetition and sought information in other spectral registers. In

listening to contrasts of timbre and rhythmic activity combined in this way, one is forced to divide one's listening strategies between passive observance and dynamic participation. Whether one follows the bell or the bass harmonic timbres is a matter of choice, but this choice is informed by the structure of the music to a certain, experientially quantifiable extent. The cyclic bell motif enters first, causing the listener to pay attention to that, but it is quickly followed by the percussive attacks of the bass guitar. The listener's ear is forced to pay attention to that, but as listener fatigue sets in with respect to the iterative nature of the bass textures one may find one's attention drawn back to the complex bell activity. The bass ostinato becomes transformed into an erratic, unpredictable entity as the bell timbres become structurally simpler over time. At some point the listener's attention is drawn back to the bell timbres, as the complexity of the bass timbres ceases. The bass timbre is reduced to a single re-iterative structure that is swept upwards in pitch (into the realm of pitch from that of rhythm and then back again) and the cyclic bell timbre becomes the dominant structural entity. Finally there is a tension between the low pulse, resulting from the downward sweep of the re-iterative bass attack, and the cyclic bell timbre. This tension is resolved by the termination of the bell timbre at 2'24.951". This could be seen as a highly subjective interpretation of events, but the point is that whilst one's attention may be diverted to one stream of musical information, one is always aware of the other. The tensions inherent in the changing relationship between the bell timbres and the bass timbres forces the listener to switch his or her dynamic, active listening mechanism between layers of musical structure, and in doing so to subjugate the other stream to be passively observed. Since the rhythmic relationship between the two layers is quite complex, passive observation becomes increasingly difficult as the passage progresses – there is simply too much information to comprehend and too few shared parameters between streams of information – and the listeners sense of time is suspended until the tension is resolved. This is another kind of vertical time to the one proposed by Kramer[xvii], it is a form of *suspended* or *mobile time*. It is mobile, since the listener's sense of time cannot remain suspended forever. This kind of compositional device sees the listener's sense of time in flux, dynamically changing according to the nature of events and information presented to the listener. This, I propose, is how time is perceived in all of music. A combination of active participation and passive observance structures our perceptions of events, and hence, of time itself.

In listening to the bell motifs, (which decrease in density and increase in regularity throughout the first half of the second movement) one becomes distracted by discontinuities in material that ones hearing mechanisms previously took for granted to be literally repetitive. If one decides to concentrate on the bass harmonic ostinato one experiences its relationship to the bell motifs. Whereas the bell motifs become relatively constant as the passage progresses, the bass harmonics become discontinuous and rhythmically complex. The motion and activity of one stream of information acts contrary to the other and so we are forced into listening to one or the other, feeling its discontinuities and temporal manipulations as *rhythmic* suspensions and resolutions.

This is more than just textural composition. The establishment of a regular meter allows one to carry out polyrhythmic transformations of rhythm and it is with these transformations (based on integer ratios such as 3:2, 5:7 etc.) that interrupt the stasis of the repeated motif. Metric modulation is a sub-structural process, since it is a modification of the structural principles of the music regardless of the nature of the material. When applied to an iterative structure we hear an exemplification of this process, a direct expression of a sub-structural musical principle in sound.

Chapter 1.4. Inside-Out

1.4.1. Inception.

Inside-Out (2000 – hereby referred to as **IO**) is a work that unites key elements of my compositional style and technique developed in previous compositions. It is a work for 8 speakers arranged in a 4X2 formation (as shown in figure 12 in relation to the track numbers used on the ADAT tape), with stereo channels at the front, near-front, near-rear and rear of the audience. It was composed partly at the composers studio and partly at the EMS studio in Stockholm. It was premiered at the University of East Anglia in October 2000.

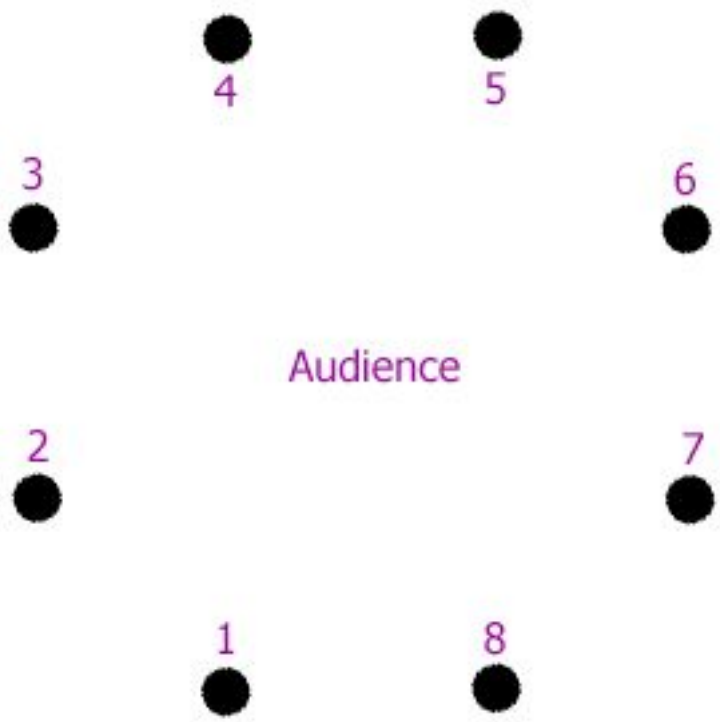

Figure 12. Speaker arrangement for **Inside-Out**.

I started by making close-microphone recordings of a flywheel, removed from the drum of a washing machine. This object has an unusual five-spoked structure and is cast from aluminium. The resonances produced by this object when struck vary depending on where the wheel is struck or stroked. Tones available vary, from concordant pitch relationships to inharmonic tones. There is a clear pitch to the resonance, which is underpinned by an octave-and-a-fourth

below it when the object is moved closer to the microphone. This interval (a fourth in terms of pitch class) is inharmonic yet concordant, an interval that implies resolution. The first movement of the work is based on recordings taken by playing this object in various ways. Its unique shape affords numerous modes of articulation, different timbres are available by striking different portions of the flywheel (the hub, the spokes, the rim). A rich variety of timbral possibilities is available in an improvisation using this object, and recordings of such improvised performances on the flywheel became the material for the piece.

An observation of how a piece may come to be (in acousmatic composition) is appropriate at this point. **IO** arose from curiosity as to the compositional possibilities afforded by recordings of the flywheel. I did not set out to compose a 10 minute, 8 channel electroacoustic composition. In fact what happened was an engagement with the material driven primarily by curiosity. The gradual formation of a composition happened as a by-product of fascination with the material. The sounds created by physically articulating the flywheel is both percussive and resonant, and has spectral characteristics of inharmonic structure and harmonically related partials. Its spectro-morphology drives the piece forwards, since the pitch relationship between the two most prominent partials is that of an octave and a perfect fourth – a discordant tonal interval that sets up the anticipation (in an audience accustomed to western diatonic harmony at least) of resolution. This not only drives the piece forward as it is heard, but also motivated the compositional processes used to create the piece itself. An engagement with musical *materials*, which results in a piece of *music*, is a paradoxical relationship. The material and the composer are engaged in a process of *becoming*, thus, the process of composition is driven by relational motives rather than intent. The transient nature of artistic enterprise (time is 'enfolded' in a work of art) centres about an *affect*/*effect* relationship between the artist and his materials. There is usually a discovery (the flywheel in IO) which initiates a process of investigation. As the artist is *affected* by his materials, the artist *effects* compositional decisions. The consequences of such decisions *affect* the interrelationships within the work, which in turn *affect* subsequent compositional decisions (*effects*).

In music, this process is continually informed by listening. The discovery mentioned earlier, which triggered the process of affect/effect (the acquisition of the flywheel), was of a

source – an auditory revelation of a novel timbre with implied musical possibilities. The process of composition – triggered by such a discovery – is a process of *cognitive feedback*.

IO is a piece where sound is arranged into serial/parallel networks. What I mean by this is that materials are subject to variants of similar musical processes in parallel with each other. The epitome of this is the pulse-network. First developed in **Batista! (Lament)**, pulse networks are multiple polyrhythmic articulations of a source. The source must be articulated into a regular rhythm prior to this (by tremolo, the gapper tool in Sound forge, cyclic phase vocoding or other cyclic/pulsate processes), or it may be a rhythmic articulation to begin with (such as the bass-harmonic ostinato in **Batista!**). These layers of polyrhythmic articulation are separated spatially – across stereo channels in **Batista!** (e.g. at 6'17") and eight channels in **IO** (at 1'36", 3'52" and 7'35"). A pulse network is treated as a compositional entity. Serial/parallel networks consist of pulse networks and other spatially distinct but musically related materials, as well as unifiers. Unifiers are materials (such as the percussive thud at 1'53"), which trigger spatial and/or timbral fusion of the materials. The example given acts as a functional transition between the dry pulsate structures and those filtered with the FFT filter, based on the spectrum of a flywheel articulation (a process described in the account of the composition of **Batista!**). A divisor is the opposite – the gesture immediately prior to 1'36" is heard as functionally "splitting" the sound into eight streams of information, which make up the pulse network.

This procedure, together with other compositional practises employed in **IO** is an extension of the illusion of cause and effect discussed earlier. Sound events are heard as triggering (causing) other events or sound effects. This can be explained as a function of how we hear. Evolutionary theory would suggest that humans seek a cause (source) when they hear a sound (signal). Acousmatic listening deprives the listener of a credible source, and so the signal is *abstracted* from its source, and we hear relationships between sound materials themselves as connected events devoid of origin or necessity for survival. Music is a special case of listening, which only humans are engaged with.

Serial/parallel networks exist in musically related forms (such as the polyrhythmic permutations discussed earlier), which may be systematically related or not. The free pitch curves applied to previously articulated material heard from 2'25" are an example of unsystematic relating of material. By unsystematic I mean that no rigorous application of theoretical principles has been imposed on the material. The application of tempo curves disrupts the highly structured polyrhythm in an arbitrary way. It is a methodical process, but there is no mathematical procedure to designing the curves. Instead the curves are designed experimentally and the results evaluated according to aesthetic criteria. There is *method* but no *system* to the procedure, therefore this technique constitutes a free compositional technique.

1.4.2. Combination Form in *Inside-Out*

IO is the musical work in my portfolio that most clearly embodies the principle of *combination form*. Different sections of the work are governed by different structural principles, which exhibit different temporalities. Our perception of time is a subjective experience, based on the order and nature of experiences in time. James J Gibson states:

> "Isaac Newton's famous assertion that "absolute, true and mathematical time, of itself and from its own nature, flows equably without relation to anything external" … leads to the idea of empty time which, like the idea of empty space, brings with it insoluble problems for ecology and psychology. This implies that events are what "fill" time, as though time were a container into which events can be put. But this metaphor is surely wrong for the psychology of event perception. Time is not a receptacle for objects…the fact is that our experience is never empty."[xviii]

If events experienced by humans are what shapes time, rather than enslavement to some natural law of progression, then it is the nature of events, which shapes *how* time is perceived. In this case there is no such thing as a distortion of time in our perception, since our perception of time *is* time to us. Rather, as Kramer sets forth the argument in the literary work, *The Time of*

Music, we experience different *kinds* of time in music. The notions of "past," present" and "future" are meaningful to us in terms of our perception. In music we perceive events in terms of conceptual space – the general space in which relationships between concurrent events. The material qualities of a section of music are heard as belonging to a unique entity – the work, movement or moment of the music.

When listening to a piece of Philip Glass's minimal, arpeggiated music for example, we hear each arpeggio as belonging to a sound-world of patterns and textures that are repetitive and structured. The conceptual space that the piece inhabits is an understanding of the structure, such that anticipation of change is thwarted, and our mechanism for listening is forced into a state of "vertical time."[xix] In information theory, this highly repetitive state has a high redundancy. Time passes quickly in such music, since notions of "past" and "future" are negated by this inception of musical time. A complex, through composed work such as *Le Marteau sans Maitre* by Pierre Boulez, will cause us to adopt a different listening strategy. The conceptual space inhabited by this non-repetitive, formalistic music is an understanding of complex relations of form. Our listening strategy is forced into a state of "multiply-directed linear time," as we seek to relate elements of the musical fabric with each other, as well as with the overall form of the work. The complex hierarchies of form in a work such as *Le Marteau* require an extreme suspension of disbelief, as functional relationships amongst materials are revealed incrementally. A music that attempts to formulate a systematic relating of material apart from cultural norms (such as diatonic tonality) demands a conceptual space of its own. It is high intensity listening, and low redundancy information. Time passes slowly as we process the information presented to us by this music, since functional relationships between elements of the music are arranged in complex hierarchies.

1.4.3. An Entropic-Process Theory of Time

A scientific explanation of time's "arrow" stems from Sir Isaac Newton's Second Law of Thermodynamics, which states that the entropy of a system will always increase (i.e. the balance between chaos and order – the chaos increases with respect to the order). There are numerous chemical and physical processes, which are irreversible, such as splitting the atom or

burning coal to make electricity. So time observes one consistent property – its direction. If time is shaped (defined) by events experienced, then certain manipulations of (sound) events will alter the perception of time (in and through music). However, a scientific approach to defining the "arrow of time" yields the likelihood that time reflects an asymmetry in the universe. Particle physicists are presently engaged in observations of *neutral kaon decay (weak interaction)* and other quantum processes. The beta decay of a neutron has exhibited a property known as Charge Parity (CP) violation[xx]. CP violation is linked to T invariance, a theory proposing that any quantum process can happen in reverse if time (T) is reversed, linked to theories of *supersymmetry*. CP violation happens when a neutron decays into kaons and other particles, it is an irreversible quantum process, and is T non-invariant. It is linked to the search to discover why the universe is so full of matter and devoid of significant quantities of antimatter. Since antimatter is theoretically, matter in reverse-time, there should be no reason why time does not flow in both directions. However, CP violation is a process that can *only* occur in one direction. If this investigation proves to be significant, it may explain why we observe time in one direction only, rather than as a dimension akin to the three spatial dimensions we move freely within.

An organic understanding of time must be based on perception and memory, since the notion of "objective time" is a meaningless concept with regard to our *experience*. Life is a process we observe uniquely, from the point of view of enslavement to that *process of entropic increase* due to the asymmetry of the universe. Time is then experienced as the order of events and their interrelationships, their relationships to us, and their interrelationships' relationships to us, rather than some force of otherness in relation to our selves. In our conscious state we appear to transcend the enslavement of entropy, if only for brief periods throughout our lives, by our use of memory. Listening to music involves both perception and memory, and it is suggested that it is this combination of dynamic perception and cumulative listening that gives rise to our perception (feeling) of different temporalities in music.

1.4.4. Composing with Mediated Temporalities.

Combination form exists in music that mediates between high-redundancy/low-intensity/fast-rate music and low-redundancy/high-intensity/slow-rate music, or other modes of listening such as *cumulative listening*[xxi]. The notion of rate here is not one of tempo, since fast-tempo music can contain little new information and vice-versa. It is in fact the concept that our perception of a piece's "fastness" or "slowness" is determined by the *nature* of its material relations and substances rather than the speed of a single metric pulse. Music that possesses the characteristics of combination form contains changes in formal compositional structure, which necessitate different listening strategies to become adopted by the listener. The notion of different species of time made manifest in music implies that one can encourage different listening strategies (and hence perceptions of time) in a work of composition. If one can make use of such devices as make these listening strategies effective, then one can combine them in a composition and thus create *combination forms* – forms made up of combinations of other forms, or *nested forms* – forms within forms.

The series/parallel description of **IO** is one aspect of its composition. The exposition of combination form above, gives us a sophisticated set of tools with which to understand such music. **IO** exhibits different temporal properties at different points. A linear progression exists from the start of the piece to the start of the first pulse network at 1'36", where the music is split into 8 polyrhythmic series, each with its own audio channel. This multiply-directed linearity is brought to an abrupt halt by the unification of timbre at 1'53". This is a filtered and feedback-pitch-shifted version of the polyrhythmic series as mentioned above, and although the processing is articulated differently on separate channels, the unity of timbre reinforces the vertical time of this section. The progressive nature of the feedback in the pitch-shift process implies linearity, but the process does not change. It is a dynamic process that remains parametrically static throughout the section, and the listener is encouraged to pay attention to the subtle articulations of this timbre, rather than

internal functional relationships (of which there are none). Is the following section linear, multiply-directed linear, vertical or moment-form? It is a combination of all three forms. There is a timbral verticality in the sustained metallic tones, a multiply-directed linearity in the metallic articulations and a moment-form development of the pitch-curve processed rhythmic articulations as (formally) unrelated musical statements.

But is this not just multiply-directed linear time (in Kramer's terminology)? There is a multiplicity of directedness in this section, but not every element is linear, and by no means are all elements formally equivalent. It is a combination of forms from combined technical approaches to time in music. A formalistic argument would hold that the sectional development of the work is fundamentally *linear*, since "vertical time" comes to an end in this work (for example).

IO is a piece of electroacoustic tape music, composed under the cultural influence of "sampling culture"[xxii]. Music has no frame as painting does for example, yet the boundaries of time that exist in *recorded* music frame the music with silence, and so time in recorded music is a fundamentally *finite* quality. Sampling culture is a cultural world where the very act of "framing" sound (by re-contextualising elements of it) is fundamental to the construction of music. The activity of composition in this culture is a continual process of juxtaposition, of framing samples with other samples to create hybrid identities and statements. A schematic notion of vertical time is valid in this context as a *compositional approach towards manipulating the listener's strategy for engagement with the music*. The relative structural stasis of the articulated timbres in **IO** is heard in contrast to the frenetic activity of the pulse networks, and thus embodies the *notion* of vertical time; the articulated-timbre sections are more vertical than the pulse networks. The influence of sampling culture becomes apparent in the second movement, where the materials of the first section are re-mixed and re-interpreted as materials for "techno" music, which is then re-interpreted in a sculptural fashion. The "framing" of sound discussed earlier is a process that happens on an abstract, cultural level as well as a temporal one. There is a stylistic archetype of techno music than governs the material in this section of the work, a new context for the sounds to exhibit new functional and formal relationships with. This is an intra-musical reference since it is music of another culture than the acousmatic concert, it has its own sense of time. It is based on experiences of being at huge music festivals (specifically the Glastonbury Festival of the

Performing Arts) and in large dance tents, where the speaker stacks are so far apart that one hears sound from the farthest as an echo of that from the nearest. It is framed by different spatial relationships to the music – on the hill at the other side of the site and in one's tent at the end of the day. Although the senses of time represented are based on personal experience, (and so highly subjective) they are articulated as variations in space as well as in time, and so there is a sense of *landscape* to this section of the piece. In the foreground of this landscape is a version of the re-mixing on the work, in which the internal structure of the re-mix is explored by a process of temporal manipulation. Traditional musical gestures are processed to become figural ones, macro-structure is extended and re-organised to become micro-structural change. The music is here, in some sense, turned *Inside-Out!*

1.4.5. The Asymmetry of the Human Brain: Consequences for Listening

Further to the information-based approach to listening, it is clear to psychologists that the hemispheres of the human brain carry out distinct and complimentary processes. Kramer:

> The duality of the human brain has been known since 1844, when British physician A. L. Wigan discovered by autopsy that a man whose behaviour had appeared normal had in fact possessed only one cerebral hemisphere. It has only been in the last two decades, however, that the implications of the divided brain have been explored in depth by psychologists. They have found that the left hemisphere is the seat of linear logic. It is there that we reason, count compute, read, and write. Right hemisphere thinking, by contrast, is holistic. The right hemisphere understands complex relationships, structures and patterns as entities rather than as the sums of parts. Although our understanding of the human brain is far from complete, it is reasonable to postulate that deep listening to music involves *both* cerebral hemispheres.[xxiii]

And later:

> Music listening is a mixture of active participation and still-spectator observation. The still spectator in us builds up a mental representation of the piece, which becomes gradually more complete as we move through the music and as we learn it better with subsequent hearings… The gradual accumulation of encoded information in the form of a mental representation of a piece is what non-linear perception, or cumulative listening really is… Cumulative "listening" is a memory process and, as such, creates an image of past events.
>
> The active listening mode, on the other hand, involves participation in continually changing materials and relationships. Even when we revel in the sensuous beauty of a non-linear composition, our active listening mode is available. This kind of listening is concerned with expectations, anticipations, and projections into the future. It is less involved with forming representations in memory and more involved with the immediacy of the piece and where it is going (or not going).
>
> Both linear expectations and non-linear memory images feed back into present perceptions. Events are retrieved from memory for comparison with other events, and the ways new events are understood are influenced by expectations [based on the memory of past events and their interrelationships].[xxiv]

So listening to a piece of music is an active, comparative process as well as a passive, accumulative process. In moments of vertical time there is a lack of structural change, and so the listener's accumulative process is less active and the listener has no option but to listen to dynamic timbral change and subtle articulations of the music. *Relative* to the first pulse network in IO, the articulation of timbre that follows is unstructured in terms of information. The *contours* of the pulse network are retained however, so the listener is forced to listen to a different aspect of the material by a process of transformation of the sound. This transformation invokes a different listening mechanism, so the listener is encouraged to perceive changes of state, of the time invoked by the music.

What if we listen to the pulse network as texture, avoiding any attempt to decode the structure of the music at this point? As Kramer makes clear above, the invocation of one listening

strategy does not annul the potential use of another (complimentary) listening strategy. The one thing we can be certain of is that the pulse network contains structural information, which may or may not be decoded, depending on the listener's deep listening skills. All the pulse networks I use in my compositions are based on mathematical integer ratios, usually limited to the numbers up to and including 9. Structure is inherent to these pulse networks, (in contrast to random granular processes) and the more complex pulse networks can be perceived as a texture of structures. The degree to which structure is perceived is dependant on the listener's perceptual skills.

What I am suggesting here is that it is possible to mediate between temporalities within a work, just as it is possible to mediate between pitches, dynamics, timbres and so on. The difference between parameter mediation and temporal mediation is that temporal mediation occurs at a higher structural level, than the microstructure of individual events. Temporal mediation is effected on the structural interrelationships and contexts within a piece, rather than at the level of qualitative difference between individual events. Species of musical time, it is suggested, are differentiated by the proportional balance of listening strategies appropriate to an understanding of the music, and to changes in this proportion *through time*. By varying the characteristics of the music in terms of its inter- and intra-structural relationships, one has the power to manipulate the sense of time's content (and hence the very *nature* of perceived time) in the listener. One can hear this in the work of Bernard Parmegiani, as well as pieces by Boulez, Messian and Stockhausen, to name but a few. If the perception of time is dependant on the types of, and relationships between events, one can conclude that music, as a temporal art form, shapes directly the perception of time.

1.4.6. Cultural Stereotypes in *Inside-Out*

Inside-Out continues by developing a sense of time that I suggest arises out of sampling culture, and from the inception of the printing press and recording technology. Conformity to an aesthetic "norm" is possible through shared experience of cultural archetypal forms. Before the revolution \that was the printing press, musical notation was developed as a memory aid for rapidly expanding repertoires based on oral traditions. Neumes were invented as gestural representations of plainsong (in the western world), a practise based in religious communities. Intended to express an eternal God, the music of monastic communities is grounded in vertical time. Concepts such as modulation are alien to this tradition. It is music intended to express an unchanging God, and although the microstructure of the music changes, the trends and trajectory of the music remain constant.

Since the advent of mass reproduction, with the invention of the printing press, non-oral traditions have developed in music as well as in storytelling and visual art. The development of western harmony has been closely linked to the development of notation, and as this has progressed it became more complex, with more chaotic, entropic development, until we see the advent of Serialism marking a maximum disorder in terms of harmonic development. Likewise, the development of recording technology has spawned new art forms and styles, and a fragmentation of western culture(s) has resulted in a *sampling culture*[xxv]. The second section of **Inside-Out** suggests music close to the acid/rave/techno of the 1990s, yet its foreground/background relationships suggest quite contradictory notions of time, and of music.

1.4.7. Multiply-Directed Linear Time in Inside-Out

The third movement of **Inside-Out** is made up from three types of source. Analogue modular synthesizer improvisations, a sequence created using the Nord Modular analogue modelling synthesizer and filtered crowd noise from a football match were used to created this section of the work. In the summer of 2000 I travelled to Stockholm (Sweden) to work in the EMS studio. Much of the material in the third movement was realised by improvisation on Serge, and Buchla analogue modular synthesizers. There is a cultural connection with the acid/rave/techno

scene here, as sound sources for these styles tended to be predominantly analogue synthesizers. The sources for **Inside-Out** recorded at this time reflect the times in which they were recorded to a large extent. Early July in Stockholm is unusual in that there is only one-and-a-half hours of darkness in each night. Many of the sources used for the work reflect this as they were recorded between the hours of 11pm and 2am, or they are an expression of the effect that this daily temporality had on me. There is a sense of submergence in the sound, and emergence from it.

The notion of multiply-directed linear time is expressed here, as elsewhere, as sound becoming striated into multiple paths or streams of information, and then becoming re-unified at the end of the section. This is what is meant by the concept of a serial/parallel network discussed earlier. The sense of linear motion in the work is temporarily interrupted, and motion is expressed in a variety of directions at once. The complexity of the motion here is brought into stark contrast *after* it is heard by its resolution into a linear, cyclic form (the pulsed bass line at 8'04"). The motion of the piece is from here on confined to decaying (reducing over time) streams, the bass, the analogue synthesizer sounds and the filtered crowd noise.

There is a sense that a spectacle has been witnessed, which comes through the processing in the filtered crowd noise. As the motion (and most of the material) of the work becomes gradually reduced in complexity and frequency range, the filtered sound becomes less recognisable. Here there is a sense of tension in the bass that is resolved and then re-enforced by the two high (pitched) bass notes – the phrase is in 20/4, an unexpected time signature given the works earlier references to dance music. The ambience of the warehouses in which raves were held (in acid/techno culture) is suggested by the reverberation of the bass in this section, but these are *empty* warehouses. The party is over, the spectacle has been witnessed, and it is the morning after. There is perhaps an element of what J. T. Fraser calls *sociotemporality* or *social time* in this[xxvi] (as well as throughout **Block Groove**), since it is based on notions of community and communal experience. The work can be heard apart from its extra-musical references, but there is another layer of meaning in **Inside-Out**, which will be heard as such by listeners with shared experience of the aural situations that inform the work.

There are three distinct phases to **Inside-Out**, reflecting three very different approaches to composition. The first phase develops as an acousmatic exploration of timbral and structural

possibilities afforded by the recordings of the flywheel. The second phase re-interprets this material as input to a piece of dance music, which is placed in simulated contexts relevant to dance music performance and dissemination. Dance music becomes the material for an abstract, sculptural process. This gestural approach to the material (carried out in the digital domain) is emulated in the analogue domain in section three, in improvised performance of material.

Inside-Out does not represent one approach to composition and to form. Instead there is a combination of approaches and formal organisations of material, the application of which is determined by aesthetic decisions made by the composer. Instead of attempting to base my compositional procedures on extra-musical models, environmental observations or narratives, I have chosen to compose music that comments on musical culture, as well as effecting a systematic application of theoretical concepts about music in works of composition. Much of this is dependent on the nature of the material – **Fright Fiction Simulator** is an obvious exception to these principles as it takes the soundtrack to a film as its material. Combination form allows a multiplicity of approaches to technique, style and formal process within a work. It is a philosophy that results in compositions, which are dynamic and engaging to the listener. It is an "open system of the arts" that acknowledges the roles of influence and memory in music – influence of proportional relationships between formal approaches to materials perceived in both a dynamic process of listening and decoding a work, and a cumulative process of acquiring an image of the piece in memory that informs the listening process. A flexible, methodical system of electroacoustic composition is what I have sought to achieve. **Inside-Out** represents the most highly developed compositional realization of this approach to date.

The motives for pursuing fluency in electroacoustic composition arose from attempts to develop a more flexible system of instrumental composition than serial harmony in a traditional metric. A discussion of **Continuum** will follow as an example of how flexible, inclusive systems of notation and harmony can *evolve*, and in doing so encompass multiple approaches and systems of notation.

1.4.8. Combination Form

In analysing instrumental compositions, discussions of formal properties are facilitated by the standardisation of sub-structural principles. Meter and pitch in much of western instrumental composition are constrained by notions such as equal temperament and binary subdivision of meter that have become entrenched in the standard format of notation. This allows one to compare like with like and arrive at conclusions about a piece based on differences it possesses with other music (analysis). It also constrains to some extent the conceptual distance a composition can travel, away from its initial set of conditions.

In electroacoustic music the imposition of meter- and key-based hierarchies is by no means a pre-requisite for musical coherence. Since the invention of the tape recorder composers have used the tools of technology to compose free structured sonic entities, and impose hierarchies of other kinds upon the blank canvas of time (mediations of space, of timbre, of narrative, of morphology etc.) The constraints of meter have only recently become embedded in the technology of music production. With the sequencer's invention (and the advent of MIDI) came the rules of traditional music notation embedded in a new compositional environment. With MIDI technology man has sought to impose constraint upon a previously unconstrained medium; the binary principles of computers make these constrained systems the most logical extension of the computer. Previously there was tape, a physical medium that offered no differentiation between one moment and the next, or there was notated music; a hierarchic rule-based compositional environment. Electroacoustic music is an approach, and media, which allow composers to explore implicit character-relationships between materials. There is no implicit rule-structure or hierarchical system constraining the composer from the outset, rather there is freedom to create rules and relationships as and when the aesthetic or conceptual necessessity arises. The idea of combination form is that works may transcend the constraints of formal principles by combination. Thus, **Particle Foil** is a piece in vertical time, which has a goal-directed linear section in the middle; a portion of the music moves towards climax, whereas the rest just happens, with no explicit functionality to the sonic interrelationships of the work. It has been reported that the gestural opening of the climax section in **Particle Foil** has a physiological effect on the listener, in

that it makes one feel as though one is tipped forwards by the music. There is no expectation of climax and then there is climax, due to the combination of temporal forms.

Embedded within the motifs of **Particle Foil**'s moment forms are linear phrases. This embedding of forms (or *nesting* of formal principles) is one way in which combination forms exist. The macro-form of this section of the music is based in a notion of vertical time, whereas the internal structure of individual elements may be linear, multiply directed or momentary. A complexity and unpredictability of the music comes from the unequal, mostly prime numbers of bars before a material is repeated, and so there is an overlapping-moment form to the work (of non-directed linear time) The existence of a linear (climactic) section of the music presents a strong argument for the linearity of the works overall form, however individual portions of the work are fundamentally cyclic and non-climactic. The idea that individual sonic identities within a work may exhibit different formal or temporal characteristics, and that these characteristics may be layered, nested and sequenced is fundamental to a discussion of combination form.

In order to find an individual and unique voice in composing instrumental music, my work has sought to extend and modify the constraints of traditional musical notation, whilst retaining its coherence as a musical paradigm. Thus my instrumental compositions may contain passages of regularity interspersed with dense polyrhythm, deterministic tonality coupled with polytonal, aleatoric compositional procedures. The rules of standard western notation are not broken by my music, rather they are augmented.

Interlude

Escape (2001), James Padley (animation), Edward Kelly (sound)

Escape was made in association with the Sonic Arts Network and the Arts Council of Great Britain. It is a 3'23" short film, where the viewer is transported through three different audio-visual environments. It has been shown in cinemas around the UK, at the hy/brids festival at the University of East Anglia in Norwich (2001), the State of the Nation festival in London (2002) and the ISEA festival in Japan (2002). In terms of the number of people who saw it, it is arguably the most successful work I have been involved with to date.

In early 2001 there was a competition for the Sonic Arts Networks **Sonimation** commission for five short films to be made as collaborations between sound artists and animators. I had already worked with James on the **True Colours** project – a series of 20 second short films, each of which was about an individual colour. James Padley (then a student at Norwich School of Art and Design) and I had produced **Dark Green** for the exhibition, held at the Sainsbury Centre, University of East Anglia in the spring/summer of 2000. On hearing of the Sonimation commission, James and I collaborated on a proposal to make the film **Escape**.

The ideas behind **Escape** are based around shared experiences of paranoia, which myself and James have both had. To escape – to get away from something dangerous or confining, only to enter an equally perilous position, became the central notion behind the project. It was designed to be a story without explicit characters where the viewer became the subject of the film. Each time the subject escapes from confinement in the film, it is to arrive in another undesirable location. Just as one cannot escape oneself, and any attempt to do so results in greater trouble, so the subject finds himself trapped out in the open sea at the end of the film.

There were storyboards made for scenes past this point (already realised in audio), which would have given the film a less doom-laden ending. However, the deadline for the project was extremely tight, and so the making of the film was cut short as the premiere approached.

The approach was to create scenes in sound, with filmic musical elements mixed into them for atmospheric effect. Recordings were made of a building site (which was filtered to create elements of the opening sequence), the sea sloshing around a pier, a paint spray can (altered in pitch to create 'bubbling' sound effects for the underwater sequence), footsteps and doors (for the corridor scene). A piece of music was composed for harp, and recorded (the harp was played by Cindy Pennick). Sections of the analogue synthesiser material recorded at EMS in Stockholm\, and the performance given by Nick Melia and Myself on turntables with live electronics were also used (for the opening of the door and the sewer scene respectively).

Much of the collaborative process consisted of discussions of materials and effects. A set of audio-visual scenes were decided upon at the start of the project, and as materials were collected for both the visual and sonic aspects of the work, to create vistas, environments in sound.

A point to be made is that whereas the construction of a virtual space in computer graphics software requires that materials (photographed textures, virtual objects etc.) be applied to pre-defined structures according to the design of the environment. Implications of environment (such as reverberation, sound effects etc.) may be as important as the sound elements themselves in determining how a soundtrack may be perceived as an environment of sound elements or characters, rather than merely a piece of music. The portrayal of sonic environments in **Escape** is designed to follow the transitions through visual portrayals of environments, enhancing the realism of the graphic narrative.

The illusion of cause and effect discussed earlier is heightened by the use of sound in **Escape**. Certain musical events happen in anticipation of events on the screen (the door opening, the journey through the tunnel). Musical tension is used in a dramatic way in **Escape**, heralding impending events, as well as heightening tension within scenes. The distinction between an *event* as a transition from one *scene* to another is important here. There are no cuts throughout the gestural narrative of the film. It is seen from the perspective of first-person, there is no dialogue, just scenes and their transitional events. The gestural narrative of the film happens in actual time, as though these were current events being transmitted from a cameraman to the viewer.

To make a piece of cinema with no explicit edits and no characters or dialogue is a unique challenge. Clarity of symbolism is important for explicit sonic cues, but it is what is not represented on the screen, which causes the film to be viewed as a piece of theatre. The footsteps of others (corridor) and gentle harp melodies, the groans of the city (sewer) and bubbling sounds of underwater, all are placed within the context of the piece in order that the listeners imagination might somehow be distracted from the inherent fiction of the work, and that the viewer may be drawn into the piece as if it were his or her own experience. Super-realistic exaggeration and synaesthetic appropriation of the sensation of falling add to the potential for the work as a piece of *escapism*. The listener is invited to escape *into* the work, only to find that there is nowhere to go, and that one is left at a wholly unsatisfactory point. **Escape** is about exactly the opposite of what 'escape' really means. It does not give the viewer the happy ending, but a sense of closure *is* evident – of death, entrapment and destruction. Escape represents the fears of its creators made manifest in a work of art, and parallels the composer's experience of mental illness (in 1993).

The music for **Escape** is concerned with events outside of the listener's field of vision. The running footsteps and slamming doors of the corridor, and the groans of activity in the sewer, imply activity away from the viewer. The viewer's imagination is invited to invent background activity, occurring in the fictional time of **Escape**s transit. Repeated viewings suggest that there is nowhere else for the viewers imagination to go, other than to imagine what lies behind the other door, or what kind of activity causes the pipes to groan so, or what kind of fish are in the water. One knows at this stage where the pieces final destination lies, and that it is only a matter of time. Were this a computer game it would be "game over", but it is not, and there is no other route through the film.

One of the concepts realised in composing the soundtrack to **Escape** was a sonic landscape of *directional* sound. Sound that implies motion is used in the first scene to imply possibilities of action. That there may be multiple exits is implied by the visual scene, except that the film begins with its protagonist (the viewer) being locked into a realm of corridors and doors. This implies that there is no way back for the viewer, and that he or she is being taunted by the running footsteps and slamming of doors in the distance. The harp melody is used to imply that

danger is present, in its harmonic tension. The system with which I create my instrumental compositions, known as Quantum Modal Serialism (QMS - discussed in part 2 of this thesis) was used to compose the harp music for **Escape**. QMS is especially good for creating this kind of continual, shifting tension in the harmony of a work. It is functional harmony, but without resolution as a necessary goal. Thus it is useful for composing music that moves through and between tonalities, rather than that which modulates via diatonic key relationships.

There are psycho-acoustic effects used in **Escape**. One of which is the Serge-generated sound (made at EMS) which happens as the door opens into the outside world. The upward sweep of an oscillator fed through a spring reverberation unit implies opening, its consequent transformation into more shrill, modulated tones implies speed, and the screeching wail towards the end of the gesture occurs in parallel with the rock of the tunnel being passed at speed. It is by synaesthetic appropriation of sound – connecting sound forms and timbres with *types* of transition/motion – that the visual element is enhanced with sound effects, a practise that is fundamental to the film sound effects industry (laser beams are silent, except in cinema!). The phasing of the rushing water sound between scenes two and three is an example of a psycho-acoustic effect used to influence the audience's perception of space and motion in the visual image. The feeling of open air and the resonance of the tube as the audience is figuratively thrown out into the sea, are effective in convincing the audience to suspend disbelief, in order that the film may be effective.

Escape has been described as "harrowing" amongst other things. It is an abstract work about circumstance that draws from experiences of insecurity in the modern world. In dealing with these issues it abstracts from them a simple principle of escape as not necessarily a good thing for the escapee. This is represented figuratively, since there are no explicit characters in **Escape**, only the audience.

Part 2. Notated Instrumental Music and Live Electronics

Audio CD Contents:

5. **Entanglement** for solo percussionist and live electronics. Percussion: Simon Limbrick, electronics: Edward Kelly.
6. **Thermal Inversion** for solo percussionist and live electronics**.** Percussion: Simon Limbrick, electronics: Edward Kelly

CDROM contents:

- **Entanglement Instant Remix v2** application for Macintosh
- **Thermos-flask-filter-player** and example **QMS** and **pattern-matcher** patches for **PD** under the **Linux** operating system on the **ix86** platform
- **Source Code and Binaries**: Sources for **PD**, **ggee, motex, xsample~** and **zexy** externals for **PD,** binaries for externals, .pdrt **PD** initialization file.

Scores:

1. **Continuum** for violin, viola, violoncello, contrabass and pianoforte. Two movements
2. **Cold Fusion** for four percussion players
3. **Entanglement** for solo percussionist and live electronics
4. **Perspectives** for violin, violoncello, contrabass, pianoforte, percussion, harp and french horn.
5. **Thermal Inversion** for solo percussion and live electronics

Part 2. Notated Instrumental Music

Chapter 2.1. A Revision of the Principles of Music Notation and Harmony

2.1.1. Motivation and Philosophy

> "The question continually on my mind all these years is: to what degree does one give up control, and still keep that last vestige where one can call the work one's own? Everyone must find his own answer here…" – Morton Feldman, *The Anxiety of Art*[xxvii].

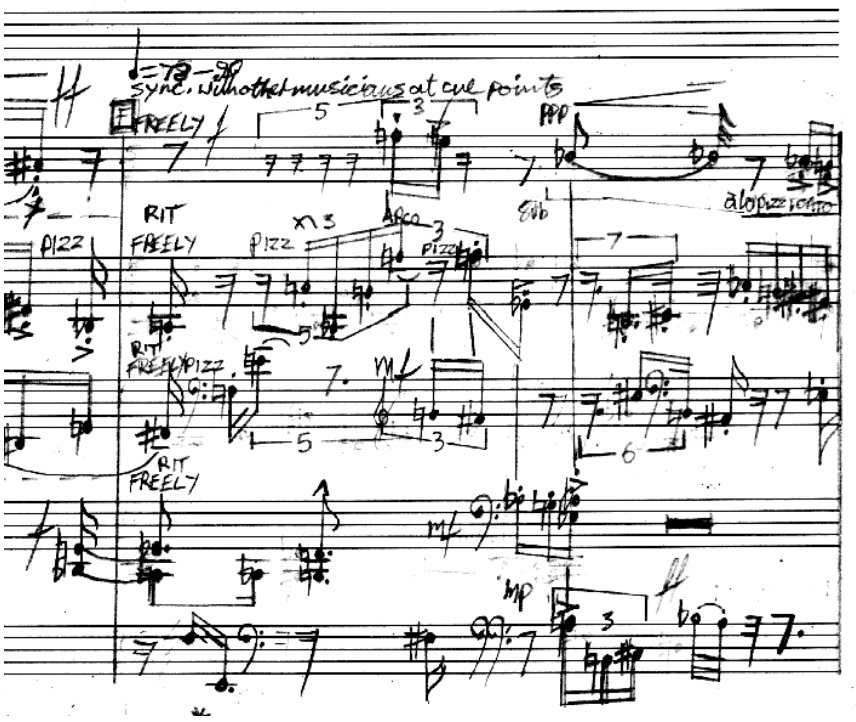

Figure 13a. A section of **Anomalous Data**, featuring the un-completed tuplet and cue points (lines linking notes together) where the musicians (apart from the piano) must accommodate the temporal error by delaying the next note.

An area of composition that interests me is instrumental composition. Since composing **Anomalous Data** in 1997, it became clear to me that I would traverse a perilous trajectory in the world of classical performance. One bar of this work provided the insight into how the system of meters and measures, of bars and beats, may be broken apart into a system of hybrid forms. The

bar, in its original notation and computer-formatted version, can be seen in figures 13a and 13b respectively.

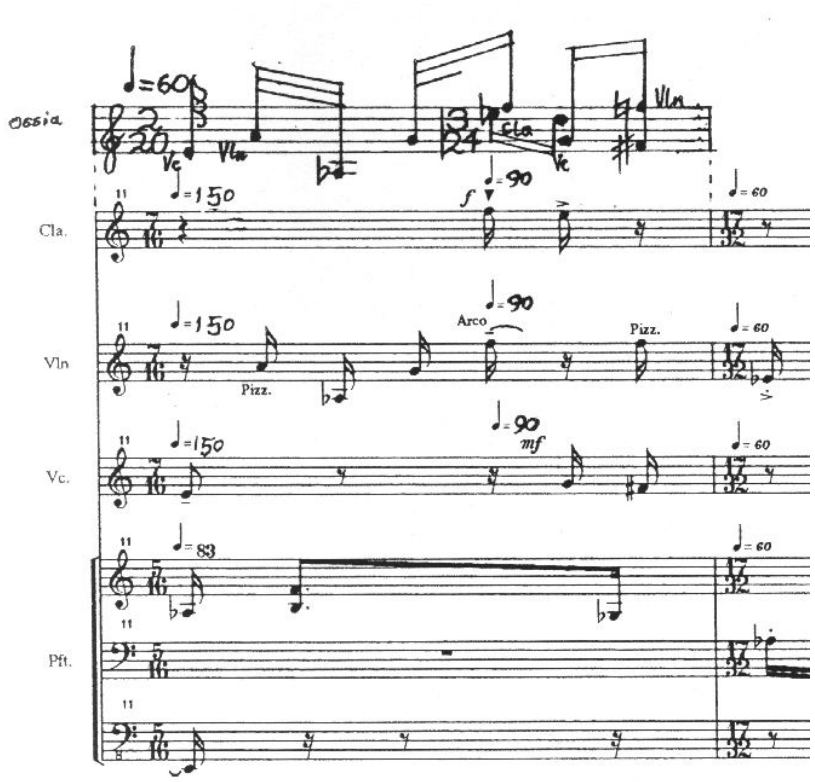

Figure 13b: The computer-notated version. Note the Ossia showing the true relationships between its metric modulations. This represents a compromise in that the tempo of the piano part is adjusted to fit the bar.

This clearly shows the metric being broken apart into uncompleted tuplets. There is a quintuplet, of which the final note becomes the first of a triplet figure. A compromised version of the music resulted from the brief for this piece insisting on computer transcription, and since **Anomalous Data** was composed I have drawn every score I have composed by hand. It is clear from the computer notation that the notion of time as a set of independent but related metrics, is incompatible with the software used to create the score (in this case, *Finale*). In order to understand the reasons for this it is necessary to look at the reasons for the existence of such packages, and through this come to an understanding of notation.

Music notation is both proscriptive and figurally descriptive. Notation can be seen as a factor in the realisation of music, in that it is a form of communication, and that effective communication requires a common understanding of its medium. Western music notation presupposes certain characteristics of common practice. The development of the printing press meant that music written down for future reference could be copied an indefinite number of times, and thus that the information encoded on the page could be passed on to an other. That other, in order to decode the information and produce music from it, must first understand the fundamental principles *on the basis of which it is written*. In the context of a world where the printing press has been invented, where information may be freely distributed and is no longer the sole preserve of scholars and clerics, we see the great enlightenment of the renaissance in the arts occurring in the 16th and 17th centuries and crucially to music, the gradually increasing necessity for the adoption of the 12 tone equal temperament tuning system.

In the early 18th century, Johann Sebastian Bach composed *Das Wohltemperierte Clavier* book I[xxviii]. It was the beginning of a new phase in the development of western music and of notation. The notion of key equivalence must only have contributed to the success of notated music in comparison to other forms of music. It is ironic that Bach would only ever have one of his works printed during his lifetime, since it was the success of his and other music that made use of modulation that led to the invention of equal temperament, and ultimately to the success of the printing press for notation and mass reproduction of music. A piece made in Salzburg could travel to Rome or London and be played *in tune*, regardless of what had been played on the instrument before, so a need for a standard form of notation *for the music of the day* was cemented. For the music of now, I believe that we need new systems of notation.

Notation was developed to describe in an abstract way what happens in sound. It has developed in context with social and cultural pressures that are different in different parts of the world – as are conceptions of music. To preserve tradition is to hold onto cultural and social values, which may be useful (for preservation of social order and prosperity, or survival). However, in some instances traditional forms and customs (such as the form of notation) become meaningless to the conditions surrounding them, or take on meanings based on misconceptions of culture or society. In order to reflect the diversity of musical practice and cultural polyvalence of

the modern world, systems such as this will need to (be) adapt(ed)[xxix], to accommodate new musics, new paradigms on music and new notions of musical time. An 18th century system of signs and symbols is frequently used, to convey 21st century musical ideas. If it is not broken (inadequate to define the material) then it does not need to be fixed, but the example given shows how easily it *is* broken by a divergence of structural principles, even on a small scale such as is shown.

Computers are machines that process information in a certain way (in the form of binary units known as *bits*). The codification of music into notation forms is a process that has been implemented into computer systems, but this process of representation of one system in another has in some ways frozen the development of music notation – and thus it poses a threat to the development of notated music itself. As more and more people have come rely on computers, to execute tasks that require *reproduce-ability,* the use of software to produce notated music has increased immeasurably. Since the common rhythmic language of the music through and for which notation became conventional was based on binary subdivisions of a metrical unit, western music notation was ideally suited for implementation in computer software (which works most efficiently with data organised as powers of two (8 bit, 16 bit etc.). I speculate that this binary conception of music has been implemented in binary computers. Whether this connection has been made or not, it is true that to compose diverse metric modulations per part of a score is not something that I have found notation software that is able to cope. In some ways the reliance on computer programs for notation is an enslavement to one conception of time, as divided up into regular successions of beats. In order to explore alternative approaches to meter than additive rhythm or mono-metric time, systematic adaptation of the *system* by which the information in the score may be required. At the time of writing, I am aware that *Sibelius* has become the de facto standard for computer-assisted music notation. Although this seems to represent a flexible enough environment for the composition of instrumental music, there is one flaw that it will never overcome[xxx]. A computer cannot postpone the decision making process and still function. The very operation of a computer requires that it continually executes instructions. In carrying out the automatic placement of notes, and making sure that each bar or tuplet is complete, the computer looks ahead to find the end of a logical unit of music (in its terms). It does not allow a situation where the mathematics of a bar (a bar of 4/20 for example) stipulate that everything *after* that bar will be offset by a certain amount –

which may or may not be made up later – of a non-binary subdivision of the beat. One advantage humans will always have over computers is procrastination. We can theoretically keep adding bars of unequal meter onto the end of this bar and still the music will have some temporal relationship to whatever else is going on. For humans, the completion of a metric modulation series (with relation to another series) can be postponed indefinitely, but the computer must have the fifth quintuplet or the numerical descriptions of parts do not equate with each other, and this is the computers prerogative.

Going back to figure 1. It is clear how the simple omission of one quintuplet semiquaver in the rhythmic scheme, has broken the system. The software I was using to transcribe the piece I had composed on paper, could not cope with the idea of a time signature outside of binary principles of subdivision of the metric. That would mean making it up in the future, or possibly never, and the future is simply not available to the computer, yet it is something that humans can conceive of, and hence it is a concept humans can use. The notion of a non linear rhythm was found to be outside of the capabilities of the computer, and so I was forced to insert tempo changes into the score. It is clear that mistakes were made as to the nature of these, and although corrections could be made to rectify this mistake it seems apparent that this is an incredibly clumsy way of notating quite a simple concept. Mistakes are inevitable, if one has a tight deadline to meet and has to make such compromises in haste. A more flexible notation system would allow corrections to retain their integrity! A compromise was issued at this point, since the whole point of this section was to have one section of the ensemble move into its own temporal continuum relative to the other section – for an instant! In the original (hand notated) original there is a line drawn, which serves to synchronise the rhythm after its temporary, non-linear disruption. The strings and clarinet are expected to add a little extra time (0.8 of a semiquaver or one quintuplet semiquaver) before commencing the next event. The software was not programmed to accept a broken (staggered) tuplet – there had to be five quintuplets in each tuple. Consequently I was forced to insert tempo changes into the parts, which approximated the metric relationships between parts, rather than having the tools at my disposal to deal with the phrase as a meaningful polyrhythmic musical statement. The *ossia* figure contains another tempo change (crotchet=60) as a result, one that alters the rhythmic relationships significantly. This was done after the

performance – at which the errors in tempo change were noticed. In a performance of such music, many of the fractional pauses (such as the 0.8 of a semiquaver pause in **Anomalous Data**) would be approximated, but this is not unreasonable. Rubato, and pause signs have been interpreted by musicians for centuries without detriment to the cohesion of the music in which these devices feature. Timing a pause to coincide with the actions of the other musicians in an ensemble is not an unusual component of ensemble performances. It is generally a good idea when working with polyrhythmic music for an ensemble to play from the whole score rather than from parts. This ensures that performers may be aware of what the other musicians in an ensemble are playing, and so allows them to remain synchronised with the ensemble. This is why each piece composed since **Anomalous Data** is scored using a proportional notation system (discussed below) since this gives performers an accurate representation of the rhythmic relationships between parts to work with, unlike a schematic, codified system alone (such as traditional notation).

Since the transcription of **Anomalous Data**, I have not composed a single note of notated music using a computer. In order to investigate non-linear conceptions of time in music in greater depth than before, I have adapted the tools of notation to suit the conceptions of music I am trying to portray. In order to accurately describe and communicate non-linear conceptions of rhythm I have resorted to a linear portrayal of time as distance along the page. This simple equivalence makes composing detail in a non-linear context a simple task, yet it does not exclude the composition of music that is linear in structure. It is an encompassing, inclusive notation system rather than a prohibitive, exclusive one. Notation software developers have yet to catch up with me on this point: the *architecture* of the system I have devised is flexible, and is fundamentally implicit to the nature of the music. In this way it is content dependent, rather than the content of a piece being context dependent, subservient to the (outdated) system in which it resides.

The notation system I have developed is a system that one can continually adapt to suit one's descriptive or proscriptive purposes. In 20th century instrumental composition this practice has been going on for some time to some extent. Many works of the 20th century make use of non-standard notational forms. These range from adaptations of elements of standard notation forms (such as the designations of various differently shaped note heads) to complete revisions and synaesthetic forms of notation (such as those used in Stockhausens **Zyklus** for solo percussion).

Henry Cowell first proposed fractional subdivisions of the superunit in his book *New Musical Resources* (1919)[xxxi] and in the **Quartet Euphometric** for strings (1916-19). Although this technique, coupled with a rather idiosyncratic set of shapes for note heads never gained widespread use and recognition, there is a compelling case for its inclusion into any comprehensive new notation system: the incomplete-non-binary metric. The notation system I have devised is a step towards such a comprehensive system of notation.

The territorial pitch maps used to compose **Cold Fusion**, **Perspectives** or **Thermal Inversion** are an example of how notation systems may be adapted to define specific material in an indeterminate way, as a set of possibilities rather than a singular, deterministic path. The development of quark-accidentals is another adaptation, one that may soon become incorporated into the score itself. It is hoped that computer software will become available in the future that will enable composers to specify their compositional environment rather than assuming a restrictive framework (conventional notation), and in doing so establish a basis for the creation of new music that explores new conceptions of musical structure.

The notation system used to compose **Perspectives**, **Thermal Inversion**, **Entanglement** and **Cold Fusion**, was mainly developed in and through the composition of **Continuum**. It is clear when looking at the score of **Continuum** that a conscious attempt was made to adapt the architecture of the notation system, to synthesize a more flexible system in which polyrhythmic music could be composed, as the making of the piece went along. In fact, **Continuum** can be taken as a model example of how compositional decisions inform the development of new compositional practices. First the metric rulers were devised – initially in order to clearly visualize polyrhythmic structures before committing them to paper. As the piece began to take shape, a fascination with independent rhythmic activity in each part led the composer to use these rulers (together with mathematical verification of the length of each passage) to composed proportionally notated polyrhythms, then to weave metrics into one another to create the kaleidoscope of metrics that is the second movement. In many ways, the composition of **Continuum** represents an extreme conception of musical complexity. I had wanted to see just how far I could push the notation – to break the system of notation I had been using in order to formulate a new, inclusive system that could not be broken so easily.

After **Continuum**'s inception (and most of the work of composition and notation) came **Cold Fusion**. An attempt was made to rationalise the notation system I had devised to make it graphically simpler and easier to read. **Cold Fusion** is a far less complex work than **Continuun** in terms of its polyrhythmic fabric, but demonstrates the flexibility of the system I have devised in its use of gestures in free or notional rhythmic forms such as the "round the edge" notation (e.g. toms on p. 14), or the accellerando/decellerando notations (e.g. gongs on p. 15). A further innovation is the use of barlines to represent synchronisation points as opposed to some hierarchic structural property, and the use of beaming to indicate phrase-structure.

The system I have developed is flexible enough to describe multiple conceptions of musical structure, from the hierarchic notation of meter, through non-binary subdivision structures and non-reversible metric modulations[xxxii] to the graphical indication of gesture. I shall proceed to document the characteristics and techniques of my notation system, which will serve as a foundation for a discussion of my compositional technique, and for the music composed using such methods.

2.1.2. Representation of Meter as a Flexible Compositional Device

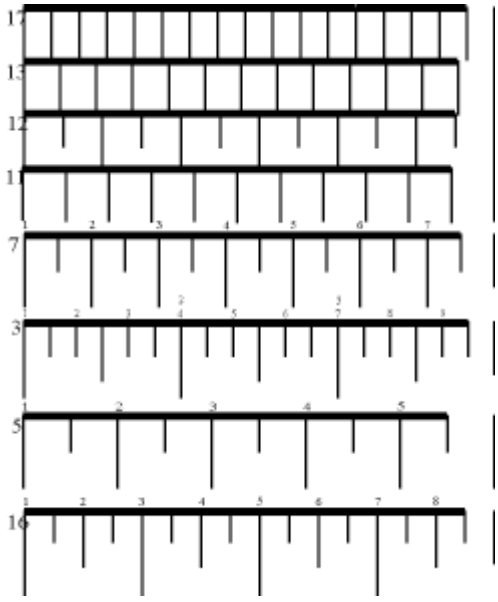

Figure 14: Metric equivalence rulers used to compose polyrhythmic music in proportional notation.

Attempts by modern composers (e.g. Luciano Berio, Karlheinz Stockhausen) to create compositional systems in which time in music is related proportionally to distance on the score, have informed the development of the system I use. In composing **Continuum** it became clear that the continuous metric modulations in each part would be extremely difficult, if not impossible for a performer to reproduce accurately, if just the time signatures were included as the only indicator of speed. What was needed was another way for the temporal structure of the score to be represented, so that players could perform according to the graphical proportions of the score as well as attempting the metric modulations indicated by time signatures. Aware of the **Sequenzas** by Berio, their use of proportional notation where time is represented by horizontal distance along the score rather than by a note's relationship to an underlying pulse, I constructed a set of rulers. The aim was to combine principles of metric notation with proportional notation, so that players could see time signatures as proportionally related to the distances between notated events. The rulers (see figure 14) are of the same horizontal length, divided up into different numbers of equal divisions. These are further divided in some cases, so that the binary subdivisions of each prime number subdivision are represented, by lines that are shorter than the fundamental (in most cases prime) subdivision of the beat. For example, the fifth ruler from the top is divided up into seven units that are in turn divided in two, representing 14^{th} and 28^{th} notes respectively. The denominator of each time signature represents its relationship to a semibreve – just as it does in traditional notation – so that time signatures may be written as relationships to a meta pulse, four of which (a semibreve) I call the *superunit*. Each ruler represents exactly half of the superunit.

The score itself is divided up into portions of equal length, equal to the length of one meta-crotchet. In earlier scores this was never explicit, but as the score for **Perspectives** took shape it became clear, that to synchronise performers with a click track (or even for performers to play the piece unaided) would be easier if the clicks (sychronisation points) were represented by vertical grid lines on the score. This method was used for the original, hand-written score of **Thermal Inversion** (2002) also. The combination of explicit temporal representation with implicit (proportional) metric representation (using the rulers), will not only help performers to stay in time through complex polyrhythmic structures, it also enables the composer to create such structures,

without losing track of where in the metric one has composed until. Composing in this way is an immensely satisfying and rewarding experience, since one can see the temporal structure of the music on the page as it is composed. The temporal relationships between events are represented by traditional beaming structures as set forth in the work, *Modern Rhythmic Notation*[xxxiii]. A note value is decided by the following numerical criterion: a note that takes its rhythmic value to be equivalent to the nearest binary value below it (4, 8, 16 etc.). Thus, a 14th note would be notated as a quaver whereas an 18th note would be a semiquaver, a 48th note a demisemiquaver and a 6th note a crotchet, and so on. Where nested polyrhythms are notated, the note value is worked out by dividing the standard subdivision by the number of durations the tuplet takes up, then multiplying it by the number of durations in the tuplet, and applying the note-value rule above. Thus a triplet in 28th notes (notated as semiquavers since 16 is the nearest binary value below 28) would be demisemiquavers – since 28/2*3=14*3=42 – 32 being the nearest binary value below 42.

Notation in free time is possible with this system too. Since it has proportionality at its core one can compose irregular structures in the horizontal space of the score that represent temporally irregular structures. Wishart (Wishart 1981[xxxiv]) discusses at length the *lattice-based* structure of traditionally notated music. It is posited in this volume that in order to compose new forms of music one must look beyond this conception of time towards an approach based on time as a *continuum*. This is stated in the context of interpreting all musical parameters as continua, to the extent where timbre is seen as a multi-dimensional conceptual space. Regular meter is just one of the possibilities of music in the time continuum, as equal temperament is in the pitch continuum. However, the system of notation invented through the composition of **Continuum** encompasses both lattice-based and continuum-based structures. Proportional Polyrhythmic Notation (hereafter referred to as PPN) is a system of notation, which is flexible in the temporal domain in a way that traditional or proportional notation systems never were. It is the instrumental embodiment of *combination form*, since it affords the composition of many disparate systems of notation of musical material.

Continuum is flawed in many ways however. As a testing ground for ideas it has proved invaluable, but as a piece of music it is very likely never to be performed. Many of the ideas for arranging material were carried out in haste, and mistakes exist at fundamental levels of

organisation of material, since the sheer scope of the work was way beyond the capabilities of the composer at the time. It could be argued that this is unimportant since the works complexity, and complex hierarchical composition process render such mistakes meaningless to any realisation of the piece[xxxv]. It was decided in fact to bring the work to a conclusion in 2000 (with a bar of 1/0, a logical extension of the metric super-structure of the movement) since it had become a hindrance to progress. However, many of the ideas first explored in **Continuum** have matured over time and have become important principles in the composition of subsequent works. **Cold Fusion**, **Entanglement**, **Perspectives** and **Thermal Inversion** would never have been composed the way they were if it were not for **Continuum**'s revision of the methods by which I compose.

Chapter 2.2. Continuum: Synthesis of a Compositional Technique

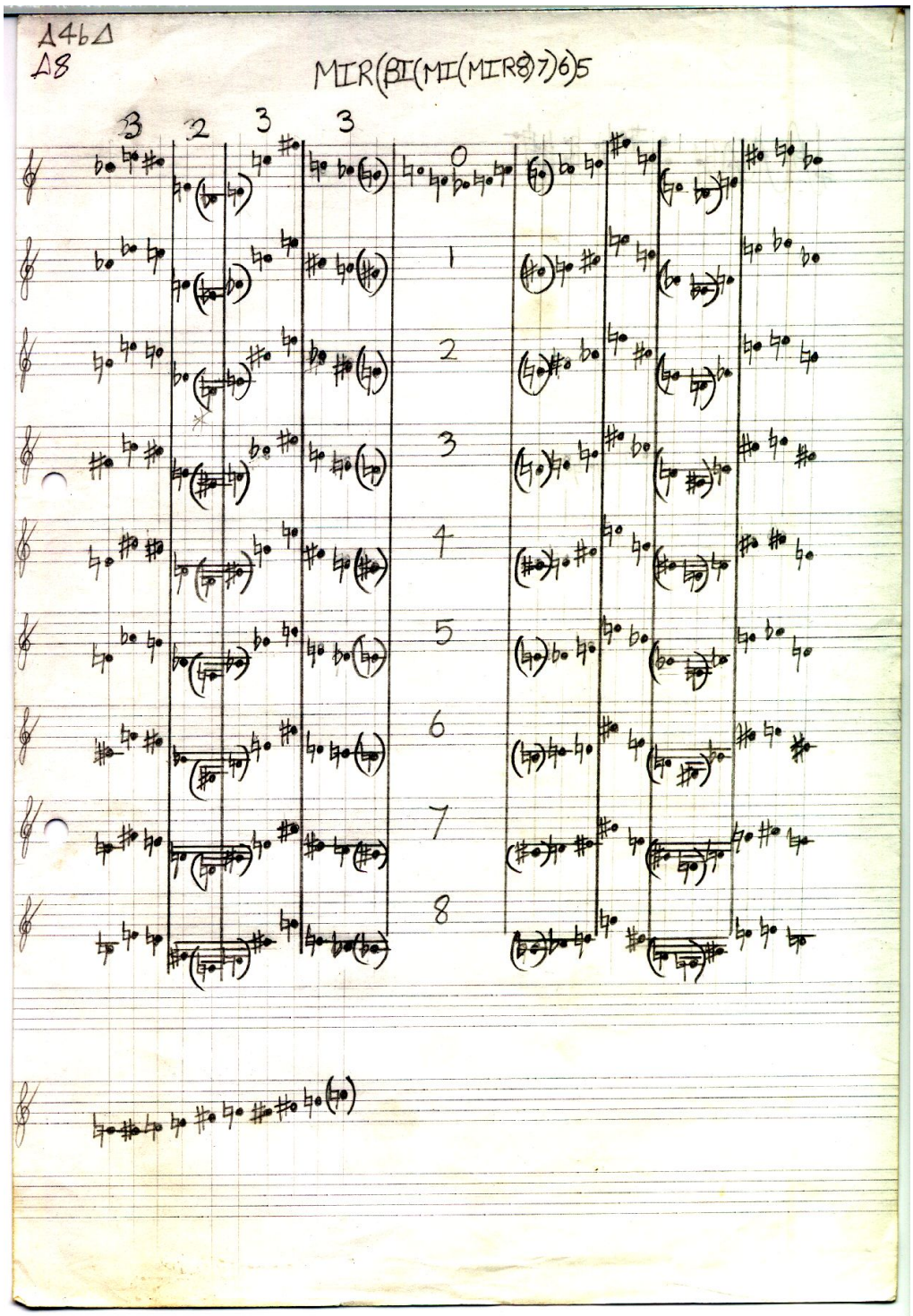

Figure 15. The *delta-8* page of modal tone rows used to compose **Continuum**, with the *mode* at the bottom and the *node* in the center.

2.2.1. Theoretical Concepts.

The composition of **Continuum**, carried out from 1997-2000, is a mirror to the development of my compositional technique in an instrumental idiom. As the piece progresses, so the notation changes. The notation starts off as traditional notation, but as the piece was composed, changes were made to the form of this notation in order to expand the possibilities afforded by notation itself.

There are three key ideas developed in **Continuum** that have become central to my instrumental composition technique. These are as follows:

1. **Modal Serialism**. The pitch material for **Continuum** was derived from a single row of 11 tones with two repeated (optional) pitches and one optional pitch - with a mode of nine pitch-classes. This system was the precursor to Quantum Modal Serialism, which is explained in a subsequent chapter (Quantum Modal Serialism for Beginners). Modal Serialism consists of tone rows with less than all twelve chromatic pitch-classes (PCs). The omitted PCs are maintained through (modal) transposition of the row, and modal inversion, where the intervals that make up the row are shifted slightly to avoid PCs that do not feature in the original row (the *node* of the row). The intention of this was to construct a system that combines the note-ordering principles of Serialism without sacrificing a sense of tonality (or tonalities) within a work. This too represents an effort to create a system that encompasses aspects of various other systems, to synthesise a *hybrid* system applicable to its parent theories. Thus a twelve tone row in this system is a row with no node, whereas another row may contain the PCs of a C major scale, or a more complex polytonal mode (such as Messian's mode 2). In **Continuum**, there were 32+8 pages of rows derived from one original page of transpositions and retrogrades. Figure 15 shows one of these pages, which are to be found in appendix 1. They were derived by taking a transposition with different intervals to the original (due to modal transposition) and inverting it either modally or literally (β inversion). This was then transposed modally to create the page. The symbol/number denotation at the top of the page

indicates which *path* of derivation, as well as which *stage* of derivation the page comes from. For example, Δ8 means path Δ, 8th derivation. The 8th was derived from the 7th, the 7th from the 6th and so on, back to an original page of rows from which the first four derivations were made. The choice of rows with different intervals to the original ensured that the modal transposition/inversion/β inversion process resulted in pages of rows with similar melodic contours but subtly different harmonic relationships to the original row. These were divided up into four sections in a rotating system of permutation: the first page was divided up into 3, 3, 3 and 2 PCs, the second into 3, 3, 2 and 3 PCs and so on. It was here that mistakes were made, although there is a conceptual conflict with this process and the process of Modal Serialism anyway, since it undermines the preservation of note ordering mentioned earlier. It did however, created enough data in order to establish the second principle technique, by mapping the names of each section onto the triangular grid.

2. **Territorial PC Maps**. The sections were each given a distinct label according to which stream of derivation the page belonged to, how many derivations had led up to each page, whether it was the original or the retrograde that was indicated, which transposition and finally which section of the row was being indexed. Greek letters α, β, γ and Δ^2 were used to denote the path of derivation as mentioned earlier, thus a section would be labeled for example, 2β o7d or 6γr3b (6th derivation, path γ, retrograde, transposition -3, section b). These indices were mapped on to a large triangular grid by a system of rotation of permutation. Lines were drawn through the grid with different coloured pencils, lines that possess different structural properties depending on their colour. Red lines thoroughly explored the material, blue lines traveled as far as possible from their point of origin, yellow lines exhibited repetitive structural properties and green lines looped and branched. The material for the composition was gleaned from this by following the lines drawn through the grid, looking up the indexed material and transcribing it onto manuscript paper. The resultant streams of PC information were used to composed the piece, together with the third principle technique:

[2] My knowledge of the Greek alphabet was evidently unsatisfactory for this. The process was begun without reference to textbooks on this, and it was deemed more important to get the composition started than to wait until satisfactory information became available!

3. **Kaleidoscopic Polyrhythmic Grid Structure**. Soon after the beginning of the second (and currently, final) movement there is a change in the structure of the notation. It is here that the concepts of the *superunit*, *proportional notation* and *meta-bars* are introduced. From bar 43 of the first movement onwards, the bar lengths become increasingly more unique to each instrument, and non-binary metrics (such as 3/5, 21/40 etc.) begin to appear, until on the third page of the second movement where a triple bar line appears. At this point the metric structures begin to alternate between two non-binary subdivisions of the meta-bar. The meta-bar is the formal unit into which each of these alternating structures are composed. Each meta-bar is a pre-composed length in terms of meta-crotchets (standard crotchet units from which subdivisions are calculated) but lasts for the same amount of time. Consequently each meta-bar has its own tempo relative to the others. This is an extreme form of nested polyrhythm. The time signatures are derived from the *superunit*. This, as it is in traditional notation, is the length of a semibreve, which is divided into smaller units to give the denominator, of the fraction that is the time signature in each bar. The alternation between subdivision values is further governed by increasing and decreasing numerators of each fractional time signature. Thus the first meta-bar of the piano consists of 14 20^{ths} + 1 28^{th}, 11 20^{ths} + 4 28^{ths}, 8 20^{ths} + 7 28^{ths}, 5 20^{ths} + 10 28^{ths} & 2 20^{ths} + 13 28^{ths}. As one quantity of subdivisions increases, the other decreases, and so there is a gradual transition between one metric and another. The meta-bar between pages 33 & 34 contains 3 metrics where two increase as one decreases, or one increases as two decrease (different for each instrument), as does the one from pp. 35-36 and the first one wholly contained within page 37. The music is for much of the first movement and all of the second, laid out in proportional notation form.

Continuum is a cumbersome melee of ideas and theories that, if it ever is realised in performance, will have to be combined with some such device as the **scrolling score** system. This system (of which there exists only a few sketched attempts written in MAX) would scan the music past the player, either on screen or on paper rolls. A line (either drawn on screen or on a piece of clear plastic underneath which the paper roll would move) would indicate when to initiate scored events. It seemed appropriate at the time of **Cold Fusion'**s inception that my energies would be

better concentrated in composing music that would stand a greater chance of being taken seriously by ensembles, and that might actually be performed. It is open to debate as to whether I could have achieved a performance of **Continuum** whilst at UEA, but my decision to bring the piece to a close, when less than half the material had been used up, was based partly in the elegance of the solution I came to realise to close the second movement, and partly on a desire to move on and compose new work.

The final meta-bars of **Continuum** consist of 7, 6, 5, 4, 3, 2 and 1 meta-crotchet, with tempo modulations inversely proportional to the number of meta-crotchets in each meta-bar. It was felt that to give up on such a radical project would constitute a breach of the composers commitment to the music, but a way of postponing its completion indefinitely came to mind, one that opens up a whole new set of possibilities that may be realised in the future. A bar of 1/0 theoretically lasts forever! As any computer programmer or mathematician knows, $1/0=\infty$, so to divide time up in this way is to create a theoretically eternal bar! I call this the suspension of metric time. If and when I decide to continue this composition it will consist of composition in free proportional notation interspersed with metric notation. The aim of **Continuum** is to explore as many different modes of temporal organisation as possible. It is likely that the composition of **Continuum** will continue if composing a piece that takes so long to produce such a small amount of music ever seems feasible again. For the time being I am content to leave it as it is, as further projects have arisen that simplify and rationalise the techniques developed in and through **Continuum**.

Chapter 2.3. Cold Fusion: Proportional Polyrhythmic Notation and the Development of a Custom Score

Cold Fusion was composed from February to November of 1999. The first seven pages were composed in response to an SPNM call for works, in association with Ensemble Bash. The piece was rejected by the Ensemble and SPNM, possibly due to its complexity (and the brevity between the submission date and the performance date). With **Cold Fusion**, the A3 format of my customised score paper was conceived. It was decided with **Continuum** that the notation and continuity of the score had been limited by using commercially available standard stave paper. With **Cold Fusion** and every subsequent piece of instrumental music I have composed, I have devised the layout of the score from scratch each time. Sometimes this has been more effective than others (the original score for **Thermal Inversion** was a little confusing according to the percussionist Simon Limbrick) but in every case I am convinced it is more effective and graphically simple than if standard stave paper were co-opted for the purpose. One very good reason for this approach is the literal (rather than purely symbolic) representation of time, which proportional notation entails. PPN is a system that combines symbolic representation with literal proportionality. This is its strength, since there are multiple ways in which time is represented, which are simultaneously displayed in this notation system. Rhythms are easily perceived as the symbolic information (beams and note values) communicates. Relative tempo and the events' relationships with other elements of the music are literally displayed, as subdivision values and spatial positions respectively. All these different representations of temporal information work together to create a score that is clear, concise and graphically simple, relatively to the complexity of the music. In **Cold Fusion** there are time signatures as 7/28, 6/24, 5/20 etc. In later works (most notably **Perspectives**) these are reduced to a single number that indicates the metric (i.e. the fundamental subdivision of the superunit on which the music is based). There follows a transcription of the performance notes for **Cold Fusion.**

Chapter 2.4. Quantum Modal Serialism

2.4.1. Quarks and QMS.

Quantum Modal Serialism (QMS for short) is the name I give to the library of techniques that I use to construct pitch material for instrumental and computer compositions. I created and adapted it to meet a need to make the material with which I was working more flexible, more malleable. A 12 tone series is in many ways a negative compositional tool, since tonality is homogenised inside the row, trapped inside the inevitability of negation since tonalities are contradicted as quickly as they are established. By tonalities I do not mean musical keys in the western diatonic sense, but modal tonalities (that encompass diatonic keys) that may vary in their chromatic density and pitch arrangement from one mode to another. QMS was invented in order to capture some sense of harmonic coherence back into a rigorous working practice, to integrate tonality into a methodical generation of ideas. Ideas from the world of quantum physics have been incorporated into this system in order to cast compositional decisions into the future, but also to make the process of performance a more interactive one. In order to establish such a system, some new accidentals have been created in order to notate indeterminate states of pitch. These are known as quarks, and quarks can change the fate of the Universe!

Quarks are indeterminate accidentals. The purpose of quarks (either in the pre-compositional process or in the music itself) is to postpone a compositional decision for as long as possible until the moment of realisation. Realisation may be as in a score, or as a just-in-time performance decision, or as a factor in determining the behaviour of a computer program (a PD patch for example). Thus it is possible to assign indeterminate points to any stage in the compositional process without sacrificing the notion of a piece possessing a characteristic form or characteristic structural behaviours. The analogy to subatomic particles is intentional[xxxvi] (and provides a loosely coupled reference for this work) , “the collapse of the wave function” (where a probabilistic wave-like function becomes a particle in a specific location by observation) is analogous to the moment of composition or performance in that one cannot say for certain where in the pitch continuum an event will be until it has arrived, which may be when the dot goes on the

stave or when the note is finally played. The reference to the Standard Model physicists use to describe the behaviour of matter on a subatomic level is used as an analogue for various indeterminate states.

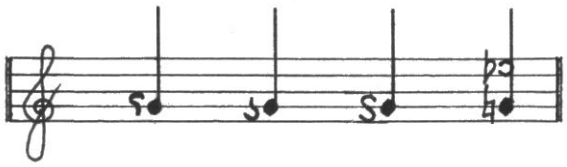

Figure 16. “Up”, “down”, “strange” and “charm” quarks.

There are to date, four quarks that have been used in composition (figure 15). The “up” quark, when invoked, alters the pitch upwards by [up to] one semitone and the “down” quark downwards by [up to] one semitone. The “strange” quark alters its host either upwards or downwards by [up to] one semitone, and the “charm” quark is a second pitch by definition more than one semitone away from the host, which the host may adopt when invoked. The words in square brackets indicate a factor that is only implemented in the computerised version of QMS, though this may be the case if instruments of traditional pitch are used. Alternatively they may provide a basis for improvisation or articulation, trills and so forth, when used in a score.

The point of all this is partly to give a piece a helping hand in developing a life of its own. One might see it as a way of giving a work a personality of its own so that rather than being merely an extension of the composers own persona, a piece may compose its own final state, by the use of pattern matching algorithms and possibly improvisation upon QMS principles (if they are embedded in the score). For the time being I’ve used it as a compositional tool, with documentation as to which pitch maps were created for each work. For me it provides a set of tools for generating pitch-class material - or other material in other musical parameters when used in conjunction with computer software such as PD. It gives a piece the chance to change, to mutate between performances as players develop relationships with the music and seek to enhance those relationships in physical performance. It also affords the computer a certain unpredictability, since the way the computer treatments behave may be linked to the outcome of “quark decisions” made either randomly, algorithmically or by sampling audio rate signals in the computer program. With

the four quarks mentioned the changes to instrumental performance (were they to become part of the score) are quite limited. With the top and bottom quarks discussed below the gamut of possible interventions by the performer is increased, yet the degree to which quarks may alter the character of the material is kept deliberately restricted. A pattern composed with quark accidentals will still possess a similar overall contour and thus retain some of its identity from one performance to the next. A piece's tonal structure may thus be defined ambiguously, yet still specific as to what its ambiguities are and how far they extend away from the notated pitches.

In these works I am using QMS as a means of generating material rather than a device for performer intervention. It is impor6tant to discuss the implications of the system I have devised, to demonstrate its flexibility in terms of defining structures with inherent ambiguity. What this system does not do is give the performer a blank canvas on which to impose his or her ideas, rather it allows for two things. It provides the composer with a set of tools to control the quantity and scope of performer intervention, or to postpone the act of choosing pitches whilst still defining structural units of material. The former is a way of composing works with more than one possible realisation without sacrificing the ability to define a work in terms of sophisticated structural detail. The latter is useful because it frees the composer from a rigid definition of the material (as is the case with strict Serialism) without sacrificing the rigorous pre-definition of tonal structures. One way in which QMS can be used to generate material is to work out modal transpositions, retrogrades and inversions of a row as with strict Serialism. Another way (and the way I have chosen to work with QMS until now) is to use quarks as superimpositions of states in order to generate mediated hybrid material in the form of a meta-score. The resultant organisation of material is henceforth referred to as a territorial pitch map, and this is discussed in the following chapter.

2.4.2. Territorial Pitch Maps

The other side to quarks is their reproductive capability. In order to discuss this we must first take a look at three techniques I use to order and generate my musical materials: pitch breeding, pattern mutation and inflation.

Pitch breeding is a mathematical operation whereby two pitch-class series can be manipulated to produce hybrid series. The "child" pitch-class of two notes is dependent on two factors: the smallest difference between the two pitches (in semitones)[xxxvii] and the direction of transfer (series a to series b, series c to series a etc). If the difference between the pitches is even, it is an average value that is obtained (e.g. A*C#=B). If the difference is an odd number then the second pitch plus the difference is the new pitch value. There is one exception to these rules, which is the tritone rule. If the difference between the two pitches is a tritone a problem arises, since the second pitch-class can be either 6 semitones higher or six semitones lower than the first. In this case the even interval/average pitch rule is instigated twice with one pitch created 3 semitones higher than the first (or second - it makes no difference) pitch and one 3 semitones lower - creating an opposing tritone to that which created it (a son rebels against his father…). The direction of transfer will drastically affect the outcome of such unions, especially when the parent series are of different lengths. The child series will always be the same length as the shortest parent (see figure 17).

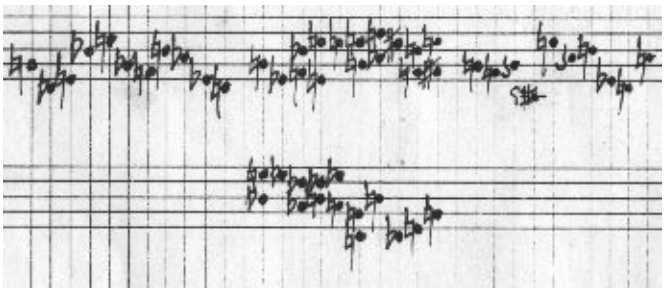

Figure 17. An excerpt from the Territorial Pitch Map used to compose **Perspectives**. Note the difference between the two hybrids resulting from the interaction between a row of 11 elements and a row of 10. The top hybrid is bred by reading both series from left to right, and the bottom by reading from right to left.

Pattern mutation happens when a series is “interbred”, i.e. its elements are bred with themselves (a*b, b*c etc. or z*y, y*x etc.). Since the child is a bastard (has only one parent) it can be said to be a mutation, and similarly the direction of transfer will effect one of two different outcomes of this process. One might even be tempted to call these “boy” and “girl” mutations - were it not for the fact that raw pitch material is inherently asexual. It would involve a degree of poetic license to do so[xxxviii]. The resultant rows of pitch-classes have one less element than the parent rows.

Inflation is the technique used to generate the top and bottom lines of material for **Thermal Inversion**, of which part 1 is complete. In inflation (see figure 18), the first note of the row is taken as the tonal center, and each interval (in steps up or down the mode) is multiplied by a fixed integer. This re-arranges the elements of the row by rotation (modulo to the number of elements in the mode).

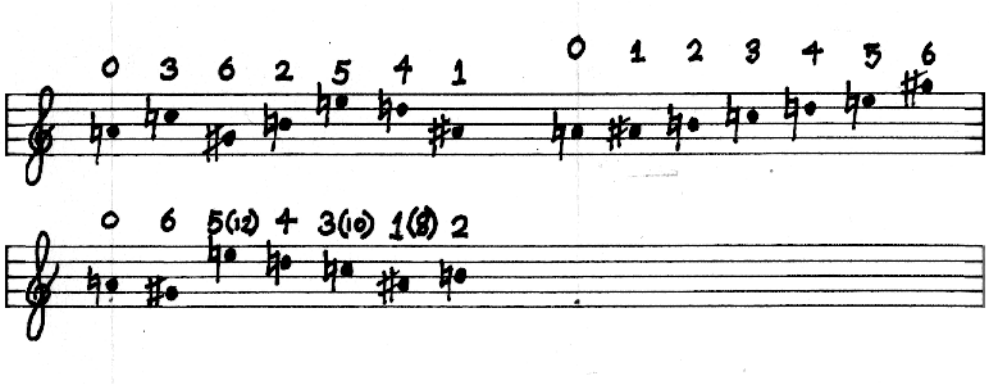

Figure 18. Inflation involves multiplying the modal index of each note by a fixed integer, in this case 2. The original is shown at the top left of the diagram, the inflated version below it, and the mode at the top right of the chart. The modal index of each note is printed above it.

So far the techniques discussed produce monophonic rows plus the occasional tritone - just more and more material one might say, but the situation starts to get really interesting when quarks are introduced into the equation. Another way in which quarks influence the process of composition is in extending the material vertically as well as horizontally. Since each quark has

more than one possible pitch value, so does the outcome of "mating" it with a pitch. This is used to generate chords, as every possible outcome may be mapped onto the series. The largest chord (consisting of 8 pitches - see figure 19) that can be generated by pitch breeding is produced by mating a strange quark with another one a tritone higher.

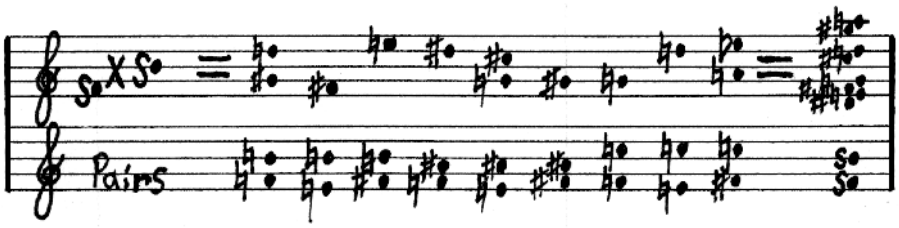

Figure 19. The interbreeding of all the possibilities inherent to two strange quark-pitches, a tritone apart results in a chord with eight pitches. The pairs of pitches bred to produce each resultant pitch or pitch-set are shown below the pitch or pitch-set.

Another function of quark breeding and quark *resolution* (i.e. the point in the compositional process where quarks become definite pitches) is in deciding the fate of a piece during realisation. By confirming the outcome of a particular configuration of quarks (i.e. by choosing one of many possibilities) and assigning this to a compositional parameter, the course of a piece may be altered either during the process of composition or in performance time (e.g. inside the computer, or in a performers interpretation of the quark). In this way compositions can be made which are *semi-autonomous* yet still retain definite structural characteristics that define their identity. This is a departure from algorithmic composition in its most traditional sense in several ways. Firstly, it requires that there be some kind of aesthetic decision on the part of the composer or performer. In that quarks are an *affective* component of the material they do not define it, rather they explicate indeterminacies within the structure of material. Secondly, quarks rely entirely on the provision of some kind of material, rather than a system of mathematical generation of material. Here it is pitch that forms the contours of the material, but with the aid of computers we can apply the same processes to rhythm, morphology or even hierarchical parameters such as repetition and global parameters such as tempo.

I choose to restrict the capabilities of the computer systems I create to respond to audio input. This is a response to a problem with regards to traditional approaches to electroacoustic music - namely how do we *perform* the music? What is happening in the moment of music that makes the music a performance, a unique musical experience, and how can we engage with the material? It is an issue of how we as composers and musicians relate our music to the outside world, to the moment of transmission, to the notion of performance with living, breathing materials and to the audience. It is quite clear to me that this approach could *only* have arisen from an interest in and practice of instrumental composition (and more contemporary approaches to electronic music) rather than a study of (invisible) electroacoustic music. The production of sound in the acousmatic notion of diffusion is hidden from the audience. Except perhaps for a blinking CD player, a mixing desk/diffusion console and some loudspeakers (all quite obscure sources) there is no readily identifiable source, no visual correspondence to acousmatic music by its very nature. There are only outputs. One could even speak of diffusion as an emasculated act of performance. It is a mediation in fact, rather than a performance of music. Acousmatic music does indeed have a well defined aesthetic and the fixedness of tape music means that a performance may be defined unambiguously (as with multiple-channel works for instance), but the fact that the material is rigidly defined before its performance takes place gives a work no room to grow, to adapt, to change. This is a common problem with electronic music and to a lesser extent with instrumental composition - and hence a more flexible approach to performance as well as composition is needed if one is to engage with the material of ones music at performance time. The reason why it is instrumental composition that has led me to treat only audio sources (electrified acoustic waveforms) as the *only* valid inputs for music that mixes computer treatments with live acoustic performance, is that the act of performing a score – or an improvisation – is indeterminate. There is no one perfect realization of an instrumental composition, since the very act of playing a piece introduces discrepancies with a theoretical original – which never existed, since notated music is a proscriptive art, a set of instructions rather than an ideal version. The reproduction of *nuance* is as important to the realization of any piece of music, so to reduce pitched musical material to a stream of MIDI note numbers is a simplification process – acceptable only if the original subtleties of the material are still available. Thus the software I am working on (including

one working example – **Thermos Flask**) is entirely driven by audio input. The parameters of such are only calibration for the process of re-synthesis of the material according to list-comparisons. If the patch is set up correctly then a constant re-interpretation of the material will occur, according to parameters derived directly from the audio. In fact there are technical issues that have not been solved as to how a transparent system may be constructed, which does not require some form of human-computer interaction in the form of an operator of the system apart from the (other) performers. Other, because to some extent the operator makes decisions based on aesthetic concerns (adjusting the specificity of pitch comparisons in order that more or less material is re-synthesised for example) and so is set to perform in some sense. The idea of the **Mirrors** computer software (discussed below) is that it may become a "black-box" system, in that the interaction between the performers of audio sources (members of an ensemble for instance) and the computer program is the *only* human-computer interaction that occurs. The nature of this is that it "listens" to the performers (retrieves and stores data about a performance that is then compared with earlier data) and re-constructs material according to common properties (phrases), so that the interaction is based entirely on the musical material. Both **Thermos Flask** and **Mirrors** are discussed in the final chapter of this thesis.

In order to understand Quantum Modal Serialism, a discussion of Modal Serialism is in order at this point.

2.4.3. Modal Serialism, the Forerunner of QMS

Modal Serialism was developed in response to the work of three composers, namely Arnold Schoenberg, Olivier Messian and Pierre Boulez[xxxix]. It is a hybrid system that incorporates features of both systems, yet affords much more depth of variation in the material than the traditional twelve-tone system. It is also a reaction to the "arbitrary" nature of much free twelve-tone composition in that its modal aspects allow it to retain a distinct sense of tonality without relying on a traditional sense of key.

The basic principle is this: it is the exclusion of notes from a passage of music that gives the music a sense of tonality. Atonal music abolishes this by saturating the chromatic, but if notes are included or even repeated in a series, a sense of tonality is allowed to creep back in. This can be accomplished without sacrificing the rigor with which serial music is constructed (although as we shall see, compositional decisions very often rely on a certain amount of local indiscipline. Here I believe lies the focus and power of serial techniques, as Boulez himself commented on the composition of *Le Marteau Sans Maitre*:

> "...starting from this strict control and the work's overall discipline there is also room for what I call *local indiscipline*: at the overall level there is discipline and control, at the local level there is an element of indiscipline—a freedom to choose, to decide and to reject" [xl](Boulez, 1976, p.66)).

A modal series has three parts to it, one real and two theoretical. The real part is the series itself, the notes in a given order (decided by the composer). There is also the *mode* and the *node*. The mode is the notes of the series arranged in ascending order (a la Messian) and the node is the excluded notes. The series - if it contains all 12 notes will have a mode of 12 notes (all pitches) and a node of none, thus it has reached saturation point. However the more interesting transformations may be applied to the series if it has less than twelve pitches present.

Modal transposition is where all the notes in the series are shifted down the order of the mode by the same amount. This results in subtle harmonic shifts in the structure of the series,

where areas of pitch-centeredness are prioritised and diffused along the series. Modal inversion is a similar process, except that for each step up the mode for the original, an equivalent step down the mode is taken in the inversion.

A beta inversion is in fact a literal 12-tone inversion. This transforms the tonal centre (the mode and the node) and so functions as the modal equivalent to a key change in traditional instrumental composition.

There is a logical notation to go with this as well - although this is in its infancy, (since no investigation of this was carried out after the quintet for strings and piano). If we take a series and designate it α, then the notation for "the beta inversion of the -3 transposition of the modal inversion of the -5 transposition of α" we can write $\beta(-3M(-5\alpha))$. It is slightly less cumbersome, but may provide a basis for analysis of this music at a later date. Transformations that are most different from their sources are arrived at by combining the various techniques of transposition and inversion.

And what of the quarks? Where do they fit into this whole picture? Well an up quark has a tendency towards a pitch 1 semitone higher than itself, and so we can write it into the mode as being higher than the pitch itself (if it happens to be present in the series as well). Similarly, a down quark is lower, but what of the strange and charm quarks? Well the strange quark has the freedom to move. If the pitch itself is present in the series as well, the strange quark can be either side. In fact the strange quark can shift up or down with each transposition, even (if so desired) to "stall" a single element for a time. The charm quark similarly can move between either of its pitches' places in the mode.

Quarks are invertible. Inversion of an up or down quark results in the opposite quark being formed. Charm quarks - when *literally* inverted - swap places with their host pitch. If more than one charm quark is present then it is the furthest quark from the host (in interval terms) that becomes the host. Quarks are not inverted by modal inversion however, as the orientation of the quark with respect to the host pitch is an integral part of the mode.

Quarks are affected by inflation also. Figure 20 shows what happens when a series containing up, down and strange quarks is subjected to the process of inflation. Up, down and

strange quarks' relationships to their host pitch-classes become inflated (as one would expect) and so are transformed into charm quarks.

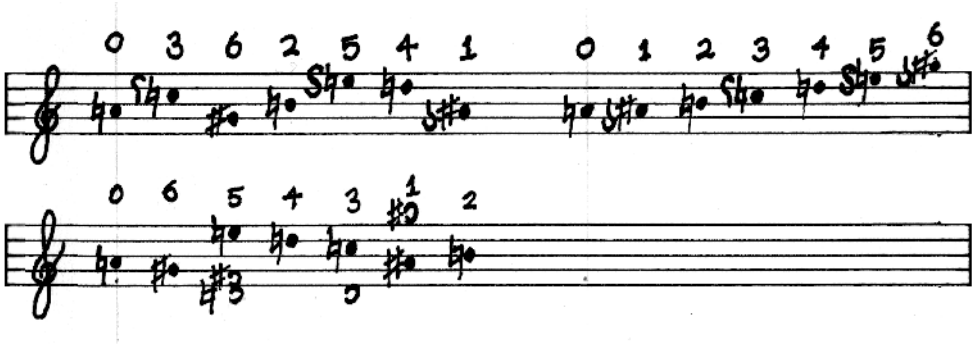

Figure 20. Inflation affects quarks, by expanding their relationships with their hosts and transforming them into charm quarks.

2.4.4. The *Thermal Inversion* Pitch Map.

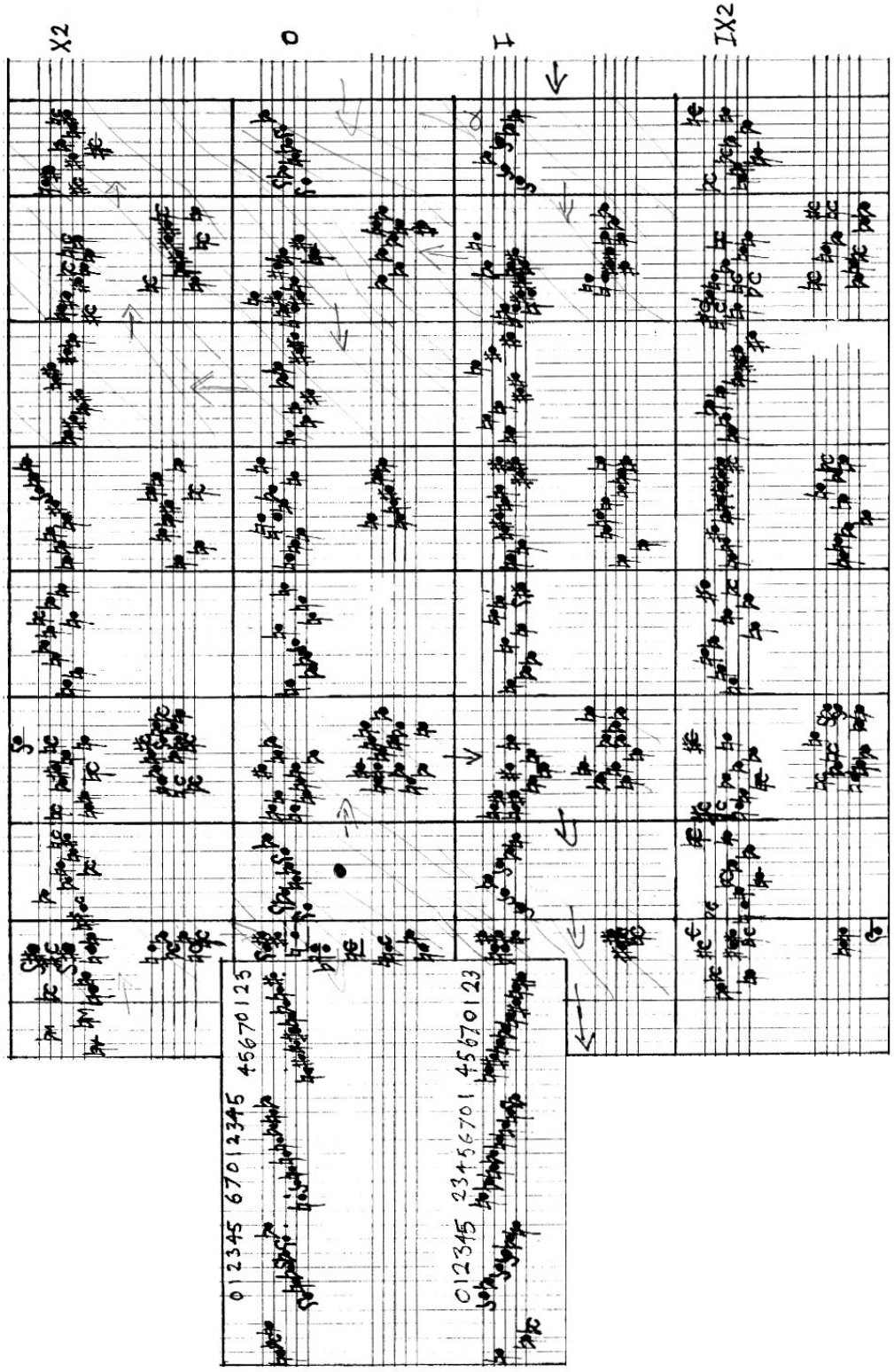

Figure 21. The territorial pitch map used to compose Thermal Inversion.

Figure 21 shows the territorial pitch map used to compose **Thermal Inversion**. The map is generated from four rows of pitches, of 3, 6, 8 and 8 pitch-classes with (some) quarks.

This particular map is the first to use charm quarks, as well as quark inversion. The modes (listed to the left of the figure) are indexed for ease of inflation. It is clear from figure 18 that the serial principles of row ordering in QMS are related to a pitches index within the mode, as opposed to its absolute index within the full 12 tone chromatic. Modal operations on QMS series are index-based, whereas literal operations (β inversion) are based outside of the mode in the chromatic index. It is conceivable that another mode could be indexed by a row, and so further transformations of a harmonic pattern could occur by mapping the indices of one rows mode to another mode or row. Indices are so fundamental to the concept of Quantum Modal Serialism that it is impossible to implement QMS procedures in computer software on any other basis. This will be discussed further in the chapter on PD implementations of pattern-matching and QMS.

2.4.5. The Top and Bottom Quarks

A new addition to the repertoire of QMS is the top and bottom quarks. They have yet to be used in a piece, but they complete the analogy with the standard model and specify a more flexible definition of pitch in terms of notation. The top and bottom quarks (Figure 22a) will be used to specify pitch ranges. They are immune to inflation, but not to mutation or breeding (as shown in figure 22b). Here the three notes in each group possess the relationship a*b=c, where c is the third note in each group. One already sees the usefulness of these, since they permit the composer some degree of freedom with regards to pitch, instead of committing one to a choice of two or three pitches only. Top and bottom quarks are the most indeterminate of the quark accidentals.

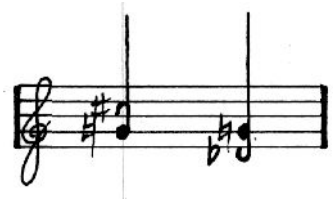

Figure 22a. The top and bottom quarks, which complete the analogy with the Standard Model.

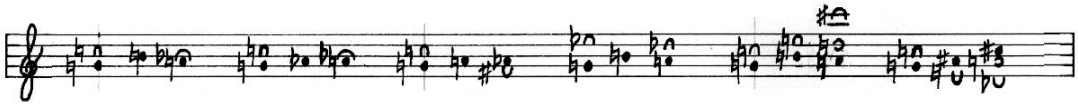

Figure 22b. Results of breeding with top and (some) bottom quarks. All of these results are invertible, since the bottom quark is a mirror of the top (just as the up quark is a mirror of the down). Notice how two of these quarks combine to produce a charm quark.

2.4.6. Indeterminate Rhythms, Dynamics and Articulation

In addition to quarks-accidentals, the potential exists to extend the scope of indeterminacy within this system. Dynamics could have its own set of symbols to represent indeterminacy, as could mediations of articulation (legato <-> staccato, arco <->arco col legno etc.) but care must be taken in constructing the score, in order that performers are not presented with too much information to process. A performance of **Continuum** would require highly complex participation on the part of the players in any case. If indeterminacies of dynamics, of articulation and indeed of rhythm were introduced *per note* into a score, the sheer quantity of mental effort needed to play the piece would require superhuman concentration. The techniques discussed thus far have been utilised primarily as compositional tools, although there is no reason why they would never become part of the score of a piece. The composition of a score that includes quarks will need careful judgment, as to where and when it is appropriate to use them.

I have yet to write a piece that exploits all of these features. **Perspectives** does not use every potential aspect of QMS. The charm quark for example is a new formulation, not fully realised at the outset of this work, but included in the formulation of **Thermal Inversion**. QMS continues to expand, as does my notation system. The top and bottom quarks have yet to be used in a piece, either as aleatory pitch ranges or as a means of generating material. I hope to compose works for solo instrument that fully explore the role of quarks in performance at some later stage.

2.4.7. The Search for a Voice in Instrumental Music: Style, Technique and Philosophy

My approach to instrumental music is kaleidoscopic. Combination form is a definition of compound forms of music, which is inclusive of multiple techniques, approaches and philosophies. The analogy of a wall where graffiti builds up over time as a continual process of addition of (varied and unrelated or related) material is appropriate here. The material is diverse in structure and substance, sometimes related to its surrounding contexts and sometimes unrelated as self contained (musical) statements. This analogy with graffiti is appropriate in understanding the role of the right-hemisphere oriented, still-spectator mode of listening, where internal maps of the material are reflected upon and referred to by the active listening processes of our perception. The dynamic interpretation of the music in time is expected to be one of shifting perspectives, of music framed by other music where character and substance overlap and integrate with other musical character(s) and context(s).

With **Continuum**, material takes simultaneous, separate structural 'paths', and then recombines into unified figures at points of coincidence. Coincidence throughout **Continuum** changes from a composed differentiation of materials within a meter to a sub-structural process that defines the implicit structure, as well as the coincident moments of the music. Onto this complex lattice of metric the material is composed in phrases and counterpoints between the members of the ensemble, sometimes in sympathy with the substructure and at other times in opposition to it. Consequently there are points of coincidence in the second movement which are important to the overall form of the work, but which happen in the middle of a phrase, and other phrases that are designed around the contours of the metric lattice itself. The point of this is to combine structure and material in such a way that the music may possess a rich variety of relationships between the time of the music and the functional relationships, inherent or implied by the use of the harmonic material. That multiple interpretations or hearings may be possible, dependent on the listening strategies employed by the audience, is also a goal of this means of production.

Time in this music is a shifting, unpredictable surface of lattices onto which the material is projected in the act of composition. The systems of generating material I have devised are open systems, in that there is no prescribed route through the material implied by a generative method (such as there exists with **Structures** by Boulez for example[xli]). Rather, the material functions as a map, which may be traversed in many ways via many different paths. With **Continuum** it was decided that the paths should be chosen through an abstraction of the material. It is not clear why this should be the case, but since multiple paths were expanded simultaneously by virtue of their origins proximity to another path (i.e. when the path being expanded was next to another paths origin, the other path was initiated), the act of composition included some, but not much, determination of the material in advance of its use. What I mean by this is that the abstraction of the pitch material into symbolic form meant that no decisions could be made on the basis of the material itself. The material was arbitrarily divided into micro-structures, which were then re-combined in a formal, abstract procedure.

At the time of **Cold Fusion**'s inception, it had become clear that this was a process of arbitration of the material akin to the negation of tonality in Serialism. In order to gain control of the process of material selection, whilst retaining the expansiveness of the method (and of Modal Serialism, which became Quantum Modal Serialism at this time), the pitch map for **Cold Fusion** was literally realised on stave paper, rather than as abstractions in the form of symbolic map references. This removed the laborious process of going through the material map and carefully transcribing each segment onto the end of the previous segment before composition commenced. It also meant that one could make compositional decisions based on where one would like the music to travel in terms of the modal, partially indeterminate pitch map. By dividing up the modal rows for **Continuum** and re-arranging them by a process of re-mapping, I had intended to create a variety and diversity of material. This method annulled the modal qualities of the material however, since the two- or three-note segments of material contain too little material for a meaningful sense of modality to be assembled. When mixed with other two- or three-note segments, the tonality of up to four different modal systems would be mixed in such a way as to become potentially atonal, although without any rigor as to the non-repetition of the chromatic within a twelve-note set. It was assumed with **Continuum** that some of the methods used to

organise material for **Anomalous Data** would work in a larger context - the division and re-mapping of row segments. These were symbolic methods of re-mapping the information, but whereas **Anomalous Data** contained relatively few pages of information (four), **Continuum** has as its material 40 pages - 720 rows and 7920 pitches! What is more, in my zeal to experiment with as many different compositional techniques as possible, I had inadvertently negated the (modal) qualities of one technique (Modal Serialism) by the use of another (symbolic re-mapping of material).

The pitch multiplication technique use to create the final eight pages of hybrid rows for **Continuum** (which were in fact never used), provided the mechanism by which territorial pitch maps can be used in a way that retained the tonalities of the QMS unit. It also generates a diverse variety of material (the original goal of the first mapping technique) whilst allowing one freedom to explore the material based on quality and suitability. The use of the large triangular grid meant that motivic cells had to referenced from the grid, copied from tone rows onto manuscript paper, composed onto the metrical grid (see appendix 1) and then scored. This process was incredibly laborious, and meaningful compositional decisions about the quality of which path to take through the pitch map were left out, in favour of arbitrary tendencies for the paths to exhibit. Instead of the compositional decisions about the *order* of material occurring at a pre-compositional stage, the new system allowed compositional decisions to be made on the basis of the material, and thus for the composer to make *aesthetic* decisions about the direction of a work, since the material is laid out in the form of pitches rather than referential codes. This process postpones compositional decisions that have to be made as a consequence of other decisions made previously as to the nature of the material, but it does not remove the *selection* of the material from the composer. Instead it constrains this selection process, so that decisions may be made with a variety of options at ones fingertips. Figure 23 shows the territorial pitch map that was used to compose **Cold Fusion**.

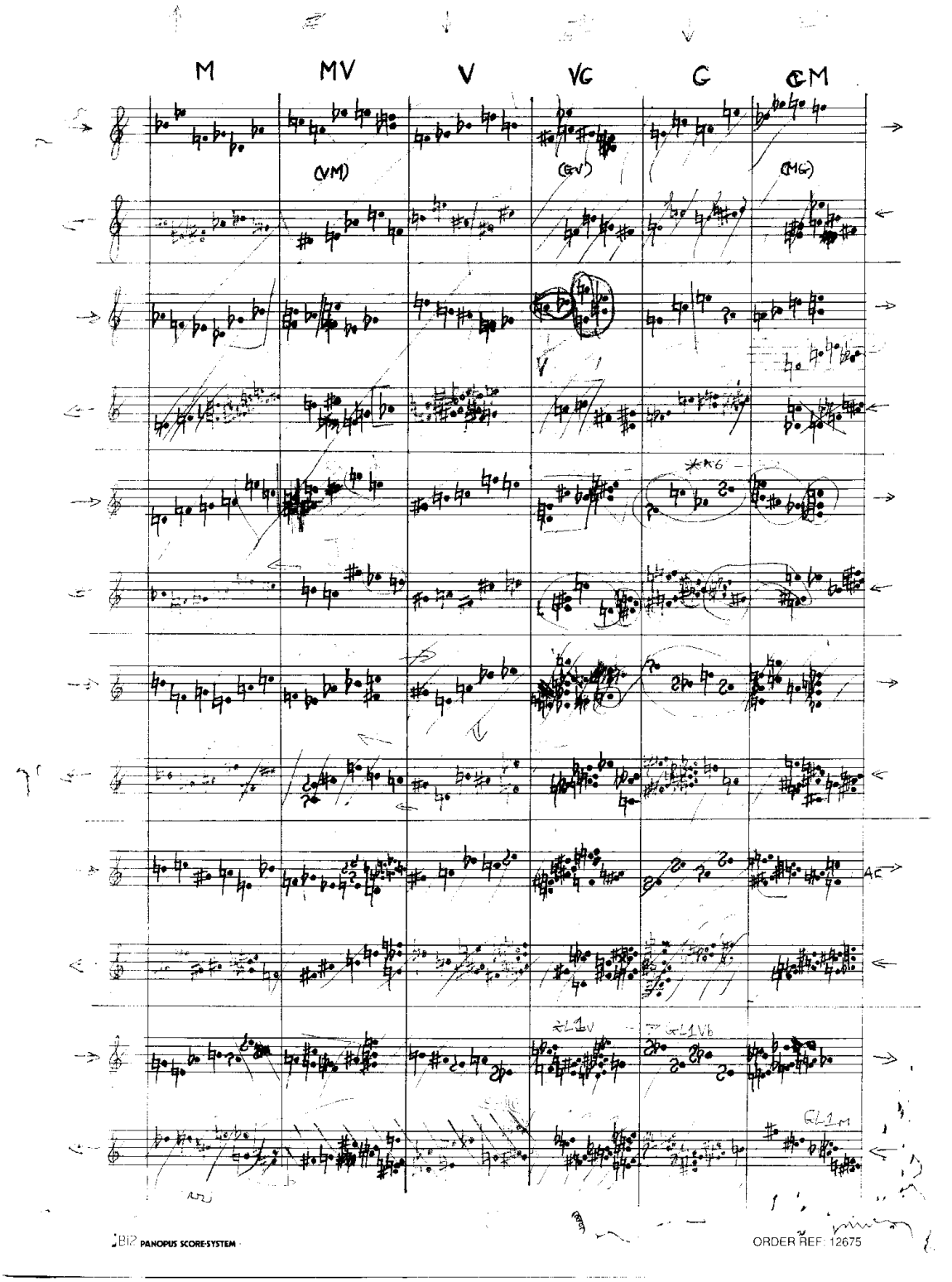

Figure 23. The territorial pitch map used to compose **Cold Fusion**.

In each composition where this system has been used, restraints have been placed on the ways in which the map may be traversed. These are as follows:

1. No cell is to be used more than once.

2. The notion that all pitches within a cell (either a QMS pitch-series or a hybrid one) must be used up before the composer moves to another cell is borrowed directly from Schoenberg's Serialism. The interest for me lies in what happens when modalities are *mixed*, but this mixing occurs when instruments or groups of instruments are set to follow divergent or separate paths through the material. Consequently it is essential that the modality of a series be expressed in its entirety, before moving on to another cell.

3. Cells chosen must be adjacent to the previous cell in a pathway, unless there is no adjacent cell that has not been used. Rather like the "Worms" computer game, where the idea is to keep turning corners without colliding with your tail.

4. The process is complete when all the material has been used[xlii].

The application of rule 2 often causes (or perhaps inspires) formal structure to appear within a work, since radical changes of material often accompany the trails "dead end" implied by rule 1, often proceeded by a break in the material for that instrument, and often revealing activity in other sections of the ensemble, if ones listening strategy is drawn to the activity that ceases. Alternatively, if one is listening to everything *but* the activity that ceases, it may become conspicuous by its absence, and so arouse expectation in the listener of impending activity.

The hierarchic rule-structure that governs exploration of harmonic territory ensures that compositional decisions will have to be made, on the basis of pre-determined options, but the system is flexible so that no one reading of the map is any more correct than any other - within the rules that govern the process of navigation. These rules determine the means by which one is allowed to operate within a given set of possibilities. The system is thus a functional system for relating material, since each decision has *consequences* determined both by the composer at the outset and by decisions made prior to the moment. However, as Boulez talks of local indiscipline in his work, so such rules are often treated as *generalisations* of compositional activity in favour of

the composer's prerogatives. This I believe to be fundamental to the process of compositional development.

The way in which this material is used is left entirely up to the composer, to be determined at the moment of composition. This is important, since material has no aesthetic of its own. It requires the judgement of a composer, a mediator, in order that its potential be fully exploited. One of the reasons for halting work on **Continuum** was that it was felt by the composer that the potential of the material was held back by the complexity of the system(s) of composition. A rationalisation of the methods was necessary, and in carrying out such a project I have developed a versatile technique, permutational and rigorous, without abandoning the primacy of aesthetic choice in the act of composition in favour of a closed system of mechanistic musical principles.

What interests me is taking diverse structural formalisms and combining them to produce hybrid forms, while retaining the effectiveness of the process of *composing* the score. Thus I have developed multiple systems for composition of rhythm and harmony, which are combined in each composition as a unification of resources.

In electroacoustic tape music there is (potentially) complete control over the materials within the constraints of the medium. In my instrumental works there has been a postponement of compositional decisions coupled with a rigorous but flexible suite of systematic approaches, with a high degree of indeterminacy woven into the fabric of the material at the outset. My approach to live electronic processing is now being pushed to the other extreme to that of electroacoustic tape composition. This is the youngest of my disciplines to develop in terms of theoretical approach and practical application, yet it is turning out to be the most surprising implementation of my temporal and harmonic theories, and will surely develop into large-scale projects of significant scope.

Chapter 2.5. Works for solo Percussion and Electronics

With **Entanglement** and **Thermal Inversion**, apart from establishing a fruitful collaborative relationship with the percussionist **Simon Limbrick** I have explored an aspect of musical time particular to solo instrumental composition. **Entanglement** takes the form of a score and a MAX patch. The music of the score is highly idiomatic of much of my composition with QMS, despite (or perhaps because of) the fact that it is derivative of **Cold Fusion**. The consists of distinct musical statements, separate in time and at times highly disparate. Its combination of compositional resources results in a collage of juxtaposed materials, rather than a logical progression from one section to the next. The *moment form* of Stockhausen and Stravinsky is expressed in the score as each section of the work follows its own musical principles independently of other partitions, yet these are linked together by the workings of the MAX/MSP patch **Entanglement Instant Remix**, which continuously samples the instrumental performance allowing the performer of the electronics to re-arrange past musical events, according to pre-defined rhythms and metric relationships.

2.5.1. Entanglement: Engagement

After **Cold Fusion** (1999), still no instrumental piece I had composed had been performed since **Anomalous Data** (1997). To find ensembles willing to play complex polyrhythmic music takes time and commitment. At the time of writing the score for **Perspectives** is completed, the scale of my works has increased regardless of lack of interest from performers. It was more important to me to continue developing compositional technique and style, than to pursue classical ensembles with busy schedules.

I had sent the score for **Cold Fusion** to Simon Limbrick (percussionist) after it was completed, on the recommendation of Simon Waters. In the autumn of the year 2000 I was approached by Simon Waters (on behalf of Simon Limbrick), with the proposition that a solo percussion piece written for Simon Limbrick, with electroacoustic resources at my disposal would be performed at concerts around the UK in the spring of 2001.

Cold Fusion took 11 months to compose. It was composed as an entry for an SPNM/Ensemble Bash call for works. The first section of the piece (up to page 7) was completed and submitted, but SPNM and Ensemble Bash rejected the piece for selection. The performance was very soon after the selection, and this point possibly was the decisive factor due to the complexity of the piece. In retrospect, a simpler piece would have been a more suitable option (in order to hear my work performed) but would have been a compromise of the musical principles I wished to explore. Instead of rejecting the piece as a failure and starting afresh I chose to continue the work through to its conclusion.

After **Cold Fusion** the opportunity arose to compose a solo piece for Simon Limbrick. Instead of composing a piece from scratch I decided to make a re-mix of **Cold Fusion**, in both the content of the score and the conception of the live electronics.

2.5.2. Realisation

Entanglement is a re-mix in several ways. Firstly, the harmonic material for the score of **Entanglement** was derived entirely from the score of **Cold Fusion**, material that had been derived once already from the quantum-modal-serial technique, the pre-composed matrix of pitches constructed for the composition of **Cold Fusion.** Compositional decisions were made by reading the score of **Cold Fusion** as though it were a pool of compositional options, making compositional decisions based on which areas of musical investigation were worth re-investigating. This process can be likened to the procedure by which a re-mix is realised in terms of sampling culture, and the practice of re-contextualisation and re-interpretation of a dance music mix. The difference between **Entanglement** and the dance music analogy is that the process of re-interpretation occurs *before the realisation of the music in sound*. This represents an embodiment of the essential difference between notated music and music composed directly from acoustic recordings and electronic synthesis of sound. **Entanglement** represents notions borrowed from sampling culture in notated form. However, the perceived deficiencies of notation are often stated as thus: notation is a proscriptive system that limits the musical possibilities potential in recordings of sound itself.

The other essential element of **Entanglement** as a conception of re-mix is the software. **Entanglement Instant Remix** (EIR) is a piece of software that allows one to construct a re-ordering and an alternative realisation of any audio input to the computer - an Apple Macintosh in real-time[xliii], henceforth referred to as performance time (see endnote). The software was designed on and for a G3 Powerbook or better-specified Apple machine, but a Windows version of the software has recently been released, and a port of EIR to Windows machines will be made available as soon as a copy of MAX/MSP for Windows becomes available.

EIR detects attack transients in the signal passed to a bonk~ object from the adc~ object in MSP. When an attack transient is detected, a recording is triggered. To compensate for the latency of the process of detection of attack transients, the audio to be recorded is passed through a delay line. An attack transient is measured as a function of the spectro-morphology of the input, the measurement of which is an FFT-based process. Bonk~ compares analysis frames of eleven frequency bands and comes to a conclusion about whether an attack transient has occurred based on the morphologies of the eleven bands' amplitudes. There is a certain amount of control over how this mechanism comes to its conclusions implemented in bonk~ and made available to the user in EIR. Since an FFT is a time-windowing process there is an inherent latency between input and detection introduced by any measurement or analysis based on an FFT. An attack however (in acoustic space and the morphology of a physical object when deformed by excitation) is never an instantaneous occurrence, thus attack transients are measured by comparing multiple frames of FFT-derived data. The latency of an FFT-based analysis (carried out in performance time) is the product of the analysis window multiplied by the number of frames to be analysed, divided by the sample rate and overlaps (the number of times an individual sample appears in each analysis frame). In order to record material (when the recording process is triggered by analysis of such material) one must separate in time the analysis and triggering of the recording and the audio stream to be recorded. Thus the input to the record~ object is delayed with respect to the bonk~ (FFT-based analysis) object. This time delay is user definable in the application. A line~ object is used to fade the audio in for the duration of the attack time in order to eliminated any clicks at the start of the sample, coupled with a decay setting to fade out the sample at the end of the recording.

The buffers are divided up into groups of 11, 9, 7, 5, 4, 4, 3, 3 and 3 buffers. Although there is no rigorous mathematical scheme that was used to determine the number of buffers in each group or the number of groups, there is a tendency for there to be more of the smaller groups so that more patterns will be played with fewer samples (and hence with less complex sonic identities as samples are repeated more often) and fewer patterns will be played on larger groups of buffers (with more complex sonic identities, as some patterns will not repeat a single sample). Every buffer in a group will be filled before the patch (randomly) chooses another group of buffers to fill and every group will be filled before the patch repeats a group or stops recording (depending on whether the "Don't stop the rock!" box is checked). This ensures that the material for playback will be continually renewed in a gradual process of replacement whilst audio is turned on.

EIR is governed by the same metric principles as the notation system I have developed. EIR re-orders samples according to rhythms, which are stored in tables. The data in these tables represent multiples of note values, which are derived as subdivisions of a *superunit*. In earlier versions of the software the superunit was set as a time value (in ms). Since version 1.5, a tap-tempo feature has been implemented. Subdivision values (16^{th}, 20^{th}, 24^{th} notes etc.) are set to default values, but may be altered individually or in groups (also since v1.5). These values are multiplied by the integer series stored in the rhythm tables to create values for metro objects, creating rhythmic patterns by which the *sequencers* are driven.

The sequencers (one per rhythm table and subdivision value) are arranged into four categories according to methods of accessing the rhythmic series and buffer group selection procedures. *Count* and *gcount* sequencers step through the rhythm tables in sequential order, whereas *urn* and *gurn* sequencers use non-repeating random number generators to "re-mix", i.e. re-arrange the ordering of rhythmic intervals. Whereas *urn* and *count* sequencers choose random samples from a single group, *gurn* and *gcount* sequencers choose samples from across a number of buffer groups, and (in some cases) implement velocity variations in the sample playback.

There are four sample playback engines in EIR. As a sequence is initiated, one of the samplers is chosen at random and play instructions are sent to that sampler. Naturally with (potentially) 34 sequences happening at once there will be a tendency for some samples to be

interrupted by others, and for simultaneous messages to be reduced to the last message to arrive at the sampler. The principle of provisional behaviour is a governing principle in EIR, just as the quark accidentals in QMS provide for provisional pitch structure. This unpredictable-yet-organised behaviour is presented here as an alternative to purely random behaviour. The behaviour of EIR is such that certain phases of its functionality are under the control of the user (such as which type of sequence to initiate), whereas other parameters are indeterminate until initiated (such as which group of buffers material is selected from and hence how old the material is that is to be re-organised). The notion that certain features of the music may be unknown, to both the performer of the audio input and the player of EIR until they have occurred, presents new configurations of material to both performers. New in the sense that there is no prior knowledge of absolute musical form, and thus the performer of EIR is provoked into responding instinctively to the material rather than relying on learned patterns of musical performance.

If the patch is used with improvisers (as has been the case), an instinctive response will issue from the improviser (to the re-organised material) and an interaction occurs between the improviser's present actions and re-interpretations of past material. A knowledge of past material (as input to the program) is unhelpful in gauging what will happen next, since material is selected at random from groups of time-local events, which themselves are chosen at random. Portions of temporally local events are grouped however, and so periods of consistency of input are reflected in the output, re-organised, re-mixed, re-structured and (sic) re-interpreted.

The four sample playback engines may be routed through comb filters or ring modulators. When playback is dry, a random panning occurs for each event. The comb filters are arranged in a 2x2 formation, so each sampler may be routed through a dyad of comb filters in counterpoint to the other dyad. The ring modulators have a glide control so that glissandi may be initiated. Each sampler has a pitch control, so that relationships between the transpositions of individual patterns may be initiated to create melodic contours in the material. At extremely low pitch settings, the interruption of one sample by another can cause clicks in the sound output, so an anti-click filter was introduced in version 1.5 to counter this. The pitch and routing options are user controlled however. Since one cannot determine which sample playback engine will be used to play a particular sequence there is an element of indeterminacy about the pitch options (unless one alters

the pitch globally). Pitch may be scaled from 0-400% so that unconventional temperaments can be used (although this is not scientific so that for example 19TET could not be chosen easily at will). Originally there were three granular processors, which used separate buffers. This was scrapped in v2.0 for two reasons. Firstly, In live performance it becomes extremely difficult to initiate the recording of these buffers, turn on the granular processors and alter their parameters whilst still playing sequences (the primary function of EIR). This is akin to playing two separate musical instruments at once! Secondly, granular synthesis is (at least in the versions used in EIR adapted from a patch found on the CNMAT MAX/MSP night school website) based on unconditional random number generators operating within fixed limits. Although this does demonstrate a principle of controlled indeterminacy, there is no explicit rhythmic connection between the density of the grains and the rhythmic principles that govern the rest of the patch and the piece it was designed to work with. Adapting other's patches in MAX/MSP is possible to a certain extent, but to re-write a patch completely when the implementation is too hard to play in performance with the rest of EIR would be a wasted effort, and so the granulators were scrapped. The resultant instrument is more ergonomic and the user only has one system of re-interpretation to think about (the live sampling/multiple sequencer technique) and so is able to concentrate on the quality of a performance.

2.5.3. Performance

EIR has been used in performance both with the percussion piece for which it was made and in improvisation (with John Bowers). The default settings for EIR are those for **Entanglement** the piece, but the functionality is extended by user access to rhythm tables, group-function tables, subdivision values and tempo. This makes EIR a general-purpose re-mix tool for use in live improvisation. It is not limited in its use to realisations of the piece **Entanglement**.

Routing options, as well as the initiation of sequences, are all accessed directly from the computer keyboard. Settings for the comb filters, ring modulators, beat subdivisions and input analysis parameters are accessed via the GUI, and in some cases may be stored as presets during

rehearsals for speedy recall at performance time. EIR is designed to be used with nothing more than a laptop with an audio input, and as such it is portable as well as versatile.

One of the strengths of EIR is its reliance on a simple principle of an attack-driven recording mechanism. It can be driven by a wide variety of inputs and can be used to create a diversity of musical effects, which are highly dependent on the nature of the input material. One problem encountered in performance is that drone-based material has a tendency not to trigger the automatic recording function. It has become apparent (since a concert whence this problem was identified) that by lowering the mask-time analysis parameter one can set the recording mechanism to be more sensitive to subtle transients.

The event-based paradigm coupled with the notion of polyrhythmic subdivision of the superunit ensures that the material possesses formal structure, and the way in which the material is distributed in temporal groups from the outset makes the act of performance a process of reflective interpretation. The material properties of the output of EIR are related to past events, which are re-mixed and re-ordered according to separate predetermined structural principles. Both performers are engaged with the process of re-interpretation, one with the material input and response to the output, and the other in initiating re-mixes of material and in making adjustments to the governing structural principles (subdivision, rhythm tables, tempo/superunit) and input/output parameters. EIR can thus be used as a tool for *communal engagement with improvised musical material*. This becomes especially apparent when the audio input is of a harmonic nature, since melody is re-arranged to create new permutations and structures out of previously formed phrases. Since the material for playback is that which was played, structural and timbral nuances are retained and juxtaposed to allow perceived connections to be made between what is played and what has been played before. This is based on a notion of time in music as a process of perception whereby we look for connections between present and past events and structures. EIR creates new *structures* from past *events,* and so the nature of musical time in a performance using EIR is based on notions of *process* and of *directedness*. The material undergoes a process of re-organisation in the musical *present*, heard in relation to *past* events, which provokes new possibilities of re-interpretation in the *future,* at performance time. A performance using EIR is directed forward in time by reference,

i.e. by the relationship between past events, present re-configuration and future consequences arising from re-organisation.

Chapter 2.6. From Thermal Inversion to Perspectives: Form and interaction.

2.6.1 Synchronisation Issues and the Development of the *Mirrors* Computer Software with Regard to *Thermos Flask.*

Perspectives is intended to be performed with the **Mirrors** computer software. This project is ongoing, just as the processes of composition and experimentation in music will continue. **Perspectives** is a finished piece, but **Mirrors** is continually being re-designed to become a flexible computer music performance system. The conception of this thesis is as a document of how my music and ideas have developed, according to notions of how time is perceived in – and perceptions of time are altered by music. It is akin to a photograph, taken at a point in time and in a sense freezing the moment of its inception. The reality of compositional activity is that it is a gradual process of becoming, which is ongoing throughout the lifetime of a musician. I have become increasingly aware through my research that time's enfolding within a work is a parallel process to the continuous personal development of the composer. Inevitably therefore this summary of my musical activity must be viewed in the wider context of the continuous development of my music and ideas. The work-in-progress that constitutes research towards the proposed **Mirrors** patch, represents an area of my research activity that is to continue indefinitely. I will document here the theories and concepts underpinning the **Mirrors** software with respect to the **Thermos Flask** software developed for the performance of **Thermal Inversion** for percussion and live computer processing. The latter software represents a prototype of how certain key elements of the **Mirrors** software will operate, and demonstrates the principles of autonomous analysis and re-synthesis, which are central to the conception of computer-assisted performance upon which **Mirrors** is based.

Thermal Inversion Part 1 is a piece for steel pan and drum kit. It is an integration of extended conventional drum rhythms derived from dance music and steel pan motifs. The piece has been performed at the Spitalfields Festival in 2002 with EIR, at the Dartington Summer School with **Thermos Flask** and at Goldsmiths College with a CD realisation of **Thermos Flask**'s output.

The harmonic material for **Thermal Inversion** (shown in figure 20) still contains various harmonic cells that are unused. A part 2 will be composed at some point in the future, with a new (more advanced) PD implementation of pattern-matcher driven re-synthesis and DSP.

Thermal Inversion has provided an opportunity for a first implementation of pattern-matching and associated techniques. It is hoped that this process will continue, with further developments in the software being used in performance as they are realised. The process of collaboration with Simon Limbrick has proved instructive and educational in terms of live performance techniques and issues. **Thermos Flask** was used at the Dartington performance of **Thermal Inversion**, and is the first live use of pattern-matcher driven live electronic performance.

Mirrors will be constructed in PD, a flexible object-oriented compositional environment similar to MAX/MSP, running on a PC under the **Linux** operating system. The design is modular, and certain key modules have been completed. The input-collector, pattern-matchers and QMS engine exhibit varying degrees of functionality, and in **Thermos Flask** there is a prototype re-synthesis system. A version of **Thermos Flask** that allows the user to load an input sound file as well as using the adc~ input is provided on the CDROM that accompanies this thesis. I will explain the functionality of the various modules of **Thermos Flask**, and will go on to discuss the way in which the **Mirrors** software is likely to develop and to function.

2.6.1. Thermos Flask: Technical Specifications

In order to run **Thermos Flask** you will need:

- A PC with Linux installed (preferably kernel 2.4 onwards). This should be at least a 600MHz machine with 512Mb RAM and a full duplex sound card (I run PD with a Soundblaster LIVE! Player™ from Creative Labs with the alsa driver – http://www.alsa-project.org with very low latency and no discernable hardware problems). The faster and better specified the computer, the more stable will be the patch.
- PD v0.35 or later by Miller Puckette. PD is available from http://www.crca-usd.edu/~msp/.

- Zexy, ggee, motex and xsample~ externals for PD. These can all be obtained from http://www.pure-data.org. Source code for these is provided on the CDROM, and pre-compiled binaries are supplied in the *externs* folder of the CDROM accompanying this thesis.

On the CDROM there is the **Thermos-flask-filter-player.pd** patch that is the version of **Thermos Flask** that allows the user to load an input soundfile. There are also the demonstration patches: **pm-demo.pd** and **pm-dur.pd,** which demonstrate the operation of the pattern-matchers. **pitches.pd** represents the current state of development of QMS in PD.

2.6.2. How *Thermos Flask* Works.

The **Input-collector** module records audio from the signal input (adc~) or from a signal input to the module. The recording process is triggered when the signal level is above a threshold set by the user by sampling an average over time of the signal input (the smoothing factor of which is also adjustable – that also affects the threshold~ object which triggers the recording). An advantage of setting threshold levels this way is that the threshold can be set as a multiple of the level of the noise-floor of the system. A hold-time parameter ensures that recording will not stop if the signal falls below the threshold for a very short period of time, so material with a high proportion of staccato playing or short percussive elements may be recorded in phrases rather than as individual events. This is important for the operation of the pattern-matchers (see below), since they are used to compare sequences of events. The **input-collector** analysis the input using bonk~ and fiddle~ objects, and so pitch and duration information (as well as octave, dynamic intensity, energy register and power of attack transients) are stored in tables along with the audio itself. Durations are stored from both the fiddle~ and bonk~ objects, so that rhythmic information is analysed both in terms of percussive attacks and in terms of pitch onsets. The threshold levels for these analyses may be configured to follow the envelope of the input, and averaged so that attacks may peak above the threshold. This ensures that events are detected more reliably than fixed threshold settings.

The pattern-matcher is an integral component of **Thermos Flask** (and of the conception of **Mirrors)**. The idea of this is to make data comparisons between characteristics of recent events and those that happened at a previous point in time, and to compare pitch-sequences with the original QMS tone rows used to generate the material for a piece. The pattern-matchers output the data in a variety of forms designed to point to patterns within the data exhibiting similar (or identical) elements and order. A pattern matcher looks for sequences of variable lengths, the elements of which are within a certain range of the comparison data. In a world where performance was a perfect reproduction of a score (an inhuman proposition), comparisons would be made between analyses of "perfect" input and "perfect" data (although such distinctions are philosophically problematic to say the least), and so only exact comparisons would need to be made and a string-matching (if a=a then TRUE, if a=!a then FALSE) algorithm could be used. In practice however, pitches and durations resultant from the analyses of real performances will rarely if ever be exact matches for discrete integers of mathematically derived or manually inputted data. The pattern matching modules created for **Mirrors** are different from previous string-matching algorithms in that they take numerical values that fall within a certain range, specified by an error factor, to be equivalent to the value to which they are compared. This also allows the operator of such software to limit the amount of matches made to some extent, by adjusting the precision of the device(s). Since the pattern-matchers are used to drive sequencer engines and sample playback/re-synthesis devices (of which there is always a limit to the polyphony), it is useful to calibrate the pattern-matchers so that patterns are not cut short by new patterns before they have been re-synthesised.

The re-synthesis engines consist of variable-pitch sample playback engines coupled with pitch-shift processors. This is so that any section of audio can be played at any duration and pitch. In use there are artefacts generated by the windowing nature of the pitch-shift process. Future versions of the **Mirrors** software will include FFT-based phase-vocoder engines (already in development) as audio re-synthesis voices, but the granular playback-and-pitch-shift engines will be retained for their aesthetic qualities. In fact the adjustment of the grain size is one way in which a computer-based performer can interact with the material as it is being re-synthesised.

The nature of this kind of audio analysis and implementation of pattern-matching is that it isolates certain musical parameters for comparison, disregarding other parameters. One problem with this approach is in deciding how re-synthesis will deal with the other parameters of a sound event in its re-synthesis. In **Thermos Flask** it is duration pattern-matching that is used to drive the audio-sequencer engines. In this instance the data comparisons occur between recent durations and earlier durations recorded throughout the work, so that no pre-defined data is used as material for comparison. In some way the use of the **Input-collector** to store multiple parameters of sound solves the problem of how to assign the pitch of the duration-pattern based re-synthesis, since there are already tables of pitches associated with the audio to be re-synthesised, although they do not always correspond since the fiddle~ object that analyses the pitch of the input is triggered by different characteristics from the bonk~ object that is used to derive durations from the material. Another version of **Thermos** could be constructed based entirely on fiddle~ derived durations and pitches already stored by the **Input Collector**. This version of the patch would clearly be much more suited to a different type of material than a percussion piece.

Thermos Flask is a highly experimental prototype, and as such it contains configuration possibilities for routing table data flexibly through the patch. Other, fixed data routing algorithms (those that interpret pattern-matcher outputs to change the index and table of the comparison inputs) are quite arbitrary, designed in order that the patch explores as much data as possible in looking for matched patterns (which in **Thermos Flask** are rhythmic patterns). A rationalization of how the software makes decisions as to where to look will happen subsequently, and will almost certainly involve the interaction of quark-accidentals with the structural process of choosing data-sets to analyse.

2.6.3. Synchronisation and Control in Perspectives

The performers of **Perspectives** will be synchronized using click tracks generated in PD. In this way, re-synthesis may be synchronized to the performance and initiated using the metro~ objects to quantize to some extent the re-synthesised events.

Methods of click-track organisation are to be experimented with. However, it is clear that as some tempo changes happen in the middle of a phrase, and performers need time to accustom themselves with a new sense of time before accurate performance can be executed, a fade in of the new click (using another sample) before the point of change, and then a removal of the first click at the point of removal is suggested. Initially after metric modulations, click tracks should include binary subdivisions of their pulse (so a 14^{th} pulse would also include 28^{th} pulses for example), which may be faded out after a short time. These kinds of measures should be experimented with in collaboration with performers, in order that a way of using click tracks may be found that does not inhibit the performers' expressive ability.

One idea I hope to implement in **Mirrors** is that the click tracks' finer resolutions may be used to quantize synthesis events and parameter changes. Thus in a performance of **Perspectives** with the **Mirrors** patch, the performance and the computer processing, will both be synchronised to the metric schemes of the piece, derived from a sub-structural superunit pulse.

2.6.4. Mirrors and Beyond

The conception of **Mirrors** as an interactive, content-based performance environment is ongoing. My vision for **Mirrors** is that it incorporates DSP effects as well as re-synthesis, a matrix-style flexible routing system, multiple inputs and outputs and QMS, all driven by the patterns derived from the analysis of audio input. In conceiving such a project it has become apparent that a more fruitful approach would be to concentrate on smaller projects that incorporate, develop and implement aspects of the **Mirrors** system. **Thermos Flask** for **Thermal Inversion** is the first of these, as a rhythm-driven interactive re-synthesis device.

The beauty of projects like **Entanglement Instant Remix** and **Thermos Flask** is that although they may be conceived in conjunction with particular score they are flexible performance tools, and as such can be used in live improvisatory performance. This is the approach I wish for all of the works I compose on paper – that they may be re-interpreted in performance, or used as a guide for performance material, improvised from, re-organised and generally take on mobile forms and conceptions of their own (and of the performers' of such music). This is why **Perspectives** has

the form of a circular score, so that it can be a living work of art rather than a repetitive experience on subsequent hearings. The charts used to make such pieces may also be useful as guides for improvisation in conjunction with EIR or **Thermos Flask**, to make a new piece.

Conclusion

The scores, tape pieces and software artefacts presented here represent a realisation of possibilities afforded the composer by time – time to compose, contemplate and realise works of music. I have manipulated temporal characteristics of music to in order to explore notions of time outside daily experiences of chronological routine. Since music exists in and through time, one cannot hope to explore every conceivable notion of time in music no matter how long one has to do this (after all, one cannot travel in time except in one inevitable direction…). Time itself will prevent us going beyond a finite existence, but in the composition and performance of, and in listening to music we explore time as a dimension in ways we cannot physically, and in doing so we are liberated from our enslavement to the march of time. The real paradox of time in music in time is this: through music we can transcend time's restrictions, but only for a moment at a time.

The research into time-related musical processes continues. The pattern-matcher based work in PD is currently under development with respect to the development of musical *agents*. These will be semi-autonomous audio engines, handling re-synthesis, signal processing and material manipulation processes, and will be driven by a network of pattern-matchers and (prospectively) other musical analysis agents. The **Mirrors** system will be built from these, and will form the basis of a flexible, material-based performance and composition tool based on musical principles and the relation of concrete attributes of material through the time of an improvisation or a work. **Perspectives** is intended as the first movement of a work that will encompass a broad range of musical practises. As soon as a performance of **Perspectives** is achieved it will be recorded, and will form the first movement, and the basis for a suite of works exploring different media and modes of composition. A flexible approach to material (as digital audio, as notated material, as input to DSP processes etc.) will be applied to produce a work that is as comprehensive in its breadth as in its depth.

Notes

[i] Clifton, Thomas: *Music as Heard: A Study in Applied Phenomenology*, New Haven: Yale University Press, 1983, p. 55. Cited by Kramer 1988, p. 5.

[ii] Miller, George A: *The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information*, Psychological Review 63, 1956, pp. 81-97.

[iii] Puckette, Miller: ***Pure Data: Another Integrated Computer Music Environment***, Proceedings, Second Intercollege Computer Music Concerts, Tachikawa, Japan, pp. 37-41, 1996. This paper is available on the internet at http://crca.ucsd.edu/~msp/publications.html

[iv] Direct Csound (now CsoundAV) is a realtime version of Csound. This package was coded from Csound sources by Gabriel Maldonado. Information on CsoundAV and Gabriel Maldonado as well as downloads of CsoundAV can be found at http://www.csounds.com/maldonado/home2.htm

[v] Ives, Charles E: *Memos,* ed, Kirkpatrick, John, New York: W. W. Norton and Company inc., 1972, p.63.

[vi] Scheaffer, Pierre: *Traité des Objets Musicaux,* Paris: Seuil, 1966

[vii] Cambouropolous, Emilios: *Musical Rhythm: A Formal Model for Determining Local Boundaries, Accents and Metre in a Melodic Surface,* In *Music, Gestalt and Computing: Studies in Cognitive and Systematic Musicology,* Ed. M. Leman, Berlin: Springer 1997, p. 282.

[viii] Stockhausen, Karlheinz: *How Time Passes*, published in *Die Rieh #3*, English translation by Cornelius Cardew

[ix] Wishart, Trevor: *On Sonic Art*, ed. Emmerson, Simon, Harwood Academic Publishers, 1996

[x] The term 'breakbeat' was coined after Kool Herc (Clive Cambell), a Jamaican-born DJ in the Bronx in the 1970s. It comes from a technique he invented of taking two copies of the same (e.g. James Brown) record and playing the 'drum break' from one, then at the end of the break start the same section from the other copy on another deck, then play the first again and so on, perpetuating the drum section of the record indefinitely.

[xi] Bogue, Ronald: *The Aesthetics of Force*, published in *Deleuze: A Critical Reader*, ed. Paul Patton 1996.

[xii] For a discussion of sampling culture see Simon Waters' doctoral thesis *Beyond the Acousmatic*, University of East Anglia, 1996

[xiii] Audiomulch is written by Ross Bencina for the Windows operating system. It is a highly sophisticated performance-time DSP studio. It is shareware and is freely downloadable from http://www.audiomulch.com

[xiv]Kramer, Jonathan D: *The Time of Music. New Meanings, New Temporalities, New Listening Strategies*, Macmillan, 1988, Chapter 11, p. 367.

[xv] *ibid*

[xvi] *ibid*

[xvii] *ibid,* Chapter 12.

[xviii] Gibson, James J: *Events are Perceivable but Time Is Not*, in *The Study of Time,* vol. 2, ed. Fraser, J. T. and Lawrence, Nathaniel, New York: Springer-Verlag, 1975, p. 299, cited by Kramer 1988, p. 346.

[xix] See Kramer, 1988, Chapter 12, for a discussion of the concept of vertical time.

[xx] See http://www.physics.lsa.umich.edu/chupp/tinvar.html and http://www.ph.unimelb.edu.au/~ywong/poster/articles/cparticle.html for a scientific discussion of T invariance and CP violation.

[xxi] See Kramer, 1988, chapter 11.2, p. 324, for a discussion of cumulative listening with respect to duration perception and musical form.

[xxii] Waters, Simon, *Electroacoustic Music: Composing Beyond the Acousmatic*, University of East Anglia 1996.

[xxiii] Kramer, 1988, Chapter 1, p. 9.

[xxiv] *Ibid.* Chapter 11, p. 367

[xxv] Waters, 1996

[xxvi] Fraser, J. T, *Time as Conflict*, Birkhäuser, 1978, discussed in Kramer 1988 Ch. 12, pp. 394-397.

[xxvii] http://members.bellatlantic.net/~vze29p4r/feldman/anxiety.html

[xxviii] Bach, J. S: *Das Wohltemperierte Clavier I*, BWV 846-869

[xxix] For a discussion of how key concepts can be likened to free agents in a competition for survival see Blackman, Susan and Dawkins, Richard: *The Meme Machine*, Oxford Press, 2000.

[xxx] That is, if quantum computing does not take over. The concept of quantum computing is based on the quantum-physical principle of entanglement. That calculations can be carried out instantaneously by measuring the quantum state of one of a pair of entangled quantum particles remains to be proven. If quantum computing ever does take over from today's technology then we may yet see computers that can implement the kind of future-provisional system I am describing. Heisenberg's Uncertainty Principle may yet have real, practical implications for the way in which I compose.

[xxxi] It is almost certain that Cowell first proposed this concept in musical form with the *Quartet Euphometric*, then formulated it in his book *New Musical Resources* (New York: Alfred Knopf, 1930). Musically useful systems of composition almost invariably arise from a discipline of practice, rather than from a purely intellectual extension of theory. In fact I would argue that this is a model for innovation in multiple disciplines, not just music.

[xxxii] Non-reversible in the sense that if 4/5^{ths} are used and 1/5th is not, a modulation back to 4/4 or some other binary time signature will not bring the part back into sync with another, consistently 4/4 part.

[xxxiii] Read, Gardner: *Modern Rhythmic Notation*, Indiana University Press, 1978

[xxxiv] Wishart, 1981, ch. 2-3.

[xxxv] How will the listener ever know, if the piece is never realised in any other form? Although this question represents a challenge to the integrity of the system used to compose the work, I feel it is better for one to produce new work than to spend all ones time revising and re-arranging the old. The work stands as a document of a process of composition, and I am content to leave it that way.

[xxxvi] In fact it was the composer and author of the present document's interest in quantum physics, coupled with a frustration at the inherent "fixedness" of musical notation that provided the seed of inspiration for this technique.

[xxxvii] There is no reason why any of these techniques may not be applied to other pitch-class or just intonation systems. The composer's choice of 12TET (twelve-tone equal-temperament) is pragmatic. This is not to say I have not investigated other systems of pitch organisation (for more information see Partch, Harry: *Genesis of a Music: An Account of a Creative Work, Its Roots and Fulfillments*, New York: Da Capo Press, 1974, as well as the theoretical work of Erv Wilson, which can be found on the internet at http://www.anaphoria.com/wilson.html) but for this music which already contains many "difficult" performance issues to be played it has to conform to at least one standard.

[xxxviii] Although I am rather fond of this notion it stretches the analogy of "breeding" to breaking point, yet my poetic sensibilities require me to include it. One is opening a semiotic "Pandora's Box" if one has to decide which is the mother and which is the father; do boys run from left-to-right and girls run the other way around etc. Some profound references to how we interact with each other and with society as a whole may be made I hope, but that is not the point of this article!

[xxxix] See Koblyakov, Dr. Lev: *Pierre Boulez: A World of Harmony (Contemporary Music Studies, Vol. 2),* Harwood Academic Publications, 1990, for an examination of the original pitch multiplication technique used by Boulez in the composition of *Le Marteau Sans Maitre,* (1955).

[xl] Boulez, Pierre: *Conversations with Célestin Deliège*, London: Eulenberg Books, 1976.

[xli] Boulez, Pierre: *Structures Premier Livre*, Universal Edition, 1952.

[xlii] This is why **Continuum** in never really finished, yet since it has eternity to go before it reaches the remainder of the material it is finished in time - for now!

[xliii] "Real-time" is a term used to denote the performance of DSP processes as a live performance activity. The notion of time as being something 'real' is based on our perception of events occurring in chronological order, and implies that events have some kind of logical, objective reason to exist in this fashion. Quantum physics (in its present understanding) makes clear that time itself is only real in the sense that our observance of events collapses the wave function (the probabilistic wave-like nature of a particle's position), and so events become observable as a consequence of measurement or sensation. Time is only real in the sense that events are observable, and here lie many philosophical and scientific paradoxes (not to mention the paradoxes raised by concepts of time-travel).

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Morton Feldman: essays:

http://members.bellatlantic.net/~vze29p4r/feldman/index.html

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http://www.pure-data.org

Miller Puckette:

http://www.crca-usd.edu/~msp/

T-invariance:

http://www.physics.lsa.umich.edu/chupp/tinvar.html

http://www.ph.unimelb.edu.au/~ywong/poster/articles/cparticle.html

Appendix 1: Triangular Pitch Chart used in the Composition of Continuum.

The next four pages consist of the four triangular sections of the territorial material map used in the composition: **Continuum**. The key to the left of each section shows which part of the large triangle the section is positioned. These are followed by the original chart showing how each page relates to the chart and the 40 pages of tone rows, 32 of which are referred to by the map. The last eight pages of tone rows are hybrids between pages from each division of the original 32 pages, but since the material in the first map is never completely used, they were never integrated into **Continuum**.