Designing An Orrery Of The Universe: The Creation of New Chamber Music Through Algorithmic Composition

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2010

School Of Architecture and Design

Design and Social Context Portfolio

RMIT

December 2010

Declaration

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

Adam Yee
9 December 2010

Abstract and keywords

The main focus of my research has been to investigate a number of ways to extend my practice as a composer. In response to a detailed analysis of the technical means and aesthetic intentions of my music during the decade preceding this research (a music fundamentally derived from Hebrew language and grammatical structures), together with consideration of broader cultural trends in 20th century musical modernism, I have designed a detailed process for creating ambitious musical works. This process has been explored in the composition of two chamber music projects - a flute solo and a piano trio - both of which are documented as musical scores and audio recordings. Computer technology is utilized at a number of key points: the melodic life of the projects is characterized by the development of themes through the agency of six discrete transformational algorithms, all of which can be applied simultaneously and independently controlled. This aspect of the process was achieved using IRCAM's software Openmusic and a rhythmic search engine of my own design. The success of these projects is considered against the principles that informed their creation and through expert peer responses and critical reception. The exegesis concludes with a detailed list of possible future directions for musical composition, some of which extend and refine the role of algorithms, and some that propose diametrically opposed strategies that respond to some probable limits of algorithmic composition I have identified through this research.

keywords

musical composition, algorithmic composition, computer assisted composition, Openmusic (IRCAM software), chamber music, parametric design, Hebrew language, musical modernism

"The winds which passed over my dwelling were such as sweep over the ridges of mountains, bearing the broken strains, or celestial parts only, of terrestrial music. The morning wind forever blows, the poem of creation is uninterrupted; but few are the ears that hear it. Olympus is but the outside of the earth every where." (Thoreau *Walden* 1854/1983 p. 129)

"In the long run, men hit only what they aim at. Therefore, though they should fail immediately, they had better aim at something high" (ibid p. 69)

"…whoever thinks that the understanding of things divine rests upon strict proofs has in his thought narrowed the wideness of God's mercy." (al-Ghazzali quoted in ed. Irwin 1999, p. 325)

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1. Introduction – from broad areas of investigation to specific problems

This chapter begins at the year 1909, which (aside from the historiographical neatness of its 100 years' remove from the time of present writing) is the year in which Arnold Schoenberg composed his monodrama *Erwartung*. This work is a seed for the development of a broad ranging contextual discussion that leads to a consideration of the philosophical and technical problems that face contemporary art-music composition. This cultural context should not however be read as research per se; it is intended more as personal (albeit informed) opinion, which informs the research outlined in the second chapter. Two general approaches are adumbrated: algorithmic composition (which I argue to be an aesthetic/technical modality) and chamber music (which is both an aesthetic and a practical response to the alienation of the new music). The chapter concludes with the basic chronology of how my project work came to be created and a description of the physical products of this research.

1.1. The broader cultural context for this research

1.1.1. Questions raised by Schoenberg Op.17 'Erwartung'

Many authors on 20th Century music have attempted to isolate a single piece that best heralds the arrival of the modern aesthetic. Stravinsky's *Rite of Spring* (1913) is a popular candidate; Andrew Ford in his radio program *Illegal Harmonies* (first broadcast on the ABC in 2007) conjectured that Debussy's *Prelude to the Afternoon of a Faun* (1894!) represents the first appearance of an unmistakably '20th Century' musical sensibility.

Delving into my own listening history, I would put forward Schoenberg's monodrama *Erwatung* (1909) as being just such a watershed in musical expression, for precisely the reasons that Webern gives in a 1912 essay, quoted below:

> Only in *Erwartung* did Schoenberg achieve the abandonment of all thematic work
> for the first time… The score of this monodrama is an *unprecedented event*. All

traditional formal principles have been severed; there is always something new, presented with the most rapidly shifting expression. This is also true of the orchestration: a continuous succession of sounds never heard before. There is no bar of the score that does not reveal a completely new sound pattern. The treatment of the instruments is entirely soloistic. The registers of the instruments are fully realized with a marvellous sense of timbre. Schoenberg scores chords in a completely new way (Anton Webern in Frisch 1999, p. 225-227, emphasis mine).

Erwartung (over a hundred years on!) is still a *very* difficult work[1]. Shawn (2002) notes that it is the 'extreme visionary clarity' (p. 101) of *Erwartung* that is the main reason that this music doesn't seem to age. The almost complete lack of repetition and internal self-reference is the diametric opposite of how musical development had operated up until that point: Schoenberg was 'in territory new not only to him but also to music itself' (p. 93).

Indeed, the invention of 12-tone Serialism[2] by Schoenberg and its adoption by his school fourteen years after *Erwartung* represents a partial return to traditional sense-making in music – in other words, Schoenberg himself (and by extension the modernist 'mainstream'[3]) retreated from this apogee of expressive radicalism[4]. It was precisely this tendency that Boulez was reacting against in his aesthetic eulogy *Schoenberg Is Dead* (1951). In what Armando Iannucci described as a 'bile-ridden obituary on Schoenberg the week he died, [Boulez berated] the godfather of serialism for not going far enough in revolutionizing rhythm and form as well as harmony' (Iannucci 2008). Boulez wrote, 'He opened the field but he closed a lot too. The last third of his life was terribly academic…I don't find it very interesting to go back to Brahms' (Peyser 1999, p. 188).

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[1] I have personally witnessed audience members walking out of a performance of this work in 1996, literally shaking their fists in disgust.

[2] Schoenberg's system for 'composition with the twelve tones' is a core development in 20th century music. In essence, the composer is restricted to the use of a 'tone row' which is a non-repeating arrangement of all the notes twelve notes of the chromatic scale, and the 48 forms of that row that can be derived through inverted, transposed and retrograde forms.

[3] What Lambert (1934) called (somewhat churlishly) 'the official revolution'.

[4] Musicologist Joseph Auner for example described 12 Tone Serialism as a 're-emergence of traditional compositional approaches at every level of organization' (Cook & Pople 2004, p. 248).

One of several starting points for my Masters research was my intuition that *Erwartung* pointed musical language in a direction that is still largely unexplored – that of maximal variety.

1.1.2. *The state of art music in the early 21st Century*

Probably the most 'contemporary' composer to have found general acceptance amongst the concert-going public is Gustav Mahler (1860-1911). Considering that the centenary celebrations of his death are already upon us, the fact that much of the music of this last century is unknown or marginal is symptomatic, I would argue, of a kind of 'culture death' (Postman 1985). The music of Schoenberg's Second Viennese School is still a closed book to most listeners, and the music of the modernist composers of the last few decades (e.g. Xenakis, Ferneyhough) is utterly incomprehensible for the overwhelming majority of the 'classical' music audience.

It is my hypothesis that two critical factors came into play at roughly the same time, both of which contributed significantly to the decline of art-music as a mainstream discourse - the position music so conspicuously occupied throughout the 19th century. The first factor was described by Xenakis (1985, p. 3) when he characterized the 20th Century as being 'a period of significant acceleration [in the] condensation towards abstraction'. Put simply, Schoenberg's revolution in musical language (i.e. the point where atonality emerges ca. 1900-1910) created a music that was not only *new*: it was exponentially more complex than the music of the 19th century. The second factor, which comes into play at precisely the same time that art-music became so demanding on listeners' intellectual resources, was the emergence of the technology of mass media, which made the intellectually *passive* consumption of popular culture utterly pervasive. Neil Postman's critique of the impact of mass media on literacy in *Amusing Ourselves to Death* (Postman 1985/2005) is a signal account of this phenomenon in relation to printed material, and I feel his thesis even more relevant when applied to art-musical culture. Contemporary French composer Phillipe Manoury argues this point in Rowe (2001):

I am concerned that a certain culture is being lost. Music is increasingly playing the role of a *diversion* and that scares me. I don't have anything against music as a diversion, but I have the impression that our society, faced with numerous problems with no resolutions in sight, considers diversion as an antidote to these problems. The more society stagnates, the more it distributes this antidote of diversion, in which music plays an important role. There is an over-consumption of the music of diversion and people don't see that music can also be the fruit of reflection and internal process, something they recognize more easily in literature (Rowe 2001, p. 5).

Aldous Huxley characterised the co-option of music by commercialism/diversion even more succinctly – 'Orpheus has entered into an alliance with Pavlov' (Dubal 2001).

The overall level of musicality in Western countries has been eroded by these self-same technologies and the culture of diversion that attends them. Compared with the situation 100 years ago, fewer people read music[5], there are fewer proficient amateurs and even fewer people engaged in making their own music through, for example, organized multi-part choral singing. Johnson (1991) gives a detailed account of the pre-eminence of music in 19th century Europe in the third chapter of his history *The Birth of the Modern.*

In the context of a discussion on the nature of 'meaning' in music, McAdams (1987) suggests that that what music 'means' is in fact played out in the tension between listeners' pattern-perception of a musical work against their culturally mandated expectations of what actually constitutes 'music'. A society that acculturates its citizens' memories with fewer musical patterns must perforce be a society with a less 'meaningful' rapport with musical culture. Even if opportunities for deeply engaging (=non diversionary) listening do present themselves, there are less people who can actually listen.

In his 2007 Peggy Glanville-Hicks address, composer/performer Jon Rose (2007) noted:

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[5] There is strong anecdotal evidence for this: in my father's youth, the sales of sheet music determined how music 'charted'. Consider also the prevalence of the piano in 19th century Australia (see Rose 2007). In Henry Handel Richardson's *The Getting of Wisdom* it is evident in several places that there were almost as many pianos at Presbyterian Ladies' College in the 1880's as there were boarders (Richardson 1910).

Here's some statistics taken in 2004 from the 'Music in Australia Knowledge Base': Out of a population of over 20.1 million people, only 230,800 persons said they were involved as live performers of music. That's a lot less than the number of pianos in Australia in 1888 when the population was well under 3 million. So how unmusical have we become? That figure 230 thousand includes unpaid and paid hobbyists as well as professionals. That's 1.47% of the population. Out of that 1.47%, only 15.2% worked ten hours or more per week. This means that less than 3,500 musicians were employed anything like full time in this country during the Howard boom year of 2004. What was their worth? There are no figures, but of that initial boast of 230,800 people who said they had been involved in music somehow, only 11,500 said they received more than $5,000 dollars in that year.

Rose also notes that these pitifully small figures are themselves inflated by the massive government subsidies given to Opera Australia and the state symphony orchestras – the museum culture 'has the whole of the cake and eats it too' (ibid.).

Music education receives less and less time in an increasingly overcrowded curriculum (Rose notes that only 34% of public school students receive sustained musical instruction), and the quality of programs themselves is under threat from the lack of highly trained instructors. Music curricula are severely compromised by pressures to capitulate to commercial popular culture, often of little intrinsic musical value: a tendency that is often accompanied by the 'dumbing-down' of content and skills. This is especially evident in the <u>pitch</u> domain of musical expression. Because popular music is grounded in short, repetitive rhythmic structures[6], ignorance of the main drivers of large scale musical form in art music – specifically its harmonic structure and thematic development– makes art music inaccessible to listeners raised on an exclusive diet of commercial popular

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[6] 'Even if they forgot what they heard in the music a few moments ago, there is no cause for concern, because the same sequences are repeated for them again and again' (Gordon 2003, p. 348). In this concluding chapter to his *Learning Sequences in Music,* Professor Edwin Gordon argues that contemporary listeners' primary connection with popular music is established through the primal beat and through lyrics.

music (see the introduction of Andrew Ford's *In Defence of Classical Music* (Ford 2005) for a thorough exposition of this concept)[7].

A quality music education that includes contemporary classical music has the potential to both generate new composers *and* the audience for their work. In Andrew Ford's *Composer to Composer* (1993) Liza Lim recalls:

> 'I really wasn't at all involved in music in my early childhood,' she admits. 'I did the usual piano lessons and hated them. But my high school had a very active contemporary music program. I remember my first lesson really clearly: the first music I heard was by Penderecki; we then were also played Bob Dylan, and some free jazz and Aboriginal music and Berio's *Visage*. […] I thought, "This is music." It was like a key being turned, and I decided to become a composer that day. I was 12.'

The marginalisation of avant garde music in Australia takes on many forms – the 'ghettoization' of that music into specialist festivals, the lack of repeat performances, the difficulty in touring works across multiple states and limited distribution through broadcast and/or CDs. One of the motivations for composing a maximally communicative music that I will propose in 2.2.2 is the fact that, if its main reception will perforce be through recordings, I reasoned that I should exploit the one serious advantage recordings have over live performance: their instant and inexpensive repeatability.

1.1.3. *Making 'sense' in an era without common practice*

A recurring controversy in the humanities is the notional conflict between (notionally!) progressive and conservative forces. Specifically musical examples of this dialectic are the controversies between Classical and Romanic tendencies in the early 19th century (Johnson 1991, p.143), Wagner and Brahms (The so-called 'War of the Romantics'),

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[7] In considering whether or not 'classical music better than other kinds of music' (Ford 2005, p.10) Andrew Ford makes the claim that the tradition of notation is what makes classical music 'uniquely different' from popular musics.

Busoni and Pfitzner in the early 20th Century, Schoenberg and Stravinsky in the mid-20th Century. Recent decades have seen similar battle lines drawn between 'modernist' and 'post-modernist' camps. The preface to the latest edition of the *Cambridge History of Twentieth Century Music* (Cook and Pople 2004) is a case in point. It begins with this thought from musicologist Susan McClary – 'We have not even begun to tell the history of twentieth century music'. The editors continue with seventeen pages of apologetics explaining exactly why a coherent, straight-line narrative *cannot be written* about this topic, concluding that their volume can only truly be seen as 'a set of resources and commentaries' (p. 17).

Notwithstanding the cyclical nature of these debates, there *is* evidence that the musical situation in the preceding century was in reality more fractured than in any other period in Western musical history – so much so that we find ourselves living in a musical era largely devoid of a 'common practice'. The implications of this are profound. Charles Rosen's (1971) survey of the music of Haydn, Mozart and Beethoven, *The Classical Style,* demonstrates how the very commonality of expressive means shared by these composers allowed for their musical language to attain an incredible level of sophistication. Rosen quotes near-contemporary of the Classical era E. T. A. Hoffmann as stating that the large-scale harmonic effects then introduced meant that 'even irony was possible in music now' (p. 80). In direct relevance to my own work (see 2.1.3.2), Rosen argues (p. 81) that the architecture of large-scale harmonic effects attained their full power in the classical era, thus allowing the *transformation* of themes (rather than simply the *contrast* of themes) to drive musical form (see section 3.2.4).

This development, which Rosen calls 'tonal drama', is a process whereby the creation of large-scale tension and release in a single movement of music is controlled by the motion through related tonal or 'key' centres, all of each posit a different relationship to the home key. Tonality, in very broad terms, is the organization of music into keys (e.g. C Major, G Major etc.). The sense of being 'in a key' gives syntactic weight to musical tones in both their vertical (harmonic) and horizontal (melodic) instantiations. Thus, even musical ideas that are very similar can be imbued with an alternative emotional patina by virtue of their fluid relationship to key.

A full century after Schoenberg's first atonal pieces, a composer's stance vis a vis tonality/atonality is probably still *the* critical shibboleth partitioning modernist from post-modernist camps: i.e. atonality is arguably the most conspicuous aspect of the modernist credo. Whilst a plethora of atonal idiolects[8] ('dialects' would imply too high a degree of confluence!) have emerged in the century after Schoenberg's Op. 11[9], it would be impossible to argue for the existence of an atonal 'common practice'.

Is the lack of a common practice problematic? To the extent that musical communication has any comparability to speech, the answer would have to be 'Yes'. In *The Language of Music* Deryck Cooke (1959) makes an elegant case for the expressive power of melodic (and tonally referential) intervals as being the prime mechanism for the elucidation of musical sense, and calls into question the capacity of atonal music to express complex emotion (ibid. introduction, p. xviii). Edwin Gordon's (2003) *Music Learning Theory* is in agreement with Cooke in that he too sees tonality as ultimately underwriting musical (at least melodic) syntax – he does however allow that atonal music should ultimately be understood as Schoenberg himself envisaged: as *pan*-tonal (rather than *a*-tonal): Gordon writes, '…the music probably sounds atonal only to persons who cannot audiate[10] rapidly changing tonalities' (p. 143). In his preface to a volume of *Contemporary Music Review* devoted to music and psychology, Stephen McAdams (1987) noted that '…complaints about its [i.e modernist/atonal music's] difficulty may be the complaints of people who have not yet acquired the "mental schemata"…that allows them to "experience" this music deeply. But perhaps it does, at times, violate psychological limits of comprehension' (p. viii).

Notwithstanding the problematic nature of modernist discourse outlined above, it has been an axiomatic personal principle that there is still a 'new music' left to be written, coupled with a suspicion that much of the post-modern critique of the avant-garde is in

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[8] Even the amongst close-knit group of composers known together as the Second Viennese School (Schoenberg, Berg and Webern), each has a strikingly different approaches to handling atonal space. In broad terms, Reginald Smith Brindle characterised the tone rows of the Second Viennese triumvirate as 'melodic', 'tonal' and 'atonal' respectively (Smith Brindle 1966).

[9] One of the canonical first atonal works.

[10] 'Audiate' is Gordon's personal term. It basically means 'inner hearing', but combined with a syntactical comprehension of the musical phenomenon being 'audiated'.

fact the death rattle of a generation of composers who (in the face of the difficulties of contemporary music's socio-cultural reception as discussed above), have thrown in the towel on their own imaginations (cf. Bennett 2008).

1.2.   Practical and philosophical positions – starting points for this research

I commenced this Masters degree immediately upon the completion of a ten-year project: the composition of my fourth opera *Cannibal Pearce[11]*. After such a long period of composing music in essentially the same way, I felt a pressing need to rebuild my compositional 'toolbox' in order to push my work to its next level of development. Throughout the composition of this opera (as indeed for most of my acknowledged output) I used some form of 'instruction book' for assembling the piece. This was typically arranged into a series of steps and, looking back on this methodology, the primitives of a more systematic algorithmic thinking are clearly present.

During the act of composing, I find I frequently have ideas about more efficient or more interesting ways of writing music. Not all of these ideas can be immediately incorporated into my current practice – to do so would be to risk compromising the coherence of the project at hand – so I maintain a record of ideas that will form the basis of the next project. Over the long course of composing *Cannibal Pearce*, this record became increasingly detailed. This reservoir of future directions - the *Post-Pearce Ideas Sheet* - is discussed at length in section 2.3.3. Implementing these ideas, and exploring the *implications* of these ideas generated most of my specific research questions (see 2.2).

When I reviewed this material as part of my preparations to apply for acceptance into the Masters stream at SIAL, I realised that what I had written in the *Post-Pearce Ideas Sheet* was

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[11] *Cannibal Pearce* was composed between 1995 and 2005, and is my largest work to date. It is scored for a small chamber orchestra of nine players, one singer and a large cast of 40 mimes and/or puppets. The opera is about an hour long, but the complex staging requirements and the sheer difficulty of the score are such that it remains my only unperformed work. The opera's libretto, constructed entirely out of primary documents and historical texts, tells the story of the Tasmanian convict/cannibal, Alexander Pearce (d. 1824).

almost entirely a *technical* account of how I wanted to write my next pieces. In order to broaden out this research for development in a formal academic setting, I felt a responsibility to also clarify some of my *aesthetic* (or musico-philosophical) goals. This resulted in a short essay-cum-manifesto called *A Music of the Incommunicable* (see section 2.3.2). Although I have since come to modify (and even reject outright) many of the ideas in this polemic (see 4.3), it was undoubtedly a progenitor of much of my current thinking, the crux of which is my desire to write a music that was as rich as possible in content without becoming incoherent.

I would now like to turn to the image in the title of this exegesis – an 'orrery of the universe'. One of the overarching goals of my research is encapsulated in this image: a fundamental goal I have as a composer is to create music that in some ways attempts to capture *everything*. Indeed the two projects attempt a symbolic description of the universe (or at least universal possibility) by virtue of their common extra-musical source, King David's paean to all physical and spiritual forces, Psalm 148 (see 1.5 and 2.1.3.1). I have always been drawn to the idealism (and the sheer *chutzpah*) of those who attempt to create all-encompassing, encyclopaedic artworks. Thus my personal pantheon has long included composers like Messiaen, Mahler (in particular his colossal *Third Symphony*) and Wagner. Proust's *In Search of Lost Time* was also a significant model for the universalist art-work.

1.3.   Why compose using algorithms?

What rational composer would refuse to listen to an algorithmic attempt to solve a problem or prefer not to hear an extension of a just-composed section of their music?... Even if these algorithmic attempts fail to please at <u>any</u> occasion, they might still inspire, if only through their failure to persuade (Cope 2000, p. 260).

Gravity doesn't explain architecture, but all architecture is subject to its laws (Narmour 1990, p.4).

An algorithm is 'a procedure or set of rules for calculation or problem solving' (Concise OED). In design terms, an algorithm can be equated with the notion of *heuristic*, or 'creative rule-of-thumb': in *Design Thinking* Rowe (1987) defined 'heuristic' as:

> …any principle, procedure or other device that contributes to reduction in the search for a satisfactory solution.

Gerhard Nierhaus' recently published survey *Algorithmic Composition* (2008) is one of very few book-length treatments of this area that I have been able to identify. He defines algorithmic composition as 'composing by means of formalizable methods' (p1) and draws on three definitions of algorithm:

> 1) A set of mathematical instructions that must be followed in a fixed order, and that, especially if given to a computer, will help to calculate the answer to a mathematical problem.

> 2) A systematic procedure that produces – in a finite number of steps – the answer to a question or the solution of a problem.

> 3) (Especially computing) a set of rules that must be followed when solving a particular problem. (Nierhaus 2008, p.2)

The third definition best captures the sense in which the word 'algorithm' is used throughout this document. The totality of the approaches used in the generation of my project work, what I refer to collectively as the Process (capitalized throughout for ease of recognition), is a self-consciously unbounded object. There are many points at which I disrupt the Process with arbitrary *deus ex machina* interventions, and many instances in which it would be misleading to invoke the cachet of science (in particular mathematics) to make any claims of being rigorously systematic. Xenakis (1985, p. 4) notes that 'art isn't just "inference and experimentation" (unlike science)… it is also "revelation." '

One of my most significant mentors, Chris Dench (see section 2.2.2) once remarked that algorithmic composition allows you to write 'a music which could not hitherto be

imagined – even by you'[12]. By enabling musical material to become (to a certain extent) *self-generative,* I have found that creative energy can then be deployed on enriching the meaningfulness of larger-scale relationships in a musical work. In other words, far less creative energy is expended on the continual generation of material at the surface level.

The French composer Gérard Grisey has described the relationship between these different levels in a musical work as being the 'skeleton, flesh and skin of time'. In his vivid metaphor, the 'skeleton of time' corresponds to the large scale architectonics of a musical work – the organization into large sections defined chronometrically. The 'flesh of time' encompasses those behaviours or characteristics that give structural cohesion to these sections: the zones in which the gaps between isolated musical events become meaningful, because memory and anticipation can combine to assess these musical events against their 'pre-audibility', to use Grisey's term. The 'skin of time'[13] is the point at which musical time and the perceptual time of the listener become increasingly indistinguishable (Grisey 1987).

What I find particularly useful about Grisey's cosmology of music is his implicit explanation of why so many of the significant aspects of music are essentially 'invisible'; i.e. they can neither be reported on directly by listeners on a moment to moment basis, nor can they be readily isolated in the physical artefact of the musical score (the 'skin'). I am reminded here of a striking lighting effect in the 1990 Australian Opera production of *Tristan und Isolde*: in the Second Act, computer controlled lighting was used to transform, through thousands of individually imperceptible increments, a 'night-time' lighting state into a 'dawn' lighting state over the duration of the entire act - a time span of some 80 minutes. This is a simple example of how phenomenological developments can be sensed in a sub- or pre-conscious way that extends beyond the normal ambitus of perceptual attention.

However, the most significant justification for my use of algorithmic composition stems from my belief that we are living in an era that can largely be defined by the absence of a musical 'common practice' (see section 2.1.3). As such, composing by *instinct* is, I believe,

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[12] Paraphrased from remarks made in personal conversation with the author, ca. 1993.

[13] A level which corresponds very closely to the information that is musically notated.

a fraught path if one's intention is to compose any genuinely 'new' music. I contend that, in order to confront an era without commonly held musical instincts, it is instinct *itself* that needs to be channelled or filtered through the lens of formalization. This has the potential to constitute a foundation of rhetorical intelligence whose presuppositions can be expressively extended (or even supplanted for expressive purpose). The composer who relies on instinct only flourishes in a culture whose musical language remains essentially uncontested.

One of the most commonly raised objections to composing algorithmically is the notion that it is the algorithms *themselves* that somehow compose the music (thus dispensing with, or devaluing human agency). The unease about computers carrying out traditionally human functions is akin to the popular reaction to the 'ascendancy' of computer chess programs, which Eade (2005) defuses in the following way:

> Remember that the computer programmers are humans too – so the real situation isn't so much human versus machine as it is unarmoured human versus armoured human (p. 258)

There is nevertheless a surface plausibility to this objection, particularly as many accounts of algorithmic composition tend to be very complex and (seemingly) exhaustive descriptions of compositional processes, largely dealing with the minutiae of how musical scores are generated, excluding any treatment of the aesthetic/expressive goals of the music.

The Process I have developed through this Masters does indeed generate a musical score. But a score can only at best represent a set of *intentions*; the realization of a score is in the hands of interpreters and the reception of their interpretation occurs in the (largely inaccessible) recesses of listeners' minds. Snyder (2000, p 88) points out that whilst interpretative nuances are what truly animates expressive musical performance, these nuances themselves are one of the least 'memorable' (taken in the limited sense of *easily*

remembered) aspects of our experience of music.[14] The score is, at best, only able to generate certain material pre-conditions for musical communication to occur.

1.4.   Why compose chamber music?

In his article *Timbre and Composition – Timbre and Language*, Boulez (1987) argues that the fundamental differences between orchestral music and chamber music lie not so much in the physical forces required for their realization, but in terms of two fundamentally distinct modalities of sense-making. Orchestral music concerns itself with the creation of rich sonic illusions: that which Adorno described as 'phantasmagoria'. The refinement of chamber music creates an 'immediate reality' which Boulez calls the world of 'analysis' or 'articulation'.

Peter Cowie (in a discussion of the origins of Ingmar Bergman's musically inspired 'chamber cinema'), brings the following idea from the 19th century Swedish playwright August Strindberg:

> Already in the 1880s, Strindberg asserted that a table and a couple of chairs were the only items required for his naturalistic plays, and in a memorandum to the actors of the time he outlined this development as "the chamber music idea carried over into drama: the intimate procedure, the significant motif, the highly finished treatment." (Cowie 1982, pp. 44-45)

It is therefore no accident that Bergman's own films make such brilliant use of chamber music – e.g. the use of a single slow movement from the Bach *D Minor Cello Suite* in his 1961 film *Through A Glass Darkly* is the perfect analogue for the extreme emotional intensity that Bergman draws from his tiny ensemble cast. It is this combination of intensity and detail, intimacy and emotional directness that sustains my interest in chamber music. There is also something inherently democratic and respectful of

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[14] This, Snyder conjectures, is the reason that we can listen to a recording so many times. From a pedagogical perspective, interpretative nuance is so interesting because it is an aspect of musical performance that can only be taught, inferentially, through direct demonstration.

individuality in this form – Elliott Carter made precisely this point in the 2004 portrait documentary *A Labyrinth of Time*.

Putting aside a small number of arrangements, pastiche and educational music, none of my mature work has been composed for orchestra. This is ironic given that the majority of my personal library (both scores and recordings), my listening time and my concert attendance is devoted to orchestral music. My primary compositional mentors[15] have all, at some stage, warned me against the pitfalls of composing for orchestra: orchestral musicians are, at best indifferent to new music. At worst, orchestral musicians have been known to actively sabotage performances: even to the extent of vandalizing scores and parts.

It is my belief that the Australian orchestral scene is (especially for contemporary music), an unhealthy environment. Professional orchestras in Australia operate in a vacuum largely without competition – the musical equivalent of the parochial 'one-newspaper town'. They present an increasingly narrow *degustation* of the Western musical canon. The irony is of course that the 19th century European music culture that produced so much of this repertoire was a culture in which new music occupied centre stage and new works could be expected to receive frequent repeat performances[16] – the exact opposite of what prevails today.

Chamber music by its nature tends to attract much more committed performers: performers who are more likely to welcome experimentation. The training and day to day experience of orchestral musicians[17] simply does not prepare then to play repertoire as rhythmically complex as my music, not to mention the challenges presented by my frequent use of microtones[18]. Chamber musicians operate within a culture of detailed and collaborative rehearsal, and chamber music concerts are often prepared over several *weeks* (as against the several *days* in which orchestral works are typically prepared).

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[15] Including Chris Dench (see 2.1.2), Richard Barrett and Michael Finnissy (2.2.1).

[16] Even as late as 1925, Alban Berg's hugely demanding first opera *Wozzeck* received more than 150 performances across Europe in the decade following its premiere (Ewan 1954).

[17] My first degree was a Bachelor of Music Performance, majoring in orchestral playing.

[18] Microtones are the pitches smaller than the conventional semitone – i.e. notes 'in between' the notes of the piano keyboard.

Despite the illusion of total control over musical material that extensive algorithmic systems might *appear* to imply, the role of human interpreters in my music is absolutely essential. Indeed, I do not believe that a purely electro-acoustic rendering would serve my personal aesthetic well. Boulez (1987, p.170) once noted that electro-acoustic sounds 'are very beautiful and well thought of, but they possess a very vigorous centrifugal force and so have great difficulty integrating themselves into a real *discourse'* [my emphasis]. The assumption that sounds can carry a syntactic meaning – that they can be assigned significance beyond their purely acoustical properties, and hence constitute a discourse of the kind that Boulez describes – is another axiom of my music.

Finally, a strong case for chamber music is quite simply a financial one – and hour of time with an 80-piece orchestra is astronomically expensive[19] compared to the hours that can be spent with a flute soloist or a piano trio.

1.5. Outline of activity, 2005-2010 and the physical contents of the ADR[20]

The three products of this Masters are a compositional Process and two projects. The Process for creating musical compositions came into being as a response to a number of specific aesthetic and technical goals, which I will present in the next chapter (see 2.2). The two projects are a Flute Solo and a Piano Trio, both titled *Hallelu et Hasheim min hashamayim* (Heb: Praise the Lord from the heavens) and are derived from the Hebrew text of Psalm 148. The Psalm takes as its subject matter a cosmogony of the universe, and has provided a rich object of contemplation throughout this research. As a speaker of Hebrew and an Orthodox Jew, there is an undeniably high level of personal investment in such texts and a concomitant desire to do them justice, so to speak. For a fuller discussion of the role of Hebrew language and texts, see section 2.1.3.1.

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[19] At the very low rate of $150 per player per call, this works out at $12,000 for each rehearsal.

[20] The 'Appropriate Durable Record' submitted with this exegesis.

In very broad terms, I spent 2005 and 2006 determining the technical specifications of the Process, developing a rhythmic search engine (called SourceR), learning how to program using the IRCAM software package OpenMusic[21], and then using OpenMusic to create the transformational algorithms[22] that lie at the heart of the Process. By the end of 2006, I had added the final touches to the Process after some compositional false starts. In 2007, both projects were completed and received public premieres. Due to work commitments 2008 was a sabbatical year, and in 2009, I began the process of formally documenting my research.

The ADR contains a 20 page score and CD recording of the Flute Solo. The Flute Solo has a 'paper' duration (by which I mean the duration generated by the exact observation of the written metronome markings) of approximately 18 minutes. The recording is just under 20 minutes' duration. The Flute Solo was premiered at the SIAL Spectrum Concert of 24 May, 2007 at the Meat Market, North Melbourne.

The ADR also contains a 41 page score and CD recording of the Piano Trio. The Piano Trio has an approximate (and possibly overly ambitious!) 'paper' duration of just over 5 minutes. The recording is 8 minutes in duration. The Piano Trio was premiered as part of Freshwater Trio's 2007 Subscription Series at Melba Hall, University of Melbourne, 27 November. They have subsequently performed the work in 2008 for Musica Viva's Coffee Concerts at the Collins St Baptist Church, and again at the Melbourne Recital Centre in 2009. The recording in the ADR was produced by Duncan Yardley for ABC Classic FM in the same year.

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[21] See 3.1.4: 'What have computers contributed to the Process?'

[22] The central (and most time-consuming) technical aim of my project work was the creation of six transformational algorithms (described in detail in section 3.3.5) that can develop thematic material simultaneously, with each process unfolding at an independent rate. Thematic development of this level of subtlety and precision would requires literally millions of calculations, which was a practical impossibility were I to use my older tools: graph paper, rulers, spreadsheets and a calculator.

2. Background – from *Bildungsroman* to specific research questions

Chapter Two of this exegesis parallels to a certain extent the trajectory of the first chapter, except that the first chapter's broad cultural context is here reduced to the personal context of an artistic autobiography. After a brief consideration of my juvenilia and formative early works, I describe the fundamental features of my musical idiolect: i.e. the features which are carried through and developed in my Masters projects. The specific research questions addressed in the Masters were derived from a range of sources, including an overseas study trip in late 2000, and two key documents: a philosophical manifesto written as a self-clarification exercise just prior to commencing this research ('A Music of the Incommunicable'), and a document assembled over the ten-year course of writing my pre-Masters project, the opera *Cannibal Pearce*. This second document, 'The post-*Pearce* Ideas Sheet', was a reservoir of possible new directions for my music. A recurrent concept in this chapter is the notion of 'shortcomings' – an admittedly awkward term when applied to artistic product - but useful in suggesting the sense of progression that undoubtedly exists between one project (or working methodology) and the next.

2.1. The development of my pre-Masters compositional practice

2.1.1. Juvenilia

One narrative thread that spans my entire musical-creative biography is the desire to bring more and more elements of my work under meaningful control. My earliest compositions (ages 5-16) were essentially notated improvisations, and were worked out largely at the keyboard. The idea of exercising 'control' over aspects of my music-writing (beyond cutting and pasting chunks of improvised musical surfaces) was precipitated by my discovery of Reginald Smith Brindle's (1966) *Serial Composition* in the music library at Melbourne High School.

The notion that pitch materials for an entire work could be prefabricated *before the score was even ruled up* was (for me) a groundbreaking concept, the ultimate implications of which I was barely able to grasp as a 16 year old. Breaking away from the limitations of the keyboard is a commonly felt need of composers – Prokofiev's *Classical Symphony* is a famous example where a composer forced himself to work entirely away from the piano. Tom Waits made the same point when he said that working from an instrument restricts musical invention:

> Your hands are like dogs, going to the same places they've been. You have to be careful when playing is no longer in the mind but in the fingers, going to happy places. You have to break them of their habits or you don't explore, you only play what is confident and pleasing. I'm learning to break those habits by playing instruments I know absolutely nothing about, like a bassoon or a waterphone (Waits 1994).

2.1.2. Meeting Chris Dench

Although I abandoned a strictly 12-tone serial methodology in my first months as an undergraduate, I retained the habit of drawing up large reservoirs of pitch material from which fully fleshed-out works could emerge with some innate, global coherence. The next major paradigm shift in my practice came in mid-1993, when I attended a holiday course with Chris Dench organised at Melbourne University by fellow composer Newton Armstrong. The encounter with Dench came at a critical juncture in my musical and personal development: after two weeks of intensive individual and group instruction, together detailed analyses drawn from Dench's own labyrinthine output, I asked him, partly in desperation, whether or not the only way I might gain meaningful control over the development of my music would be the study of mathematics. He replied, "Why bother? You're already studying Hebrew."[23]

Although I had been a student of Hebrew language for only 18 months, it had already become (and continues to be) a consuming obsession. That Hebrew language might be

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[23] Paraphrased from personal recollection.

re-cast in musical forms was at once startling and obvious. Another one of Dench's maxims that directly informs this Masters project was his belief that composers should find creative algorithms to 'automate' those aspects of music composition that they feel they don't have particularly good instincts for – a stepping stone to what Dench would often describe as "the composition of a music that could not hitherto be imagined: even by the composer herself"(ibid).

2.1.3. *The fundamental features of my musical language[24]*

There are a number of preoccupations in my work that, taken together, constitute a summation of my personal style. Furthermore, the aspects of my music that I am about to describe in turn have all been stable features of my acknowledged mature oeuvre: a period of roughly 15 years. These features are:

- The use of the Hebrew language as a starting point for musical composition
- The use of melody/themes as the raw material of musical argument
- Exploration of a range of textures, but within the 'ur-texture' of dense microtonal polyphony
- Composition in discrete formal sections
- The quasi-traditional use of vertical harmony: what I term 'Functional Atonality'
- The recurring experiential gestalt that I call the 'Abyss of Incomprehensibility'

2.1.3.1. *The Use of The Hebrew Language*

The first piece I composed using a Hebrew text as the fundamental source is also, by no coincidence, my earliest acknowledged work. Composed in January 1994, *shiru le'Hasheim shir chadash* is a quartet (for flute, clarinet in A, violin and guitar) composed for the Libra Ensemble who premiered it in March of that year. It was based on the 149th Psalm, with each letter of the Psalm coded into musical pitches. The first alphabetic cipher I put together to carry out this process was fairly primitive. In part inspired by Dench's 'cartouche' principle (i.e. his generation musical materials out of names, usually those of

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[24] i.e. features that are common to both *Cannibal Pearce* (the immediate pre-Masters project) and my current work

his works' dedicatees), I started allocating pitches in ascending order, assigning the first Hebrew letter, aleph, to the pitch 'A'[25]. Then, with minor modifications, I assigned the letters of the letters of the Hebrew alphabet to an ascending quartertone scale from that initial 'A'. I then wrote out the complete Psalm text into musical pitches (my source material), and composed a piece using those materials, the sections of which mirrored the psychodrama of that text.

There were a number of serendipitous occurrences in that first attempt. For example, the two Hebrew plural endings (masculine *'-im'* and feminine *'-ot'*) were direct musical inversions of one another. Also the most sacred of the seven divine names in Hebrew scripture – the four letter Tetragrammaton (or 'ineffable' Name) – worked out to be a microtonally bisected perfect fourth: i.e. a perfect interval cut in half. This 'name' is one of the most conspicuous themes in the Flute Solo composed as the first of my Masters projects.

Every piece I have composed since then has added gradual refinements to this method. The alphabetic cipher is a tool that aims to reveal the fundamental inner workings of Hebrew lexicon and grammar through musical logic. In the preliminary statement to his thesis defence, composer/architect Iannis Xenakis made an elegant plea for music's capacity has to reveal the truths latent in other disciplines. One of his arguments is that, whilst scientific endeavour proceeds from inferential and experimental truth-seeking, art…

> …exists in a third mode, one of immediate revelation… The revelation of beauty
> occurs immediately, directly to someone ignorant of art as well as the connoisseur.
> This is the strength of art and, so it seems, its superiority over the sciences.
> (Xenakis 1985, p. 4)

Many of these refinements to the alphabetic cipher were made to highlight harmonic correspondences between the most frequently used words in the text I am treating. Most word forms in Hebrew are derived from triliteral root forms (Heb. *shoreshim*) and it is naturally more important to assign the 'root' letters before the morphological letters. The

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[25] 'A' and *'Alef'* being my initial in both Hebrew and English.

numerical value of the text (in Hebrew, as in Greek, there are correspondences between letters and numbers: this relationship is called *gematria*) has been used as the source for the rhythmic life of my music for the past decade (see Figure 4).

Musical composition must, I feel, be more than an academic exercise: it is critical to my personal philosophy that music should be *about* something[26]. Furthermore, the personal/religious reasons for grounding my music in the Hebrew language are undeniably significant. In George Steiner's epic study of the art of translation *After Babel*, he takes up the theme of Hebrew's historical status as the primal language *par excellence*:

> This Adamic vernacular not only enabled all men to understand one another, to communicate with perfect ease. It bodied forth…the original Logos, the act of immediate calling into being whereby God has literally 'spoken the world'. The vulgate of Eden contained, though perhaps in a muted key, a divine syntax – powers of statement and designation analogous to God's own diction, in which the mere naming of a thing was the necessary and sufficient cause of its leap into reality (Steiner 1975, p. 60).

2.1.3.2. *The Use of Themes*

The translation of Hebrew texts into musical notes automatically pre-patterns those pitch materials into ready-sorted sentences and clauses. The use of 'themes' (often called phrases or motifs) enables a composer to build meaning and coherence into musical structures. The musical repetition and development of these themes is the point at which a linguistic analogy falls down: the speaker of a language as repetitious as music would be exhibiting the symptoms of mental illness. Thus it can be inferred that sense-making in music comes from a much less symbolic/referential syntax than language. In *Music and Meaning,* Bob Snyder writes:

> Grouping factors in early segmentation can favour segmentation or continuity – every musical event either develops a connection with the previous event or

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[26] This is I suppose an essentially Romantic *Weltanschauung*.

separates itself from it to some degree. Control of this relative segmentation or continuity of patterns is one of the primary ways music can be made to be dynamic and push forward in time… the level of musical grouping which is most directly related to short term memory is the *phrase* (Snyder 2000 pp. 32, 37, emphasis mine).

Olivier Messiaen's commitment to melody can be found in the very first sentence of his *Technique of my Musical Language:* 'The melody is the point of departure. May it remain sovereign!' (Messiaen 1956, p. 12). Themes are the basic building block of my music's textures[27], and the contrast between the texture-complexes of individual sections is the principal driver of my musical teleology, as will become clear in the technical description in Chapter Three of this document (3.3.1 to 3.3.8).

However, one of the initial directions for this Masters (see 2.2.2) came from my *dissatisfaction* with the thematic principle in music – if music is so dependant on repetition, I asked myself, perhaps the deciphering of musical meaning represents little more than a kind of sterile intellectual exercise or game? In John Bird's biography of Percy Grainger, he notes that Grainger's most experimental notated music (and most certainly his Free Music) is characterised by:

> …a definite tendency to create music in which there was little, if any repetition of thematic ideas…One of Grainger's early defined musical aims was to strive to make music a mirror of nature rather than a mirror of man's impressions of or feelings aroused by nature (Bird 1999, pp. 69-70).

The creative tension between the centrality of theme and my desire to escape from the primacy of repetition is an ongoing conflict in the machinations of the Process.

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[27] It should be noted that the whilst the abandonment of melody is a supposed tenet of high modernism, Griffiths (1981, p. 271) argues that from 1970, the return of melodic thinking is evident across a diverse range of modernist composers – he further proposes that the minimalism of Reich and Glass represents this tendency in its most extreme form.

Dense microtonal[28] polyphony[29]

Having established the primacy of melody in my music (see 2.1.3.2), I will now turn to the two defining characteristics of my melodic language: the use of microtonality and the superimposition of simultaneous melodic strands. These two features account for much of the density and richness of the music I compose, as well as its tendency to lurge towards incomprehensibility (see 2.1.3.6).

The desire to write densely polyphonic music is another personal obsession. Music can say so many things at once (and say them *coherently[30]*): this is perhaps music's most important singular claim as an art form. My obsession with polyphony is also a longstanding one: I have a sketchbook I was working in as a fifteen-year-old, when I first encountered truly polyphonic music (Thomas Tallis). I immediately started sketching a similarly dense, multi-part music[31].

From my first years as a serious listener, the music I felt closest to was, in the main, characterized by multi-layered polyphonic thinking. The wind band music of Percy Grainger's that I was exposed to in the Melbourne Youth Symphonic Band led to my discovery of Grainger's orchestral music – *The Warriors* made a profound impression on me as a fourteen-year-old, and I still consider it one of the most ambitious Australian orchestral works ever composed. The ultra-Romantic language of Mahler (especially the *5th Symphony*) and Richard Strauss (*Salome* in particular) were also formative influences, as was Schoenberg's opera *Moses und Aron*. Schoenberg's audacious setting of the Voice from the Burning Bush in Scene One of that opera has a talismanic quality for me: in order to depict this voice, Schoenberg uses multi-part choral forces, mutli-part speaking chorus, soloists embedded in the orchestra and a speaking children's chorus – polyphony as an analogue for the Divine.

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[28] See footnote 18.

[29] Literally 'many voices' – music composed from independent melodies which harmonize together.

[30] …in that simultaneously stated materials can both form an organic and complementary whole, as well as allowing for any component in the texture to be attended to individually should the listener choose to foreground that element.

[31] …without any idea of what made this music tick: this is a good example of the kind of untutored effort that Twyla Tharp discusses in *The Creative Habit* (2003).

Defining sections (see 2.1.3.4) by their mode of polyphonic elaboration has long been a feature of my musical language. Typically, this involves an interplay between the number of active voices (=independent melodic strands) in any one section, the *type* and *register* of the instrumental voices that take those roles, and the organization of how voices are deployed (i.e. whether they are evenly spread, or clumped at the beginning or end of a section – what I call their archetypal disposition: see Figure 19). Combined, these features imbue a section with its particular formal/teleological *gravitas*.

Microtonality, the use of pitches separated by intervals smaller than the semitones of the Western chromatic scale, has been a feature of my music since my undergraduate days. It was something I encountered first as a performer of other people's music – the first microtonal music I was asked to play was a chamber work by fellow student composer Martin Mackerras. The effort involved in essentially relearning my principal instrument (the oboe) in order to play microtones was extremely rewarding. At the same time, my association with the composers and performers clustered around the newly-emerging Libra Ensemble, as well as my exposure to Chris Dench's thought (see 2.2.2), also encouraged this exploration.

2.1.3.4.   *Composing in sections*

Most music is organized into sections – consider the ubiquitous 'verse-chorus' structures of popular song. Sections of music are defined by the (relative) invariance of basic features in a section, such as melodic material or tone colour (orchestration). Sectional organization aids memory by creating larger zones of structural repetition, which often form a springboard for developmental processes.

Writing in sections is such a basic feature of my music that I have, up until now, not even considered it a feature as such. A rationale as to why I compose in sections might simply be that almost all of my favourite music behaves this way: e.g. Ferneyhough, Xenakis, Messiaen, Mahler. Beyond this, the *stability* of musical sections enables certain large-scale contrasts to be achieved very economically. Continuous or 'smooth' forms (e.g. much of Wagner, Ligeti, the minimalists) tends to intentionally undermine closely argued teleology: in essence, I want my pieces to *go somewhere*, and using extreme

repetition (or extreme duration) to induce psychological states strikes me as lazy and even unmusical – i.e. intense strobe lighting can do the same thing, but strobe lighting cannot 'do' sonata form.

The direct formal inspiration for my first acknowledged work, *shiru le'Hasheim shir chadash* (see 2.1.3.1) was Handel's cantata *Laudate Dominum,* in which every section of the cantata was a 'fleshing out' of a single verse of Psalm text. In my rendering of the 149th Psalm, each verse became a discrete section within a free-flowing single movement form, the sections being marked off in the printed score by the Hebrew letters designating that versification.

Given the extreme density that characterizes so much of my music, I was never really attracted to writing very long pieces – my longest continuous piece of music to date (Scene One from *Cannibal Pearce*) is just over 20 minutes long and consists of 35 very different sections. Indeed, all 540 A2 pages of *Cannibal Pearce* can be performed in under 60 minutes, notwithstanding the fact that the opera includes a prologue, five scenes and is staged across four completely distinct locations.

2.1.3.5. Harmony – 'Functional Atonality'

Since composing my first acknowledged work *shiru le'Hasheim shir chadash,* (see section 2.2.3.1) harmony has had an increasingly important role in my music. Harmony – the superimposition of different tones to create chords, and the interplay of between chords – has a profound capacity to invest music with a great deal of meaning.

The alphabetic cipher for translating Hebrew text into musical pitches has the interesting effect of imparting an innate meaningful hierarchialization of pitch[34] to my music, which reaches beyond purely melodic references when heard within the harmonic structures I deploy. My initial step in preparing the cipher is to construct a distribution table for every Hebrew letter in the text that I am setting. Then I begin to assign pitches to each letter,

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[34] It could be argued that this constitutes a type of 'tonality'.

starting from the most to the least commonly occurring letters. One advantage of this process is that I can assign the tempered, non-microtonal pitches (i.e. the ones that can be played on the piano) to the most commonly occurring notes so that the number of 'normal' notes heavily outweighs the microtones. Microtones are undeniably harder to play, harder to play in tune and harder to listen to. This favouritism I show to certain tones is one way in which my music differs from 'classical' notions of atonality. A strict application of Schoenbergian[35] principles demands that all tones should be of equal importance.

Within harmonic systems, a discrete pitch can 'mean' several things at once – i.e. a note exhibits syntactic 'weight' against the prevailing harmony in addition to its melodic function. Harmony thus enables a composer to throw aspects of the melodic argument into relief, and to make melodic tones more or less significant by virtue of their proximity or estrangement from the expectations that harmony establishes. Vice versa, when harmony changes against a single stable reference pitch, that pitch can be given great poignancy and apparent motion, despite its immutability.

Harmony is so closely associated with tonality that certain modernists have denied its significance altogether – as a teenager I recall hearing a radio interview with the Australian modernist stalwart Felix Werder in which he declared, "I haven't thought about harmony in forty years!"[36] My drift towards a greater role for harmony is that the tonal cognition of harmony, every time we are presented with a complex of musical tones, is completely unavoidable: apparently babies as young as 6 months have been observed responding to completed (or thwarted!) presentations of cadences (Deutsch 1999). Cadences and cadential patterns are sequences of chords that resolve with a sense of conclusion towards the home key or tonic, and are probably the most fundamental feature of Western tonal harmony. Furthermore, one of the implied conclusions of Deryck Cooke's (1959) *The Language of Music*[37] is that some kind of tonal principle is so fundamental to both music history and the physical nature of sound that it is

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[35] It is important to note that Schoenberg's own atonal music often doesn't actually work this way (see Shawm 2002, Frisch 1999).

[36] Personal recollection of an interview on ABC Classic FM ca. 1990.

[37] See my discussion of Cooke in 1.1.3

unavoidable. By extension, I would go so far as to say that harmony is simply too powerful a tool *not* to use.

The personal term I apply to my harmonic thinking is 'functional atonality'. 'Functional' is a term borrowed from conventional tonal harmony. I invoke 'functionality' in its sense that harmonies (chords) can be invested with purposeful direction, and thus have agency to effect the build up and resolution of tension. Nevertheless, my harmonic language is fundamentally 'atonal' in that there is no clearly defined single key centre, nor a tertian sensibility[38] that accounts for the harmonic objects found in my music. There is, however, a definite pitch hierarchy derived from the letter frequencies of Hebrew language – namely the alphabetic cipher I discussed in 2.1.3.1 – that has implications for both the harmonic *and* the melodic structure of my music.

British composer Robert Simpson comments in the sleeve notes to his *Ninth Symphony*[39] that whilst his music is not conventionally tonal, he is very interested in retaining what he calls 'the expressive power of intervals'. This way of working represents, I believe, a possible rapprochement with Cooke's thinking. The voicing of my chords, their orchestration and most importantly the logic of voice leading[40] are all traditional tonal/harmonic concerns that I freely incorporate in my music.

> ### 2.1.3.6. *From the 'Abyss of Incomprehensibility' to 'An Orrery of the Universe': Philosophical Goals?*

There is an almost atavistic aural image that occurs in every one of my pieces of the last 15 years. I apply another idiosyncratic term to this image: the 'Abyss of Incomprehensibility'. This is the point where the polyphonic argument of the work tips over into a state of deliberate and complete perceptual overload. There are a number of precursors to this state in my aesthetic biography. These include times I went stargazing in the country with my father: particularly when I first saw and began to appreciate

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[38] 'Tertian' describes the creation of chords out of stacks of intervals known as thirds (e.g. from C to E), including triads and their extension into seventh, ninth… (etc.) chords.

[39] Robert Simpson *Symphony No. 9*, Hyperion Records CD CDA66299, released 1988

[40] I.e. ensuring that the smooth (or otherwise!) transition of one chordal 'shape' to the next.

objects like the Milky Way and the Magellanic Clouds. I also recall with particular significance snorkelling at the Great Barrier Reef as a child and swimming right off the edge of the reef. The sudden perspective shift from shallow water to peering over the edge of a continental shelf imparted a sense of profound existential panic that I seek to revisit and to explore musically.

I have always been attracted to the idea of *microcosm*: that a single object might encompass a vast totality – Walter Benjamin described a similar feeling, I believe, when he delighted in finding a Jewish craftsman who engraved the entire *Shema Israel* prayer onto two grains of wheat (Benjamin 1970, p. 17). Again as children, my brother and I devoured books of Escher prints. As a ten year old I saw (in a museum in Stockholm) an antique clockwork model of Hell in which every single one of the wooden automata was individually animated in extraordinary and elaborate ways.

The names given to God in the mystical Jewish traditions – the *kabbalah* or 'received knowledge' – also take up the idea of approaching the divine through contemplation of the infinite. One of the kabbalistic names of God is *ein sof* (without end) or even *emek ha'ein* (the depths of nothingness/non-being). Part of the impetus for this Masters was a desire to compose a music that mirrored the unknowable complexities of the Divine (Scholem 1954).

In the first chapter of *Algorithmic Composition*, Nierhaus (2008) begins his historical discussion with a treatment of how the desire to account for the divine through the creation of 'machines for truth-making' laid the groundwork for both the development of clockwork automata and by extension modern computing. I was particularly struck by Nierhaus' description of the *Ars Magna* made by the religious mystic Ramon Llull (1232–1315). The *Ars Magna* was a kind of paper-computer that attempted to combine schemata of knowledge and language into a universal truth machine. Leibniz's quest for a 'universal calculus' (side benefits of which were the construction of one of the earliest mechanical calculators and the discovery of binary numbers) is contextualized by Nierhaus in a long tradition of philosophers, composers and engineers who, depending primarily on the capacity for the power of permutation to create millions upon millions of results from a small and manageable set of elements, hoped to capture some of the

secrets of the cosmos. Messiaen spoke admiringly of the 'disproportionate' creative power of permutation (Xenakis 1985, p. 31).

Creating musical settings fit to contain the 'Abyss of Incomprehensibility' has been a formal conundrum in my music for a long time. In the past, these regions were typically placed at the beginning or the end of works; a goal of this Masters was to realign every section of my music and every pre-compositional process into some relationship with the nadir (or perhaps the zenith!) posited by the music of the 'Abyss…' This set of conceptual relationships extends out in the impossible image of an 'Orrery of the Universe'.

2.2. Shortcomings identified in my pre-Masters practice: specific research questions

2.2.1. *The seeds of this research: lessons with Finnissy and Barrett in 2000[41]*

In December 2000, I spent a brief period in England and the Netherlands studying with composers Michael Finnissy and Richard Barrett. In preparation for writing this section, I recently looked over my notes from these lessons. I am struck now by just how much of the work in my Masters research was anticipated in these discussions.

Michael Finnissy (b. 1946) is a widely respected composer, teacher and concert pianist. After listening to and reviewing the scores of all of the music I had thus far composed, his main suggestion was that I should make the formal procedures underpinning my music less obvious. A metaphor he used was that of a story told from multiple (and even contradictory) perspectives: his opinion was that if pre-compositional musical structures are too obvious, then they will tend to become the main point of interest in a piece. He equated this to a prologue who tells the audience *everything* a plot will contain before the play even commences, leaving no gaps for the audience's expectations to inhabit.

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[41] The following section is based on personal notes made by the author in 2000.

Another observation Finnissy made was that, at any given point, about 20% of the surface activity in my music was inaudible. His follow up to this comment was, interestingly, that this "wasn't a problem" and should in fact become a conscious part of the expressive armoury of my music (see 2.1.3.6). In other words, by *controlling* the amount of 'incomprehensible' material in my music, I would have another mechanism for propelling form – a dialectic between clarity and obscurity. In my notes from that meeting I have pencilled in a diagram showing a percentage slider of 'comprehensibility': the exact same kind of percentage slider that would later be applied to almost all the developmental strategies in my Process.

Snyder (2000) makes the point that a certain amount of redundancy is actually an essential leavening in most modes of communication. Too much concentration of information means that there are very few opportunities to pause and parcel up new memories (what psychologists call 'chunking boundaries'). In other words, the lack of sufficient internal repetition works against the very nature of short-term memory formation (p. 211).

Richard Barrett (b. 1959) is a well known British composer of demanding avant garde instrumental and electro-acoustic music. His first observation about my work was that the thematic materials are only ever elaborated using polyphonic means – they are never developed *thematically* per se. One of his suggestions was to devise strategies to enable themes to evolve either towards, away from, or 'around' their original forms. I had consciously resisted this ever since I started composing using Hebrew text as a source: this was because of a self-imposed dogma which held that, since my pitch materials were derived from an immutable text, my thematic material itself also needed to be immutable. In hindsight, this was a clear instance of confusing the map for the terrain.

Barrett showed me a range of techniques that he used to translate language into rhythm[42]. As I recall his methods, he would carefully note the rhythmic weighting of syllables in recorded spoken versions of his texts. He would then set up a system to create rhythms that reflected, exaggerated, transformed or even inverted these speech rhythms. On reflection, this was the precursor for the most significant rhythmic procedure I

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[42] Barrett developed these systems when composing his opera *Unterwasser* (1997-98).

developed through this research: the 'Difficulty' algorithms (see 3.1.4, page 65). Rather than using *syllabic* structures to pre-pattern rhythm, I used the relative size of intervals (i.e. size of the gaps between notes) to generate primary rhythmic information (see section 3.2.4).

Barrett was also highly critical of the 'sameness' of the pieces I played him. He asked me why I felt the need to maintain similar levels of polyphonic density all the time. He observed that my treatment of ensembles was so democratic that "…perhaps if you wrote for the same instrumentation again, you'd write the same piece"[43]. He applied the same observation to my use of dynamics and articulation, and encouraged me to apply the same level of care to these parameters as I did with the speed (or 'rate') of themes. At this stage, the only 'laddered' (see section 3.1.2 for an explanation of 'laddering') process in my music was the control over the relative speed of themes. It was in some part due to Barret's encouragement that I went on to apply the concept of 'laddering' as a general organizational principle in my projects.

2.2.2. *Aesthetic Shortcomings:* 'A Music of the Incommunicable' *(Jan 04)*

> To say that something in the world is "organized" is really just a way of saying that
> it lies within the limits of the processing capabilities of the human nervous system
> (Snyder 2000, p. 31).

During the course of composing *Cannibal Pearce*, I maintained a file of ideas for incorporation into my next projects. The ideas in this 'post-*Pearce* ideas sheet' (see 2.2.3 below) are almost entirely *technical* ideas. As I contemplated undertaking my next projects within the context of a higher degree, I wrote a brief manifesto that attempted to explain these technical ideas within an overarching aesthetic, musico-philosophical framework. This document is called *A Music of the Incommunicable – Notes on the Next Piece*, which I completed in January 2004. Thus my goal in preparing the *Music of the Incommunicable* manifesto was an attempt to clarify (to myself, in the main) a number of ideas that I had

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[43] From my notebooks of the lessons, 19/12/00.

become drawn to as a means of both validating and extending the methods I had been using for close to a decade.

The document is modelled after a page of the Talmud, in itself a polyphonic text *par excellence*, consisting of a fragmentary source text called *mishna*, a central discussion of the *mishna* called *ge'mara*, and at least two side columns that contain commentary, explanation and interrogation of the *ge'mara*. These two columns are the primary talmudic commentaries of *Rashi* and the *ba'alei tose'fot*: *Rashi* is the explicator par excellence, whilst the *ba'alei tose'fot* elaborate on or call into question *Rashi's* readings. A host of other marginalia have clustered around these primary strands over more than a millennium and a half.

In *A Music of the Incommunicable,* the role of the *mishna* is taken by a quote from Proust[44], elaborated in quasi-talmudic style through a main text and two subsidiary glosses. One of the principal ideas in the document was that I wanted my post-*Pearce* music to be 'a music which can only be appreciated after ten or twenty hearings'. This is both a statement about the richness of the music itself, as well as recognition of the fact that the kind of music I write is much more likely to be disseminated through recordings than through frequent live performances.

Snyder (2000) points out that, from a psychological perspective, multiple-listenings create an *accretion* of mental schemas, which grow with each listening until the mental representation becomes closer and closer to the complete content of the actual recording. At this point we have effectively 'exhausted the piece' (p. 100). It is a commonplace that this saturation point is reached very quickly with banal popular music. Snyder also notes that live performances <u>cannot</u> operate this way: nuances of interpretation will always provide what he terms 'micro-surprises'.

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[44] '…if it fails, there is a lesson to be drawn from its impotence (whereas from the success of realism there is nothing to be learnt), the lesson that this essence is, in part, subjective and incommunicable…it would be my book, but with its help I would furnish them with the means of reading what lay within themselves'. (Proust trans. Moncrieff/Kilmartin/Enright, 1922/1992 *Time Regained*, p.242).

One of the targets of my manifesto *A Music of the Incommunicable* was the very conventionality of music as an art form. I adopted an extreme position, postulating that music bound by *any* conventions of 'sense making' is post facto a *conventional* music in a pejorative sense. My quasi-Dadaist position in January 2004 was that a music that made *no sense at all* – in other words, a music that made no attempt to communicate *anything* – would in fact be the ideal music to force listeners deep into their own subconscious in an attempt to impose meaning from the wellsprings of their own intellectual and emotional resources.[45]

In his article on the perception of atonal music Imberty (1993) notes that, more than melodic or thematic argument, atonal music is assimilated through what he calls 'the salience of events', and that these events are *only established through repeated listening*. He proposes that atonal music is driven by 'dynamic vectors' i.e. the tension between where the music *seems* to be headed and those features that remain the stable throughout a work. This neatly captures what had hitherto been an unconscious dynamic in my compositional thinking. The research I have undertaken in this Masters is a *conscious* amplification of this perceptual modality.

I also attempted in *A Music of the Incommunicable* to make a case for a music that (to some extent) contained everything (i.e. that any set of developmental possibilities suggested by the music would be somehow present in the work), arguing that this music would be irreducible and as such, beyond analysis – an 'orrery of the universe'. Such a music would, I hoped, be suggestive of possibilities beyond itself. This point lead to the only technical consideration in the manifesto – that all controlled phenomena be 'laddered' (see 3.1.2).

My initial research plans were centred on psychological research[46]. One of the many fruitful things I took away from this psychology-focused phase of my research was the

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[45] A sonic *Finnegan's Wake?*

[46] I conjectured that if I could control the development of my music finely enough, surely it would follow that I could then record people's reactions to that music to ascertain how the processes used in the music were perceived. The plan for this never-to-be-undertaken experiment was to generate a field of relationships that would reveal the 'event horizon' where thematic transformations cease to be recognizable as *variations*, and are instead perceived as completely different objects. This turned out to be

what Rowe (1987) defined in Design Thinking as a 'wicked problem' i.e. a problem with no clear definition, no hope of a definition and no 'stopping rule'.

A comment Charles Rosen made in respect of the famous British musicologist Donald Tovey neatly explains the incompatibility of this perceptual approach with my more universalist aesthetic goals:

> Tovey…denied the importance of thematic relations if the actual mechanism was not directly audible as an effect: that is, if one could not hear one theme being derived from the other step-by-step during the course of the piece. But a composer does not always want his developments, however carefully he may have worked them out, to take the form of a logical demonstration; he wants his intentions made audible, not his calculations (Rosen 1971, p. 38)

The abandonment of this research direction was predicated by a number of factors. My readings in music psychology and perception became frustrating as I found that the types of investigation being carried out in this field are so highly focused on minute perceptual questions, they are ultimately far removed from the all-encompassing quality of authentic musical experiences (Stevens et al 2002). Snyder (2000, p. xvii) notes critically that the vital animating effects of culture and context on how music works are perceived are 'carefully eliminated in many music psychology experiments'. In his concluding remarks, he notes that,

> …because of their idiosyncratic nature, freer forms of association are much harder to study in standardized scientific experiments. Indeed, very little research has been done on free associative structure in music, although it is clear that our long-term memory representation of music pieces of music have a considerable amount of it (p. 224).

McAdams (1987) arrives at a similar conclusion, noting:

> In spite of the fact that increasingly sophisticated methods of data analysis have made possible a clearer definition of the dimensions of artistic attributes, several aspects of artistic experience that are not specifically due to the nature of the art object, such as the influence of culture and personal associations, confound to a great extent any generalizations that one might make about aesthetic experience (McAdams 1987, p.6).

As early as 1942 Langer argued from philosophical principles that a scientific account of music would always be 'an essentially barren exercise.' Helmholz, the pioneering investigator of physics and music perception, circumscribed his discoveries by noting musical expression was 'by no means furnished by the natural formation or natural function of our ear' (Mc Adams ad loc). As I learned more about the psychological complexity of music perception, I became convinced that aesthetic and expressive

concept of the Wundt curve. (Miell et al 2005, p.63) Although I was not aware of this concept when I wrote *A Music of the Incommunicable* it is a useful means to understanding the aesthetic position I had adopted at that stage.
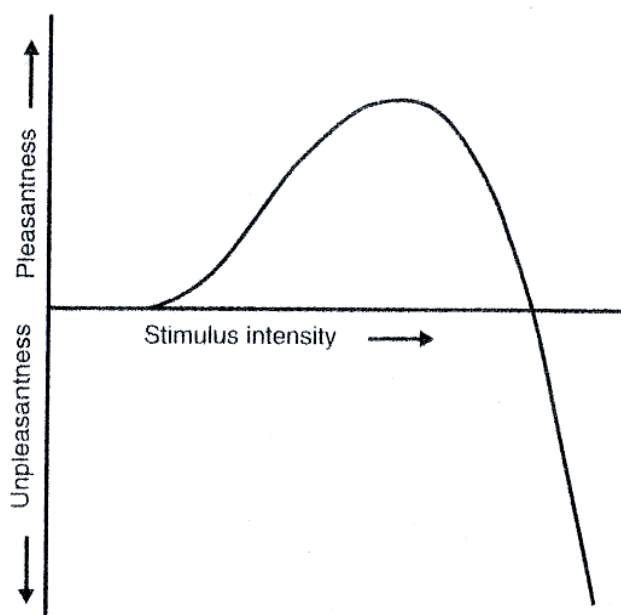
Figure 1 The Wundt Curve: riding the crest of 'unpleasantness'

The Wundt Curve (Figure 1) maps how, as a stimulus (for example, a piece of music) gets more complex, the listener (or viewer, reader etc.) finds that stimulus more and more interesting/pleasant. There is, however, a tipping point where something becomes *so* complex that it is no longer enjoyable – the line continues inexorably lower as increased complexity not only makes a piece less enjoyable: it becomes actively unpleasant. Thus, my initial aesthetic intention could be understood as an attempt to write a music that continually rode on the 'crest' of the Wundt Curve, operating at the point where the very complexity of the music constantly threatened to hurl itself into incoherence.

The criticism I made of 'successful' music (i.e. comprehensible in a traditional sense) in *A Music of the Incommunicable* was, in retrospect, spurred on by Finnissy's observation that

conclusions could not be reliably drawn from this mode of investigation. In *Antipodes of the Mind* Shanon (2002, p.35) notes that an exhaustive, multi-volume technical description of the piano would tell you very little about the music of Beethoven[46].

my music gave listeners "all the answers". I began to wonder if even the most inventive thematically-based music was nothing more than an elaborate game with which we flatter the audience by encouraging them to decipher and somehow 'solve' the music. This was at odds with my (still current) personal philosophical position that music does indeed have a genuine claim to deep psychological verity. In other words, that the powerful and transformative emotional states that most people ascribe to music are indeed 'real'. The quote from Proust (page 41) that commences and concludes *A Music of the Incommunicable* encapsulates this conviction.

These ideas are already far removed from the aesthetics of *Cannibal Pearce*, which is in many respects a highly repetitive work. The same seven basic themes are used (often without pitch variation) across the entire hour-long duration of the opera. My main technique for developing tension was increasing the density of polyphony, and my only technique for transforming themes was a primitive version of the 'Focal Depth' algorithm (see p.63), where certain pitches were deflected according to the results of dice throws. This restricted developmental vocabulary was a deliberate choice: a *Guignol-esque* Tasmanian convict-cannibal splatter-opera was not a sensible vehicle for profound musical introspection.

Finally, the unstated goad to much of *A Music of the Incommunicable* was the urge to protest against what I feel is the timidity of musical life in Australia (my conclusion at the end of 1.1.2). It could be argued that in order to occupy radical ground in Australian new music, it is enough simply to assert that there exists a new music left to be written.

2.2.3.   *Technical Shortcomings: The* 'Post-Pearce Ideas Sheet'

Nowadays any attempt to talk about music's "meanings" in other than technical terms is often deplored. Yet it seems to me self-evident that description that goes no further than musical facts can never be more than a trivial occupation (Mellers 1983, p. vii).

Competent technique is what mediocrity has in common with genius, so there is small point in getting enthusiastic about it (James 1990, p. 97).

The *Post-Pearce Ideas Sheet* I maintained whilst composing *Cannibal Pearce* has the following self-consciously idealistic sub-title: 'Radical Reinvention through Systems'. When I wrote those words I imagined I would be able to completely overhaul my practice as a composer simply through a careful redesigning and extension of the algorithms that create much of my material. Whilst much academic writing about composition (see the quotation from Mellers above) stresses technical aspects of writing music, it is the *aesthetic* concerns I discussed in the previous section that truly animate the Process.

During the course of writing *Cannibal Pearce* I was already becoming quite dissatisfied with the imprecise control I had over the rhythmic life of my music. The rhythmic material in *Cannibal Pearce* was derived from a long rhythmic reservoir (which I refer to as the work's Protorhythm: see section 3.1.1). Having patterned the *pitch* material of themes, I would assign those themes to different parts of the Protorhythm according to their relative rates (the Protorhythm itself evolves very gradually from slow to fast). Having decided what part of the Protorhythm was allocated to each theme, I would stich the notes into the rhythm in a largely instinctive way.[47]

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[47] See Downton's (2003) discussion of the 'immanent knowledge of the designer' (p.94)

Figure 2 An Example of *'Cannibal Pearce...'* Protorhythm Workings: my old method of marrying pitch and rhythm

> In Figure 2, we see an example from the working notes of my opera *Cannibal Pearce*. This page contains beats 34-39 of the *Pearce* Protorhythm. The musical stave contain the pitches of a themes for viola. Having partitioned off sections of the Protorhythm for interpretation, I selected which attacks would actually receive a pitch. The freehand sketch between the stave and the Protorhythm is the actual musical material that was used in the final score. This represents the best fit I could make between the 'musical' demands of the pitches and the available rhythm.

On the *Post-Pearce Ideas Sheet* I set myself the challenge of finding some way to control rhythm so that I could move between striated[48] and non-striated subdivision, as well as creating rhythms that were responsive to the intervallic structure of melody (i.e. where interval size would be related to duration). This was the origin of the idea of 'easy' and 'difficult' rhythm (see the discussion on 'gradient' in 3.2.4). I also felt that my slower music was less rich in rhythmic meaning than my fast music.

I also wanted to introduce more controls on melodic contour. Rather than defining the contour of themes in a way common to all instruments (i.e. the number of tones the melodic 'centre' passes through), I wanted to find some way to account for the fact that the impact of a melody's movement is bound up with the compass of a particular instrument (i.e. a melody moving through two octaves on the oboe has much more impact than the same motion on an instrument with much larger range, such as the piano: see Figure 21, page 79).

One annotation on the *Post-Pearce Ideas Sheet* reads: 'Every idea should be a stakeholder in the development of themes, i.e. a theme shouldn't just develop along a single trajectory. This was the first inkling of the 'simultaneous development' principle that necessitated my adoption of IRCAM's OpenMusic software. Having seen my composer colleague Newton Armstrong using Patchwork[49] in the mid 90s was also a key influence. I noted

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[48] Lit. marked with linear, parallel grooves or furrows. Rhythms that are, or that consist mainly of reiterated pulses, like a metronome.

[49] IRCAM's precursor to OpenMusic.

on the *Post-Pearce Ideas Sheet* that multiple systems could exercise a kind of multiple-body gravitational deformation on all of the themes in a section. Using the 'graph paper and pencil' algorithms of *Cannibal Pearce,* I could only really apply developmental strategies to themes one at a time.

I noted on the *Post-Pearce Ideas Sheet* that the kinds of algorithms I was proposing would necessitate collaboration with a programmer. I also suggested that that the Protorhythm should be subject to a 'hierarchy of what gets checked first': this is precisely the kind of search capability that my collaborator David Yee[50] programmed into the 'SourceR' program which I wrote in flowchart and he coded in APL.

A great deal of the eventual Masters Process is directly adumbrated in *Post-Pearce Ideas Sheet*. In the next chapter of this exegesis I will provide a detailed description of the complete Process I designed for composing my two Masters projects.

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[50] The author's father.

3. Account – from Process to Projects

Having thus far considered my compositional practice up to the point immediately before commencing this Masters, in this chapter I will discuss the fundamental concepts underpinning my Masters projects. This is followed by a detailed account of the Process that generated the two projects.

The first eighteen months of my Masters were spent:

- deciding what I wanted my new compositional techniques to actually *do*, from both aesthetical and technical perspectives
- learning how to program IRCAM's OpenMusic computer-assisted composition software
- developing a rhythmic search engine (called SourceR – see 3.1.4)
- testing and calibrating the new techniques available to me in OpenMusic and SourceR.

Many of these tasks (especially learning OpenMusic) were completely new challenges. The chapter on problem solving in *Design Thinking* (Rowe 1987) proved highly valuable: Rowe describes how to classify problems, the importance of defining problems comprehensively and includes numerous problem-solving strategies (e.g. you can write a description of a solution to a design problem before taking any steps towards that solution). Once I was satisfied with the operation of the new compositional algorithms, I then set about organizing the totality of these steps into a single straight-line Process, and using this Process to create my two projects: a Flute Solo and a Piano Trio

Chapter Three of this exegesis focuses almost entirely on explicating the Process: consideration and evaluation of the projects themselves is taken up in Chapter Four. The Process is an embodiment of Xenaxis' maxim that 'art has an imperious need of organization… a need for its experimental truth' (Xenakis 1985, p. 4).

3.1.   The fundamental concepts behind the Process

3.1.1.   The Protorhythm

All of the rhythmic material in the projects derives from the Protorhythm. The Protorhythm is a long (62 crotchets or 'beats', in music notation) object[51] containing a vast array of rhythmic possibilities.
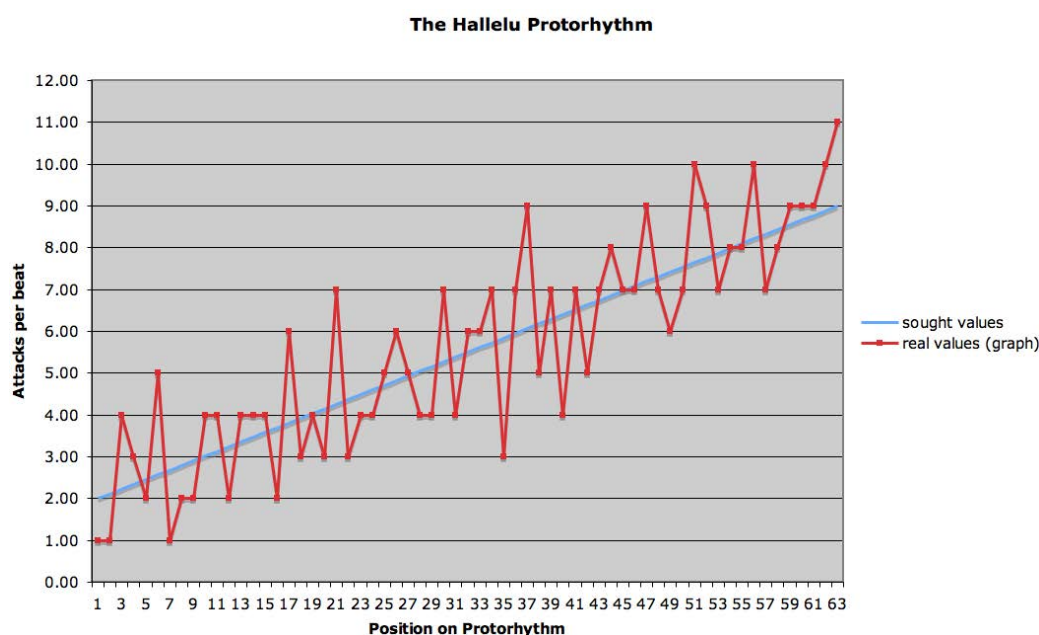
Figure 3 The Spread of Attacks per beat in the '*hallelu…*' Protorhythm: the source of all rhythmic material in the Projects

Figure 3 shows the Protorhythm's evolution from slow to fast, the x axis being position in musical beats and the y axis the number of attacks within that beat. The blue line 'sought values' was the target number of attacks, and the red line 'real values' shows the actual attacks I used. There is a great deal of deliberate 'fuzziness' in this acceleration, to create musical interest.

The Protorhythm is derived from the gematria (see 2.2.3.1) of the 148th Psalm text – the primal source for both projects. In order to create interesting interference patterns

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[51] The Protorhythm exists in both music notation and as an OpenMusic patch.

between sets of numbers, I used three 'streams' of number, all of which are compressions of the Psalms' raw[52] gematria. An example of this working is shown in Figure 4:
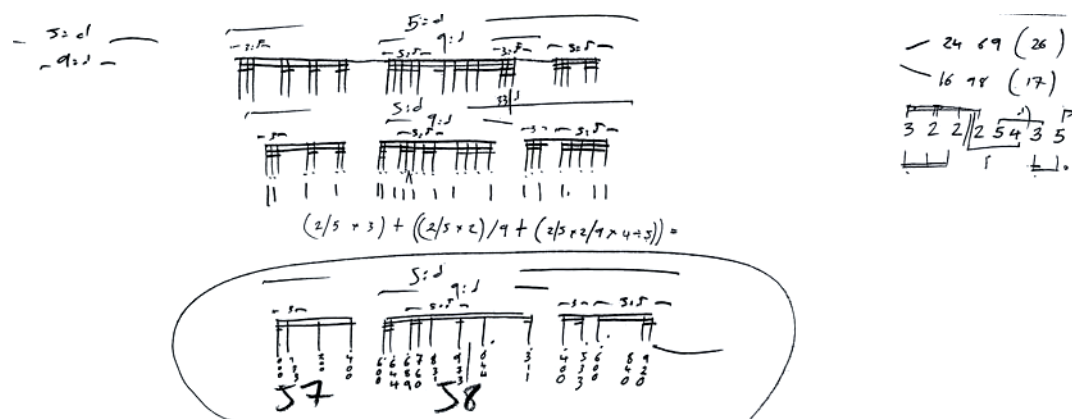
Figure 4: Example of how *gematria* (Hebrew numerology) is re-cast as musical rhythm from a fragment of the *'Hallelu…'* Protorhythm

The numerical marginalia in top right hand corner of this figure show the *gematria*-derived primary and secondary divisions of musical time, as well as the desired rate of attacks (see Figure 3). The bold numbered musical fragments (i.e. beat numbers 57 and 58), with their attacks noted in 1/1000ths of a beat[53], are the final product of these interactions.[54]

For every section of a work, the Protorhythm is freshly divided. In other words, once I have determined the total number of themes in a section, and their relative rates (attacks per beat), I allocate each of those themes to a different segment of the Protorhythm. Each theme's unique rhythm will be derived from that segment. The quantity of rhythmic material in a section generally means that each section typically contains a complete statement of the Protorhythm. This generates rhythmic cohesion between all the sections of the pieces, despite widely varying rates and tempos. The program I developed for locating 'best fit' onsets from the Protorhythm, SourceR, is discussed in section 3.2.1.

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[52] The range of the raw gematria is too broad to have immediate 'musical' usefulness; some Hebrew words have a single digit value whilst others have a value in the thousands.

[53] This assumes a standard of one beat per second.

[54] This example is taken from one of the final (and hence fastest) positions on the Protorhythm.

SourceR marries the 'ideal' rhythmic durations of a theme (expressed in milliseconds) to the 'best fit' durations found within any part of the Protorhythm.

The Protorhythm has another level of self-reference in that the three number streams derived from the *gematria* of the Psalm are repeated three times. With each repetition, however, a certain quantum of proportions is folded back on themselves, creating the possibility of nested irrationals[55].
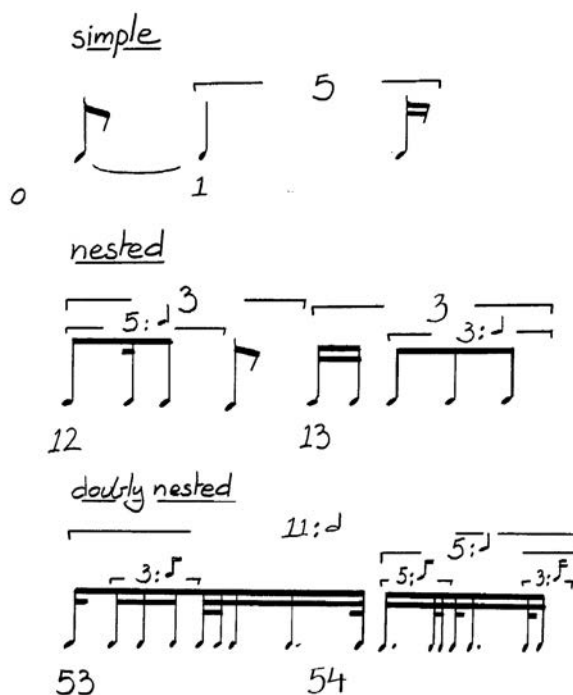
Figure 5 Simple, nested and doubly-nested 'irrationals' – three distinct levels of complexity in the *'Hallelu…'* Protorhythm

Figure 5 contains three examples from the Protorhythm, taken from each conceptual 'third' of the Protorhythm, beginning, middle and end. The first is a simple division, with no nestings allowed. The second example contains a single level of nesting, and the third contains doubly nested irrationals (i.e. the final triplet

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[55] Traditional music notation deals with rhythmic divisions in multiples of 2 or 3 i.e. a beat can easily be split up into 2, 3, 4, 6, 8… etc. smaller parts. Musical beats split into *other* kinds of sub-divisions (e.g. 5 or 7 smaller parts, being quintuplets and septuplets) are commonly referred to as *'irrationals'* (although this is, strictly speaking, mathematically suspect nomenclature). *Nesting* irrationals – where for example a quintuplet contains another quintuplet – creates enormous potential for very subtle and complex rhythms, in particular the non-iterative, non-striated rhythms that characterize the modernist aesthetic (see Smith Brindle 1966).

within a quintuplet, itself within an undecaplet). The large numbers underneath refer to their respective positions on the 63-beat long Protorhythm.

3.1.2. 'Laddering'

One of the defining features of my music since 1998 is the 'laddering' of the rates of themes within sections of the piece. Once I had decided what the fastest and slowest themes would be in any given section, I would create a 'ladder' of equidistant rates between these two extremes. These rates would then be assigned to each of the themes in the section. As a reference point, the slowest allowable music (typically averaging only one attack per second) was present in some form in every section.

When I first employed this technique, it was already my explicit intention to create a music that suggested a state of maximal possibility: in other words, if any kind of 'speed' could be present in a section, the listener would become conditioned to expect that the next type of material could be *anything*. The other effect of this principle was that sections of my music could no longer be simply categorized as fast or slow: instead, they occupied bands of probability, which imbued the music with an all-encompassing 'cosmological' quality. The closing section of my quintet *amar naval be'libo* is a good example of this, as well as being an example of an 'Abyss of Incomprehensibility' (see 2.1.3.6). As I will demonstrate, the core *technical* aim of the Process was to apply the principle of 'laddering' at as many points in the Process as possible.

3.1.3. *Tension levels, Archetypical Disposition and the* 'Hallelu *Mandala*'
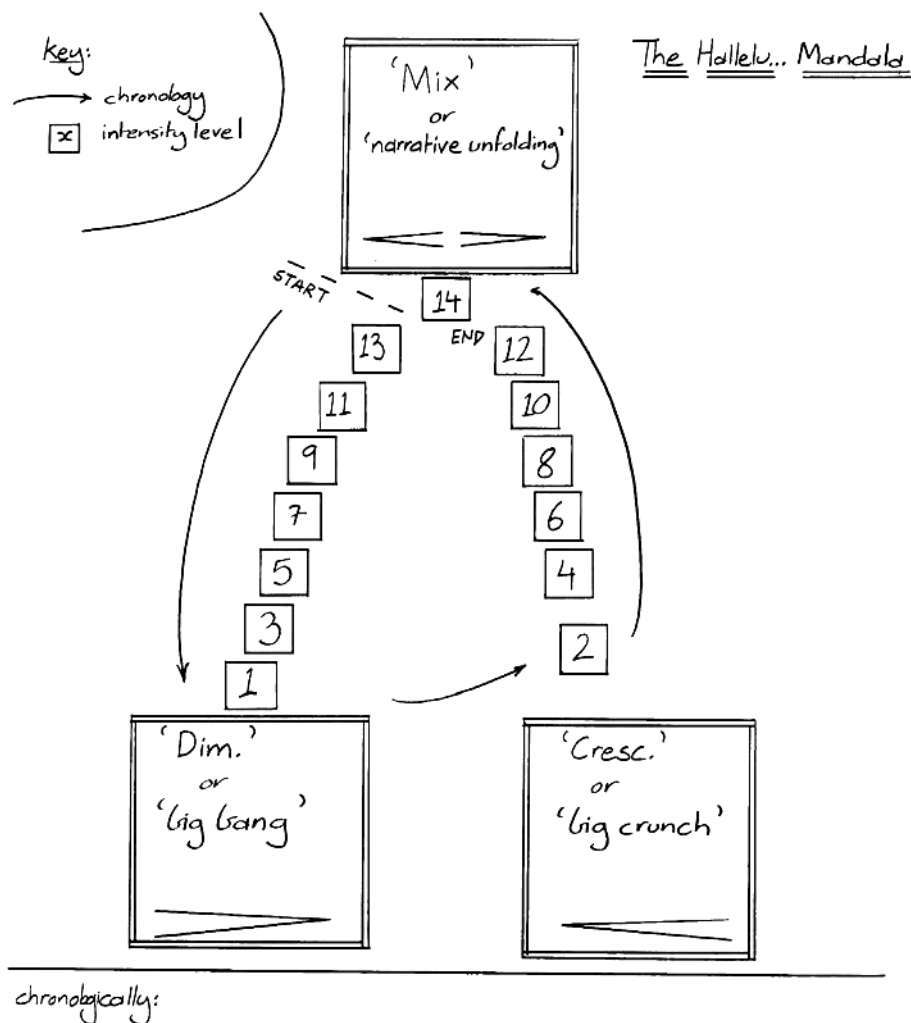
Most of the controlled, developmental phenomena described in the Process exist on continua of 'tension' and 'relaxation'. This is a well established dialectic in Western musical discourse – i.e. that music is driven by factors that either build or dissipate psychological tension. Notwithstanding my stated attempt to expand musical language with these projects, there is an inescapable psychological verity to certain musical effects that transcend stylistic considerations; e.g. a texture in which instruments become louder, faster, higher in pitch and more polyphonically dense will create more tension, regardless of whether that material is by Mozart or Ferneyhough. There are fourteen levels of

tension in the two projects[56] and these levels determine the global settings for most of the variables in the Process.

A number of the steps in the Process refer to an 'archetype'. I use this term in the sense of a primitive model or image. Archetypes describe the overall character or disposition of a section, and act to shape and direct a range of phenomena within that section. There are three archetypical dispositions used in the Process. The relationship between the three is depicted in Figure 6 The *Hallelu* Mandala.

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[56] The tension levels are assigned to 14 sections, being the 14 verses of the Psalm, according to the '*Hallelu* Mandala' (see page 55).

'Mix'
or
'narrative unfolding'

The Hallelu... Mandala

START

END

14
13   12
11   10
9   8
7   6
5   4
3   2
1

'Dim.'
or
'big bang'

'Cresc.'
or
'big crunch'

chronologically:

sections: alef bet gimel dalet heh vav zayin Het tet youd youd alef youd bet youd gimel youd dalet
א ‎ב ‎ג ‎ד ‎ה ‎ו ‎ז ‎ח ‎ט ‎ ' א' ‎ב' ‎ג' ‎ד'

| intensity levels: | 13 | 11 | 9 | 7 | 5 | 3 | 1 | 2 | 4 | 6 | 8 | 10 | 12 | 14 |

START > <   'Dim.' 'Cresc.' <> 'Mix' END

Figure 6 The *Hallelu* Mandala – showing the ideational and chronological relationships between the Archetypical Dispositions

The boxed numbers in Figure 6 refer to the 14 tension levels in the pieces (assigned to each of the sections, and common to both of the projects). The outer arrows show the *chronological* evolution from one archetypical state to the next. Archetypes govern the deployment of texture (3.2.2), rate (3.2.4), tessitura (3.2.4) and transformation (3.2.5). More importantly, they *yoke together* all of these disparate

steps to give each section its expressive teleology[57]. This formal progression across the 14 sections of the projects is expressed in the '*Hallelu* Mandala'. A simpler chronological presentation is given at the bottom of Figure 6, which also gives the Hebrew names[58] of each of the sections.

The three archetypes in the Mandala are:

1) 'Dim.' (or 'Big Bang'[59])
The 'Dim.' Archetype is the state in which the controlled phenomena are arranged entirely in the order: [most tense→least tense]. The name 'Dim.' (a common music-printing abbreviation) derives from the Italian musical term *diminuendo* (=getting softer). The state of slowing/getting softer/dissipating tension.

2) 'Cresc.' (or 'Big Crunch')
From *crescendo*, 'getting louder' in Italian: The state of speeding up/getting louder/increasing tension.

3) 'Mix' (or 'Narrative Unfolding')
The 'Mix' archetype is a random, smooth and patternless[60] distribution of phenomena across the section. Given that one of the aesthetic aims of this Masters is the creation of states of maximal possibility, the 'Mix' state represents an kind of expressive ideal and is privileged as the formal terminus of both projects (See the discussion on form in 2.1.3.6).

The '*Hallelu* mandala' (Figure 6) describes the interrelationship of the fourteen 'tension levels' against the three 'archetype' states: together, these factors give individual sections their defining cast. The chronological order of the tension levels leads from a state of near maximum tension, to a central fulcrum of maximum repose, and concludes with the state of actual maximum tension. This is what I refer to later as the 'bow-tie' structure (see 3.2.1.1). This is an analogue of the Psalm text, which begins in the heavens, descends

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[57] What Dench calls 'formal architectonics'.

[58] =verses from Psalm 148.

[59] Yet another idea of Dench's. I once heard Dench describe his early orchestral work *Afterimages* as being an exploration of what he called 'cosmological forms'.

[60] Not strictly *patternless* – more 'without any discernable tendency'.

to the depths (through a series of natural forces) and then returns to the heavenly realm (through a processional 'dumbshow' of various human agencies).

The archetypes follow a divergent yet complementary teleology: the first seven sections move from near total 'Mix' to the pure 'Dim.' archetype; the final seven from pure 'Cresc.' to the total 'Mix' state. This bluntness of this strategy is deliberately masked, however, because the tension levels in the central sections 6, 7, 8 and 9 are so low that developmental processes have scarcely any possibility for expression. Ironically, some of the most (structurally) brutal music occurs in the quietest, most gentle sections.

3.1.4.   *What have computers contributed to the Process?*

> The opinion is, alas, very widespread that Xenakis' music is composed by computers… When we look more carefully we can see that this obviously has no meaning. In *Formalized Music* we can find an admirable formula: 'In this domain we find that computers render certain services' (examiner Olivier Revault D'Allonnes quoted in Xenakis 1985, p.16).

The preceding quotation, a statement taken from one of Xenakis' doctoral examiners, alludes to both the possibilities and limitations in using computers as a compositional tool. I have been using computers in my pre-compositional planning for many years now, but until undertaking this Masters my use of computers was limited to simply managing repetitive arithmetic (usually in Excel spreadsheets). Examples include generating large spreads of rates, calculating the length of themes (given the combination of speeds and lengths), or dividing up the Protorhythm into equidistant regions. Once these large arrays had been generated, I would use them as look-up tables to compose from. Even at this nascent stage, overarching expressive goals[61] drove the use of mathematics: Xenakis (1985, p. 6) himself described mathematics as 'a springboard towards self-revelation'.

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[61] There is also an element of analysis-via-synthesis in this methodology: If I could get algorithms to generate notation that resembled my 'busked' (i.e. non-systematized) composition, I would be granted both a deeper understanding of my practice, as well as the tools to extend that practice.

Thematic development was carried out using very time-consuming pencil-and-paper algorithms. In *Cannibal Pearce* the development of themes was effected using simple versions of the 'tessitura' (see 3.2.3) and 'rate' algorithms (see 3.2.4). In some sections I began using a primitive 'focal field/depth' technique (see 3.2.5) by rolling dice against each note and using the resulting numbers to determine how far a note would stray from its original position.

As a result of my Masters research, I have now developed a sophisticated environment in OpenMusic for implementing many key stages of composition, and have developed from scratch a rhythmic search tool: SourceR. I had been bothered for a long time by what I considered a fundamental imbalance in the way I was able to manipulate musical material. Whilst any given *pitch* could be purposefully shifted around the totality of musical 'space', there is no such freedom with rhythm within the framework of traditional music notation. In order for rhythms to be readily performable, the attack points[62] need to sit within the limited 'grammar' of musical notation. Traditional music notation pre-supposes a system of grouping in that beats typically subdivide into groupings of 2 or 3 (called 'simple' and 'compound' time respectively).

Modernist composers sought to break down the hegemony of these two divisors (and by extension the audible presence of a fixed beat) by using alternative, smaller prime divisions of the beat e.g. into 5 or 7 (quintuplets and septuplets). Such divisions are often referred to by musicians as 'irrational'[63] rhythms. One path taken by many composers[64] is the extensive use of multiply subdivided beats (see Figure 5).

What I aimed to achieve with SourceR was to develop a program that would take a given 'ideal' set of attacks (expressed in milliseconds) and would search through a large set of rhythmic possibilities until it found a 'best fit' rhythm *that could be easily expressed in traditional music notation*. Because there would always be better alignments at the faster, more complex end of the Protorhythm (where there are so many more attacks), there

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[62] The places within the musical beat where notes commence.

[63] See page 52.

[64] …and particularly by those composers associated with the 'New Complexity'; e.g. Finnissy, Barrett, Dench, Ferneyhough.

had to be a mechanism to constrain the search to various parts of the Protorhythm. In practice, this meant deriving slow themes from the early parts of the Protorhythm and fast themes from the later parts, and an allowance for overlap when the total amount of required materials[65] exceeded the actual length of the Protorhythm.

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[65] This was, more often than not, the case. Thus, the more amount of thematic material in a section, the more rhythmic repetition and cross-reference would occur. This creates a kind of governor mechanism on cognitive overload for both performer and listener.
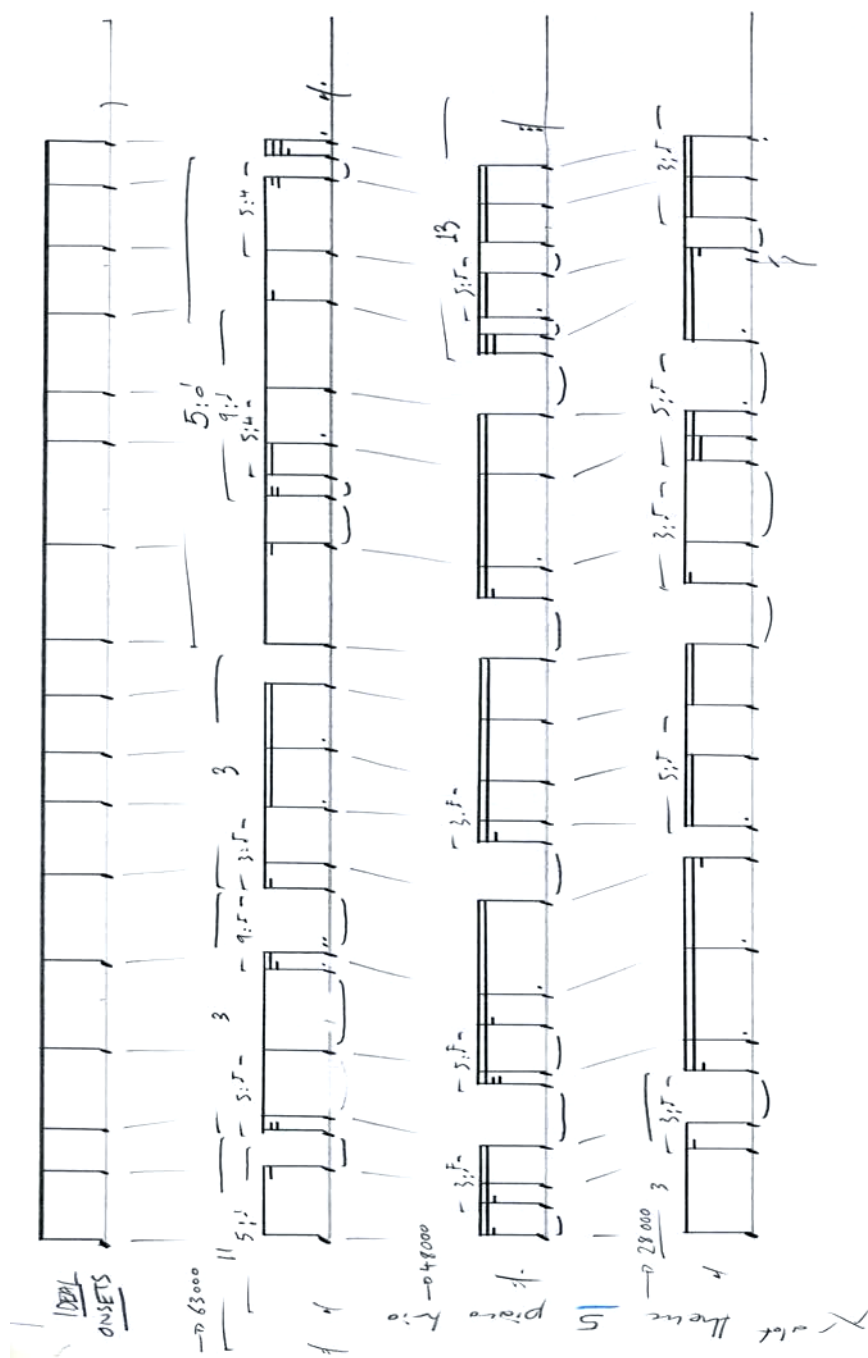
Figure 7 Three Rhythms generated by SourceR, each forming closer approximations of an ideal set of rhythmic onsets

In Figure 7, I show a strictly proportionately-notated example of three rhythms derived from SourceR. In each case, a different (i.e. faster, more detailed /complex) region of the Protorhythm was searched to find the best fit. The examples show how the rhythms become progressively closer to the 'ideal' proportion set (top line).

During the course of this research I have re-thought and extended most of my pre-Masters 'paper and pencil' algorithms within IRCAM's computer-assisted composition software OpenMusic. OpenMusic is a visual programming environment for computer-assisted composition. The most important use of OpenMusic is a 'patch' I have created that allows me to deploy up to six transformational algorithms simultaneously across any number of themes (see 3.1.4, Figure 27).

I have also created annotated workspaces that prompt, implement and link many of the stages of the compositional Process when coupled with a parallel Excel spreadsheet for raw 'number crunching'. Xenakis (1985), in discussing permutations, remarked that the vast quantity of choices thrown up by computer-generated algorithms itself requires a 'machine' to achieve meaningful arguments: my work with Open Music represents a personal attempt to craft such a machine.

Purposeful, fine control of thematic development was something that I felt was lacking from the music I was writing before undertaking this Masters. The ability to deploy multiple tranformative strategies, each with independent developmental trajectories, would have been a practical impossibility using my old methods. To use a visual analogy: controlling so many aspects of thematic development is akin to digitally animating an object that is changing shape, colour, speed and direction whilst moving freely through three-dimensional space.

Each of the six transformational algorithms accepts a 0%-100% input. Each algorithm has a 'default' setting, which is the point of maximum 'relaxation' or non-development. The first three algorithms ('Focal Field', 'Focal Depth' and 'Scalic Reordering') are concerned with manipulating pitch. The final three ('Segmentation', 'Gradient' and 'Accel./Rall.') generate and transform the rhythms which were themselves derived from the pitch materials.

The six algorithms are:

1) 'Focal Field'

'Focal Field' defines the percentage of the notes in a theme that are allowed to drift away from their source positions. This algorithm randomly selects that percentage of pitches for treatment. The default setting for this algorithm is 0% (non-development).

NB Wherever possible, I have used the same theme in each of the figures that follow: it is the 'masthead' theme of both projects, derived from the title text *hallelu et hasheim min hashamayim* (Ps. 148:1).

Figure 8 (0, 25, 50, 75, 100)% 'Focal Field': increasing the *numbers* of notes straying from their original positions

> Figure 8 shows five stages of a theme's development from a 0% to 100% 'Focal Field'. For this example, the 'Focal Depth' has been set to 100% (i.e. so that any note may drift from its original position as much as a tritone up or down – see next paragraph).

2) 'Focal Depth'

Given that a certain percentage of notes may be allowed to drift in pitch, 'Focal Depth' determines exactly how far those notes will be allowed to drift. At a setting of 100%, notes may drift as far as a tritone. In musical terms, this is the bisection of an octave: at this range, a note is given enough room to drift so that it could potentially become any other note). The exact size of the deviation is determined randomly. The default setting for this algorithm is 0% (non-development).

Figure 9 (0, 25, 50, 75, 100)% 'Focal Depth': increasing the *distance* that notes stray from their original positions

Figure 9 shows five stages of a theme's development from a 0% to 100% 'Focal Depth'. For this example, 'Focal Field' is set to 50% (i.e. half the notes are subject to 'defocusing').

3) 'Scalic Reordering'

'Scalic Reordering' rearranges any percentage of notes into a purely *ascending* or *descending* order. As with 'Focal Field', the notes to be treated are selected randomly at each calculation. Notes that fall outside of this selection are unaltered. The default is setting for this algorithm is 50%, at which point the original theme is passed on with no reordering. At 0% all notes are arranged into descending order and at 100% all notes are put into ascending order.

Figure 10 (0, 25, 50, 75, 100)% 'Scalic Reordering': gradually rearranging pitches into ascending or descending order

Figure 10 shows five stages of a theme's development from 0% to 100% 'Scalic Reordering', the outer limits the completely descending and completely ascending forms.

4) 'Segmentation'

'Segmentation' determines how many different durations – how many discrete types of note length - will be used to create the theme's rhythm. For example, if there were only one duration, the theme would have no rhythmic variety – it would be metronomic. Indeed, in order to avoid completely the possibility of iterative rhythms, the *minimum* number of durations is set at two (being the 0% setting). The default is 100%, at which point every note in the theme has its own unique duration: another instance of the 'maximal variety' aesthetic ideal. Iterative rhythms are much less common in my music than 'smooth' non-striated rhythms, and are rhythms that I generally avoid. They are being emblematic of popular and reactionary postmodern composition (see 1.1.2, and footnote 69).

Figure 11 (0 25 50 75 100)% 'Segmentation': controlling variety of durations within a theme

In Figure 11 (a screen shot of five 'ideal' rhythms generated in OpenMusic) we see five versions of the same theme with progressively finer segmentation i.e. greater internal rhythmic variety.

5) 'Gradient'
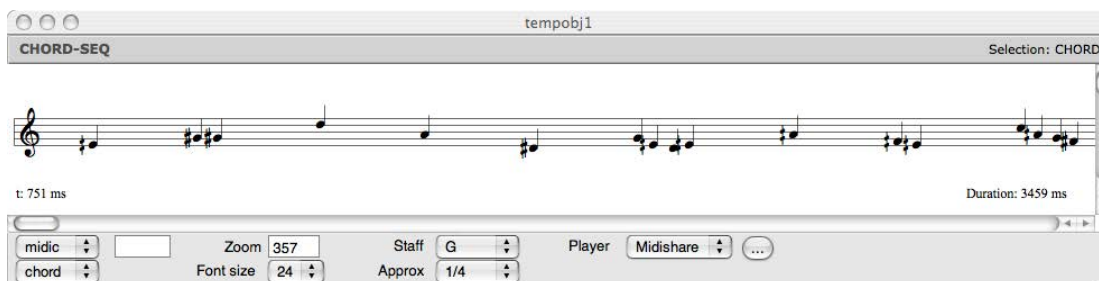
Figure 12 An 'Easy' Rhythm: where interval size is *directly* proportionate to note length

There are two aspects to the 'Gradient' algorithm yoked together in a single continuum. Firstly, 'Gradient' determines the relative gap between the shortest and longest types of duration. Secondly, 'Gradient' arranges these distributions into one of two archetypical states. I call this the 'difficulty' of rhythms: 'easy' rhythms are those where small intervals are played quickly and large intervals ('leaps') are played slowly (see Figure 12). 'Difficult'

rhythms are a direct inversion of 'easy' rhythms – larger leaps are very rapid, and smaller, stepwise intervals are slow. This is a fundamental axiom of instrumental performance[66].
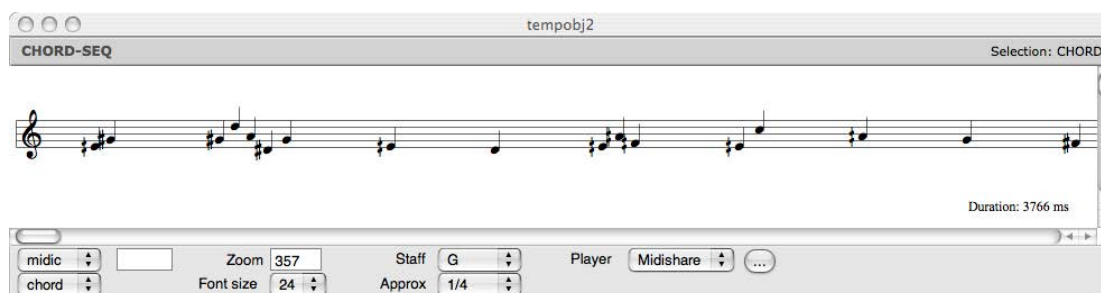
Figure 13 A 'Difficult' Rhythm:

where interval size is *inversely* proportionate to note length

Figure 13 is an example of 'difficult' rhythm. Because of the inherent awkwardness of the 'difficult' rhythms, the default setting for this algorithm is 0%, maximum easiness. From 0%-50%, the rhythms are all 'easy'. From 51%-100% they are all 'difficult'. What distinguishes the rhythms that occupy the *centre* of the range is the contrast between the types of duration. As the values near 50%, the difference between the durations making up the rhythms lessens: the central part of the range (25-75)% is characterized by greater rhythmic uniformity.

At the extremes of the range (0% and 100%), the shortest value is set to what I call the 'vanishing point' duration. The 'vanishing point' duration is the shortest (and therefore the fastest) duration I allow in my music, which I have set at 1/17th of a second[67]. The other durations are then 'laddered' to the longest possible duration, within the boundary of the theme's total length. This length is the theme's rate of notes/second, multiplied by the number of notes in the theme.

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[66] Larger intervals require more demanding physical procedures on the part of the performer i.e. string players need to leap over the fingerboard, pianists need to shift hand positions across the keyboard, and brass and wind players have to significantly alter the disposition of their mouths (embouchure) as well as their fingers.

[67] Seventeen attacks per second has the potential to coalesce into an actual pitch (Snyder 2000) – the lowest A on the piano is about 27 Hz.

**Figure 14 (0 14 29 43 57 71 86 100)% 'Gradient' Rhythms: controlling the contrast
between fast and slow durations**

Figure 14 shows how the rhythm of a theme evolves over the full range of the
'Gradient' algorithm. In order to show the role of 'Gradient' as clearly as possible,
the 'Segmentation' was set at 0% (minimum variety of note length types).

6) 'Accel./Rall.'

The 'Accel./Rall.' algorithm is the rhythmic equivalent of 'Scalic Reordering', which
rearranges the whole (or parts) of themes into ascending or descending scale order. Once
the 'Segmentation' and 'Gradient' algorithms have determined the essential components
of the rhythm, 'Accel./Rall.' rearranges any percentage of these durations by their length.
At 0%, the durations are all arranged into 'short→long' order. The musical term for this
state of deceleration is 'rallentando' (abbreviated to 'Rall.'). At 100% the durations are all
in 'long→short' accelerating order ('Accelerando' or 'Accel.' in Italian). The default for
this algorithm is 50%, the point at which this algorithm passes on (without alteration) the
durations generated by 'Segmentation' and 'Gradient'.
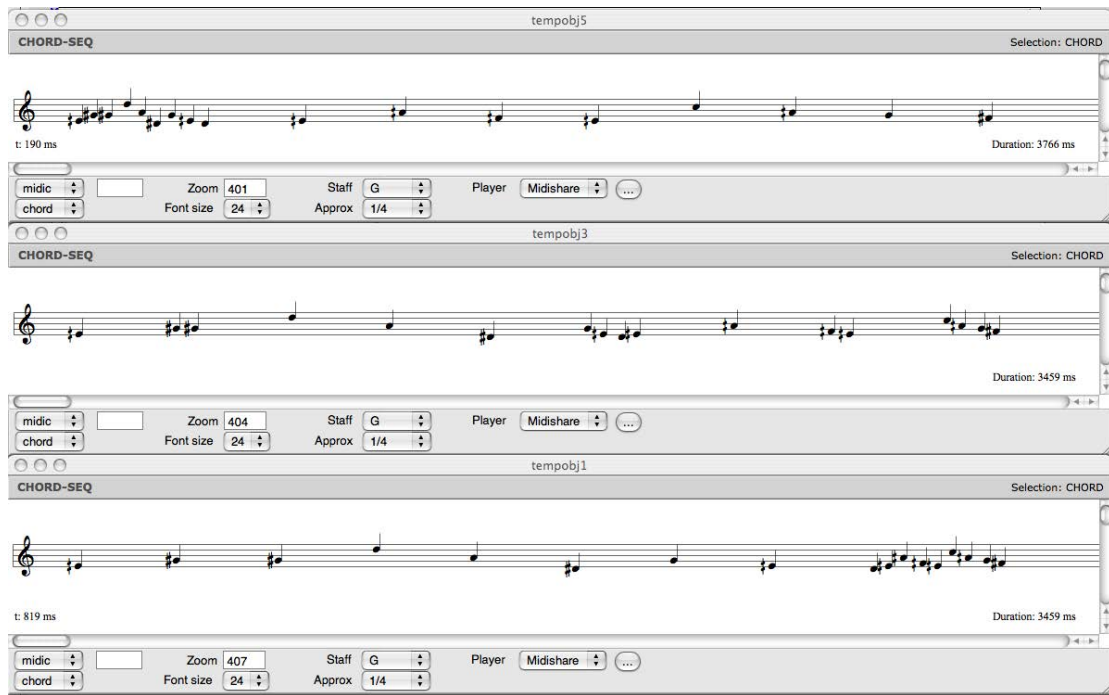
Figure 15 (0 50 100)% Accel./Rall: showing decelerating, unaltered and accelerating forms

In Figure 15 we see three versions of a theme from across the full range of the Accel./Rall. Algorithm: complete deceleration to complete acceleration of all available durations.

The development of SourceR and the transformational algorithms represent the most significant *new* aspects of my compositional practice; they have certainly been the most time consuming aspect of this research. Although my music is significantly enriched by these new approaches, the central aesthetic concerns, described in 2.1.3, have remained more or less constant in the two Masters projects. In the remainder of Chapter Three, I will turn my attention to the *integration* of these new methods, as embodied in the 22 step Process.

3.2.   The 22 steps of the Process

The physical form of the Process is a fifty page display book filled with diagrams, instructions, printouts from Excel spreadsheets and graphs. It is a manual for writing

musical compositions, and in turn generates a complete set of working notes that pertain to each of the projects.

For the purposes of this exposition, I will discuss the 22 step Process in the following eight sections:

- Framing Conditions (3.2.1)
- Texture (3.2.2)
- Tessitura (3.2.3)
- Rate (3.2.4)
- Thematic Transformation (3.2.5)
- Creating the Sketch (3.2.6)
- Harmony (3.2.7)
- Editing for Performance (3.2.8).

3.2.1. *Framing conditions*

A: Barring/Tempo/Duration
B: Themes/Subthemes

Before the Process is initiated, a number of key components are already accounted for. The raw pitch materials have been generated (see p.28) and the Protorhythm has been composed.

3.2.1.1. *A: Barring[68]/Tempo/Duration*

Although bars have a clear syntactical function in traditional music (e.g. the ubiquitous 4 beats of rock music, the 3 beats of waltz time), two factors combine to *obscure* the perception of bars in my music: namely, the generally very slow tempos, together with the complexity of the surface rhythmic structure. My music purposefully avoids a clear

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[68] 'Barring' refers to the division of music-notational space (via long vertical lines) into short separate sections ('bars'), typically between 2 and 6 beats long.

delineation of *any* kind of beat, let alone anything that could generate repetitive metre[69]. Howeverm barring is still a useful way of keeping track of the placement of material in a section (see N Graph Allocation, p.91) and as a rehearsal aid[70].

In keeping with the overarching principle that everything must ultimately derive from the Psalm text, I use the number of letters in each word to determine the barring of each section. For example, the first six words of the first verse *'halleluyah, hallelu et Hasheim min hashamayim'* generate (from their Hebrew letters) the first six bars (6, 4, 2, 4, 2, 5 beats respectively) of the Piano Trio.

Thus in the Piano Trio, the total number of bars in each section is determined by the respective quanta of letters in each verse of the Psalm text. This generates a basic 'on paper' duration for every one of the 14 sections. Against this distribution, I applied the 'laddering' design principle. Earlier in my discussion of musical form (see 2.1.3.4), I explained how a purposeful formal teleology is an important aspect of my music. The main formal trajectory of the Masters projects was a journey from near maximal tension to maximal relation and then back to actual maximum tension – the 'bow-tie' form (See 3.1.3 for an explanation of how the 'bow-tie' is derived from the psychodrama of the Hebrew text).

The 'bow-tie' form is paralleled in the distribution of different musical tempos[71] following a 'fast→slow→fast' scheme. From analysis of previous works, I derived a range of metronome settings that complemented my rhythmic language – at this stage of the composition Process I lined up the 'on paper' lengths of sections against this range of ideal metronome markings, multiplying them together to create a 'raw' set of durations for each section.
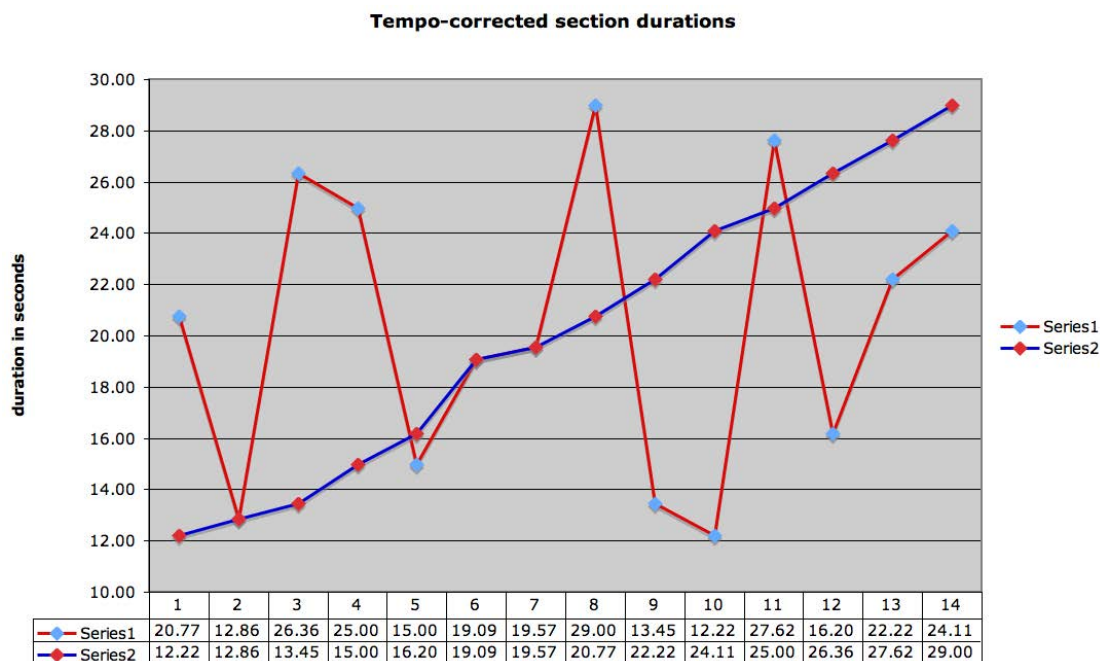
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[69] Interestingly, Stockhausen once described regular metres as being 'fascist', as he closely associated this type of musical expression with the marches he heard as a young man in Germany in the 40s (Griffiths 1981).

[70] Bars are numbered in musical scores for precisely this reason.

[71] Being the actual *musical beats per minute*, specified by a metronome marking.

This set of section durations was very close to the ideal of 'laddering'. In order to make section duration a truly 'laddered' set, I made minute corrections to the tempo markings for each section.

Tempo-corrected section durations

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Series1	20.77	12.86	26.36	25.00	15.00	19.09	19.57	29.00	13.45	12.22	27.62	16.20	22.22	24.11
Series2	12.22	12.86	13.45	15.00	16.20	19.09	19.57	20.77	22.22	24.11	25.00	26.36	27.62	29.00

Figure 16 Tempo-Corrected section durations in the Piano Trio: the 'ladder' of section lengths against their chronological order

In Figure 16, Series1 shows the chronological order of the duration of each section of the Piano Trio. Series2 shows these durations arranged into ascending order – their 'ladder'. The proximity to a truly even 'ladder' of durations is as close as the whole-number values of musical bars and metronome settings will allow.

The Piano Trio was written for performers who are not specialists in contemporary music, so the rhythmic surface is much simpler than that of the Flute Solo. In order to invest this simpler rhythmic material of the Piano Trio with the same degree of nuance as the Flute Solo, the Trio operates at much faster tempos. My music of the last fifteen years or so has typically operated at very *slow* tempos, coupled with highly active and complexly notated rhythms. This has proven successful with specialist players performing under a conductor. A Piano Trio performs unconducted as a matter of well

nigh unassailable convention[72], so I chose to write at much faster tempos that would sound as active and detailed as my usual music, despite being made up of simpler-looking rhythms. The Piano Trio's rhythms were all derived from the 'slower' first two-thirds of the Protorhythm, avoiding most of the notoriously difficult nested rationals (see Figure 5).

I took a very different approach to tempo in the Flute Solo. Because it is an unaccompanied work, and having worked with the dedicatee Elizabeth Barcan on many previous occasions, I knew I could write a piece where the level of rhythmic detail was extremely precise. To this end, the Flute Solo uses the entire gamut of the Protorhythm. Barring is not specified in the Flute Solo: it is written out as a continuous stream of melody. This reflects the specific purpose of that work: it is in fact a compositional study of sorts, concerned purely with the *melodic* aspects of my Masters research, and without any consideration of harmony or polyphony. Given that the most novel aspects of my practice – SourceR and the transformational algorithms – operate purely on melody, I wanted to compose a work in which these aspects could speak with unfettered clarity.

Once the duration of each section has been established, the next step is to populate each section with thematic material.

3.2.1.2.   B: Themes/Subthemes

The amount of thematic material assigned to each section is also a 'laddered' process. The basic amount of thematic material (what I refer to as the 'top level') corresponds to the number of clauses in the Hebrew text of the verse. The prosody of Biblical Hebrew dictates that there are typically (and never less than) two clauses per verse, sometimes three and occasionally four.

Depending on the local intensity level, a section may have between one and four levels of themes and subthemes (see Figure 18). These levels correspond to the number of active instruments in the section. In the monophonic Flute Solo, these levels are implied by

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[72] Probably because the intimacy and organicism of chamber music would be stifled by corralling three players into a uniform conducted beat.

virtual instruments that are defined by their passage through different parts of the flute's large compass. In my working notes, I designated these levels after a quintet of 'virtual' instruments (from high to low: flute, violin, clarinet, viola, cello) compressed into the flute's range. This was a way of differentiating those levels in my mind; it was also a way of imposing 'exotic' (=non flute-like) instrumental characteristics on this material at the final editing stage.

Loci of the flute's 'virtual' quintet
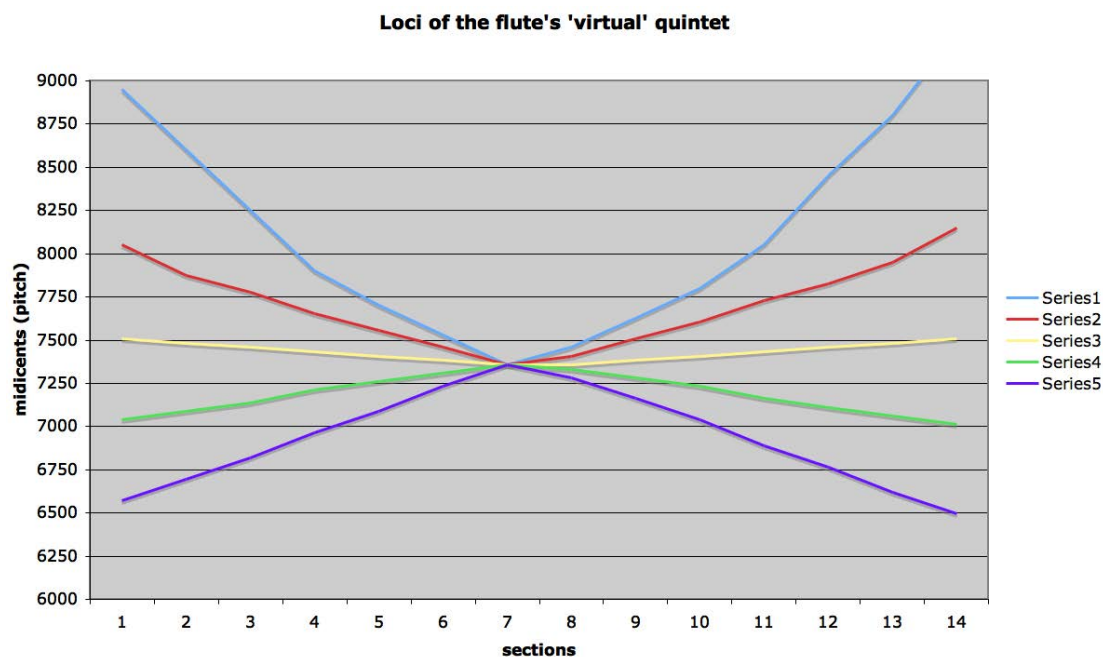
Figure 17 The 'bow tie' loci of the flute's 'virtual' quintet: the fusing together and teasing apart of the pitch-identity of melodic strands

> In Figure 17 we see the movement of the five 'virtual' instruments (series 1-5) across the course of the Flute Solo. These loci represent the central pitch point around which each strand of material is patterned. The pitch loci are spread apart as far as possible at the maximum tension level (section 14); the five loci converge completely at tension level 1 (section 7) so that the differentiation into these different 'instruments' is completely dissolved at the centre of the 'bow tie' structure.

The amount of material is 'laddered' according to the prevailing tension level. In the most calm section, there is a simple statement of just two themes with no repetition or elaboration. In the final (and most active section) of the Flute Solo, the four clauses are expanded out to 32 separate themes argued over four textural levels.

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In Figure 18, we see (in the far right columns) schematics for the themes and subthemes of both projects. This clearly shows the relationship between the tension level and amount of material in a section. The Piano Trio is much more economical in its use of material because it is a shorter work, and because (unlike the Flute Solo) it is not made up solely of melodic material. Note the hierarchy of themes, representing in three colours the levels of *hauptstimme*, *mittlererstimme* and *nebenstimme* (Ger: principal, middle and subsidiary voices). [73]

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[73] These terms are derived from Schoenberg.

THEMES → SUBTHEMES CHART

H
H(1+2)
N

PIANO TRIO (∅)

section	intensity level	no. of themes (clusters) → no. subthms	themes + no. subthms	PIANO TRIO (∅) schematic / no. levels
א olef (1)	13	3	11	4
ב	11	2	7	4
ג	9	2	6	3
ד	7	2	5	3
ה	5	2	4	2
ו	3	2	3	2
ז	1	2 [×1..]=	2	1
ח	2	2	2	1
ט	4	2	3	2
י	6	2	4	3
יא	8	2	5	3
יב	10	2	6	4
יג	12	3	11	4
יד yod dalet (14)	14	4 [...×4] = 16 / 85		4

Figure 18 The *Themes/Subthemes* chart for the Flute Solo and Piano Trio: the repetition of themes and their assignment to different hierarchical levels

3.2.2.   *Texture[74]*
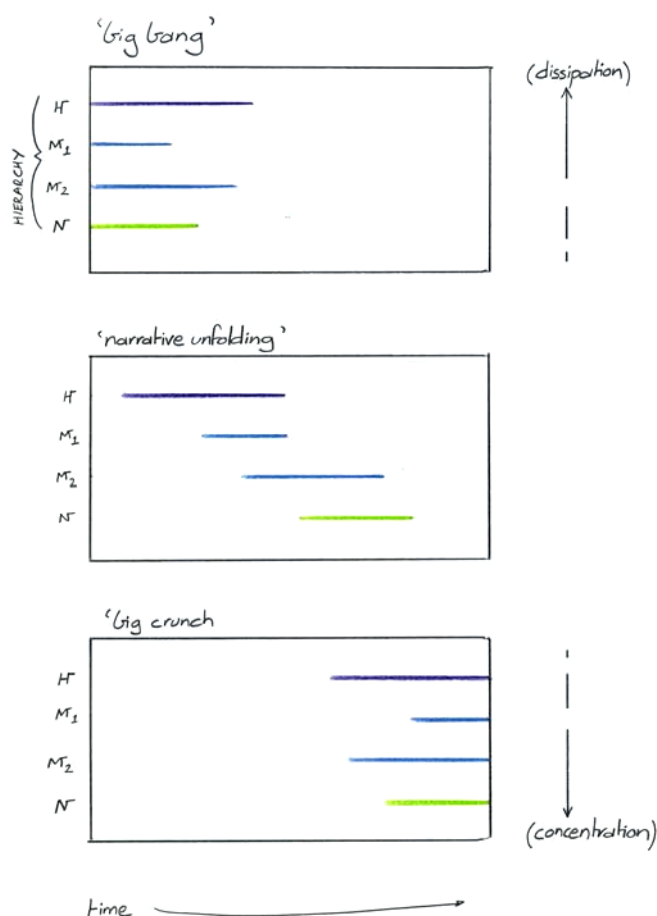

C: Texture: Archetype

D Texture: Orchestration

Having determined the number of themes at step B and the length of sections at step A, the exact temporal placement of themes within each section is determined at step C. Whilst my music is by nature polyphonic (see 2.1.3.3), the *hierarchies* of themes do create a type of quasi-homophony, in that subsidiary voices can become so slow that they start to function as de facto accompaniment.

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[74] The term 'Texture' in its musical sense describes the functional relationships between the various levels of a musical work. Textures are typically classified as monophonic (a single sound source e.g. my Flute Solo), polyphonic (music made up of many independent voices), homophonic (melody and accompaniment) or heterophonic (many voices but all essentially doing closely related versions of the same material).

Figure 19 The 'Big Bang', 'Narrative Unfolding' and 'Big Crunch' textural archetypes (see Figure 6)

Figure 19 shows how the archetypes (see 3.1.3) that operate at this level are 'laddered' between the extreme states 'Big Bang' (the 'Dim.' archetype) and 'Big Crunch' (the 'Cresc.' archetype) to generate contrasting musical textures. The notional centre of this continuum is a balanced state called 'Narrative Unfolding' (the 'Mix' archetype) which has a completely smooth distribution of themes. During the two halves of the piece (the first half being a journey from near-perfect 'Narrative Unfolding' to 'Big Bang', and the second half being a journey from 'Big Crunch' to perfect 'Narrative Unfolding' in the final section) the intermediate states are calculated by their place on a 'laddered' continuum between the extreme states. The placement of themes is further nuanced by allowing the entries of themes to be proportionally responsive to the relative lengths of themes i.e. after a longer theme, the next entry is staggered, and vice versa.

Once the number of themes, their placement and their hierarchy of importance are
determined, this step assigns an actual instrument to each of the four hierarchical levels.
In the Flute Solo, I used five 'virtual' instruments corresponding to different parts of the
flute's range. The Piano Trio was actually conceptualised as *four* instruments– the two
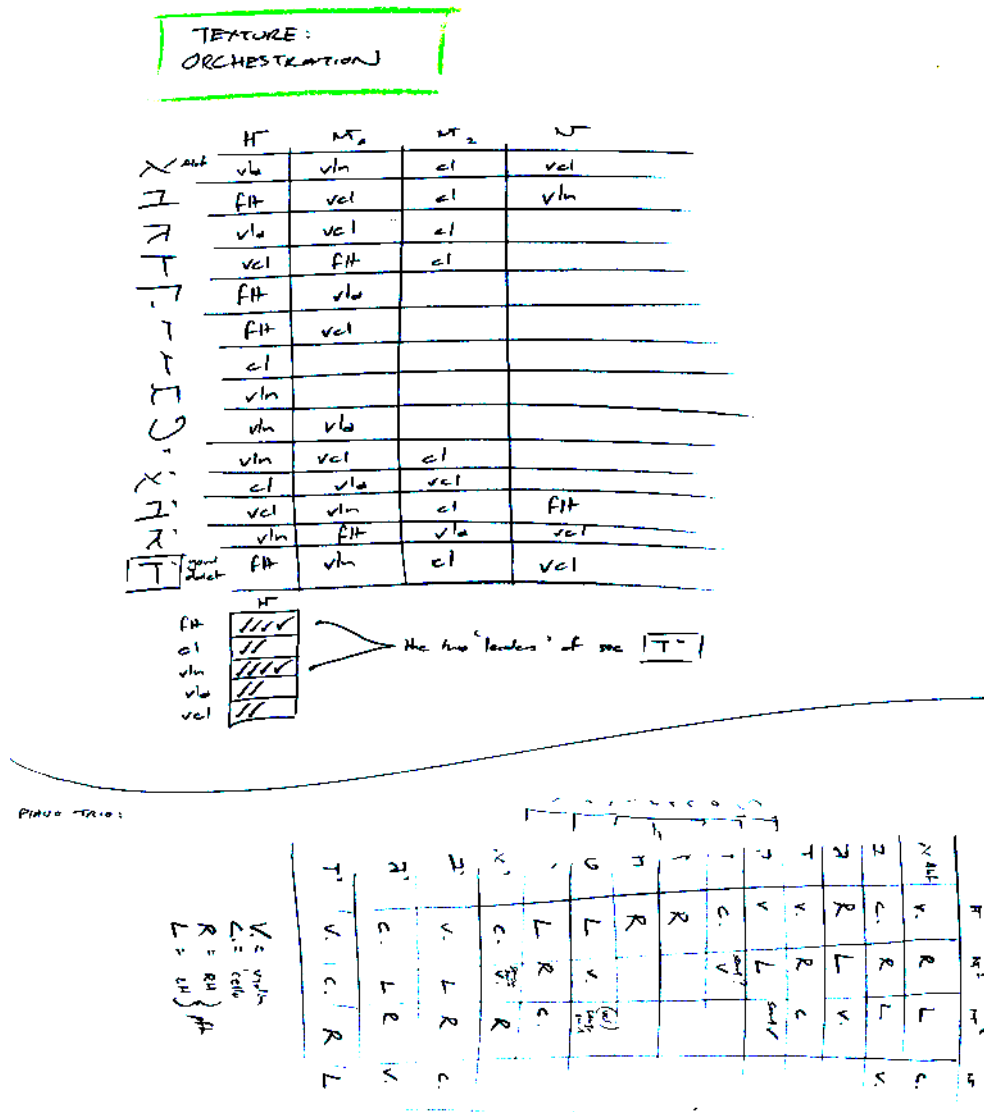string parts plus the two hands of the pianist.

Figure 20 *Texture: Orchestration* **of Both Projects: allocating instruments to the
hierarchy of themes**

Figure 20 shows the hierarchical arrangement of the Flute Solo's 'virtual' quintet
and the actual instruments used in the Piano Trio (the horizontal table at the

bottom of the figure). The top row shows the hierarchialization and the Hebrew letters refer to the names of the 14 sections of both projects.

3.2.3.   *Tessitura*

Strictly speaking, tessitura means 'the range within which most notes of a vocal part fall' (Oxford American Dictionary, Mac Edition 2005), but I use it in an extended sense. In the Process, 'Tessitura' encompasses three things: the location of themes on an instrument's total compass[75], the directionality of themes (ascending or descending) and their 'gradient' (i.e. how 'steep' is this ascent or descent?).
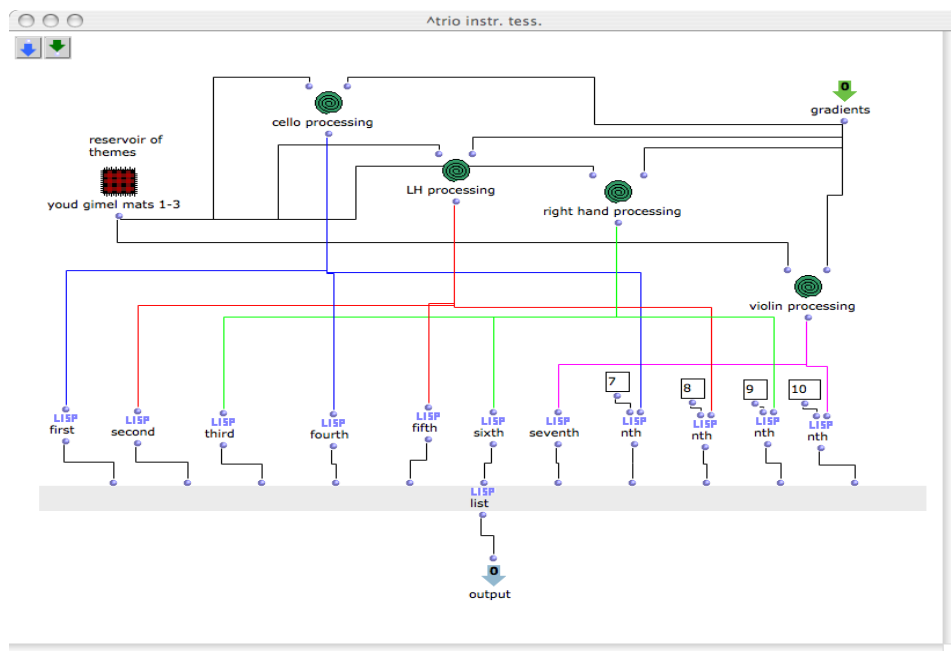
Figure 21 Screenshot of the Piano Trio Tessitura patch, top level: tailoring materials for each of the instruments

The Tessitura patch (Figure 21) limits the pitches of a theme to within an octave wide band. That band shifts, following a central locus, keeping the theme's pitches within an octave-wide band (rather like a system of moons orbiting around a planet). This locus can ascend or descend, and the Process determines how much of an instrument's total possible compass is involved in this movement. E.g. the piano

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[75] The musical term for the total range of a given instrument, from its lowest to highest note.

has a huge compass and the violin a much smaller one, so a motion of 10 percent is much larger in absolute terms when applied to the piano than to the violin.

3.2.3.1.   E Tessitura: Distribution

Every theme is assigned a directional 'chirality' in that is it either ascending or descending. Note that this pre-patterned directionality doesn't *reorder*[76] the pitches of a theme as such – it has an ascending or descending tendency by virtue of the influence exerted by the central pitch locus. Step E simply applies a ratio of ascending to descending themes, 'laddered' from 100:0 through 0:100, according to the order in Figure 22.
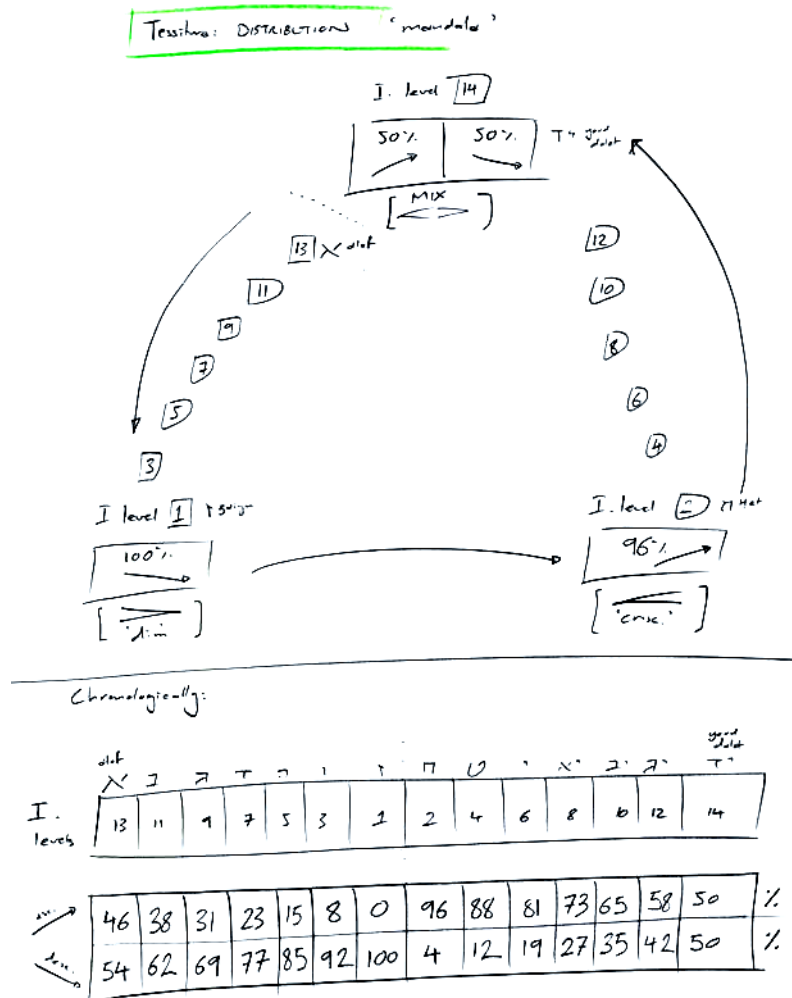
[76] The 'Scalic Reordering' algorithm does this (see 3.2.5).

Figure 22 The *Tessitura: Distribution* Mandala: determining the ratio of ascending to descending themes

Figure 22 shows how, as the formal teleology heads towards the 'big bang'/'dim.' archetype, a higher proportion of themes descend, and vice versa in respect of the 'big crunch'/'cresc.' archetype.

3.2.3.2.   F Tessitura: Gradient

Having determined the number of ascending and descending themes, step F specifies what percentage of an instrument's compass is used by each theme. I have written a patch in OpenMusic which takes percentage data as an input, and then reprocesses themes so that they are tailored to the varying ranges of each instrument in the ensemble.
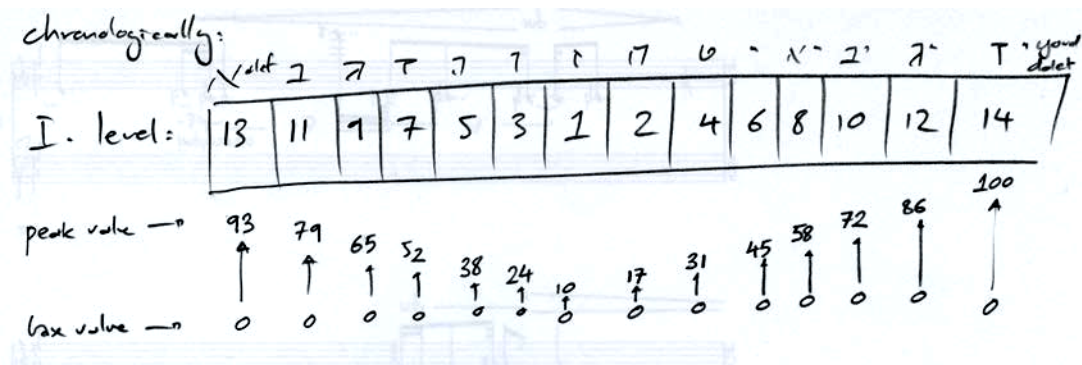
Figure 23 The Peak Values for 'Gradient':
how much of an instrument's range is used?

For any given section there is a 'laddered' maximum allowable gradient. These peak gradients are shown in Figure 23. The gradients for all the themes are then 'laddered' back from that peak value.

The minimum value of 0% is the point where the themes do not move at all outside of a single octave 'lock'. This means that there is always one theme in every section that is not subject to any ascent or descent – aesthetically, this forms a stable point of reference setting off the trajectories of the other themes.
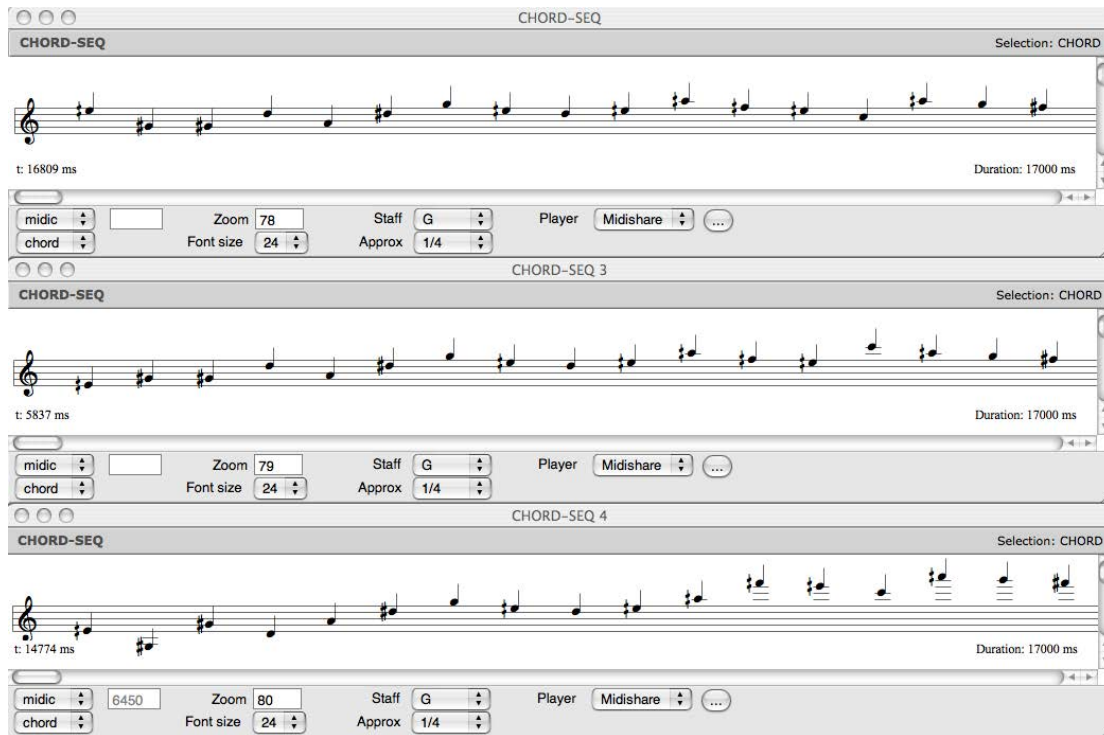
Figure 24 (33, 66 and 100)% Gradients, using in this example increasing amounts of the violin's total range

In Figure 24, we see a theme (written for violin) that has been processed at increasingly extreme gradients. The top line example sits mostly within a single octave, whereas the bottom line traverses most of the violin's conventional range.

3.2.3.3.   *G Tessitura: Archetype*

Step G imposes a purposeful section-wide order onto both the (ascending/descending) directionality of themes and the gradient (i.e. the percentage of an instrument's range that is traversed). Like all the other examples of 'archetype', step G creates a musico-aesthetic 'identity' for the section in respect of the three archetypical states.

In order to determine the order in which direction and gradient are deployed, I use the 'scalic reordering' patch. But instead of reordering *pitch*, I here use it to reorder the distributions of direction and gradient. NB: for maximal variety, the reordering is calculated *twice* so that there wouldn't be a direct correspondence between gradient size and directionality.

3.2.4.   *Rate*

'Rate' describes the speed at which a theme unfolds, expressed as the average attacks *per second*. This standard allows rates to be compared across sections irrespective of the different metronomic musical tempos (which generate different rates of attack *per beat*).

3.2.4.1.   *H Rate: Distribution*

At Step H, I determine the different rates that will be applied across the themes in a section. Much like *Tessitura: Gradient*, the spread of rates is 'laddered' back from a peak value assigned to each section, indexed to the intensity level of that section.
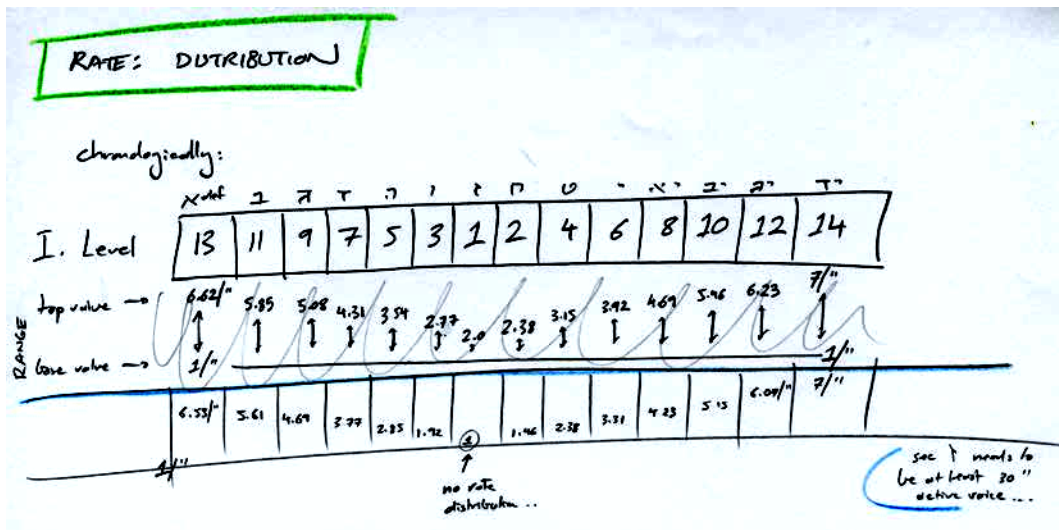
Figure 25 The Peak Values for Rate: being the maximum number of attacks per second allowed in each section

The 'laddering' back of rates terminates at the slowest rate allowable: i.e. one attack per second. This rate is present in every section, and it is the *only* rate at the nadir of the tension levels (section 7, verse *zayin*). These limits were derived from the analysis of past pieces (I reviewed the pre-compositional notes from *Cannibal Pearce*, but I also reverse engineered fully fleshed-out passages from other completed scores that seemed particularly effective). The slowest value was also cross-calculated to generate enough material to fill out the duration I had allocated to that slowest section.

Step I corresponds to the other 'archetype' steps described thus far i.e. steps which determine the arrangement of phenomena ('distributions') into a section-wide order that reflects that section's place in the global teleology of the work. This is shown in Figure 26:
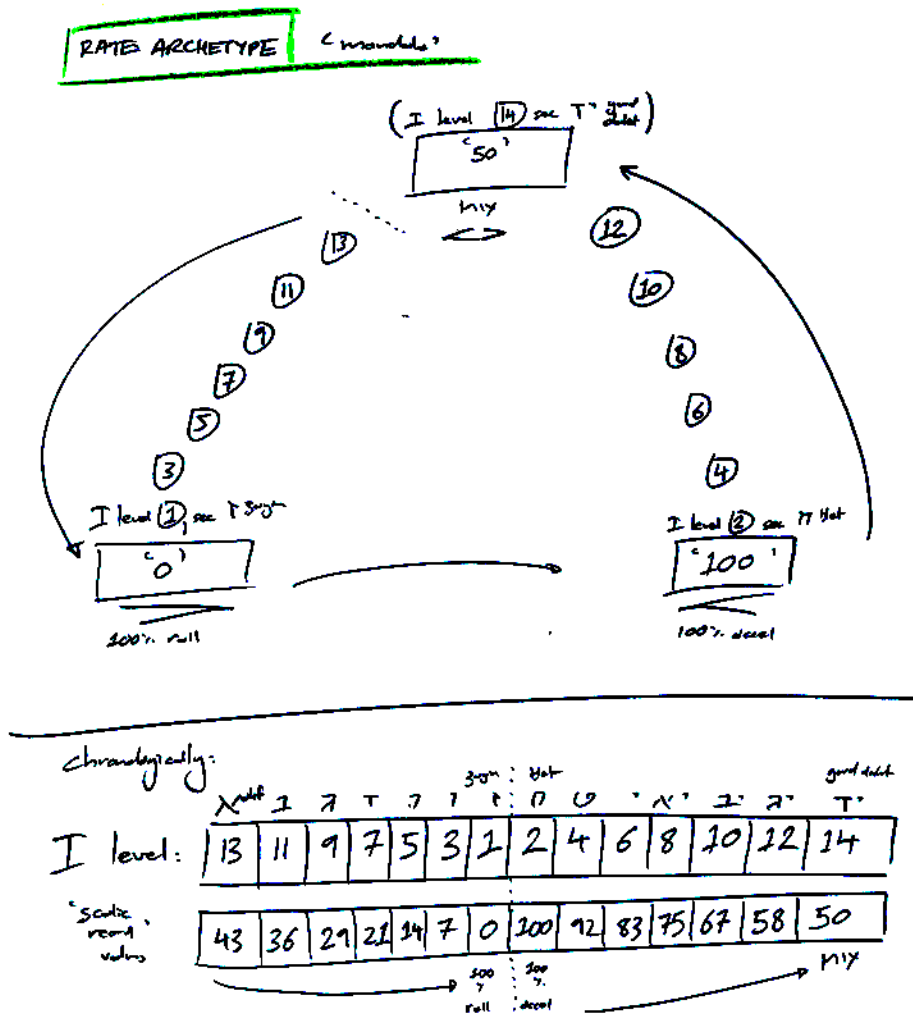
Figure 26 The *Rate: Archetype* Mandala:

controlling the arrangement of fast and slow themes in a section

In Figure 26, the 'scalic reordering' patch is once again used to shape material on a continuum linking the three archetypal states. The reordering of rates thus imbues a whole section with an overall tendency towards acceleration or deceleration, argued through the juxtaposition of *all* the themes, rather than the behaviour of any individual melodic gesture.

Thematic Transformation

I discussed the six transformational algorithms that I developed in OpenMusic in section 3.1.4. The next four steps (J, K, L and M) are all concerned with the deployment of these algorithms. Figure 27 shows the level of my OpenMusic workspace where the interconnection of the transformational algorithms is most explicit. The numbered arrows are the points where data (pitch information, rates etc.) determined in the preceding steps are accepted.
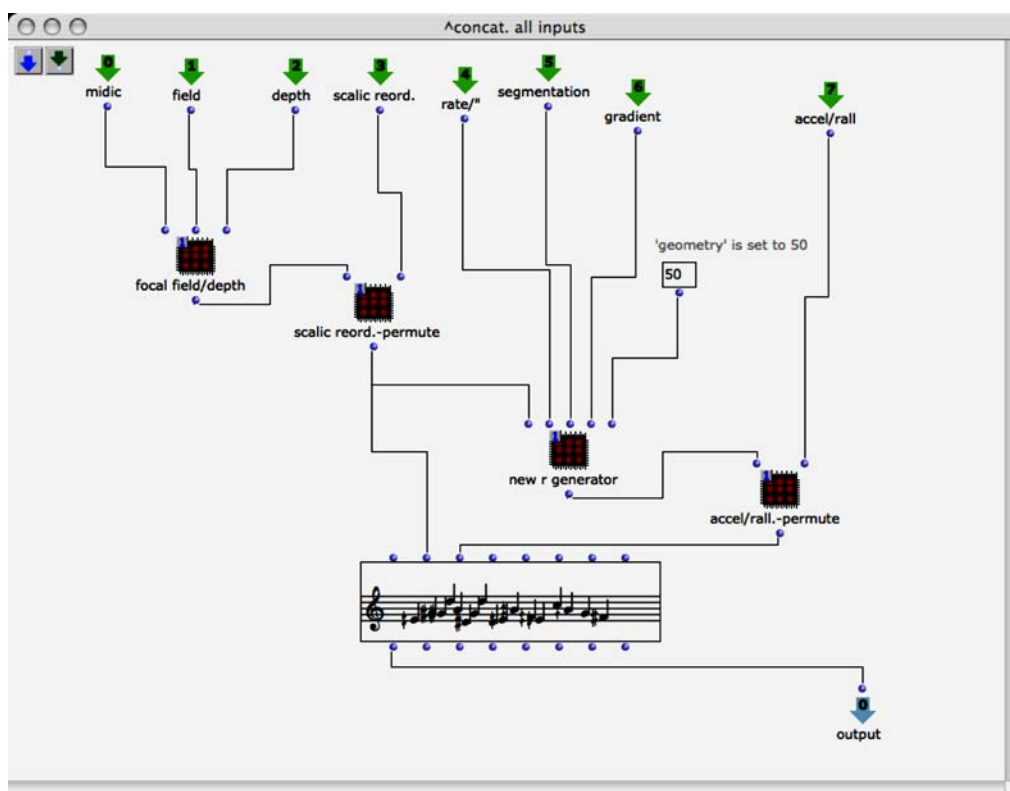
Figure 27 Screen Shot of the Transformational Algorithms, top level, where data is fed into the patches that transform themes

3.2.5.1.   *J Transformation: Distribution*

Step J refers to the proportion of transformational processes which are heading *away from* or *towards* states of increased tension. This is binary disposition similar to Step E *Tessitura:*

85

Distribution. Figure 28 shows how the percentage of 'towards tension' themes against 'away from tension' themes is calculated.

Figure 28 The *Transformation: Distribution* Mandala:
controlling the trajectory of thematic-developmental tension

3.2.5.2.   K Transformation: Gradient

Different sections use different amounts of algorithmic transformation, depending on Tension Levels. Furthermore, not all of the algorithms are used as intensively. Like previous steps, the total extent to which a transformational archetype is allows to express itself is limited by peak values (see Figure 29).
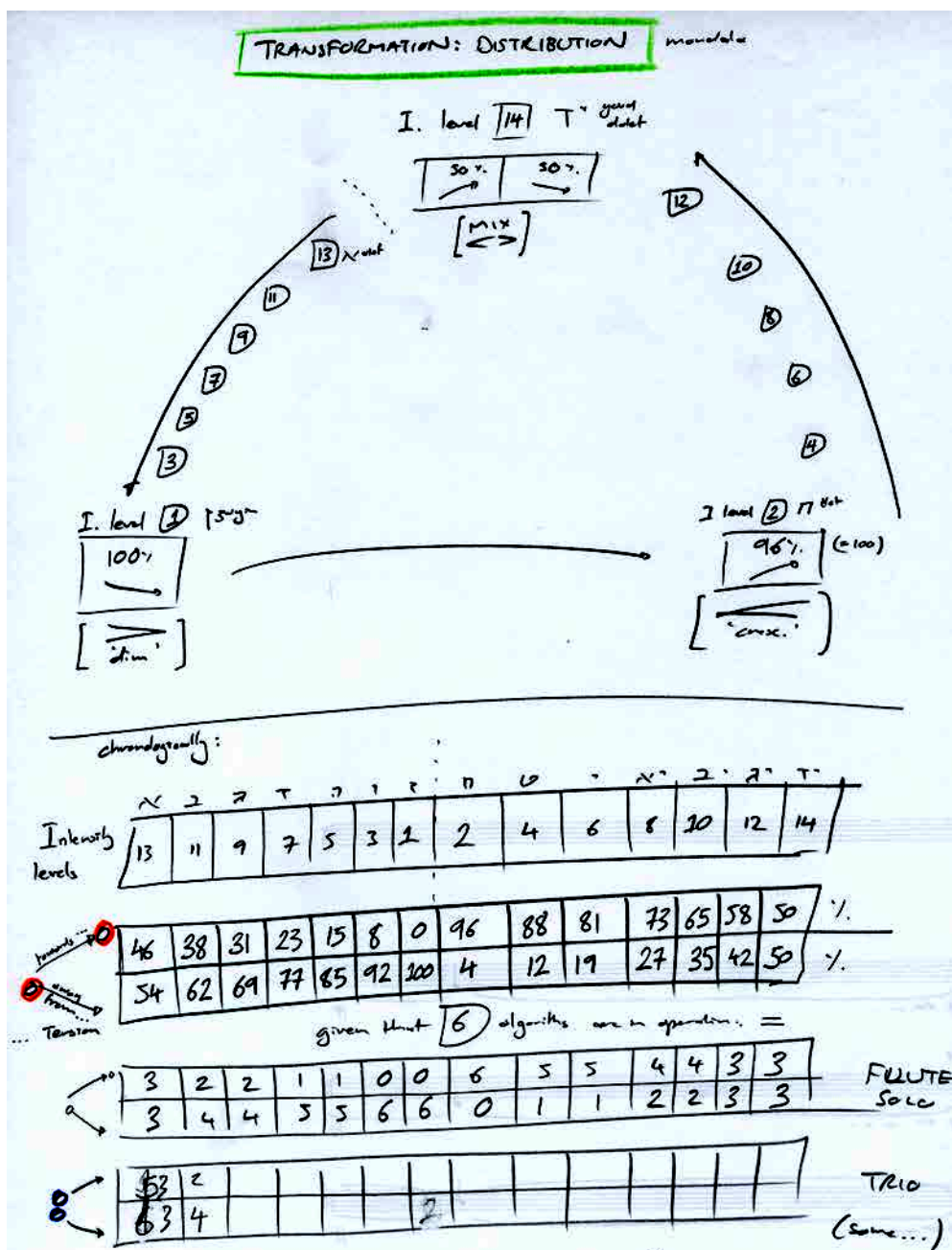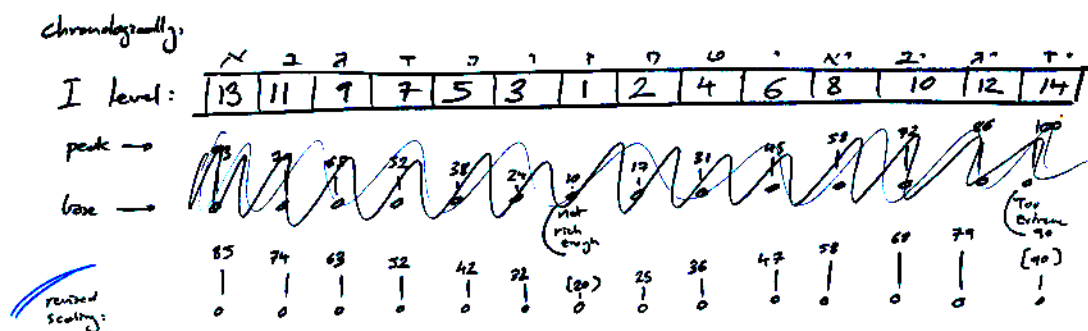

Figure 29 The Peak Values for Transformation:

determining how far the most extreme developmental algorithm will run

The peak value (the maximum amount of expression given to the most favoured algorithm) is 'laddered' across all 14 sections. Within sections, the percentages the remaining algorithms are allowed to run are in turn 'laddered' back from this peak value.

These peak values were determined through practical experimentation with OpenMusic. The highest peak value is 90% (not 100%, as I originally planned) because, if any one algorithm is allowed to fully express itself, it generally has the effect of obliterating the influence of all the other algorithms. Similarly, the lowest peak value is 20% (not 10% as I originally planned) which is the smallest amount at which the algorithms' effects could be reliably perceived.

Within each section, the percentages are 'laddered' back to a limit of 0%, which is present in every section. This ensures that one of the algorithms is deactivated, forming a stable reference point in every section. In *Body, Memory and Architecture,* Bloomer and Moore (1977) note that 'a sense of centre is indispensable for the ordering of stimuli' (p. 39). Practical experimentation showed that this adds significantly to coherence and comprehensibility.

The 'orchestration' of transformation refers to the hierarchy of the different algorithms, analogous to the way the thematic hierarchy is orchestrated against actual instruments. The transformational algorithm assigned to the 'peak value' (determined at step K) will naturally have the greatest influence over the nature of the section. Using a simple permutation generator (built in OpenMusic), I created this arrangement (Figure 30) of the 6 algorithms that has maximum variety of the type of transformational algorithms allocated the prime 'peak value' position.
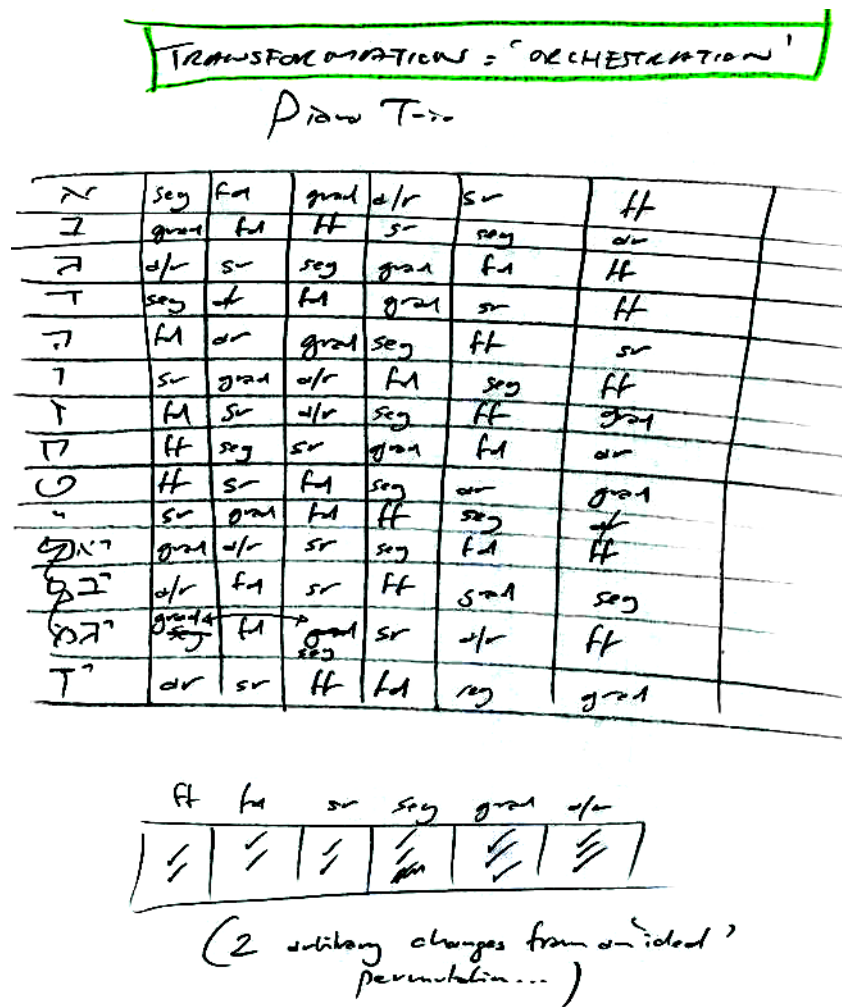

Figure 30 *Transformation: Orchestration* **of the Piano Trio: creating maximal variety of transformational dispositions**

Figure 30 shows the hierarchy of algorithms in the Piano Trio, the transformational algorithms in the far left column are in prime position and are allowed to express themselves at that section's peak value.

3.2.5.4. M Transformation: Archetype

Step J determined that a certain percentage of the algorithms would be heading *towards* states of increasing tension, the remainder heading *away* from those states. Step K determined the percentage that the transformational algorithms would run, and step L 'orchestrated' a hierarchy of the six algorithms.

Step M simply allocates whether or not an algorithm is heading towards tension or away from tension, depending on the archetypal character of the section. In the final application, I always assigned 'tension increasing' characteristics to the most active algorithms (once again, to allow them to assert their transformational character onto the section).[77]

The default settings for each algorithm constitute a fulcrum. These default points are described fully on page 61. This fulcrum value is present in any given section – it is an algorithm's movement *towards* or *away from* that fulcrum which fully articulates the archetype of the section.

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[77] My original plan was to control which parts of the range of every possible transformation were used. This would be calculated in relation to the Intensity level of each section, so that high intensity sections would play out at the most tense parts of each algorithm's range, and vice versa for the most relaxed sections. I discovered (by creating simulations in OpenMusic) that this would tend to bring up too many extreme forms, and a much less subtle musical result.
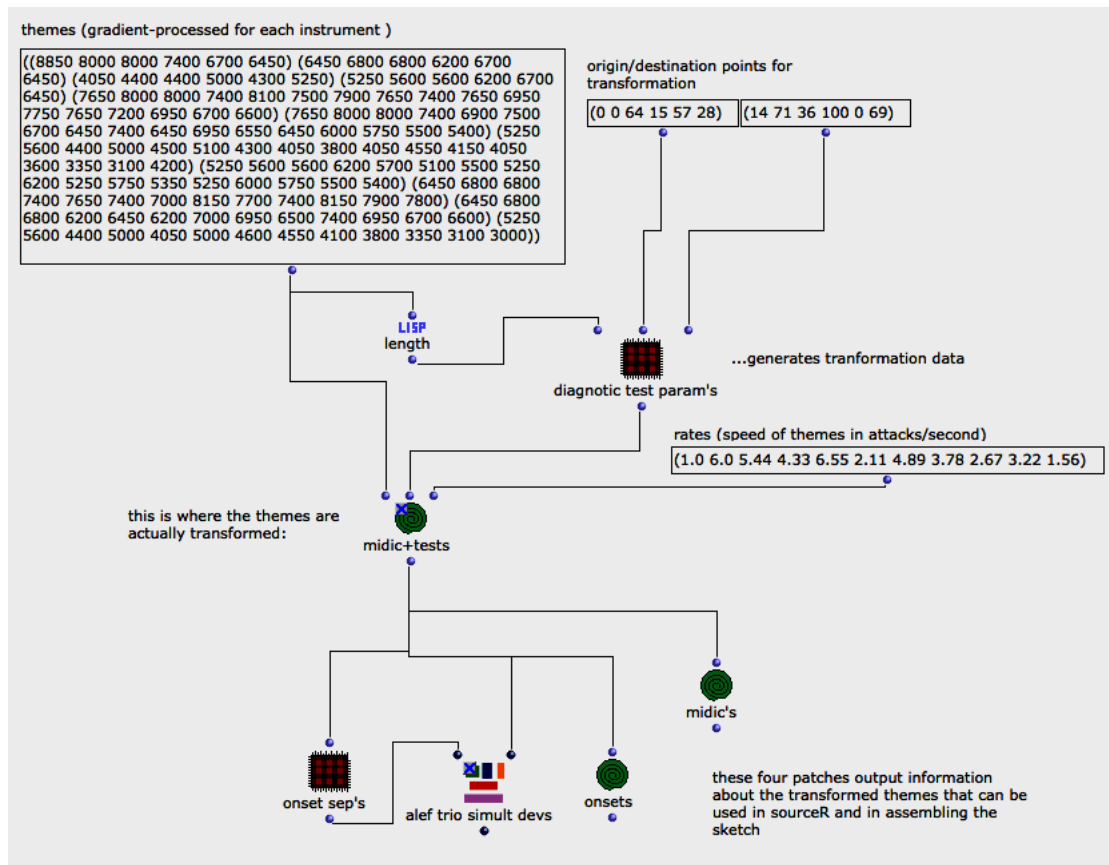
Figure 31 Entering transformational data into OpenMusic: (the green 'midic+tests' loop contains all of the patches in Figure 27)

Figure 31 shows the point in OpenMusic where the 'origin' and 'destination' levels for the transformational algorithms are fed into the patch containing all the algorithms. Depending on the number of themes, this patch automatically generates a ladder of transformation states onto all the themes in a section. Like the other 'archetype' steps, this level of sense-making is played out across a whole section. E.g. in Figure 31, the fourth element in the two origin/destination sets, segmentation, runs from 15 to 100 (it is the 'peak value' in this example). By the last theme in the section, the 100% value will result in complete segmentation, every note having a different length.

3.2.6.   *Creating the Sketch*

At this stage of the Process, the raw thematic material has been created. Turning this into music notation is the task of the next two steps.

3.2.6.1.   *N Graph Allocation*

At the Graph Allocation stage, I bring together many of the preceding steps into a single schematic which is organised chronologically. The *Graph Allocation* collates barring, instrumentation, the type (theme/subtheme hierarchy) and the precise location of themes. This is used as a blueprint for preparing the sketch. Figure 32 is a scan of the *Graph Allocation* of the final section (section 14, verse *youd dalet*) from the Piano Trio.
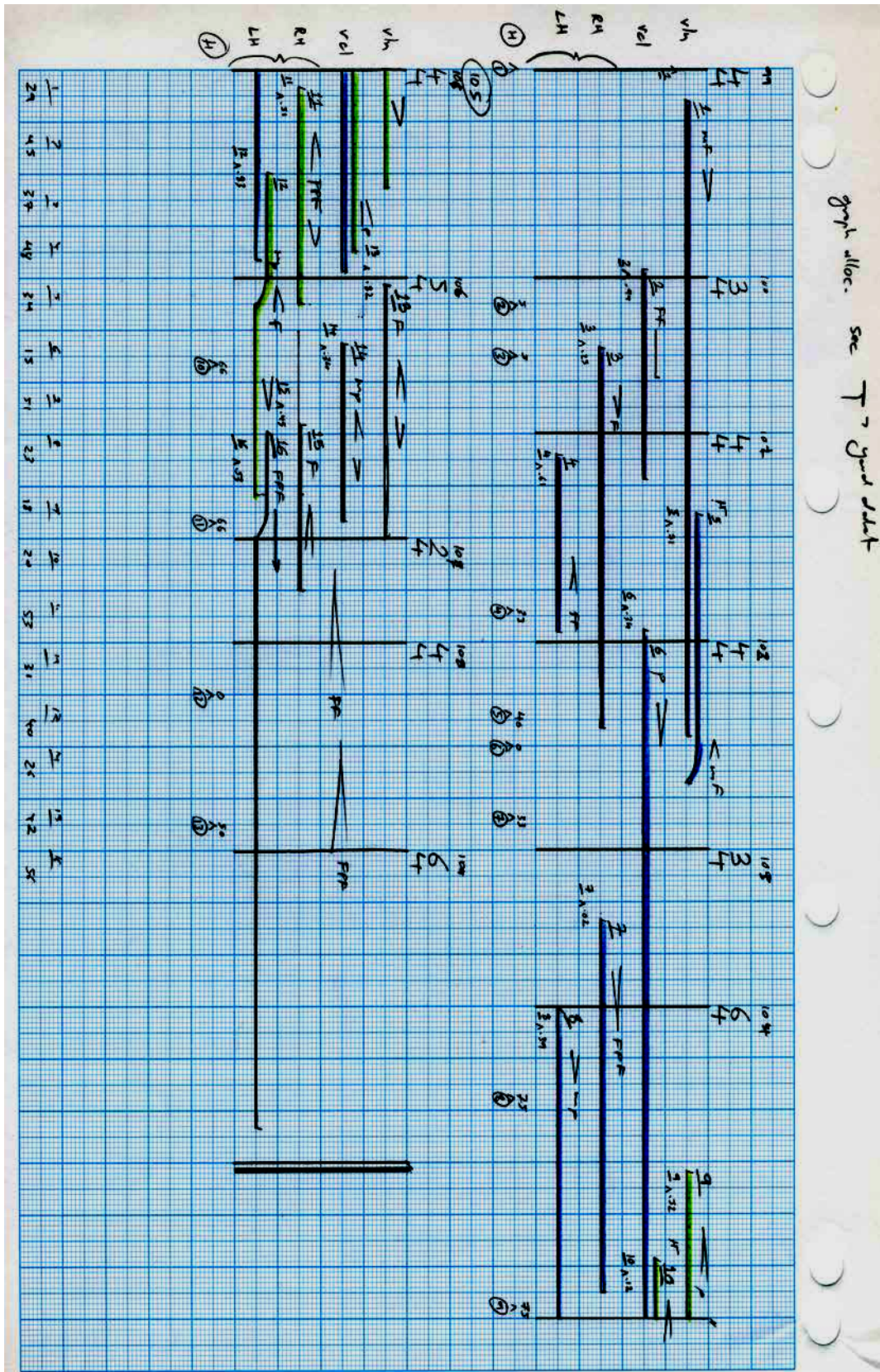
Figure 32 The *Graph Allocation* **of Piano Trio, Section 14: this schematic organizes all the previous decisions into a maquette of the musical score**

3.2.6.2. *O Sketch*

The rhythmic information generated by OpenMusic is expressed purely in milliseconds. These values are processed in SourceR so as to generate corresponding rhythms in music notation. Once I have generated the notated rhythms, I combine them with the transformed pitches to form the sketch. It is noteworthy that it is *only* at this very late that the product starts to look anything like traditional music.

The sketch is, however, little more than 'formwork' – in his chapter on the history of bridge building in *Success Through Failure: the Paradox of Design* Petroski (2006) describes how the medieval bridge builders would first translate their plans into wooden formwork – in essence, a negative of the completed bridge – upon which actual stone could be laid. The day on which the formwork was stuck out occasioned a massive carnival.[78] In actual musical communication (see Miell et al 2005), the 'striking of the formwork' only occurs when the piece is being listened to or thought about.

Figure 33 A typical single bar of sketch (cf Figure 41), being the rapidly assembled 'formwork' of the final score

3.2.7. *Harmony*

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[78] It was not uncommon for bridges to fail spectacularly (and fatally) when the formwork was struck, so the carnival also held the promise of a macabre spectacle.

At this stage, the sketch is purely syntactical musical information (i.e. only pitch and rhythm) with no dynamics, articulation or any ad hoc editorial intervention. The creation and interpolation of a harmonic argument goes a long way towards binding the independent polyphonic strands together into a concerted musical argument. Harmonic material is, like melodic material, generated from the Hebrew Psalm text. In their harmonic manifestation, each word in the source text becomes a *verticality* i.e. an object in which all the notes in the word are sounded simultaneously to produce a chord. Figure 34 shows the harmonic material of the final section of the Piano Trio, together with the Hebrew text that generates both melodic and harmonic forms.


Figure 34 Melodic and Harmonic forms derived from Hebrew text: from letters to melodic fragments, harmonic reduction and eventual orchestration

Another decision made at this stage is to determine which words are privileged to become harmony. In the sections governed by a 'big bang' archetype (1-7) harmony was revealed from the initial words (i.e. the *first* words in the verse were preferentially treated as harmonic material). The opposite situation pertained in the 'big crunch' sections (8-13). Musically speaking, this creates a sense of 'moving away from' (or of 'heading towards') stable material – the stability in this instance being generated by the parity of melody to its background harmony. One of the axioms of musical expression is that consonance between melodic tones and their harmonic accompaniment generates relaxation/stability. This is one of the main ways in which I realise my 'functional atonality' concept (see page 34).

3.2.7.1. P Harmonic Density

The *Harmonic Density* step determines the number of harmonies that will be used in a section. This generates a harmonic rhythm unique to each section. Generally speaking, the faster the harmonic background changes, the most tension is generated. By analysing the harmonic rhythm in different sections of *Cannibal Pearce,* I set as constraints a range of average durations of 2" to 7.5" per harmonic event. I then assigned these durations to the 'intensity level' boundaries (i.e. sections 7 and 14), and 'laddered' the harmonic rhythm across the intervening 12 tension levels.

Piano Trio Harmonic Density
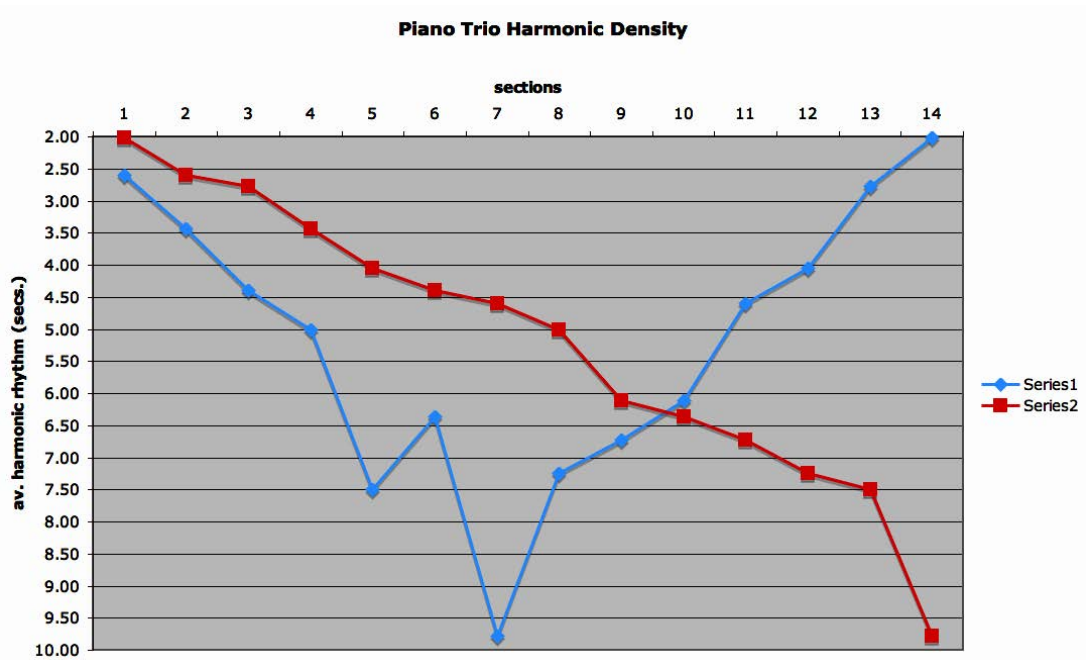
Figure 35 The Harmonic Density of the Piano Trio: chronological and 'laddered' versions of the average length of harmonic events

Figure 35 shows the ranked distribution (series2) and the chronological (series1) distribution of *Harmonic Density* across the Piano Trio, giving the average length (in seconds) of each harmonic event.

3.2.7.2. *Q Harmonic Distribution*

Step Q generates a set of durations for harmonic events. A very uniform (iterative or striated) harmonic rhythm has the potential to dissipate tension.[79] Therefore, at the lowest intensity level, all the harmonies have exactly the same duration. At the maximum intensity level, there is the *largest possible difference* between the duration of the shortest and longest harmonic event, with a 'laddered' distribution in between.
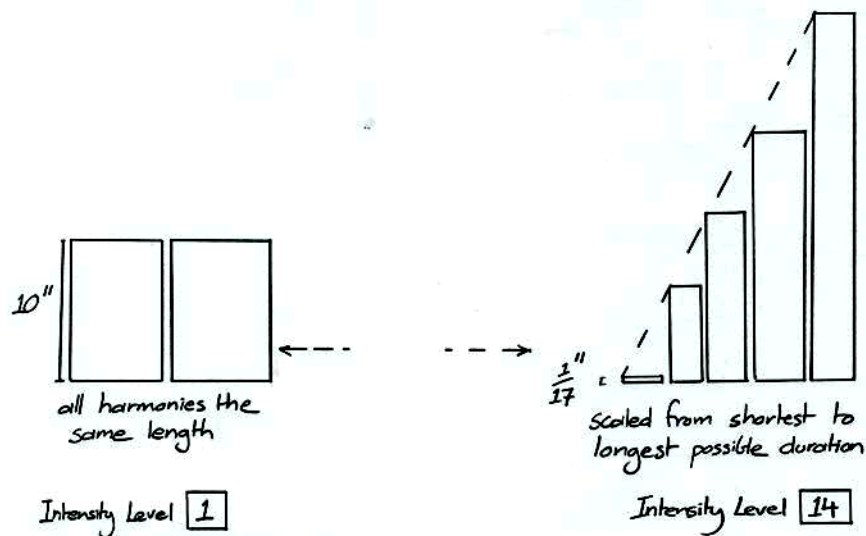
Figure 36 Harmonic Distribution at Intensity Levels 1 and 14: controlling the regularity/irregularity of harmonic rhythm

3.2.7.3. *R Harmonic Archetype*

Like all other 'archetype' processes, *Harmonic Archetype* orders phenomena across a section according to the 'mandala' of archetypes. In this case, the different durations of

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[79] Witness minimalism, New Age music, most of today's dance music...

harmonic events from Step Q are organized so as to speed up, slow down or be mixed according to the archetypal disposition of the section.
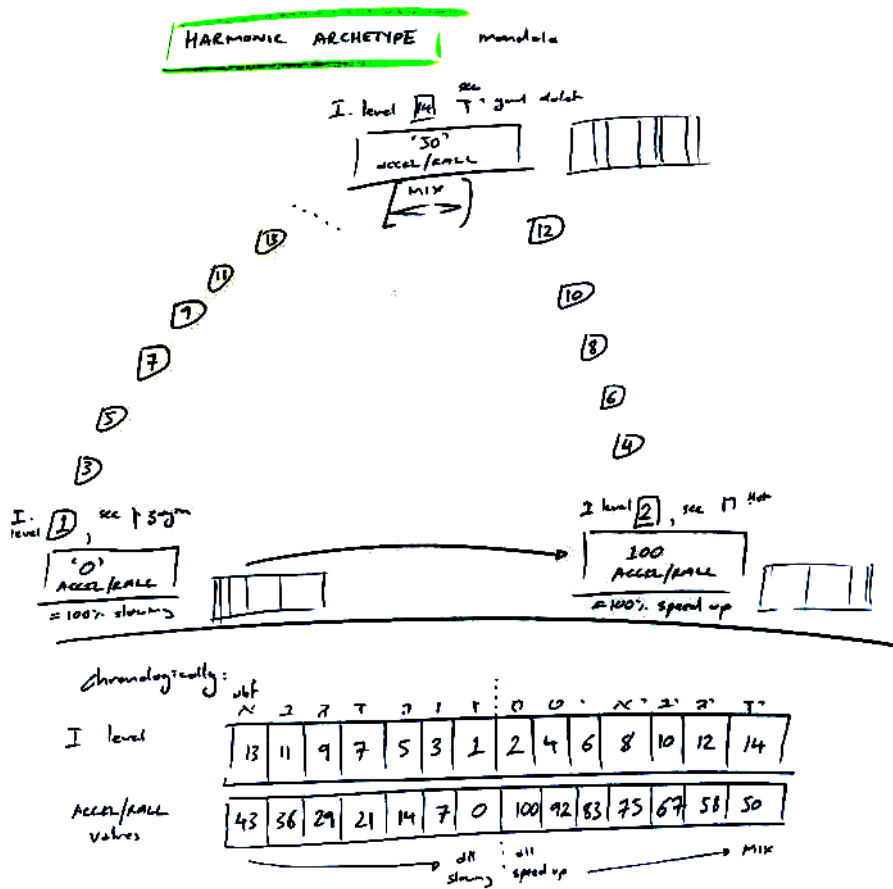
Figure 37 The *Harmonic Archetype* Mandala: the purposeful ordering of the harmonic rhythm (see Figure 36)

3.2.7.4.   S Orchestrate Harmony

This step employs another series of OpenMusic patches.
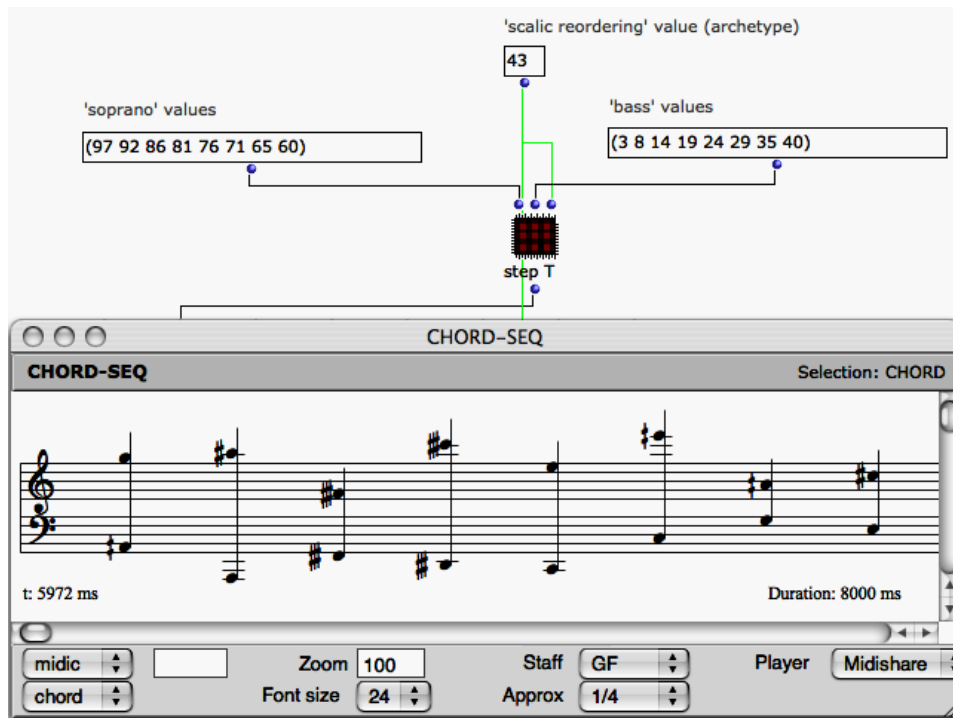
Figure 38 An example of the 'chorale boundaries' generated in OpenMusic: controlling the ascent, descent and range of harmonies

Figure 38 shows a set of boundary pitches within which a section's harmonic events must fall. These are the same boundaries that generated the harmonic argument of Figure 34. Note that these boundaries are also governed by the Mandala: at tension level 14, harmonies can be orchestrated across a very large range, whilst the harmony at tension level 1 occurs within a single central octave. The tendency for these boundaries to move upwards or downwards across the section is also determined by the prevailing archetype.

Once the boundary pitches of the harmony are created, orchestration becomes a series of trade-offs between what instruments are available, and what parts of their range they are playing in. The actual position of harmonies – their onsets - are written into the Graph Allocation at this step. I also create a set of voicings for each of the harmonies which make sense in quasi-traditional terms i.e. purposeful voice leading (where each voice moves as smoothly as possible from one chord to the next) and harmonic re-enforcement (where chords can be construed as having a quasi-tonal identity, I try to present them in a way that plays with this impression).

At this stage, I attempt to imagine that the sketch is a discovered manuscript (composed by someone else) that needs to be fashioned into a practical performing version. This is a productive self-delusion, and I have no scruples about being unfaithful to the manuscript when I notice interesting ad hoc details that can be elaborated on or even by interpolating new material.

This is, perhaps, an application of the Morelli Method (Cope 2000) in reverse: Morelli devised a system for the authentication of paintings by concentrating on the idiosyncratic execution of seemingly *minor* details like fingernails, earlobes or haloes – at this stage, I impose innumerable personal filigrees on the score that, in toto, constitute the impress of personality in the interstices between structure and interpretation.

One example of this occurs in the Piano Trio at the opening of section 9 (verse *tet*): when I was playing through this section at the piano, I noticed the accidental similarity between the voicing of the first harmony and the opening of the Adagietto from Mahler's *Fifth Symphony* – so I extended this impression by interpolating a direct quote of the harp part from that movement (Figure 39). The late Australian concert pianist Geoffrey Tozer, who was present at trio's premiere performance, picked up on this; but so far, no one else has seemed notice it.

Figure 39 Quotation from Mahler's Fifth Symphony:
extending a serendipitous similarity at the editing stage

I feel strongly that allowing space for the operation of instinct is vital. In the years I have been composing I have build up some reasonably sharp instincts. In *Style and Idea*, Schoenberg (1975) calls the spontaneous acts of the subconscious during composition as 'gifts'. Indeed, one of the lessons I learnt from my initial readings in music psychology and music perception is that many (if not most) of the things going on in our minds when we compose or listen to music do not operate at the level of reportable, conscious thinking; allowing for instinctual response taps into this wealth of musical and extra-musical experience.

In an interview on Radio National renowned Australian potter Milton Moon reflected thus on the boundary between art and technique (or 'craft'):

I think that I'm a bit careful about using the word 'art'. Everything initially is a craft, you've got to learn a craft, even if you're playing the violin, you've got a craft to learn. All musicians know that. Now if it goes beyond being a craft, it can then become something we call art.

Now in the case of a violinist, if they play their craft, they perform their craft so well, one might say that they are a performing artist. If you are a potter, now if you're doing what you did yesterday, you know you can do tomorrow, that is a craft. But then again, if you go beyond that, if you want to - well I use the term 'going out on your cutting edge', if you go into new territory, then you are involving yourself in something quite different. Now whether or not this becomes an art is another matter.[80]

3.2.8.1.   U Mastering

This stage is so named because it is akin to the mastering stage in audio production. At this step, I superimpose a dynamic *level* and a dynamic *envelope* on every theme in the section.
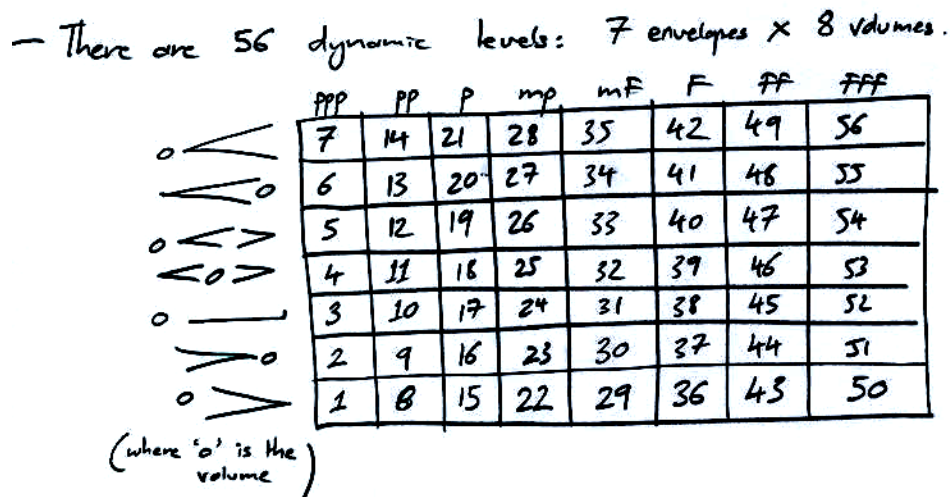

Figure 40 The *Mastering* Grid: using a table of 7 levels and 8 envelopes to create a large array of dynamic possibilities

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[80] First broadcast 10 December, 2006.

There are 56 levels of dynamic, generated by a grid of 8 dynamics (top line) and 8 envelopes (left side). The small circle in the dynamic envelope column shows where the dynamic marking (e.g. pp, mF) is situated within the envelope.

Because of the acoustical problems of mixing very loud and very soft dynamics, the distribution of dynamics in any one section occupy limited parts of the total spread of 56. At the least intense level, the limits are from 1-15. At Intensity Level 14, the spread goes from 15-56.

The actual dynamics used in a section are 'laddered' between these two points. The arrangement (archetype) of these dynamic levels is, once again governed by the mandala. Once these dynamics and envelopes are determined, they are first put into the graph allocation. This enables me to oversee the section-wide musical logic of dynamics at a glance before it is transferred to the score. The integration between these global dynamic instructions and the idiomatic contingencies of the instruments generates another set of complex trade offs which result in a product that, while undoubtedly richer for being algorithmically controlled, is much more vivid by virtue of my extensive interventions.

3.2.8.2. *V Edit/Fair Copy*

The final editing and the generation of the fair copy is a painstaking process. Completing a single page of score can take as long as much as four hours depending on the complexity of the page. The quality and detail of the calligraphy is significant for several reasons.

My music is challenging enough to play in any case – asking performers to decipher a messy score would be anathema. Furthermore, because I know it will take me so long to write a page, I force myself to write with as much commitment and integrity as I can muster. My scores are also prepared using 'time space proportional' notation (yet another practice gleaned from Dench) which means that the physical proportion of the notes on the page is an exact analogue of their temporal proportions (e.g. a note that takes 2 seconds is exactly twice as long *on the page* as a note that takes 1 second). This means, theoretically, that performers could put on a metronome, run their finger along the page

at a steady rate[81], and get a fairly exact idea as to how to realise the rhythms without having to decode the notated rhythm at all.

The final rationale for my fastidious calligraphy is that the quality of my final manuscript is probably the most important way I convey the seriousness of my intent to performers. Figure 41 shows the fair copy of the sketch page shown in Figure 33.

Figure 41 Fair Copy of Figure 33: conveying intent through calligraphy

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[81] Not unlike the 'follow the bouncing ball' principle in open-caption sing-a-long movies…

4. Synthesis/Evaluation – turning answers back into questions

I make films for my friends…and my enemies (Buñuel, quoted in Cowie 1982)

As I write, it is almost four years since the completion and first public performances of my two projects. In this final section, I will evaluate these projects in the light of the specific research goals – aesthetic and technical – identified at 2.2. This personal evaluation will be complemented through the evaluation of others – including an expert peer (composer Matthew Shlomowitz), and two professional writers on music (The Age reviewer Clive O'Connell and composer/author Gordon Kerry). I will conclude with what I contend to be the single most important product of this research: an outline of the impact this research may have on future directions.

4.1. How successfully do the Projects respond to the shortcomings identified in 2.2?

Since the 2007 premiere of the Projects, I have made many opportunities for the intermittent but focused review of the Projects through their recordings. This is an ideal way of answering at least one of the aesthetic goals of this Masters: namely, would I be capable of producing music that would only come into its own only after multiple hearings? In other words, would this be a music that actually benefits from having recorded media as its primary mode of reception?

I would have to answer this with a resounding 'Yes'. Each time I revisit these pieces, I hear additional levels of inter-referentiality and coherence. Moreover, I have experienced these moments of revelation at many levels of listening, e.g. hearing thematic development both within and across sections, hearing harmonic connections between various parts of the work, and becoming aware of the expressive contribution of subsidiary voices ('subthemes') once the cognitive load of decoding primary thematic layers is ameliorated by repeated listening. Ultimately, my advice to readers of this

document is to conduct the following simple but powerful experiment themselves – find a space where you won't be interrupted by anything, set up a quality playback system, and listen to one of the projects at least three times through in close succession. Indeed, these were the suggested guidelines I gave to peer reviewers (see 4.2.1).

The initial aims presented at 2.2.2, particularly in respect of creating a music completely beyond convention,[82] has been tempered by experience – whilst the projects are informed by a commitment to composing a music suggestive of maximal possibility (the blanket application of the 'laddering' and 'mandala' principles has ensured this outcome), my experimentation in OpenMusic lead me to conclude that a music that extends conventions as much as is *expressively* comprehensible is in fact a more interesting goal.[83] N.B. I am *not* claiming that this goal has been completely (or even largely) realised in these projects – it was simply too ambitions to achieve this in the context of two relatively short, modestly scored chamber works. I have, however, moved much *closer* to this goal than I could have using my pre-Masters modus operandi, and this goal will most certainly influence the thinking behind my next planned project (see my concluding remarks in 4.3).

The trajectory of development in my music is now controlled so finely that even at one of the most obvious levels – namely Rate (the fastness or slowness of the music) – the transition from 'fast to slow'[84] is perceived below the level of immediate conscious attention. The incremental slowing over the first ten minutes of the Flute Solo is a primary example of this – at no point does the music suddenly seem to be slowing, despite the complete transformation that occurs over this time.

This incremental journey creates a shift in the listener's basic mode of musical perception. The rapid outer sections are so fast that the music is perceived primariy as contrast between separate themes. The moderate pace of the first and last quarters

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[82] The extreme position, postulating that music bound by *any* conventions of 'sense making' is post facto a *conventional* music in a pejorative sense.

[83] At this point, I can confidently propose a distinction between musical comprehensibility and musical expression. After all, music still "works" for 'lay' listeners, does it not? See Shlomowitz's remarks on the 'intelligent non-expert' in 4.2.1.

[84] Being the attenuation of the 'bow-tie' form.

concentrate the listener's attention within individual themes. However, the central sections are so slow that the most atomic level of musical meaning - the expressive 'synapse' between just two notes - becomes the primary zone of attention. With these projects, I feel I have finally answered Finnissy's critical observation (see 2.2.1) that my music gave listeners 'nothing to solve'. The music I am writing now has moved away from direct repetition as the primary means of delivering polyphonic argumentation. What is repeated in my music now are ideational repetitions i.e. repetition of particular ways of working out music problems.

In his philosophical novella *Rasselas*, Samuel Johnson describes this idea of larger scale sense-making in a dialogue between the main protagonist and a poet:

> "This business of a poet," said Imlac, "is to examine, not the individual, but the species; to remark general properties and large appearances. He does not number the streaks of the tulip, or describe the different shades of the verdure of the forest. He is to exhibit in his portraits of nature such prominent and striking features as recall the original to every mind, and must neglect the minuter discriminations, which one may have remarked and another have neglected, for those characteristics which are alike obvious to vigilance and carelessness" (Johnson 1759/2007, p.29).

Perhaps the most important achievement of this Masters is that I have radicalised my music without the imposition of yet more surface detail. This arrests what had been a seemingly unstoppable trend of the past fifteen years. Then proof of this is that musical surface of my Projects (especially the Piano Trio) actually looks much simpler than the music of *Cannibal Pearce*. Rather than achieving additional complexity and richness through the superimposition of more and more lines of polyphony denser melodies, every formally controlled aspect of the compositional Process, deliberately and purposefully, imbues the material with meaning.

It is the description of my current working methods, which makes up the bulk of Chapter Three of this paper, that embodies the positive response to technical issues. Mellers (1993, p. vii) notes that 'any musical judgment, however technical, is also psychological'. The kind of thematic development I can do in OpenMusic is now one of the defining (and probably the most original) aspects of my music. Many of the future

directions outlined in 4.3 consider precisely how these transformational procedures can be given both more compelling settings, as well as even greater control over formal architecture.

4.2. Evaluation from an expert peer and critics

4.2.1. *Reflections from an expert peer, composer Matthew Shlomowitz*

In a series of phone conversations commencing in June 2010, I have been exploring many of the themes of this research with Adelaide-born, but now London-based composer Dr. Matthew Shlomowitz. Shlomowitz is a student of Ferneyhough's and received his PhD from Stanford – his current practice combines a busy schedule of freelance composing and lecturing at the Royal College of Music.

After listening to my Projects and studying their scores, Matthew was very positive about the quality of the work – specifically, the melodic life of the pieces, the expressive role of harmony and the compelling formal teleology of the works.. However, he was deeply suspicious about many of my fundamental aims. He feels that the goal of writing a music that reveals itself over 10 to 20 hearings is a fool's quest. Firstly, because people don't listen to music that way and secondly, because he feels that music should make a strong claim on the audience at the *very first* hearing. He is also dismissive of the importance of the transformational algorithms, and suggested that I may have created them purely for my own amusement, in that what they do is neither particularly audible or indeed one of the main salient features of the Projects. He stated that what makes my music interesting – contrast of sections, functionally atonal harmony, my exuberant melodic rhetoric – are in fact all features of my pre-Masters practice.

One fruitful touchstone we keep returning to in our conversations is the idea of the 'intelligent non-expert'. We both lament that fact that contemporary classical music doesn't hold much place in the cultural diet of non-experts who would happily engage with contemporary culture in almost every other form: dance, cinema, theatre and visual art. However much we might rail against the current state of contemporary music

audiences, these are the conditions – the players *and* the audiences – with which we perforce must engage.

4.2.2.   *Some broader critical responses – Clive O'Connel's reviews in '*The Age' *and Gordon Kerry's book '*Composing Australia'

Clive O'Connell has reviewed the piano trio for *The Age*[85] twice. The first review, reporting on the premiere performance, was published on November 27, 2007[86]. The formal dynamics of the piece were obvious to him as a first time listener; he noted the piece's motion from "dramatic vigor to a static plateau and back again" (the bow-tie structure). Furthermore, I believe he also recognized something of the piece's deeper technical concerns – laddering between extremes – when he commented on the music's "…interdependence in language that unifies the acerbic and the lyrical." Given the purely aesthetic aim of trying to write a genuinely new music, it was encouraging that he noted my "originality of voice".

His second review was of a Musica Viva performance a year later. In this (unfortunately unpublished) review he focuses on other aspects of the work, which is in itself a partial validation of my 'multiple listening' hypothesis. He wrote, "…this time around, what impressed more was the demand for micro-intervals from the string players, giving the work's impact an unusual, unsettling character as though Yee were attempting to generate sound facets or near-images of the same note." O'Connell once again took the trouble to comment on the "highly individual" nature of the music.

The most substantial published reaction to my Masters work thus far, appears in Gordon Kerry's 2009 book-length survey, *New Classical Music: Composing Australia.* Describing my Flute solo as a "tour-de-force", Kerry wrote " Yee's method lately has involved the use of software programs to elaborate musical information in much less time than a human brain would take." I think it is fair to say that Kerry has responded to the expressive potency of the music, concluding his section on my work by noting "the 'algorithmic'

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[85] Melbourne's only broadsheet newspaper and the closest we have to a paper of record.

[86] The full text of both reviews can be found at 5.1.

method is not necessarily restrictive of creative choice. And the poetry in numbers that Yee discovers has a long history as a proof of divine agency" (Kerry 2009, p. 176).

4.2.3. *Some Personal Evaluation of the Projects*

The Flute Solo is an undeniably ambitious piece – at the premiere I remarked to soloist Elizabeth Barcan that it was, in many ways 'private' music[87]. By this I mean that the ideal setting for this music would probably be one performer playing for one listener in an intimate acoustic. The labyrinthine complexity of this music suggests to me that, perhaps for one of my next projects, I need to write a piece (using similar methodologies) that is so obvious as to be almost didactic – perhaps the song curriculum[88] I have outlined for The King David School is an attempt at this goal, starting as it does from the simplest possible compositional means. This is, of course, the opposite extreme to the ground occupied by my Masters Projects – and yet it is a logical complement to them.

There is a certainly a great deal of excessive compression in the Piano Trio. Thirty two themes is simply too much material for a five minute piece, especially when we consider that a typical 'common practice'-era symphonic movement of 10-15 minutes typically limits itself to 2 or 3 principal themes. Notwithstanding the fact that we don't live in the Classical Era, as Snyder (2002) and McAdams (1987) point out, the fundamental limits of human perception don't really change...

4.3.   How this research might inform the creation of my next projects

During the development of the Process, and even more so during the actual composition of the projects, I maintained a record of ideas for projects beyond this Masters. This is of

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[87] Like Bach's *Goldberg Variations* or the flute sonatas Couperin wrote for Louis XIV… indeed, much of the corpus of music for lute or clavichord.

[88] This curriculum (titled *Se"th)* exists as manuscript and privately published (by The King David School) booklets in the author's personal collection.

course an analogue of the 'post-Pearce Ideas Sheet' (see 2.2.3); the document which fundamentally gave rise to this Masters research. The complete list of ideas (quite possibly the single most important product of this research!) in incorporated *in toto* as appendix 5.3.

I have to be open to the possibility that Shlomowitz's critique is right: such a high level of systematisation might be imprisoning me in a highly restrictive and extremely time-consuming set of protocols that, being inescapably bound up with craft/technique, actually restrict me from harnessing more of my raw artistic inspiration. This question will perforce be answered, provisionally, by each new piece. By way of conclusion, I have already commenced my next major project, an opera based on Sheridan Le Fanu's novella, *Carmilla* (1872). Current directions indicate that it may well also constitute an answer to the same broad cultural problems outlined in the first chapters of this exegesis, but through working methods that may constitute the very antithesis of the last five years' work (see section 5.3).[89]

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[89] To whit: a simplification of all current methods, rich in direct repetition, immediately assimilable by the intelligent non-expert; the music made visible through theatre, text and strong visual imagery. Something I could write in a year and put on in any space, something written for friends and colleagues to perform that won't need month of rehearsal or thousands of dollars in grants to stage.

5.   Appendices

5.1.   Full texts of Clive O'Connel's Age Reviews

Clive O'Connell has reviewed the piano trio for 'The Age' twice. The first review, reporting on the premiere performance, was published on November 27, 2007:

> …At the night's centre came a continuous double: Adam Yee's mobile arrangement of the Mahler song *Das irdische Leben*, which flowed into an original trio, *Hallelu et Hasheim min hashamayim* - an arresting reaction to Psalm 148, *Praise the Lord from the Heavens*. While the Mahler arrangement maintained the insistent character of the song's dialogue between a starving child begging for bread and its helpless mother, the new trio showed the young composer's originality of voice, its five-minute span moving from the dramatic vigor to a static plateau and back again, using the three instruments sensibly and emphasizing their interdependence in language that unifies the acerbic and the lyrical.

His second review was of a Musica Viva performance a year later. This review, unfortunately unpublished, was forwarded to Freshwater Trio (private correspondance).

> Musica Viva's popular Coffee Concert series began this year with the Freshwater Trio revisiting some material programmed in the group's subscription recitals last year, adding in a Haydn work to flesh out the recital's length.   In the centre of the morning's work came local composer Adam Yee's *Hallelu et Hashem min hashamayim*, a highly individual response to Psalm 148 in which David commands praise for God from all creation, animate and inanimate. This short piece appeared on the Trio's November recital last year when its dramatic movement from high activity to near-stasis and back again attracted most interest. This time around, what impressed more was the demand for micro-intervals from the string players, giving the work's impact an unusual, unsettling character as though Yee were attempting to generate sound facets or near-images of the same note, a technique requiring a high degree of pitch exactitude from Zoe Black's violin and Josephine Vains' cello…

5.2.   Full excerpt from Gordon Kerry's *Composing Australia*

The most extensive reaction to my Masters work thus far appears in Gordon Kerry's 2009 book-length survey, *New Classical Music: Composing Australia*. In a chapter describing various composers' incorporation of religious and spiritual themes, he writes:

> More recently, Chris Dench has delved into aspect of Jewish mysticism in works like *'atsiluth*, but it is his student Adam Yee (born 1974) who has consistently drawn on Jewish imagery for his small but distinguished output of work. Yee's first acknowledged work dates from 1994. *Shiru l'adonai shir chadash*, like much of Yee's subsequent work, takes its title from the Psalms… It is a very assured piece of complex late-modernist writing for clarinet, violin, flute and amplified guitar, characterized by long chords that explode into intricate, polyphonic patterns. Yee makes use of rapid and extreme changes of dynamics, microtonal intervals and extended instrumental techniques. The rhythmic and metrical density insures and ecstatically kaleidoscopic texture; a new song indeed. A much more recent work, *Hallelu et Hasheim min hashamayim* (2007) takes its title from Psalm 148, which calls on the whole of creation, heaven and earth, mountains and hills, fire, ice and snow, to praise the Lord. Rather than producing a Mahlerian symphony, Yee's work is a 20 minute tour-de-force for solo flute, again using a variety of tone productions, non-diatonic intervals and extreme dynamics. As flautist Elizabeth Barcan put it, 'the attempt to represent the rejoicing of the entire universe on a mere flute was certainly a big ask'. But it works. Yee's method lately has involved the use of software programs to elaborate musical information in much less time than a human brain would take. He can generate limitless variations on rhythmic and thematic patterns, and *Hallelu et Hasheim min hashamayim* sought to prove that, working in the single dimension of melody… the 'algorithmic' method is not necessarily restrictive of creative choice. And the poetry in numbers that Yee discovers has a long history as a proof of divine agency (Kerry 2009, p. 176).

5.3.   The complete 'post-Masters ideas sheet': blueprints for new compositions

The following is a complete statement of the ideas outlined on the 'post-Masters idea sheet':

- One of the new territories opened up by this Masters is a new level of confidence in the expressivity of my slow music. Given the inherent expressiveness and introspection of slower music, I could use a rate distribution that actually emphasizes the slower materials in my next projects – bending the bottom of the 'ladder', so to speak.

- I have an ongoing interest in exploring Mahler's music through transcriptions for smaller forces, in addition to the study of historical piano reductions of his works. This reveals much about Mahler's compositional thinking; in particular, the great care he took over controlling texture regardless of the quanta of instruments being deployed. This suggests to me that, as I embark on works of more symphonic scope, I should perhaps compose a sketch that *precedes* orchestration entirely. This way I could get beyond the complete co-dependence of melody on a single instrumental manifestation, as well as creating more interesting and diaphanous textures.

- A related point: so long as a melody is tied to a single instrument, melodies in my music are still either 'on' or 'off'. A more subtle approach to orchestration would be to have complexes of instruments assigned to a single melodic line that can both build up and disintegrate those lines.

- Transformations in my music currently progress arithmetically and always in a single direction in any one section. Although such trajectories might stretch the limits of perceptibility, the next piece cold apply transform geometrically, or even through more complex paths. For example, a section might slow for most of its length, then rapidly accelerate at the end. The same effect could be achieved

through the concatenation of much smaller sections into formal 'paragraphs'.

- One application of this 'irregular transformation' idea would be a new algorithm I am developing called 'Contour Printer'. One observation[90] I have about music is that the repetition of patterns of ascent and descent *within* themes is a powerful way to create similarity and variation. This patch would take a basic sequence of 'ascending/descending' steps from a source theme, which would act as a template. These directions would then be applied to the other themes in a section. In this regard, it would be similar to the 'Scalic Re-ordering' patch, except that it would operate on single intervals rather than on the course of whole themes.

- Even if I don't end up using such complex strategies, I will definitely make this simple change to the way I present thematic transformation: I will make the chains of themes that unfold across each section either begin or end with a repeated pair of themes. (e.g. a1, a1, a2, a4, a7…) This will enable the listener to experience a cogent origin (or destination) point for themes.

- The two Masters projects spend most of their time exploring the lower reaches of the developmental algorithms. The reasons for this were outlined in 3.2.5.2. In the context of longer pieces with greater numbers of instruments, it might be interesting to exploit the tendency of the extremes of these algorithms to take over and obliterate the effects of other processes. In fact, one of the plans for the next piece is to embody a journey from repetition to transformation to gesture: a work which is an extremely gradual transition over 60-90 minutes between these three archetypes of musical sense-making. If I am going to tackle such a duration, the extreme time demands of my current working methods (i.e. the Process) will need to be completely reconsidered, perhaps in the light of Shlomowitz's critique.

- An alternative to the previous idea: write a piece that is even simpler (music for children? A homage to Bartok's *Mikrokosmos*?) and more accessible that the

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[90] Every time I teach a Year 9 composition/analysis unit on Melodic Contour my students discover more and more examples of this phenomenon at work.

Masters projects and that allows the transformational algorithms to 'speak' in the most direct fashion possible – perhaps reclaiming some of the obviousness that I was striving to abandon, but with new drivers of form and development in play.

One of the principal lessons I have gained from teaching atonal music to students for more than a decade is that this music <u>really is difficult</u>. Perhaps I need to apply Schoenberg's rule that no more than 25% of the features of a theme can change at any one step without a transformation becoming imperceptible. Perhaps a possible next step for the modernist aesthetic would be to use this highly complex language to say some simple things, or maybe to use complex objects but to repeat them unchanged.

- The *Mastering* step could be employed with a greater degree of subtlety – at the moment, the archetype determines a distribution that is essentially 'crescendo' or 'decrescendo', and that distribution is applied to all the themes in chronological order. In the next pieces, I will nuance this so that the separate hierarchical levels are given discrete dynamic distributions i.e. all the 'hauptstimme' themes will occupy a higher dynamic range than the 'mittlererstimme' themes.

- Whilst my obsession with Hebrew language is probably incurable, there is one side effect from reliance on Hebrew prosody that I should address. There is a certain sameness in the length of themes in my music, corresponding to the stability of the poetical lengths of each Hebrew sentence. In the next piece, I would like to find a mechanism for reducing the themes back to a few essential notes, and a companion mechanism for extending a single verse out to any length. I will probably use a in-built feature of Hebrew – the creation of morphemes from root letters (see page 28) – to reduce theme length. Dench's system of 'looping' fragments of themes could provide the means to extend themes (particularly those words that are subject to harmonic elaboration).

One metaphorical image I have for this is the Tibetan prayer-wheel, in which the spinning of the wheel is equated with a recitation of the prayer inscribed thereon. Each of my themes could be 'spun out' hundreds of times. The use of very short themes elaborated at slow tempi, would create a nice bridge between melodic and

harmonic materials. This is currently achieved only through the serendipitous meshing of harmonic tones into melodic strands.

- Once I have a mechanism for generating many local, small scale variations on my themes, I would like to employ them to canonically elaborate the principal melodic strands – once again, this is a means of getting past the 'one instrument, one line' hegemony. Any melodic line could be reinforced by a flock of subsidiary voices that are either unison, close echoes of the theme or in true counterpoint. The direct inspiration for this is a piece for two player pianos by Nancarrow in which the second piano commences about a minute after the first, but performs the same material significantly faster. Thus, the piece executes a seamless journey from counterpoint to imitation to unison (at the final climactic chord).

- I still haven't worked out an expressive function for passages where harmony is absent altogether. I think this must be an important expressive resource – in my darker moments I fear the all embracing expansive chorales of harmony in my music might sound like a gigantic wheezing harmonium…

- Maybe I have form all wrong. To explain: my music to date is generally cast in sections, all of which are (thematically) largely self contained[91]. Historically, most music doesn't operate like this; it is an artform that is highly dependent on direct thematic correspondences across sections. One possible strategy in the next project is to return to the 'holographic' forms I explored in the 90s (i.e. forms in which every part refers, in some way, to the whole).

A metaphor for this process is the 'lensing' effect that can be used for the 'dock' of the Macintosh operating system. As the mouse pointer moves over the various icons in the dock, they are each magnified on the screen. The surrounding icons are also partially magnified, scaled back to their normal size depending on their distance from the mouse pointer's focal point.

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[91] I am overstating the case somewhat – the Hebrew texts are themselves highly self referential and this is borne out in the music.

In a similar fashion, I could compose a multipart work in which every subsection contains (in some form) every other section – e.g. using the Masters projects as an example, I could write a fourteen part work and every section would itself contain fourteen parts. However, in the first section, the first part of the section would be take up the vast majority of that section's length, trailing away to a minute reference to the material in the fourteenth section which might be a single note or single chord. Thus a lens would pass over the each of the sections, magnifying the individual parts in turn of an object, the whole object however remaining constantly within each section's 'field of vision'.

• Another idea regarding form: maybe the way to make peace with the disparate nature of my multi-section works is to break them up into separate movements with short breaks in between. These gaps between movements typically have the effect of inviting the audience to enter into a new mode of listening, and to tackle the next section with fresh ears, so to speak. Thus the experience of absorbing the piece would be akin to walking through a gallery, pausing to take in individual paintings (rather than, say, a cinematic experience).

Snyder (2000) suggests that music that flouts traditional repetition-based structure is actually engaged in a process of 'memory sabotage' which has the effect of 'intensifying the local order of the present' (p. 234). When local concerns become paramount, it would probably be wise to concentrate listeners' attention at that scale by casting my next piece in the multiple brief movements.

• A final thought on musical form: whilst I have taken great care to ensure maximum variety of chronological time, I am not sure if I am considering psychological time quite so carefully. My work in education finds me frequently playing very unfamiliar music to students of various ages. Typically, students report that a minute of fast, highly varied music 'feels' longer than a minute of slow, uneventful music. This is, on the face of it, counterintuitive: I believe this is clear evidence for music's ability to condition the psychological state of listeners.

Given this, I could experiment with a distribution of section lengths that

progressively favours (=elongates) the slower sections, and scales back the sections containing the fastest material. In conclusion, a number of factors I have mentioned in this section all seem to be pointing in a similar direction: the next piece will be longer, slower, more repetitive and *in many parts (superficially) even simpler*: but will continue to be enriched by the application and extension of the type of the algorithmic/universalist thinking that I have established through this research. It is amusingly ironic that my conclusions at this point this could be so easily read as a call to reclaim several conspicuous 'reactionary' post-modernist values! Yet Xenakis himself noted that repetition 'offers a kind of security with regard to time, which, *in fact, never repeats itself*' (Xenakis 1985, p. 68; emphasis mine).

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