Typology of relations between acoustic instruments and electronics in concert music: an analysis- and composition-based approach

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0.1 Related publications

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Mogensen, R., Deletaille, N. and Roudier, A. [2014], 'The arpeggione and fortepiano of the 1820s in the context of current computer music', *Early Music* **XLII**(4), 545–554.

0.2 Abstract

In the growing repertoire of 'mixed' score-based concert works (works that combine acoustic instruments with electronics), how can we gain a systematic view of patterns of practice in recent composers' shaping of relations between acoustic instruments and electronics? The research aim has been to answer this question by building an analytical view of patterns of practice in mixed works from composers Kaija Saariaho (1952–), Luciano Berio (1925–2003), Jonathan Harvey (1939–2012) and others; and also to apply such an analytical view in my own compositional practice. Three central research outcomes have emerged as contributions to knowledge: 1. a preliminary typology of these composers' uses of relations between acoustic instruments and electronics in mixed chamber music works; 2. a related portfolio of original mixed works for various instrumentations with computer; 3. a narrative account of the research process providing the critical basis for future work which could expand the analytical and creative results encoded in the typology.

The typology is presented in the form of a catalogue of transformation paths organised in a hierarchy. Narrative description of the process that has generated the typology has emphasised an iterative intertwining of three research strands: 1. *analytical interpretations of repertoire*; 2. *research-based practice*; and 3. *practice-based research.* From a methodological stance, the pivotal analytic tool used is *Transformation Analysis* adapted from the music analysis approach of David Lewin (1933–2003) [2011*a*; 2011*b*]. Analyses of three repertoire pieces in particular: Saariaho's *NoaNoa* (1992), Berio's *Altra voce* (1999) and Harvey's *Ricercare una melodia* (1984) have provided core elements for the typology and these analyses have formed the grounding points for the research. The portfolio of original works has been composed using a substantial input of ideas generated through analysis of these three core works as well as other repertoire; this has resulted in a series of original 'parodic' works (in the sense of Linda Hutcheon [2000]) forming the strand of

research-based practice. Processes involved in the composition of these portfolio works are examined from both analytical and autoethnographic viewpoints, which form the central part of the *practice-based research* strand.

The intertwining of the three research strands has resulted in a spiralling development of the research project: analyses have fed into compositional processes which in turn have generated more analyses. Through the iterations in the research process a typology has gradually been built, providing an interpretation of patterns of practice of the relations between acoustic instruments and electronics. This typology is specific to the repertoire examined, but the process is investigated with a view towards wider applications.

Contents

List of Figures

0.3 Acknowledgements

To undertake a cross-disciplinary analytical and creative PhD project on a part-time basis is a special challenge to the intellect and stamina of the researcher, and while it may seem a solitary endeavour at times, it is a process that is entirely dependent on the work of a large group of individuals. First, I would like to thank all the authors, composers and performers, whose writings, compositions and recordings have made my own contribution to the bigger cultural Text possible. Their names are of course listed in the citations and References and so I will not attempt to list them again here. I am also grateful to the musicians who have engaged in the performances of my works, their efforts have been both instructive and encouraging for my creative output. These musicians are named in the text in relation to the portfolio works, and have all been essential to the success of the project. I would also like to extend my heartfelt thanks to my three supervisors at Birmingham Conservatoire: especially Dr. Jamie Bullock for early discussions in various technical and conceptual directions. Many thanks go to Prof. Lamberto Coccioli in particular for his input on the compositional side of the work. Also many thanks to Prof. Deborah Mawer whose input from a musicological perspective along with her attention to textual details has had a significant impact on my writing and certainly has helped me to find my way more effectively in my engagement with this academic discourse. I found invaluable resources at the library at Birmingham Conservatoire and other BCU libraries as well as at the University of Birmingham library and I would like to thank the library staff at all these institutions for their helpfulness and professionalism. Most of all, I would like to thank my parents for their life-long encouragement of my engagement with creative and intellectual work.

0.4 Introduction

In the growing repertoire of mixed[1] score-based concert works, how can we gain a systematic view of patterns of practice in recent composers' shaping of relations between acoustic instruments and electronics?[2] This question presupposes that there are identifiable patterns of practice. If such patterns do exist, then how can they be identified? Also, if we can find individual patterns, how can such patterns be related in the systematic scheme of a typology, which might have practical applications for the creation of new compositions? Through the research documented in this dissertation I propose answers to these questions by using patterns of practice, derived through analysis and encoded in a typology, as tools within the processes of composing new mixed works. The contributions of the research can be summarised as consisting of three parts: 1. a typology of composed relations between acoustic instruments and electronics in selected mixed works; 2. a portfolio of original works which engage with relations between acoustic instruments and electronics as praxis; 3. an autoethnographic account of the practice- and research-based process in the present thesis.

[1]There are some variations in the terms commonly used to designate this repertoire. I am using the term 'mixed' music, an expression reminiscent of the French '*musique mixte* which had ... come to be used for any music combining live performers with music on tape' as was noted by Simon Emmerson (1950–). [Emmerson, 2007, 104] However, my use of 'mixed' music is equivalent to Emmerson's use of 'live electronic music' which refers to '*both* music produced and performed through real-time electroacoustic activity of some kind *and* music which combines live performers and fixed electroacoustic sound ("tape")'. [Emmerson, 2007, 104] I prefer the term *mixed* to *live* in order to avoid issues presented by the second term, as Emmerson suggests '[t]he idea of any 'live' music is increasingly difficult to define'. [Emmerson, 2007, 89]

[2]Composers whose works are examined in this thesis include Kaija Saariaho (1952–), Luciano Berio (1925–2003), Jonathan Harvey (1939–2012), George E. Lewis (1952–), Tristan Murail (1947–), Cort Lippe (1953–), Karlheinz Stockhausen (1928–2007) and George Crumb (1929–). The repertoire examined includes works from 1971–2015, as is discussed in section 1.5.

The motivation that initiated the present research was the intuition that, indeed, there are patterns of practice in composers' shaping of relations between acoustic instruments and electronics. This also provoked the thought that in establishing a systematic view, in the form of a typology of such practice, one could generate some usable tools for composers and others interested in mixed music. These thoughts came, at least in part, from years of professional activity in composition and performance of mixed concert music in various contexts in the USA and Europe.[3] Given such a background, one might expect an experimental approach to the research topic from me; perhaps initiated by sketching a typology and then testing this in my own compositional practice. In earlier research I had followed this kind of approach but found the results inadequate; my attempts at basing a system of categorisation completely on my own creative work was biased by my view of the compositional processes and only yielded categories of very limited scope.[4] To answer the questions in the present thesis I sought a more general solution, and so I needed to find methods that could provide some distance from my own works: I had to attempt to derive categories from the works of other composers and this demanded analysis of their works. This approach resonated well with my previous compositional practice where creative parody had been an important tool. I had often used analyses of

[3]I have engaged in many diverse projects as a composer and musician: I led a music performance group in New York in the period 1993–2001, with varying personnel and repertoire and have also worked with many performance groups including Aarhus Sinfonietta (DK) and ToneArt (DK); I have worked with top-level soloists including Esther Lamneck (clarinet and tarogato), Niels-Ole Bo Johansen (trombone) and Marianne Leth (flutes). I have made music for dance productions with several New York City-based choreographers including Douglas Dunn, Renata Chelichowska and Louise Klixbüll. I have made music for theater including Chaula (Antwerpen) and Pursue the Pulse (Amsterdam/New York), and the Aarhus Circus School in Damascus, a humanitarian project in Syria sponsored by the Danish state.

[4]This early attempt at defining categories will be discussed further in section 2.4.

repertoire as sources of ideas for writing new works, and so analysis as a tool for creative parody emerged as a common thread between my research and creative practice.[5]

Given the research aims, the weight of my previous practical experience, my creative work and investigations in the early stages of the research, the method of the project moved towards an iterative practice- and analysis-based process where an analytic view is applied in composition, which in turn develops the more general analytic view. In my literature searches I found this approach congruent with Hazel Smith and Roger T. Dean's 2009 model of an 'iterative cyclic web' which 'accommodates practice-led research and research-led practice, creative work and basic research.' [Smith and Dean, 2009, 19] My research process inhabits all of these four parts of their 'cyclic web': 1. This is 'practice-led research' in that works of art are produced (the portfolio) and, during the processes of composing those works, further elements are added to the typology; 2. equally, it is also 'research-led practice' since the compositional processes are addressing concepts and issues from my analysis results; 3. it is 'creative work' in that new music is created and new interpretative analytic views are proposed; 4. it is 'basic research' in its development of an original analytic approach to the relations between acoustic instruments and electronics in 'mixed' concert works, using an adaptation of Transformation Analysis from David Lewin (1933–2003).[6] [Lewin, 2011*a*,*b*]

The iterative research- and practice-led process has focused on the development of the typology of relations between acoustic instruments and electronics. This process is critical and self-critical. Each iteration has provided critique and re-evaluation of the products of this research: the portfolio, the emergent analytic approach, and the emergent typology. In the initial stages of the research I examined established analytic views of interactivity and found myself in agreement with Edward J. Downes and Sally

[5] I will discuss my use of the parody concept further in section 1.6.

[6] I have also adapted Soft System Analysis from Robert L. Flood's and Ewart R. Carson [Flood and Carson, 1993], but this plays a lesser role than transformation analysis.

J. Mcmillan who wrote that: 'The literature on interactivity includes many assumptions and some definitions but few tools for operationalizing the concept of interactivity in computer-mediated environments.' [Downes and McMillan, 2000, 157] Downes and McMillan proposed a 'conceptual definition of interactivity based on six dimensions: direction of communication, time flexibility, sense of place, level of control, responsiveness, and perceived purpose of communication.' [Downes and McMillan, 2000, 157] Such a six-dimensional concept of 'interactivity' gives a fairly complex view, which may be useful in broad contexts focused on communication. Spiro Kiousis reduces his definition to three dimensions: structure of technology, communication context and user perception; but these dimensions are also rather complex and high-level conceptual categories. [Kiousis, 2002]

Much of the analytical work on music has used a variety of conceptions of 'interactivity', 'interactive' and/or 'interaction' which will be discussed in section 1.1. But for the development of the typology I will bypass the complexity of using these terms and focus instead on a concept that I take to have less theoretical baggage: *the relations between acoustic instruments and electronics*. I examine these relations through transformation analysis. Whether or not these relations could be called 'interactive' or seem to embody 'interactivity' does not determine their potential positioning in the typology. Thus I have attempted to some extent to be 'counterinductive' in my approach to theory in the sense of Paul Feyerabend (1924–1994). [Feyerabend, 2010, 13–16] As a result I propose transformation analysis and soft systems analysis as key tools for understanding patterns of practice in the relations between acoustic instruments and electronics in mixed concert music. I do not propose this research to be in competition with other approaches; instead the research has been conducted as an alternative to the established approaches (as discussed in section 1.1), with which I argue it can coexist.

I have performed and documented this research as an 'insider' in the field of mixed music with all the subjective baggage this implies. I am an insider in the sense that

I am an experienced practitioner of mixed music, engaging at various times in roles as composer, performer and audience. In this area I have the condition of '*habitus* – embodied history, internalized as a second nature and so forgotten as history' as described by Pierre Bourdieu (1930–2002). [Bourdieu, 1990, 56] My ways of thinking about music, and the relations between acoustic instruments and electronics, are deeply ingrained through formal training, practice, habits and practical experience as a working composer and musician. But this research process has enabled me to examine some aspects of my *habitus* from the 'outside', from the more formal point of view of transformation analysis. This point of view may appear to give some degree of 'objectivity' to the research in the sense that Anselm Strauss and Juliet Corbin define the term for the context of 'qualitative research' in social science: '*Objectivity:* The ability to achieve a certain degree of distance from the research materials and to represent them fairly'. [Strauss and Corbin, 1998, 35] Certainly, in each iteration of the research process I have renewed my perspective upon my own practice, within both composition and analysis, and I have attempted to present this development 'fairly' in the sense of Strauss and Corbin. However, the validity of a potential claim to objectivity is questionable. My analytic interpretations are not separated from my first-hand experience of working as a composer and taking part in performances of the music; and the iterative, self-reflective research process is at least partly autoethnographic in the sense of Tony E. Adams, Stacy Holman Jones and Carolyn Ellis. [Adams et al., 2015] Within the field of ethnography, Adams, Jones and Ellis propose that 'Autoethnographic stories are artistic and analytic demonstrations of how we come to know, name, and interpret personal and cultural experience.' [Adams et al., 2015, 1] My activity as a composer is closely tied to my work as a researcher. The narratives about my compositional processes for the portfolio works are descriptions of my own thoughts, motivations and work procedures (in Chapters 2, 3, 5, 6 and 7). Some of the compositional ideas are derived from analytic research, and I attempt to take on the role of researcher as I write, examine and edit these descriptive

commentaries. As a result these descriptions can be read as autoethnographic stories that embody qualitative research.[7]

My narratives about the composition processes for the portfolio works present highly subjective propositions and reactions on varied topics such as: death, changing perspectives, pitch structures, *Don Quixote*, parody and improvisation. The compositions may also be listened to as autoethnographic musical 'stories'. Such a listening stance does not, however, necessarily hear the 'story' of the compositional process. The 'story' perceived by the listener may well be very different from the 'story' found in my narration describing the compositional process.[8] This differentiation fits in the schema of Jean-Jacques Nattiez's theoretical three-part ('tripartite') division of the 'objects' of the music work: 1. the 'poietic' or 'complex process of creation'; 2. the 'neutral level' or 'the material reality of the work'; 3. the 'esthesic' or 'complex process of reception'.[9] [Nattiez, 1990, 10–17] The compositional 'story' then is a narrative of the 'poietic process', while the audience's perceived 'story' is part of the 'esthesic process'. These two 'stories' are connected by the 'work object' or 'neutral layer' in Nattiez's theoretical schema, in other words the score, computer programme, recorded media and other material 'traces'. In the context of Nattiez's theory, the analytic parts of my research are focused on esthesic interpretation of the 'neutral level' or 'trace' of repertoire works.[10] These analytic interpretations become inputs to the typology and to the poietic processes. The compositional processes

[7]Adams, Jones and Ellis point out the etymological basis for the term: 'Autoethnography invokes the self (auto), culture (ethno), and writing (graphy). When we do autoethnography, we study and write culture from the perspective of the self.' [Adams et al., 2015, 46]

[8]The distinction between 'composer story' (meaning) and 'work story' (meaning) coincides with the 'intentional fallacy' argument by W. K. Wimsatt, Jr. and Monroe C. Beardsley, in the field of aesthetics. [Wimsatt, Jr. and Beardsley, 1987]

[9]Jean-Jacques Nattiez (1945–) builds on Molino, Saussure and other theorists. [Nattiez, 1990]

[10]Nattiez considers the 'neutral level' or 'trace' of the work to be where: 'the symbolic form is embodied physically and materially in the form of a *trace* accessible to the five senses.' [Nattiez, 1990, 12]

of portfolio works are described to show the inclusion of these inputs. A poietic process generates a new work, to which the same analytic (esthesic) approach can be applied, which in turn generates new inputs to the typology and the following poietic process and so on, continuing through the iterations of the research.[11]

To give a general overview, the iterative research process can be summarised in the diagram shown in Figure 1,[12] which can be seen as a distilled version of Smith and Dean's 2009 model mentioned above. [Smith and Dean, 2009, 19] During the course of the research I established the typology concept as a means to organise the analytic results so that these results could become tools for practical creative work.[13] I have attempted to present the narrative of the dissertation text in a form that explicitly reflects the iterative process.

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[11] Nicholas Cook (1950–) points out that 'there is something paradoxical about the idea of the neutral level, in that it is hard to see how it can be conceived in terms that do not invoke either the poietic or the esthesic, if not both'. [Cook, 2001, 181] Lasse Thoresen (1949–) proposes a solution to this criticism with a reorganisation of Nattiez's 'semiotic tripartition, in which the neutral domain is seen as the *observable aspects* of the esthesic and the poïetic domains, respectively, and its status as an independent domain of research is reduced considerably'. Given Thoresen's terms, my research can be qualified as being focused on both the '[n]eutral side of the poïetic domain' as well as the '[n]eutral side of the esthesic domain'. [Thoresen, 2007*a*, 5]

[12] The pathways in Figure 1 can be described as follows: the repertoire works are subjected to analyses, which inform the typology and composition processes. The composition processes result in the portfolio, which is also subjected to analyses. The typology is created through analysis and feeds back into the analytical and compositional processes.

[13] I have only tested the practical use of typology elements within my own creative practice, but future work could include application of the typology by other users.

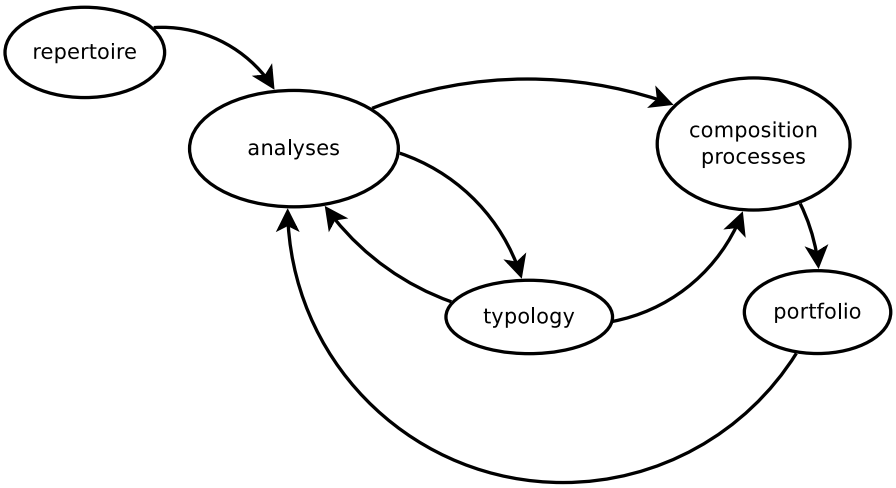

Figure 1: Overview of the research process.

In my compositional activities during the past twenty years, analytic interpretations of specific repertoire, as well as more general analytic views of music and sound, have often served as a key source of stimulation for my imagination. Analysis, undertaken by myself or acquired from published literature, has given me a feeling of grounding on which to organise my ideas for new works, and a basis upon which to relate my musical thought to the wider musical landscape in Western culture. This use of analysis has then become a basis for much of what may be considered as 'parody' in my compositions.[14] I have self-consciously used parody as a key resource, both at auditory and conceptual levels of my compositional activity. In the present research I have continued this approach and have reflected it in my descriptions and commentary on compositional process, while also notating analytic information for development of the typology.

In Chapter 1 I discuss the relevant background literature. While working towards establishing a systematic view of relations between acoustic instruments and electronics, I have found my own adaptation of Lewin's generalised analytic approach [Lewin, 2011*a*]

[14]I refer to *A Theory of Parody* [2000] by Linda Hutcheon (1947–) for analysis of the 'parody' concept, and discuss this in section 1.6.

to be an effective tool for what Strauss and Corbin call 'conceptual ordering'.[15] [Strauss and Corbin, 1998] I give an introduction to the transformation analysis approach in Chapter 2, applied first to Kaija Saariaho's *NoaNoa* (1992) for flute and electronics, and subsequently to the compositional process of my portfolio work *The Ghost of Judith.* The analytic procedure consists of segmenting the work and applying this segmentation into a theoretical space in which 'transformation paths' can be traced. In Chapter 3 I examine the compositional process of *Trio in 3 times 3 rooms* and also adapt soft systems analysis as another analytical tool. This analysis maps relations between components and actors in the performance situation as a 'human activity system'. [Flood and Carson, 1993; Wilson, 2001] Soft system diagrams provide a grounding for matrix representations of points in the performance situation over the duration of a piece, and therefore offer a different, but related perspective to the transformation analysis results. In Chapter 4, through comparative study between analyses of 'transformation paths' in *NoaNoa* and other works by composers Berio (*Altra voce*, 1999), Harvey (*Ricercare una melodia*, 1984) and Lippe (*Music for Clarinet & ISPW*, 1992), I discover some patterns of practice in the ways that various composers change the relations between acoustic instruments and electronics within musical works. This comparative study results in expansions of the typology.

The practice-based research method has been an iterative process of exchange between purely analytic work, creative application of the analytic work and the compositional activities that have generated the new works in the portfolio. I attempt to give a sense of this iterative process through the structure of the text, where commentary on the analytical and compositional activities are interwoven to some extent. The processes of

[15] Strauss and Corbin define '*Conceptual ordering:* Organising (and sometimes rating) of data according to a selective and specified set of properties and their dimensions'. [Strauss and Corbin, 1998, 15] In the present research, transformation analysis gives the basis (set of properties) for the approach to segmentation of the music as well as the approach for extraction of information about the relations between acoustic instruments and electronics (the data) according to the segmentation.

composition are described in Chapters 2, 3, 5, 6 and 7, resulting in the typology of relations between acoustic instruments and electronics which is catalogued in Appendix B. I propose the typology as being usable from both analytic and compositional perspectives; this is supported by its having been developed from the iterations of practice-led research and research-led practice. The scope of the dissertation has only encompassed the testing of usability within my own work, it will be left for future research to test usability by other composers and/or analysts.

The project includes five new works in the composition portfolio, which demonstrate creative applications of the conceptualisations (often the typology elements) derived from the analytic work. The portfolio works have also made an integral contribution to the cumulative analytical results through the iterative research process described above. At various points I have used analytical perspectives of works by other composers (Harvey, Berio, Lewis, Crumb and so on) as a basis for structures, concepts and development of the relations between acoustic instruments and electronics in the new portfolio works. This activity may sometimes result in an explicit intertextual[16] poïesis[17] in the new works. I will not attempt to account for all the semiotic, philosophical or other consequences of such intertextuality, since it would extend the text of the present study far beyond its scope as a PhD dissertation. The focus remains on the development and application

[16]See Graham Allen for a survey of theory on intertextuality. [Allen, 2011] Michael L. Klein states that 'there are simply too many operational definitions of intertextuality to fix upon one'. [Klein, 2005, 12] My use of 'intertextuality' in the research process is what Klein calls a 'poietic intertextuality', which concerns 'those texts that an author [or composer] brought to her writing'. [Klein, 2005, 12] Klein points to a distinction between 'influence and intertextuality, where the former implies intent or a historical placement of the work in its time or origin, and the latter implies a more general notion of crossing texts that may involve historical reversal', but I will not address this distinction as it would be beyond the scope of the present thesis. [Klein, 2005, 4]

[17]The term 'poietic' is used by Nattiez in his semiotic approach to music. [Nattiez, 1990] But I use the word 'poïesis' here to imply a functionality which has a generative role in relation to a musical work, a kind of *allopoïesis*: analysis is generative in that it produces ideas for new compositions.

of the typology that I have derived from the documented analytical and compositional activities.

My commentaries on the portfolio works focus on some of the pivotal choices that I made during the creative work, and especially on how these choices relate to elements and concepts from the typology. The compositional process within each work became a critical discovering and reworking of typology elements, as practice-led research, and each portfolio work resulted in some revisions and/or additions to the typology elements and structure. I have attempted to use the typology elements as a high-level vocabulary to access patterns of practice within the compositional processes of each portfolio work. I expect and argue that the typology should have practical applications for other practitioners as well: from the computer technologist's stance, the typology vocabulary is a high level language, which can be seen as analogous to software design patterns.[18] From the score-writing composer's point of view, the new vocabulary could enable access to integrating dynamic relations between acoustic instruments and electronics in compositional processes. For performers involved in concerts of this repertoire, the vocabulary could potentially facilitate communication and insight into performance practice of the late twentieth and early twenty-first centuries. I have started addressing this in a limited way during critical examination of performance practice of one of my own works (*Sonata Neo-Schubert*) in a 2014 article. [Mogensen et al., 2014] While thorough testing of such compatibility is beyond the scope of the present dissertation, it is my hope that

[18]The book *Design Patterns* by Gamma (et al.) is a key work in the literature on design patterns in object-oriented software programming. [Gamma et al., 1995] These design patterns are reusable abstracted representations of solutions to common design problems. My typology is not focused on programming, and does not follow the format of the Gamma book. Nor does it prescribe 'simple and elegant solutions to specific problems in object-oriented software design.' [Gamma et al., 1995, xi] However, my typology does describe patterns of practice in the relations between acoustic instruments and electronics, and so captures solutions to *compositional problems* regarding the relations between acoustic instruments and electronics, that have been developed in the repertoire that I have analysed.

the typology may help to create conceptual bridges between different activities around the repertoire of score-based music that integrates acoustic instruments with electronics.

Chapter 1

Research context and methodology

The driver for this research has been my desire to gain a more nuanced model of the compositional uses of acoustic instruments with electronics than was previously available. While working on this problem I identified several key concept areas that provided the research context: analytic and creative practice, typology and related categorisation, transformation analysis, interaction and interactivity, listening, composition and performance practice. The analytical and compositional practice forms the core research, which is both practice-based research and research-based practice, presented with an autoethnographic narrative, as was discussed in the Introduction. The typology concept (discussed in section 1.1) is an organisational tool for the analytic products of the research, while the portfolio is the medium for the compositional products of the research and, although they are presented separately, the typology and portfolio have grown in tandem. The typology is based on transformation analysis, as will be discussed in section 1.3, and is grounded in a particular approach to categorisation, as discussed in section 1.1. The result of this combination of concepts is that the focus has become one of *paths*

of change among varying relations between acoustic instruments and electronics. These paths of change are abstractions that I link to soft systems interpretations of the music works, as introduced in section 1.2. The typology results from the iterative analytical-compositional process and the documentation of this process is a key contribution of the research. The objective of the research documentation is therefore to provide a coherent typology, an artistically meaningful portfolio, and to provide sufficient clarity in the research narrative around the iterative analytical-compositional process so that it might be repeated by other researchers working in other musical and technical contexts. In order to provide a robust background for the typology and creative portfolio, I examine approaches to listening, notating and understanding electronic sound in section 1.4. Furthermore, some biases in the research and creative processes are addressed in section 1.5. The use of analysis as a tool for composition has resulted in a distinctly parodic aspect in the portfolio works, and the concept of 'parody' is explicated in section 1.6.

1.1 The *typology* concept in the context of 'interactivity' and 'relations between acoustic instruments and electronics'

A *typology* is commonly understood as a collection of types that are presented within a system of broader categories. Typologies have been proposed in many fields including: Lang's 'typology of urban design'; [Lang, 2012, 44] Persson's 'Typology of Interactivity Functions for Visual Map Exploration'; [Persson, 2006] Schaeffer's 'typomorphology', or typology of sound morphology; [Schaeffer, 1966] Uspensky's 'typology of compositional options in literature as they pertain to point of view'. [Uspensky, 1973, 5] All of these typologies are constructed by using categories of 'objects', organised in some systematic way. I have attempted to ground my implementation of categories in linguistics, specif-

ically in George Lakoff and Mark Johnson's theory of categorisation[1] and evoke what Lakoff calls 'prototype theory': for 'something' to be a specific type, it will have to be identifiable as having characteristics that approach the prototype characteristics, to a degree that makes that 'something' acceptable as an instance of that specific type. [Lakoff, 1987, 58–67] I have attempted to apply this paradigm in identifying and describing types, since an essential feature of Lakoff's prototyping concept of categorisation is that these do not have sharp boundaries. Unlike 'classical categorisation' where something is either inside or outside a category, Lakoff claims that inclusion in a category is a matter of degree of similarity to the prototype of that category. [Lakoff, 1987] This kind of flexibility in the idea of categories is useful for defining types and super-types in the hierarchy of my typology, as will be seen in the discussions in later chapters.

Some categorisations of relationships between acoustic instruments and electronics exist in research literature on computer music. Robert Rowe (1954–) has proposed a few general categories. [Rowe, 1993, 2000, 2001, 2009] They tend to be formulated either from the stance of examining the functionality of the electronics in relation to the acoustic sound, in other words what the electronics *do* to the acoustic sound: whether the electronics expand the sounds of the acoustic instrument, or whether they have an independent role. He categorises accordingly. In the two books entitled *Interactive Music Systems*, and *Machine Musicianship*, Rowe proposed a taxonomy which polarised what he called the 'instrumental paradigm' and the 'player paradigm' in interactivity. The 'instrumental paradigm' aspect is present when the computer-parts of the works can be heard as extending the sounds of the acoustic instruments performed. Rowe describes this as follows: 'performance gestures from a human player are analysed by the computer and guide an elaborated output exceeding normal instrumental response.' In Rowe's 'player

[1] Lakoff and Johnson's 1980 book *Metaphors We Live By* is a key text on their theory for understanding metaphor and categorisation. [Lakoff and Johnson, 1980] Raymond W. Gibbs Jr. [1992] puts Lakoff and Johnson's work in the context of a large collection of literature on metaphor theory.

paradigm' the computer exhibits more independence as 'an artificial player, a musical presence with a personality and behavior of its own, though it may vary in the degree in which it follows the lead of the human player.'[2] [Rowe, 1993, 8]

Rowe also distinguishes between 'score-driven systems' and 'performance-driven systems'. For the former he specifies that '[s]core-driven programs use predetermined event collections, or stored music fragments, to match against music arriving at the input'. For the latter, contrasting idea, he elaborates that '[p]erformance-driven programs do not anticipate the realisation of any particular score'. [Rowe, 1993, 7] In those classifications, he is concerned mainly with MIDI-based data manipulations, which can be seen as a high-level precursor to the more low-level direct real-time spectral analysis data manipulations which are now practical on twenty-first century personal computer systems.[3] Rowe evaluates contemporary developments in interaction as a gradual hybridization between systems that reference audio signals and systems built around the high-level objects available in MIDI representation. He argues that: '[s]ub-symbolic systems are rich in spectral information, but deliver fewer high-level objects for manipulation... [and] we are seeing a growing convergence between the two approaches as better content descriptions evolve'. [Rowe, 2009, 40] The programming of these types of hybrid systems is facilitated by a number of currently available specialised programming environments.[4]

[2]Simon Emmerson implicitly extends Rowe's two paradigms: 'The first continues the very notion of the instrument as extension of the human body... the computer becomes an appendage capable of transcending both the physical limitations of size and maybe soon the mental limitations of the human brain.' Emmerson furthermore describes the second paradigm: 'we can see the computer as generating *another performer*... This added musician may progressively be gaining almost human characteristics such that the equivalent of a Turing test might be some measure of successful performance.' [Emmerson, 2009, 168-169]

[3]MIDI is the acronym for Musical Instrument Digital Interface, a protocol 'designed for real-time control of musical devices'. [Roads, 1996, 972]

[4]Some examples of software environments that are designed for use in programming interactive music: *MaxMSP* is available from www.cycling74.com (accessed March 6, 2016).

In his 1993 book, Rowe classified response methods of an interactive computer system as: 'transformative, generative, or sequenced.' [Rowe, 1993, 7] In recent music works, all of these response methods may coexist in a single composition. While Rowe's classifications seem very general, they do provide some interesting conceptual points of departure for the development of new analytical frameworks.[5]

Many directions related to 'interactivity' have been actively pursued in the music research community during the past two decades, including: Winkler's composition approaches to interactivity; [Winkler, 1998] work on gesture recognition; [Camurri and Volpe, 2004; Overholt, 2009; Wanderley and Battier, 2000] interactivity as applied to specific instruments such as Nicolls [2010] on the piano and Bassingthwaighte [2002] on the flute; real-time score generation; [Kim-Boyle, 2010] interactive improvisation machines; [Lewis, 2000; Rowe, 2001] and interactive music in video games. [Collins, 2009] Elizabeth McNutt argued that 'performance[s] may be described as "interactive" on many levels'. [McNutt, 2003, 297] Mike Frengel includes 'interactivity' as a node in his 'multidimensional framework of relations between live and non-live component pairs in mixed works'. [Frengel, 2010, 96] Contemporary composer/researchers sometimes document their ideas and developments of interactive computer works, often with a focus on technical issues, some examples include: Cort Lippe[6] [1993; 1994; 1996; 1997*a*; 1997*b*; 2002] and Marinos Koutsomichalis [2011].

PureData is available from http://puredata.info (accessed March 6, 2016).

SuperCollider is available from http://supercollider.github.io (accessed March 6, 2016).

IntegraLive is available from http://www.integralive.org/ (accessed March 6, 2016).

EyesWeb is available from http://www.infomus.org/eyesweb_ita.php (accessed March 6, 2016).

[5] In Chapter 2 I discuss a system of four 'interactivity types', which I developed by building on Rowe's categorisations. But this categorisation system provided only superficial analytic results, as I discuss in relation to the composition process of *The Ghost of Judith* in section 2.4.

[6] Papers by Cort Lippe are available as pdf files at
http://www.music.buffalo.edu/faculty/lippe (accessed March 17, 2016).

George E. Lewis called his work *Voyager* (1987) an 'interactive computer music system', and 'conceive[s] a performance of *Voyager* as multiple parallel streams of music generation, emanating from both the computers and the humans – a nonhierarchical, improvisational, subject-subject model of discourse, rather than a stimulus/response setup.'[7] [Lewis, 2000, 34] In a 2009 article he stated that '[t]he improvised, interactive encounter becomes a *negotiation*, in which decisions taken by the computer have consequences that must be taken into account by all the parties to the exchange'. [Lewis, 2009, 462] The terms 'interactivity' and 'interactive' have also been used in many other contexts such as an '[i]nteractive music composition system', [Unehara and Onisawa, 2004] an 'interactive evolutionary system', [Moroni, 2000] an '[i]nteractive swarm orchestra, a generic programming environment for swarm based computer music', [Bisig et al., 2008] as well as in William M. Newman and Michael G. Lamming's textbook on human-computer interaction in general software contexts. [Newman and Lamming, 1995]

In the wider field of Human Computer Interaction (HCI), the 2007 textbook *Human-Computer Interaction* by Alan Dix (et al.) points to 'Norman's *execution-evaluation cycle*' as 'the most influential model of interaction'. [Dix et al., 2007, 124] According to Dix, the 'interactive cycle of this model' has 'two major phases: execution and evaluation' consisting of seven 'stages' that form the goal-oriented activities of the human user of a computer system. Dix states that 'Norman uses this model of interaction to demonstrate why some interfaces cause problems to their users... in terms of the *gulfs of execution* and the *gulfs of evaluation*'. [Dix et al., 2007, 125-126] It is a model intended to provide tools to improve usability of computer system interfaces; and this would appear to be useful for the development of the software on which computer music is based. As discussed in the Introduction (see page 4), the focus of this research is on identifying patterns

[7] I propose an analytic view of Lewis' *Voyager* in section 7.2, and use this in the compositional process of the portfolio work *Paese favola*.

of practice; to systematically evaluate the effectiveness of software interfaces of such patterns is beyond the scope of this dissertation.

Some writers propose explicit definitions of 'interaction' and 'interactive'. Rowe starts his 1993 book stating that '[i]nteractive computer music systems are those whose behavior changes in response to musical input'. [Rowe, 1993, 1] In his essay 'The aesthetics of interactive computer music', Guy Garnett proposes a definition that '[i]nteraction has two aspects: either the performer's actions affect the computer's output, or the computer's actions affect the performer's output'. [Garnett, 2001, 23] While writing about practice in distance education with human computer 'interaction', Ellen D. Wagner proposes that '[s]imply stated, interactions are reciprocal events that require at least two objects and two actions. Interactions occur when these objects and events mutually influence one another.' [Wagner, 1994, 8] But defining 'interaction' or 'interactivity' is not necessary for the present research, instead I have focused on *the relations between acoustic instruments and electronics*. Whether or not instances of these relations are considered to be 'interactive' or to include 'interactions' or 'interactivity' is not decisive for the relevance of such instances to the typology. It will suffice to define these 'relations' in an adaptation of Wagner's definition as: describable influences between two objects in a music performance situation. In the works (by Saariaho, Berio and others) analysed here, the two objects are usually a musician (or a group of musicians) and a computer.[8]

The idea of the *relations between acoustic instruments and electronics* being defined primarily as describable influences, gives a basis for segmenting music and looking for such relations within the musical work. But the choice of an analytical technique that will allow consistent and comparable interpretations of the segmentations across different works is crucial. I will first discuss the possibility of 'soft systems analysis' in section 1.2, in which I describe the performance situation as a system, so that I might identify

[8]One exception is Harvey's *Ricercare una melodia* which uses analogue tape delay in the original version; this work is examined in section 4.4.

the characteristics of such a system. This approach can work as an extension of previous work by Rowe and others as discussed above. But during the research I have found that relevant patterns of practice appear through the use of transformation analysis, and that the results of this approach to analysis have been more useful within the compositional processes of the portfolio works. Transformation analysis will be introduced in section 1.3 and subsequently applied as the pivotal analytical approach in the research.

1.2 Using *Soft Systems Analysis*

Early in the research process I investigated the possibility of viewing 'interactivity' as Human-Computer Interface, and I looked for a method to concisely indicate such an interface in a manner that could facilitate comparisons between diverse musical works. This was perhaps symptomatic of a bias in my presumptions, that 'interactivity' was a key concept, and that such a human-computer interface was to be based on two-way sound analysis: the musician listens and adapts his/her interpretation of the score to what he/she hears in the computer sound, and the computer analyses the playing of the musician(s) and changes the electronic sound output according to this analysis.[9] This conception of 'interactivity' is based on an information feedback cycle between computer and performers which gives the possibility of unique musical events in each performance. Part of the attractiveness of the conceptualisation of 'interactivity' is that it points to many musical possibilities that do not exist with fixed electroacoustic parts (on tape or CD) since the interactivity of the computer program allows the electroacoustic music to adapt to variations in the musicians' interpretations of the scores.

In order to attempt an analytic view of the human-computer interface idea I adapted the method of *Soft Systems* analysis as discussed by Flood and Carson [1993], Checkland [1981] and Wilson [2001]. Soft system analysis is an approach that calls for diagrammatic

[9]This is reminiscent of Garnett's 2003 definition of 'interaction' mentioned on page 19.

visual mapping of the elements and the connections between elements of a system.[10] I took as a premise that in their performance situations, score-based concert works could be understood as 'Human Activity Systems', within the framework and methodology of Soft Systems Theory. Flood distinguished between 'structural' and 'behavioural' modelling approaches to system identification. [Flood and Carson, 1993, 71] Applying Flood's view to the music performance situation, a basic premise would be that there exists a collection of physical elements necessary for a performance of a musical work to exist, which we can identify following a structural modelling approach. This necessary collection of elements will vary from work to work, according to instruments and equipment needed, musicians and technicians required, and the physical media which carry the information about the composition. In the works examined in the present research these physical elements will be specified to some extent in the score of a particular work. So, the model of a given piece begins with a structural model approach, based on the physical elements specified in the score of the piece.

The soft systems diagrams can show the 'objects' and the routes which 'influences' can take between these objects. [Flood and Carson, 1993] I apply this concept in my soft system diagram of the performance situation of Kaija Saariaho's *NoaNoa* for flute and electronics as shown in Figure 1.1. In this diagram physical 'objects' are named within rectangles, persons in ovals and arrows indicate what I interpret to be directions

[10]Soft systems analysis has mainly been developed for applications in economics, business studies and other social system modelling. Some adaptations of the method was necessary. The CATWOE test [Wilson, 2001, 24-28] of 'Root Definitions' had to be redefined for the current research in music performance systems. These systems have sets of purposes and structures that are significantly different from those of business systems models. In a larger cultural context, the CATWOE test may be applicable to modelling music works, but the current research is at a low-level resolution where the involved processes of the system are taken to be essentially self-contained, and the basic purpose of the system is taken as a given: to realise the manifestation of a given work in a performance space.

of 'influences' between these objects, all within the performance situation of the work *NoaNoa*.[11]

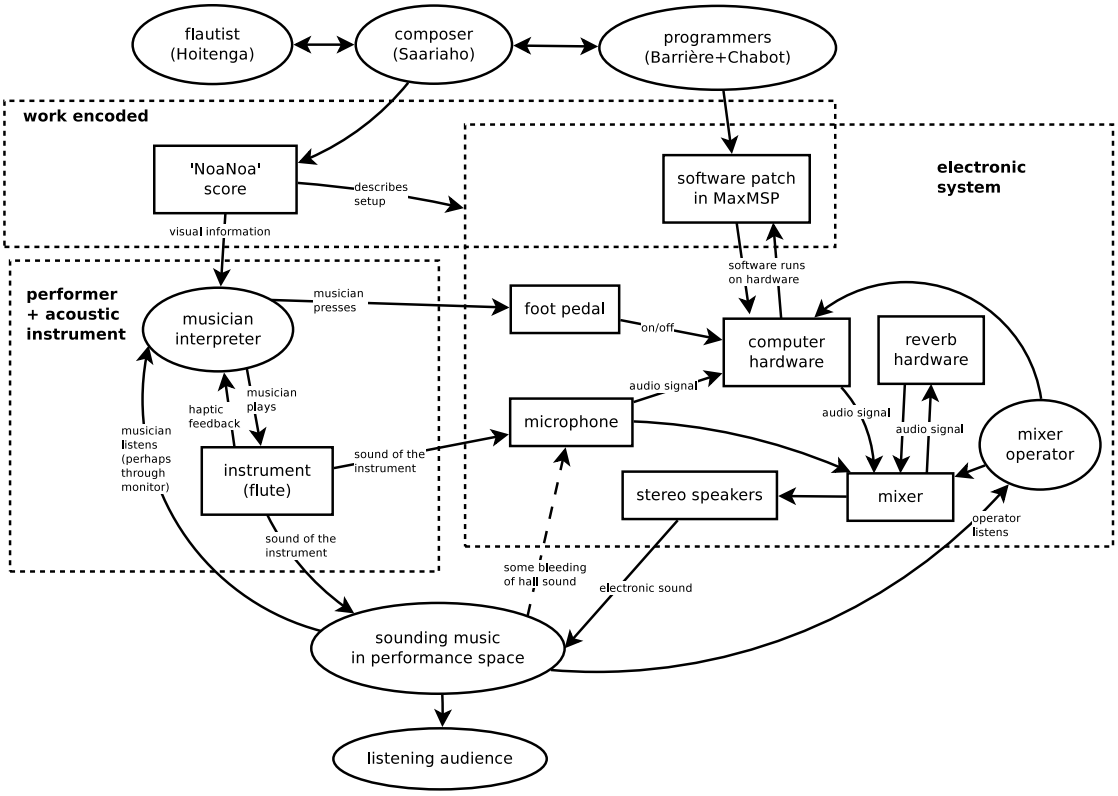

Figure 1.1: Soft system diagram of Saariaho's *NoaNoa*, indicating components and connections.

We can represent the components and connections of the soft system analysis as a

[11]Some issues with making soft systems diagrams in this context can be formed as questions: How do we obtain consistency in interpreting flows of influence between components in the systems? How are various types of influences to be defined: Interpretation, Audio Streams, Control Level Streams, Coding Protocols, and more? Are there logical thresholds for what can be considered influence? How can we consistently evaluate flows of influence? What are the influences of the audience on performers? I will not attempt to answer these questions, instead I accept the soft systems analysis as being a subjective interpretation of the apparent physical and digital virtual components, and the apparent physical and digital virtual connections between these components.

collection of System Signal Paths (SSP) between the acoustic instrumentalist and the electronics:

SSP(1) = musician→foot pedal→computer(software) = $m1 \rightarrow fp \rightarrow c(sftw)$.

SSP(2) = musician(flute)→microphone→computer(software) = $m1(fl) \rightarrow mic \rightarrow c(sftw)$.

SSP(3) = musician(flute)→sounding music = $m1(fl) \rightarrow snd$.

SSP(4) = computer(speakers)→sounding music = $c(sftw \rightarrow spkr) \rightarrow snd$.

SSP(5) = sounding music→musician(ears) = $snd \rightarrow m1(ear)$.

The SSP shorthand representation can be represented as a vertical array such as shown in Figure 1.2. As will be discussed later in Chapter 2, we can use basic operations to represent changes in the system over time, which allows a linking between the soft system view and the more detailed transformation analysis of changes in the relations between acoustic instruments and electronics. I will use soft systems analysis only as a supportive view, which does not feature substantially in the final typology. In the chronology of the research process I started applying soft systems analysis early on as will be discussed in section 2.4. The usefulness of this approach was soon eclipsed by my adaptation of transformation analysis. Transformation analysis is effective as a method to describe how the system behaves over time, and some background on transformation analysis is discussed in section 1.3.

$$\begin{pmatrix} m1 \rightarrow fp \rightarrow c(sftw) \\ m1(fl) \rightarrow mic \rightarrow c(sftw) \\ m1(fl) \rightarrow snd \\ c(sftw \rightarrow spkr) \rightarrow snd \\ snd \rightarrow m1(ear) \end{pmatrix}$$

Figure 1.2: Vertical array representation of the soft system diagram of Saariaho's *NoaNoa*.

1.3 Transformation analysis: Lewin's *Generalized Interval System* (GIS)

As mentioned in section 1.1, I have chosen to adapt David Lewin's transformation analysis as the central analytic tool for generating the typology. This choice of analytical approach results in patterns, which I have found more useful, as compositional tools, than the classifications by Rowe and others discussed in section 1.1. I will give some brief background of the approach in the following text, and apply transformation analysis to musical works in Chapters 2–7.

My application of Lewinian transformations is a formalist analytical approach that gives a reductive view of the music examined. This approach has both advantages and disadvantages. A particular advantage is that the distillation of the musical material, guided by the analytical objectives, results in very succinct analytical results (examples can be seen in Appendixes A and B) which are rich in information regarding the relations between acoustic instruments and electronics. The analytical reduction, with consistent notation, allows the identification of transformation paths,[12] which are relatively simple elements that can be used for comparative study across works by Saariaho, Berio, Harvey and other composers. Furthermore, the results of such comparative study can be organised in the form of a typology such as is shown the typology hierarchy map in Appendix B.1 which can be read as a map of patterns of practice.[13]

My transformation analysis has been focused on the relations between acoustic instruments and electronics and, through reduction, ignores some details of pitch-based musical structures as well as ethnographic concerns regarding the repertoire works examined. This reductionism is arguably a disadvantage of the approach since there is a possibility that relevant information may be omitted. There may also be some bias

[12]See Chapter 2 for details of the analysis approach.

[13]I return to this point in the discussion regarding Figure 8.1 in Chapter 8.

inherent in my choices regarding which aspects of the music I focus on; in other words, the aspects that I have judged to be relevant to the analytical goals.[14] However, I have attempted to make the analytical context as clear as possible and argue that I have achieved 'a certain degree of distance from the research materials' which I propose as 'weak' objectivity. [Strauss and Corbin, 1998, 35] Furthermore, the reductiveness of the formal analysis is complemented with autoethnographic narrative which details the 'personal and experiential' context of the analysis and its applications in the composition processes of the portfolio works.[15] [Adams et al., 2015, 102]

David Lewin's published analyses are for the most part focused on formalising analytic spaces describing pitch-class transformations. Two key examples of Lewin's work are the books *Generalized Musical Intervals and Transformations* and *Musical Form and Transformations*. Lewin [2011*a*,*b*] In Chapter Four of the first of these books he presents analyses of works that generalise the intervallic concept to models of time and timbre. The basic operation of his approach is to segment a musical work according to analytic goals and then to map this segmentation onto a theoretical transformation space. The segmentation provides points in that space, and transformations that create paths between these points can then be described. Relations between paths and points in the theoretical space can then be used to examine the structure of a given piece.[16] Lewin points out that his networks show transformation possibilities in the theoretical space, rather than a listing of applied transformations from a compositional process. The theoretical space is not an imitation of the practical transformations actually performed by the composer during his/her creation of the piece. Instead, the analysis results are gen-

[14] I discuss more potential biases of the research approach in section 1.5.

[15] I discuss objectivity and autoethnography further, in relation to the research, in Chapter 8.

[16] Satyendra [2004] has given a brief introduction to Lewin's analytical approach from a music analysis point of view. Hall [2009] wrote a review of Lewin's books from a mathematician's perspective.

erated from what in Nattiez's terms would be a purely 'esthesic' or audience viewpoint. [Nattiez, 1990]

Lewin's use of 'Generalized Interval Systems' [Lewin, 2011*a*] as an analytic tool has been subject to critical extensions in literature on music theory. Of particular relevance to this thesis is an inconsistency in Lewin's formalism, whereby Lewin is assuming the numerical value assignments to pitch-class intervals are 'natural' while also stating that pitch classes 'acquire their numerical names in an arbitrary fashion' as noted by Dmitri Tymoczko. [Tymoczko, 2008, 168] Tymoczko argues that the labels in different spaces are not necessarily related, even if they are assigned identical symbols, because the references of the symbols are not necessarily related.[17] In other words, the arbitrary assignments of numerical values to elements in one space do not relate the elements of this space to those of another space that perhaps are also labelled with the same numerical values.

I will take these criticisms to mean that such inconsistency in symbol references is a consequence of the contextual aspect of Lewin's transformation analysis, in that the characteristics and representations of the theoretical space of one musical work will not necessarily be consistent with those of the theoretical space of another musical work. But this does not exclude the possibility of comparing transformation relationships (or transformation paths) between different theoretical spaces: points in two spaces may not have equivalent signified musical materials, but the transformations that lead to or from each point may still encode (or signify) comparable or even equivalent transformational processes.[18] This potential equivalence of transformation paths will be examined further in the comparative analysis of repertoire works in Chapter 4, and it is a central con-

[17] Tymoczko's article is a response to extensions of Lewin's transformation theory proposed by Julian Hook. [Hook, 2007]

[18] Allen gives an introduction to Saussure's 'definition in which a [linguistic] sign can be imagined as a two-sided coin combining a *signified* (concept) and a *signifier* (sound-image)'. [Allen, 2011, 8]

cept for the development of the typology of relations between acoustic instruments and electronics.[19]

Tolga Tüzün has provided an exploration in contextual transformation analysis of timbral spaces. [Tüzün, 2008, 2009] His analysis of Tristan Murail's work *Winter Fragments* (for six instruments and electronic sound, 2000) is based on his own segmentation of 'timbral classes' in the published score. His focus is on 'how to organize theoretical constructs based on timbral objects and their transformations in a musical composition', and he aims 'to uncover/discover contextual group operations in a timbral space'. [Tüzün, 2009, 11] This idea of 'timbral objects' is useful, but he only applies it to electronic sound in the form of a fixed media recording.[20] This is insufficient for describing the *relations between acoustic instruments and electronics* in works where the electronics are performed in a more active manner such as when a computer generates the electronic sound during a performance, with variations in this computer sound being linked to sound analysis of musician performance.[21] To achieve more inclusive analytical views of these kinds of works, I adapt Lewin's transformation analysis by specifying Timbre-Pitch Classes (TPC) based on my own segmentation. These TPCs include descriptions of pitch and timbre dimensions together with signal paths which enable the inclusion of more detail about relations between acoustic instruments and electronics. I illustrate this

[19]In other words, I am taking a purely transformational perspective without any attempt at addressing Lewin's 'Cartesian perspective' which would involve quantifying intervals in transformation spaces. [Lewin, 2011*a*, 157–160] These two perspectives are not mutually exclusive, Lewin argues that '[the transformation attitude] enables us to consider intervals-between-things and transpositional-relations-between-Gestalts not as alternatives, but as the *same* phenomenon manifested in different ways'. [Lewin, 2011*a*, 159]

[20]I return to Tüzün's work on page 65.

[21]These are often works that might be called 'interactive' as discussed in section 1.1. Examples of this kind of performance situation will be examined in the repertoire works and portfolio works in Chapters 2–7.

kind of analytic view in Chapter 2, with analysis of Saariaho's *NoaNoa* and subsequently use it throughout the dissertation as a basis for deriving elements for the typology of relations between acoustic instruments and electronics. There are some precedents to Tüzün's work on segmenting timbral spaces, but these generally use conceptions other than transformation analysis. These are found in an extensive literature focused on the acts of listening to and writing analysis of acousmatic music, and on engaging in the production of 'listening scores'. While it has not been constructive to attempt to incorporate the approaches from this literature directly into the typology development, they do form a useful background study for understanding the perception of electronic sound in mixed works. I will survey some of these sources in the following section 1.4 and point to concepts that I have used in the research.

1.4 Approaches to listening and to representing electronically-generated sound

Electroacoustic sound[22] is by definition a constituent element of mixed works. In many cases the electroacoustic sound of a mixed work does not conform to the assumptions of traditional score-oriented analytic interpretations; instead other approaches have been devised for representing electroacoustic or acousmatic sound. Pierre Schaeffer (1910–1995) pioneered a phenomenological approach to sound which has had an impact on

[22]Leigh Landy (1951–) has discussed a variety of terms and definitions used for electronic sound, with an emphasis on language use in Romance and Germanic languages, and prefers the general term '*sound-based music*' in his 2007 book. [Landy, 2007, 9–19] He does point to the terms 'computer music' and 'electroacoustic music' which could cover many of the works included in the present research. But 'computer music' tends to imply *digital* computers, while a work like Harvey's *Ricercare una melodia* employs analogue tape recorders in its original version. In the present context the term 'electroacoustic sound' seems best for covering sound/music from both analogue and digital systems and I will tend to use that term.

much of the subsequent published literature concerning acousmatic music. [Schaeffer, 2012, 1966; Schaeffer and Reibel, 1998]

In 'The Concrete Experiment in Music', Schaeffer argued for the concept of the 'sound object' or 'sound being' which 'evoke[s] neither pure music nor drama' but fills the 'whole space... between the musically and the dramatically explicit'. He also proposed that a recording of sound would 'contain the "musical object" in material form'. [Schaeffer, 2012, 134] As documented by the book *In Search of a Concrete Music* he directed his investigations to go beyond the 'consequences of limiting music to notatable, performable sounds'. [Schaeffer, 2012, 135] In their 'Outline of a Concrete Music Theory' Schaeffer and Abraham André Moles (1920–1992) proposed an approach to sound object classification using 'three dimensions of pure sound' to arrive at criteria of 'sound families'. [Schaeffer, 2012, 191–221] Schaeffer's concept of 'sound object' was 'grounded in (although not limited to) studio practices of the immediate postwar [World War II] period.' [Schaeffer, 2012, xi] Even so, the concept of the 'sound object' is useful for segmenting sound events for analytical interpretations in mixed music and I will refer to this concept sometimes during the narrative of the analytical work in this thesis.[23]

Denis Smalley (1946–) built on Schaeffer's phenomenological approach in order to formulate a system for describing the listening experience of electroacoustic music. [Smalley, 1997, 1986] Smalley called this system 'spectromorphology' and proposed the approach as 'a descriptive tool based on aural perception'. [Smalley, 1997, 107] He defined a system of psychoacoustic interpretations which provided the discursive basis for his understanding

[23]Albert S. Bregman proposes a concept of an 'auditory stream' which he defines as 'our perceptual grouping of the parts of the neural spectrogram that go together'. [Bregman, 1994, 9] He 'refer[s] to the perceptual unit that represents a single happening as an auditory stream', where 'a physical happening (and correspondingly its mental representation) can incorporate more than one sound'. [Bregman, 1994, 10] I interpret Bregman's 'auditory stream' as being equivalent to the Schaefferian 'sound object' concept, but to thoroughly investigate this equivalence is beyond the present scope and will be deferred to future research.

of spectral change in music. His assignments of psychoacoustic meanings to sound experience were personal and sometimes seem rather limiting. For example, Smalley wrote of the possibilities that 'true musical meaning is blocked' when an apparently incorrect 'mode of listening' is employed by the listener. [Smalley, 1997, 109] Such an instance would seem to exclude meaning from any work which might happen to ask the listener to employ that particular 'mode of listening'.[24]

Smalley's theory of spectromorphology has had a significant influence on the acousmatic research community, and has provided the basis for numerous articles that have developed his approach (some examples include Blackburn [2011], Klien et al. [2010], Nyström [2011] and Tanzi [2011]). For my own creative practice and typology development, Smalley's specific assignments of ideological and psychoacoustic meanings to sound experiences do not seem to facilitate the understanding of the relations between acoustic instruments and electronics in mixed works. But as we will see beginning in Chapter 2 and throughout the following chapters, I do interpret experiential contents in a descriptive way and use this as part of the basis for identifying typology elements. However, as will be noted again later in this section, I am also investigating composer *intentions* that are indicated in the written score and computer codes, which is an area Smalley does not cover in his spectromorphology.

Robert Cogan (1930–) proposed an approach to understanding spectral change in sound, a 'Theory of Oppositions', which was based on paradigmatic relations between sonic categories as documented in his book *New Images of Musical Sounds*. [Cogan, 1984, Chapter 5] In summary, Cogan quoted N. S. Trubetzkoy as arguing that the key 'concept

[24] The concept of 'mode of listening' seems rather close to the concept of 'aesthetic attitude' which George Dickie argues is a 'myth' which 'no longer seems to say anything significant'. In Dickie's analysis the definition of 'aesthetic attitude finally turns out to be simply attending [to the artwork]', in other words: it is simply paying attention to the music. [Dickie, 1987, 114] I will defer a more in-depth analysis of the concept 'mode of listening' to future work, as it would be beyond the scope of the present thesis.

of distinctiveness presupposes the concept of opposition. One thing can be distinguished ... only insofar as it is contrasted with or opposed to something else.'[25] [Cogan, 1984, 125] [Trubetzkoy, 1969, 31] Cogan proposed 'thirteen opposing characteristics by which every musical sound distinguishes itself in its sonic context'. [Cogan, 1984, 126] These opposition pairs were named and defined as descriptions of relative characteristics of spectrograms within the context of a musical work, and were to be evaluated, for any instance of a sonority, as negative (−), positive (+), mixed (±), or neutral (Ø). Such evaluations provided indications of directions of changes in spectra over time. Cogan emphasised that 'the oppositions [were] to be regarded contextually and relatively, rather than absolutely'. [Cogan, 1984, 133] With his 'table[s] of oppositions' Cogan looked for 'archetypes of sound shapes' which he regarded as structurally defining characteristics of musical works. [Cogan, 1984, Chapter 8]

While spectrograms can be useful tools for working with sounds in the electronic context, Cogan's system of opposing characteristics does not seem to distinguish very well between concurrent sounds, and so cannot address the relations between acoustic instruments and electronics in mixed works. However, I do employ the concept of opposing qualities to distinguish some typology elements.[26] During composition and analysis work I have used spectrograms for orientation in sound recordings on some occasions, but without formalising categories in the sense undertaken by Cogan. As a result these spectrograms do not feature as a necessary tool for my typology development.[27] Cogan's

[25]This idea echoes Saussure as discussed by Palmer: 'The paradigmatic relations are those into which a linguistic unit enters through being contrasted or substitutable, in a particular environment, with other similar units.' [Palmer, 1981, 67]

[26]One example is in the difference between 'DRY' and 'FREEZE' as will be discussed in section 2.1.

[27]I do not mean to imply any dismissal of the usefulness of spectrograms to analysis in general. Spectrograms have been fruitfully used for analyses of electroacoustic music by other researchers, as is evident in books such as *Analytical Methods of Electroacoustic Music* edited by Mary Simoni [2006] and *Electroacoustic Music: Analytical Perspectives* edited by Thomas Licata [2002].

emphasis on the context-dependency of his analysis is also echoed in my use of Lewinian transformation analysis, as discussed in section 1.3.

Lasse Thoresen (1949–) adapted Schaeffer's typomorphology [Thoresen, 2007*b*; Thoresen and Hedman, 2009, 2010] and developed what he called 'aural sonology'. [Thoresen, 2007*a*] With this work Thoresen provided a system of categories for electroacoustic or acousmatic music.[28] He has also developed a symbol set entitled 'Sonova' for notation in analytical listening scores of electroacoustic music.[29] Thoresen presents his symbol system for 'Spectromorphological analysis of sound objects' [Thoresen, 2007*b*] and applies it in an analysis of the work *Les objets obscurs* by composer Åke Parmerud. [Thoresen and Hedman, 2009] Thoresen built his system on Schaeffer's typomorphology, [Schaeffer, 1966] but he extended and revised Schaeffer's concepts, and proposed that 'Schaeffer's typomorphology could be made into a better tool for practical analysis'. Thoresen then presented 'a set of conceptual and graphic tools for the aural analysis of music with an enriched sonic morphology'. [Thoresen, 2007*b*, 129–130] He put his approach in a semiological context based on the theory from Nattiez [1990], but modified his 'semiological tripartition', so that the 'neutral domain' of the sound work object overlapped with the 'esthesic' and 'poïetic'[30] domains. [Thoresen, 2007*a*, 4–7] In this way, Thoresen adapted a theoretical basis that required the listener to actively determine the listening mode employed. Thoresen argued that '[t]he neutral side of the esthesic domain must be constituted by an act of the listener through his choosing the requisite listening intention'. [Thoresen, 2007*a*, 6] So in his view, the listening intentions are to be chosen by

[28]Normandeau has also proposed a revision of Schaeffer's typomorphology, but it is not as extensively developed an analytical tool as Thoresen's system. [Normandeau, 2010]

[29]The *Sonova* font of signs for Spectromorphological analysis of sounds is available from: http://www.spectromusic.com/downloads/downloads.html (accessed Jan.5, 2012).

[30]Thoresen uses the spelling 'poïetic' [Thoresen, 2007*a*, 5] while the Abbate translation of Nattiez uses 'poietic'. [Nattiez, 1990, 15]

the listener, and the choice is to be made explicit.[31] As a consequence, aspects of the listening intentions should then be communicated in parallel with the notated material, as part of the analytical process. The requirement of analytical contextualisation is of course central to the present thesis. However, my analytic listening intentions in this research are only partially oriented towards notating sound, and this is only as support for notating changes in the relations between components generating that sound: the acoustic instruments and the electronics.

In his 2003 book *L'analyse des musiques électroacoustiques: modèles et propositions*, Stéphane Roy (1959–) employed a pictographic approach to create an analytical representation of the work *Points de fuite* by composer Francis Dhomont (1926–). Roy attempted to create 'an inventory of morphological units' which would function as a representation of 'the neutral level' of the music work. [Roy, 2003, 201-214] Roy used principles from Nattiez's semiological approach[32] to structure his analysis of electroacoustic music, and

[31] See also Thoresen's discussion of 'listening intentions'. [Thoresen, 2007*b*, 132] Here I take 'listening intentions' to mean *analytical* intentions, implying a reductive approach, and so Thoresen's 'listening intentions' would not be seen as a version of Dickie's 'aesthetic attitude' mentioned on page 30. [Dickie, 1987]

[32] Jean-Jacques Nattiez [1990] theorised a 'Semiological Tripartition' where the 'neutral level' was a physical 'trace' of the work, as I mentioned in the Introduction. In the case of an acousmatic work the recording would probably be considered the 'trace'. Roy used Nattiez's 'Semiological Tripartition' which has three 'objects': '(1)the poietic processes (2) the esthesic processes (3) the material reality of the work (its live production, its score, its printed text, etc.) – that is, the physical traces that result from the poietic process'. [Nattiez, 1990, 15] The 'neutral level' or 'trace' of the musical work is then (3) which he also described as: 'the symbolic form [of the work] is embodied physically and materially in the form of a trace accessible to the five senses'. [Nattiez, 1990, 12] The 'poietic processes' are the processes of creating the work, while the 'esthesic' processes are the processes of reception, the experience of listening to the work. [Nattiez, 1990, 17] Given these three objects, Nattiez emphasised '[t]hree families of analysis [that] correspond to these three objects' giving: '(1) poietic analysis (2) esthesic analysis (3) analysis of the work's immanent configurations (of the trace); that is, analysis of the neutral level'. [Nattiez, 1990, 15]

to examine an array of writers on sound morphology analysis (Schaeffer, Smalley, Cogan and others). He proposed pictographic representation as a general approach to creating 'listening scores'[33] and provided a key to describe the sound characteristics that he intended to represent with pictograms in his listening score of *Points de fuite*. This pictogram key named contrasting metaphors in order to describe pictograms representing sounds, which formed the elements of his 'inventory'. [Roy, 2003, 210-212] In his listening score, the pictograms are placed in sequence, on a left to right timeline. Roy used this pictographic representation of the 'neutral level' as the basis for further analytic development in his 2003 book, drawing on theorists such as Nicolas Ruwet, Leonard Meyer, Fred Lerdahl and Ray Jackendoff. [Roy, 2003, Chapters VII-X] Thoresen noted that 'Roy's graphic approach could also work well in combination with INA/GRM's *Acousmographe*, which also bases its approach on intuitive representations of the sound.' [Thoresen and Hedman, 2009, 319] Software packages such as *Acousmographe*[34] from Ina.fr and *Eanalysis*[35] by Pierre Couprie are applications that generate visualisation of sound, in order to facilitiate subsequent analytic interpretations which can take the form of annotations to the visualisations.[36]

These various analytic views of sound are interesting and relevant to mixed works and so one might expect them to be important to the analytic material of a typology of relations

[33] A 'listening score' is a transcription in Roy's terms: 'l'objet résultant d'une [analyse du niveau neutre] de l'œuvre'; the listening score is the artefact that results from an analysis of what Nattiez would call the 'trace' or 'material reality' of the work. [Roy, 2003, 201] [Nattiez, 1990]

[34] Acousmographe is available from: http://www.inagrm.com/accueil/outils/acousmographe (accessed March 18, 2016).

[35] *Eanalysis* is available at: http://logiciels.pierrecouprie.fr/ (accessed March 18, 2016).

[36] The graphic approach may also be used as described by Smalley in 'the diffusion score of an acousmatic work, [which is] often a free, sketchy, graphic representation of the sounding context produced primarily as a timing and memory aid for the person diffusing a work in concert'. [Smalley, 1997, 108]

between acoustic instruments and electronics.[37] But for this typology I did not find it necessary to represent the sound of the works pictographically (in the manner of Roy) or by symbolic notation (in the manner of Thoresen).[38] Instead I rely on the scores and audio recordings of a work as the 'material reality of the work', to use Nattiez's expression.

[37]I examined these possibilities, and one outcome of this research was a study comparing the accessibility of Thoresen's symbol system with a pictographic approach to transcription. I have presented versions of this work at the conferences EMS14 in Berlin, Germany, and EuroMAC 2014 in Leuven, Belgium. The paper is published as a chapter (in French) in a book of the EuroMAC 2014 session proceedings. [Mogensen, 2016]

[38]I ground my distinction between 'pictographic' and 'symbol system' in the analysis of notation by Nelson Goodman (1906–1998) from 1976, so that I use 'symbol system' to mean a *notational system* where the written symbols unambiguously signify distinct classes of sound qualities. [Goodman, 1976, Chapter 4] 'Pictographic' representation employs visualisations of sounds, where clear boundaries of sound quality classes are not necessary. Goodman's conception of a musical score is focused on function as a practical aid to sound production, which is not the context of Roy's and Thoresen's listening scores, but Goodman's analysis is still useful in analysing differences between these two approaches to listening scores. Goodman's definition of a 'notational system' has the necessary conditions of 'character-indifference' and that the characters in the system must be 'disjoint'. [Goodman, 1976, 132–133] Thoresen's symbol system complies with these requirements for a notational system in that his classifications of sound characteristics are abstract classes to which only one type of character is associated with any one class of sound characteristics, and any instance of a character refers to the same class of sound characteristics. The inscriptions, as instances of characters, refer to distinct characters where variations in the visual implementations of the inscriptions do not create ambiguities in their character references. In other words, Thoresen's symbol set is character-indifferent and disjoint. Roy's pictographic score may be said to symbolise the sound of the music work and in Goodman's terms be a symbol system, but as Goodman proposes: 'not every symbol system with a notational scheme is a notational system.' [Goodman, 1976, 130] The pictograms are not character-indifferent and are in Goodman's terms a 'nondisjoint classification' and hence not a 'notational system'. [Goodman, 1976, 134] The pictographic approach would also appear to be a 'syntactically dense' scheme in Goodman's terms, since it 'provides for infinitely many characters so ordered that between each two there is a third.' [Goodman, 1976, 136] The pictographic approach appears to allow for infinitely many inscriptions of characters and so, according to Goodman's analysis fails the requirements of a 'notational system'.

[Nattiez, 1990] In Thoresen's revised version of Nattiez's semiological tripartition this would be the 'neutral domain [which] is seen as the observable aspects of the esthesic and the poïetic domains'. [Thoresen, 2007*a*, 5] From the score and recording I describe an interpretation of the experiences of the acoustic and electronic sounds of the performance of a piece. This does perhaps conceptually resemble Smalley's 'descriptive tool based on aural perception', [Smalley, 1997] but unlike Smalley's listening-based descriptions of purely acoustic sound I include interpretation of intentions as indicated in the written performance scores (and computer code when this is available). I have used pictographic representation as a tool for sketching sonic ideas, such as the sketch for the quintet version of *Paese favola* as shown in Figure 7.7. This kind of visual sketching might be considered a graphic analysis of the aural image in my imagination, but it is not an analysis of features of the final work. Instead, while indicating computer sound in my performance scores, I use short descriptive words and phrases. In summary, my approach to representing sound is eclectic and pragmatic, and in the typology I attempt to use a minimal notation to describe my segmentations of Timbre-Pitch Classes as will be discussed, beginning in Chapter 2.

1.5 Repertoire choices and other researcher/composer bias

Much of the repertoire-based analytical work in my research for this thesis has been applied to music by Saariaho, Berio, and Harvey.[39] But during the dissertation narrative I also refer to music by Stockhausen, Crumb, Siegel, Lippe, Lewis and other composers, written between 1971–2015. I make some analytic observations about works by these composers, and utilise these views within my own compositional processes for the port-

[39]The works examined include the score *NoaNoa* by Saariaho [1992] with references to the recording *Private Gardens*, [Saariaho, 1997] the score *Ricercare una melodia* by Harvey [1992] with references to the recording *Wheel of Emptiness* [Harvey, 2001] and the score *Altra voce* by Berio [1999] which can be heard online at https://www.youtube.com/watch?v=DW8Ugv87FsQ (accessed March 6, 2016).

folio works. As a result my portfolio works are 'parodic' of some or some parts of these repertoire works, and I will discuss the parody concept more in section 1.6. The choices of these repertoire works are based at least partly on pragmatic concerns: it is easier to undertake the analysis of a work when both score and recordings are published and accessible. I have chosen works that interest me both as a listener and as a composer, and sought to include a variety of instrumentations.

The written scores that I have examined for this research are generally in traditional notation or at least based on such notation practice. Transformation analysis of 'graphic' or other alternative notations in 'mixed' works could complicate my exposition of the analytic process. Whether or not analysis of such works is practical in general with my approach will be a question for further work well beyond the scope of this dissertation. Even so, I do stretch some of the limits of standard notation into what might be considered 'graphic notation' in parts of my own portfolio works *Blandango Willow* and *Paese favola*; so I can propose the analytic approach to be useful for at least some directions in alternative notation systems.[40] In addition to the repertoire works I address my own history as a composer, by brief analytic views of aspects from my past works, as they become relevant in the compositional processes for the new portfolio works. There may be inherent bias in analysing my own works, and as discussed in the introduction, the work includes an autoethnographic perspective, alongside my use and development of transformation analysis as a systematic tool.

Implicit in my use of transformation analysis is a multiple 'satz' concept of the musical work from Heinrich Schenker (1868–1935).[41] This will be most prominent in Chapter

[40]I also propose an analysis of Lewis's improvisation machine *Voyager* in section 7.2, which is a piece that has no written score for the human performer.

[41]Some sources on Schekerian analysis include Heinrich Schenker's own *Five Graphic Music Analyses* [Schenker, 1969] and critical commentary by a number of theorists in the 1977 volume *Readings in Schenker Analysis and Other Approaches.* [Yeston, 1977]

5, where I interpret 'interlacing strand' structures in order to identify larger scale organisations of transformation paths. These organisations would seem to be very similar to a Schenkerian 'middle-ground', while the transformation paths might have been understood as 'foreground' elements. Investigating the possibility of 'ur-satz' levels will be reserved for future work.[42]

To examine pitch organisation I have tended towards using pitch-class set theory.[43] I have used pitch-class analysis results as the basis for generating pitch structures while composing the portfolio works; and so this approach to analysis has been a filter for pitch organisation in my research-based practice. The effect of the choice of analytical approach is perhaps most prominent in the last portfolio work *Paese favola* where the score is almost exclusively defined by a sequence of pitch-class sets with which the performer is expected to improvise while interacting with the computer part (see the discussion of this work in Chapter 7). My choices in this aspect of the project were pragmatic and it is beyond the scope of the present work to test the typology and/or its development process for compatibility with other approaches to analysis of pitch organisation.

The iterations of transformation analysis in the research process will be somewhat biased by my dual role as analyst/composer in the portfolio works. Sketches of ideas for portfolio works[44] made during the composition process (Nattiez's 'poietic' part) will direct or at least influence some of my subsequent analysis (Nattiez's 'esthesic' part)

[42]For an introduction to Schenker's '*concept of structural levels*' see Allen Forte's 1977 essay. [Yeston, 1977, 3–34]

[43]A key text in pitch class set analysis is *The Structure of Atonal Music* (1973) by Allen Forte. [Forte, 1973] Shorter introductions to pitch-class set notation and manipulations are available in several introductory analysis and composition textbooks, including Lester [1989, Chapters 5–9] and Kostka [1990, Chapter 9]. Some important earlier sources include articles by Milton Babbitt (such as [Babbitt, 1961]) and Forte. [Forte, 1964]

[44]For example see those shown in expressions (3.4), (3.5) and (3.6).

and so would seem to be a root of bias for this analysis.[45] Such bias is perhaps also a consequence of the autoethnographic aspect of the research; it results from my personal engagement with the composition, in other words the 'researcher's personal experience'; [Adams et al., 2015, 1] it can be seen as informative, given 'careful self-reflection'; [Adams et al., 2015, 2] but it may also limit the analytical outlook as applied to this context.

The demand for 'analytical distance' could be understood as being a part of Roland Barthes' *doxa*[46] or Kristeva's *phenotext*.[47] The bias from the involvement that I have as a composer with the work may result in some resistance in the reader to accepting my analysis as *doxa* or *phenotext*: my analytic views are perhaps too personal. But in spite of such bias my analysis can be read as an autoethnographic study and as part of what Barthes considers the 'text here meaning the intertextual.' [Allen, 2011, 71] In my role as analyst of my own music, I am 're-writing' the understanding of the music, and the meaning of the analysis 'comes not from [me] but from language viewed intertextually'. [Allen, 2011, 72] I can perhaps interpret the personal nature of the autoethnographic study as being revealed to be intertextual 'distance' through Barthes' 'death of the author', because I am merely rewriting musical Text. [Barthes, 1977, 142–148] I return to these ideas briefly in the Conclusion to make a point, but to analyse these issues thoroughly is beyond the scope of this dissertation and can be addressed in later work.

My analyses of the musical works in this research are descriptive rather than explanatory and the research points to an open-ended approach to the codification of practice. The evaluation of this codification is based on its applicability as a tool during the prac-

[45] See discussion of Nattiez's theoretical 'tripartite' in the Introduction, page 6.

[46] 'Barthes uses this suffix as a term for anything which constitutes general opinion, or is at any one moment in society considered unquestionable or natural.' [Allen, 2011, 219]

[47] 'Texts which attempt to produce clear and unequivocal meaning will be almost totally describable in terms of the phenotext.' [Allen, 2011, 220]

tice of composition. To accept that the new tool could be integrated into the composition process, we presume *a priori* that the composition process is already at least partially an analytic process before the introduction of the new tool. This analytic stance is the case with my own compositional practice, but it may or may not be more generally applicable to the working methods of other composers. So I examine the compositional process not as a definitive approach, but as an open-ended approach which I expect may be used by others. I take the study of this iterative research- and practice-led process as an autoethnographic document that suggests systematic analytic methods for understanding patterns of practice for the relations between acoustic instruments and electronics.

1.6 Use of *Parody*

Parody was mentioned in the Introduction as a theme for my creative activity and some examination of this term will help to clarify later discussions about the portfolio works. Linda Hutcheon (1947–) proposes 'to define parody as a form of repetition with ironic critical distance, marking difference rather than similarity'. [Hutcheon, 2000, xii] She emphasises 'the importance of considering the parodic text's entire "situation in the world" – the time and the place, the ideological frame of reference, the personal as well as the social context – not only of the instigator of the parody but also of its receiver'. [Hutcheon, 2000, xiii] Her focus is on 'parody' in twentieth-century art and she argues that by the 1980s: '[p]arody is one of the major forms of modern self-reflexivity; it is a form of inter-art discourse'. [Hutcheon, 2000, 2] She proposes to distinguish 'parody' as separate from 'satire' by her characterisations of 'ethos' of these two terms.[48] She

[48]Hutcheon considers the 'ethos' of *parody* as '*un*marked' or neutral; the 'ethos' of *irony* as 'marked' or 'coded in a definite way' – 'pejoratively'; and *satire* 'possesses a marked ethos, one that is even more pejoratively or negatively coded [than irony]'. [Hutcheon, 2000, 56–60]

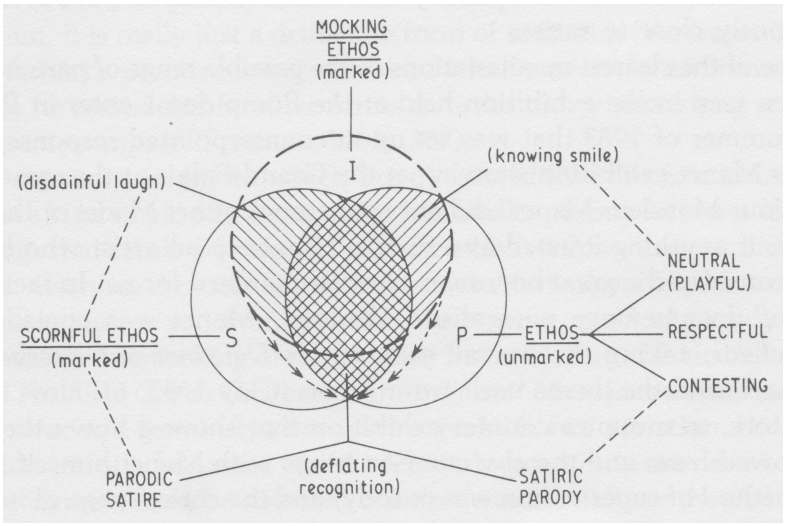

Figure 1.3: Hutcheon's visualisation of interrelations. [Hutcheon, 2000, 63]

includes a diagram as an overview of these classifications which is reproduced in Figure 1.3.[49]

Hutcheon's diagram is useful for positioning the discourse regarding 'parody' in my own creative practice. Some of my past mixed works which I would consider very obviously 'parodic' include: *All Numbers Language* (2006) which parodies some of the cello suites by J. S. Bach and Benjamin Britten in an electroacoustic context; *Views from Plato's Cave* (2009) which parodies Luciano Berio's *Sequenza V*, Debussian tonal colours as well as process ideas by Iannis Xenakis, all in an electroacoustic music context; *Sonata Neo-Schubert* (2010) parodies Franz Schubert's *Arpeggione Sonata* (D821) as well as other Schubert works, jazz style elements and electroacoustic music.[50] I would place the parodic aspects of these works on the right-hand side of Hutcheon's diagram, since I would

[49] See also Shepherd's 1986 review of Hutcheon. [Shepherd, 1986]

[50] *All Numbers Language* is recorded by soloist Nicolas Deletaille (cello) on Contreclisse, Belgium; [Mogensen, 2009] *Views from Plato's Cave* is recorded by soloist Niels-Ole Bo Johansen (trombone) on Classico, Denmark; [Johansen, 2016] and *Sonata Neo-Schubert* is recorded by Nicolas Deletaille (arpeggione) and Alain Roudier (fortepiano) on Contreclisse. [Mogensen, 2011*b*]

consider my parodic work to have various nuances of being 'playful' and 'respectful' of the source works, but also that they are 'contesting' to current musical culture. My own interpretation of these works has usually been that they are parodies which are not satirical of the parody sources. For example, in an article in the *Early Music* journal I called *Sonata Neo-Schubert* a 'thought experiment', which 'in literature would be called an "alternate universe": where Schubert sonatas and computer music would be contemporary and integrated'. [Mogensen et al., 2014, 552]

In the works mentioned in the previous paragraph, it should be clear that my interest has been in creating *parodies* of the older works in Hutcheon's sense, and not satire. I have maintained this attitude in the new works for the portfolio. A significant way in which I create Hutcheon's 'trans-contextualization'[51] is by placing musical materials that have been derived from older works, into a new context of live, reactive or 'interactive' electroacoustic music and sound. As Hutcheon points out: 'The parodied text today is often not at all under attack.' [Hutcheon, 2000, 103] I see the 'contesting' part of my work as being directed more towards genre attitudes in music; I find no convincing *a priori* reason that a musical style from any historical-cultural setting could not be used along with any other sound materials to create new musical 'trans-contextualizations'. It is my opinion that such qualities can make music very relevant to the contemporary listener.

Chatman criticises Hutcheon's concept of parody by arguing that 'Hutcheon's redefinition, "imitation with ironic difference," is simply too broad'. [Chatman, 2001, 33-34] He asks, '[d]are we found our definition of parody on a term itself so problematic as "irony"'? [Chatman, 2001, 34] While it seems correct to point out that the concept of 'irony' is not thoroughly analysed in the Hutcheon text, it seems that a common use definition

[51] In Hutcheon's use of the term, '[p]arodic "trans-contextualization" can take the form of a literal incorporation of reproductions into [a] new work... or of a reworking of the formal elements' of the old work, where this reworking results in the formal elements of the new work. [Hutcheon, 2000, 8]

is sufficient to support Hutcheon's narrative.[52] Hutcheon is perhaps expanding what would otherwise be covered by the word 'parody' but this expansion seems very useful and perhaps necessary, if there is no other current way of formulating the concept she is addressing with 'parody'. Her claim, that the meaning of the term will be historically (or context) dependent, would only seem to make the term more flexible and have a wider range of potential meanings. To analyse these issues in detail is beyond the scope of the present work. I merely position my attitude as a composer in relation to Hutcheon in order to proceed with a clearer concept of 'parody' in my portfolio works. This attitude is aligned with and interacts with my use of analysis of repertoire as an integral part of the composition process; as will be seen in later chapters, the portfolio works are saturated with parody.

[52]Hutcheon did examine 'irony' in her later book *Irony's Edge: The Theory and Politics of Irony.* [Hutcheon, 1995]

Chapter 2

Transformation analysis of Saariaho's *NoaNoa* (1992), and relation to the composition of *The Ghost of Judith*

Kaija Saariaho's 1992 composition *NoaNoa* for flute and electronics forms a central repertoire work for this thesis. [Saariaho, 1992] I examined this work as the preliminary test case for my approach to transformation analysis and a number of ideas from this analysis have provided fuel for composition of the subsequent portfolio works, as will be discussed in the later chapters. The present chapter focuses first on introducing the approach to analysis and notation, and provides a small, preliminary typology. In sections 2.3 to 2.5 the focus shifts to the first portfolio work: *The Ghost of Judith*. In those later sections I review some early analytical views that I have discarded, and relate the more successful transformation analysis approach to the features of the portfolio work.

2.1 Saariaho's *NoaNoa* and Timbre-Pitch Class segmentation

Much of the drama in Saariaho's *NoaNoa* seems to stem from the ways in which she has combined the flute and electronic sounds.[1] There is a striking economy of pitch structures in the piece. But these pitch structures are developed through complex timbral variations that are created, at least in part, through the changing combinations of the flute sounds with electronic sounds.[2]

As discussed in section 1.3, contextual transformation network analysis as proposed by Lewin offers a formalised approach to describing movement through a 'theoretical space' via 'transformation paths'. [Lewin, 2011*a*,*b*] Lewin's own analyses of pieces are mostly focused on transformations in pitch spaces, but he also suggests transformation analysis as a generalised approach which can be applied to any musical dimensions. I have used transformation analysis in order to understand the relations between acoustic instrument

[1] In the 1993 ICMC Proceedings the composer and her collaborators provide some discussion of approaches to the development of *NoaNoa*. [Chabot et al., 1993] Here they state that Saariaho 'is interested in the idea of a timbral space, in which one can define variations and interpolations', and also 'the relations between timbre and harmony'. [Chabot et al., 1993, 210] Furthermore, '[t]he basic material includes various classes of playing modes and patterns controlled by several layers of interpolation processes'. [Chabot et al., 1993, 211] They specify three 'classes' of flute 'playing modes and patterns': 1. the 'trill' class which includes various pitch modulation techniques as well as 'flutter tongue' and 'multiphonic[s]'; 2. the 'noisy' class which also includes 'multi-phonics, flutter tongue', along with spoken sounds and various other effects; 3. the 'pattern' class which is stated to include 'scale, microtonal scale, glissando, repetitive pattern, etc'. The overlaps of descriptors in these three 'classes' is not explained, so I will avoid trying to interpret these in the present analysis.

[2] There is a published CD-ROM with the computer part for *NoaNoa* [Saariaho, 1998] in addition to the published performance score. [Saariaho, 1992] I have used the recording by flautist Camilla Hoitenga on the audio CD *Private Gardens* as a reference. [Saariaho, 1997] There is also a Pure Data patch for performing *NoaNoa* in the Pd Repertory Project developed by Miller Puckett and available online at: http://msp.ucsed.edu/pdrp/latest/files/doc (accessed March 22, 2016).

and live electronics which occur in *NoaNoa* and other works, and to build a typology of such relations. In my analysis of *NoaNoa*, I begin first by describing Timbre-Pitch Classes (TPC) as arrays of dimensions: pitch structures and timbral structures. I have employed a notation for these TPCs in which I have aimed for compactness and ease of comprehension of the characteristics which the analysis has distilled out of the piece. The TPCs become points in the theoretical space which I map out in a transformation network. In the following text I will first focus on the initial 21 bars (pass 1 in the theoretical space) of *NoaNoa*.[3] From this transformation network I extract 'paths' in the theoretical space. These paths start in the initial TPCs and move through transformation functions to other TPCs.[4]

The first pitch structure in *NoaNoa* I name α(IC4), which designates the pitch pattern idea α – a contour motif – of a large interval jump, which in the bar 1 instance (see Figure 2.1) manifests an Interval Class 4 (IC4).[5] In this same instance the flute sound is sent through an 'infinite reverb' which results in an electronic sustaining of the flute pitch.

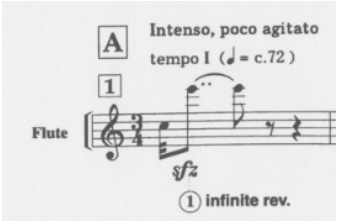

Figure 2.1: Bar 1 from Saariaho's *NoaNoa*.

Tüzün describes a kind of sustaining effect by electronics which he names FREEZE in his timbral space analysis of Tristan Murail's *Winter Fragments* (2000). [Tüzün, 2008,

[3]My TPC and transformation network analysis of the complete score of *NoaNoa* is listed in Appendix A.1. In this chapter, I use selected parts of the complete analysis to support the narrative of the thesis.

[4]The initial TPCs would be 'input nodes' in Lewin's terminology. [Lewin, 2011*a*, 207]

[5]See the discussion of set theory as used in this thesis, in section 1.5.

2009] Here I adapt the same descriptor, as it seems to metaphorically fit the effect. The Timbre-Pitch Class of bar 1 — TPC(1) — can then be described as shown in expression (2.2): it is an array with two elements, the top one is the pitch description and the bottom element is the timbre description. In the following discussion, I will refer to the elements of the array as components of the TPC. I had initially used a horizontal vector such as shown in expression (2.1). The horizontal and vertically notated arrays may be equivalent in analytical meaning, but for consistency and greater clarity I have preferred the vertical array (or *column vector*) format.[6] The vertical array notation has also served to give better ease of reading and to help enforce consistency when the TPC descriptions become more complicated, as will be seen in later chapters.[7]

$$\text{TPC}(1) = \Big(\alpha\big(\text{flute}(\text{IC4})\big), \text{FREEZE}(\text{flute} \rightarrow \text{REVERB}^{\textit{infinite}})\Big). \tag{2.1}$$

$$\text{TPC}(1) = \begin{bmatrix} \alpha\big(\text{flute}(\text{IC4})\big) \\ \text{FREEZE}\Big(\text{flute} \rightarrow \text{REVERB}(\textit{infinite})\Big) \end{bmatrix}. \tag{2.2}$$

In bar 3 of *NoaNoa* we find a contrasting pitch structure, which I name β(flute(IC1(gliss))). Here a small interval (IC1) is manifest with a glissando (see Figure 2.2).

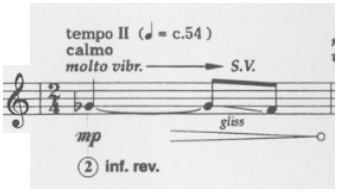

Figure 2.2: Bar 3 from *NoaNoa*.

[6] A 'column vector' is a matrix with only one column.

[7] In expressions (2.1) and (2.2) I am representing sound as a pair of dimensions: pitch and timbre. While this is an ordered pair, this is so only for convenience, it is not intended to indicate any sense of primacy of pitch. The emphasis of my analysis will be on the timbre components and I argue that these are the key components to understanding the relations between the acoustic instruments and electronics.

The TPC of this bar then becomes similar to the first bar, but with the β pitch structure. I initially used the form in expression (2.3), but again in the interest of consistency I later wrote this as a column vector, shown in expression (2.4).

$$\text{TPC}(3) = \Big(\beta\Big(\text{flute}\big(\text{IC1}(\text{gliss})\big)\Big), \text{FREEZE}\big(\text{flute} \rightarrow \text{REVERB}^{\textit{infinite}}\big)\Big). \tag{2.3}$$

$$\text{TPC}(3) = \begin{bmatrix} \beta\Big(\text{flute}\big(\text{IC1}(\text{gliss})\big)\Big) \\ \text{FREEZE}\Big(\text{flute} \rightarrow \text{REVERB}(\textit{infinite})\Big) \end{bmatrix}. \tag{2.4}$$

In the recording of *NoaNoa* on the 1997 CD *Private Gardens*, [Saariaho, 1997, track 5] the 'infinite reverb' seems to be turned off for bar 5.[8] This bar repeats the β pitch structure, but without the reverb, so the Timbre component becomes DRY.[9] The TPC of bar 5 differs from that of bar 3 primarily in its timbre part (see expression (2.5)).

$$\text{TPC}(5) = \begin{bmatrix} \beta\Big(\text{flute}\big(\text{IC1}(\text{gliss})\big)\Big) \\ \text{DRY}\Big(\text{flute}\Big) \end{bmatrix}. \tag{2.5}$$

This DRY characteristic should be understood as distinct in relation to the previous FREEZE quality.[10] In a concert situation some amount of subtle reverb would most likely be added to the amplified flute sound, and adjusted according to the acoustics of the performance space. Saariaho writes in the score instructions that a 'second reverb

[8]This seems contrary to the indications in the published score where there is no 'stop rev.' indication until bar 8, but I expect the interpretation has been approved by the composer who, according to the CD notes, was involved with the CD recording. [Saariaho, 1997, booklet, 1]

[9]The designation 'DRY' is a commonly used description for an unmodified audio signal. See for example Zölzer's *DAFX: Digital Audio Effects* for terminology in the field of digital audio processing. [Zölzer, 2011]

[10]This DRY–FREEZE distinction echoes Cogan's 'opposing characteristics'. [Cogan, 1984, Chapter 5] See discussion in section 1.4.

is used to soften the amplified flute sound, the Lexicon LXP-15 sound, and possibly the recorded audio material on direct-to-disk'.[11] [Saariaho, 1992, Performance Data]

TPC(3) and TPC(5) have pitch structures in common: both contain β(flute(IC1 gliss)). But their timbre structures are FREEZE and DRY, respectively. This allows us to describe a theoretical transformation between the two with the name: $-FREEZE$, which will designate a move in the transformation space, from FREEZE to DRY.[12] From this we derive our description of a transformation path in the theoretical space, as shown in Figure 2.3 and as a path of vertical arrays in expression (2.6). This transformation path does not involve bar 4 which separates the two measures in the chronology of the piece.[13]

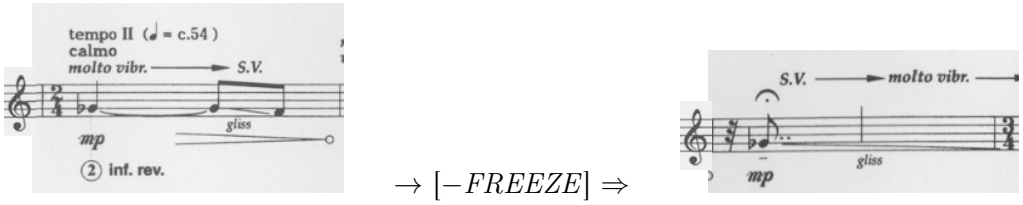

Figure 2.3: Transformation path of bar 3 to bar 5 in *NoaNoa*.

$$\begin{bmatrix} \beta\Big(\text{flute}\big(\text{IC1}(\text{gliss})\big)\Big) \\ \text{FREEZE}\,\Big(\text{flute} \rightarrow \text{REVERB}(\textit{infinite})\Big) \end{bmatrix} \rightarrow \Big[-FREEZE\Big] \Rightarrow \begin{bmatrix} \beta\Big(\text{flute}\big(\text{IC1}(\text{gliss})\big)\Big) \\ \text{DRY}\,\Big(\text{flute}\Big) \end{bmatrix}. \tag{2.6}$$

[11] Taina Riikonen examines 'the live flautist's embodied identity during the real-time reverberation and the pre-recorded part [of *NoaNoa*]'. [Riikonen, 2003, 109]

[12] I will italicise transformation path component names such as $-FREEZE$, in order to better distinguish them from TPC components such as FREEZE.

[13] It will often be the case that transformation paths will jump through the chronology, as these paths indicate changes in the relations between acoustic instruments and electronics, across different points in the segmentation, and do not necessarily show a progression of musical development.

A more concise representation of the transformation path is shown in expression (2.7). Here the $\rightarrow$ and $\Rightarrow$ symbols designate path directions in the transformation space.[14] I will not emphasise investigation of the formal possibilities in the matrix or vertical array representations since this is not the goal of the present research. Instead, I mainly use the notation as a concise format to help ensure consistency across elements in the typology.

$$\text{TPC}(3) \rightarrow [-\mathit{FREEZE}] \Rightarrow \text{TPC}(5). \tag{2.7}$$

In terms of signal paths, the transformation happens by turning off the routing of the flute sound input (from the microphone) that enters the 'infinite' reverb. To connect this transformation path with my soft system view of *NoaNoa* in Figure 1.1, I think of an addition operation on the column vector from Figure 1.2 as follows in expression (2.8). So an implementation in the soft system view of $-\mathit{FREEZE}$ can be equivalent to the removal of the routing of the audio signal to the software: $-(\rightarrow c(sftw))$. This may seem obvious, but it serves as an illustration of the possibility of drawing parallels between the soft systems and transformation approaches to analysis.[15]

$$\begin{pmatrix} m1 \rightarrow fp \rightarrow c(sftw) \\ m1(fl) \rightarrow mic \rightarrow c(sftw) \\ m1(fl) \rightarrow snd \\ c(sftw \rightarrow spkr) \rightarrow snd \\ snd \rightarrow m1(ear) \end{pmatrix} + \begin{pmatrix} -\big(m1 \rightarrow fp \rightarrow c(sftw)\big) \\ -\big(\rightarrow c(sftw)\big) \\ 0 \\ 0 \\ 0 \end{pmatrix} = \begin{pmatrix} 0 \\ m1(fl) \rightarrow mic \\ m1(fl) \rightarrow snd \\ c(sftw \rightarrow spkr) \rightarrow snd \\ snd \rightarrow m1(ear) \end{pmatrix}. \tag{2.8}$$

[14] The symbol $\rightarrow$ means 'goes to, puts in relation' and $\Rightarrow$ means 'from... follows' according to DIN 1302. [Harris, 1998, 1031]

[15] This transformation path analysis is also summarised in the Transformation Path Types Catalogue on page 297.

Later in the piece an interesting pitch structure shows up in bars 17–19 (see Figure 2.4), where the small IC1 of β is inverted to IC11 or IC1 with an octave displacement, hence becoming an α motif by exhibiting relatively large intervals.

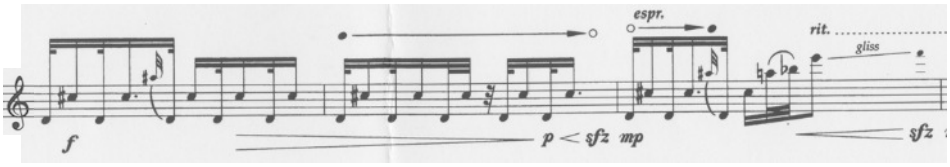

Figure 2.4: Bars 17–19 from *NoaNoa*.

The TPC of bar 17 to the beginning of bar 19 can then be indicated with pitch structure $\alpha(\beta(\text{flute(IC1)})\text{inversion})$, as shown in expression (2.9). While the $\alpha(\beta(\text{flute(IC1)})\text{inversion})$ may be an interesting pitch structure, this quality will not be a material aspect for type designation. The focus of the typology will be the relations between acoustic instruments and electronics and as a result, pitch structure transformations will often be ignored when classifying transformation paths. In my interpretation the $\alpha(\beta(\text{flute(IC1)})\text{inversion})$ in this case forms part of a $-$*FREEZE* type instance, and my typology entry for TPC(3)$\rightarrow$ [$-$*FREEZE*] $\Rightarrow$TPC(17–19) can be seen in the Appendix B.2 on page 300.

$$\text{TPC}(17-19,1) = \begin{bmatrix} \alpha\Big(\beta\big(\text{flute(IC1)}\big)\text{inversion}\Big) \\ \text{DRY}\,\Big(\text{flute}\Big) \end{bmatrix}. \tag{2.9}$$

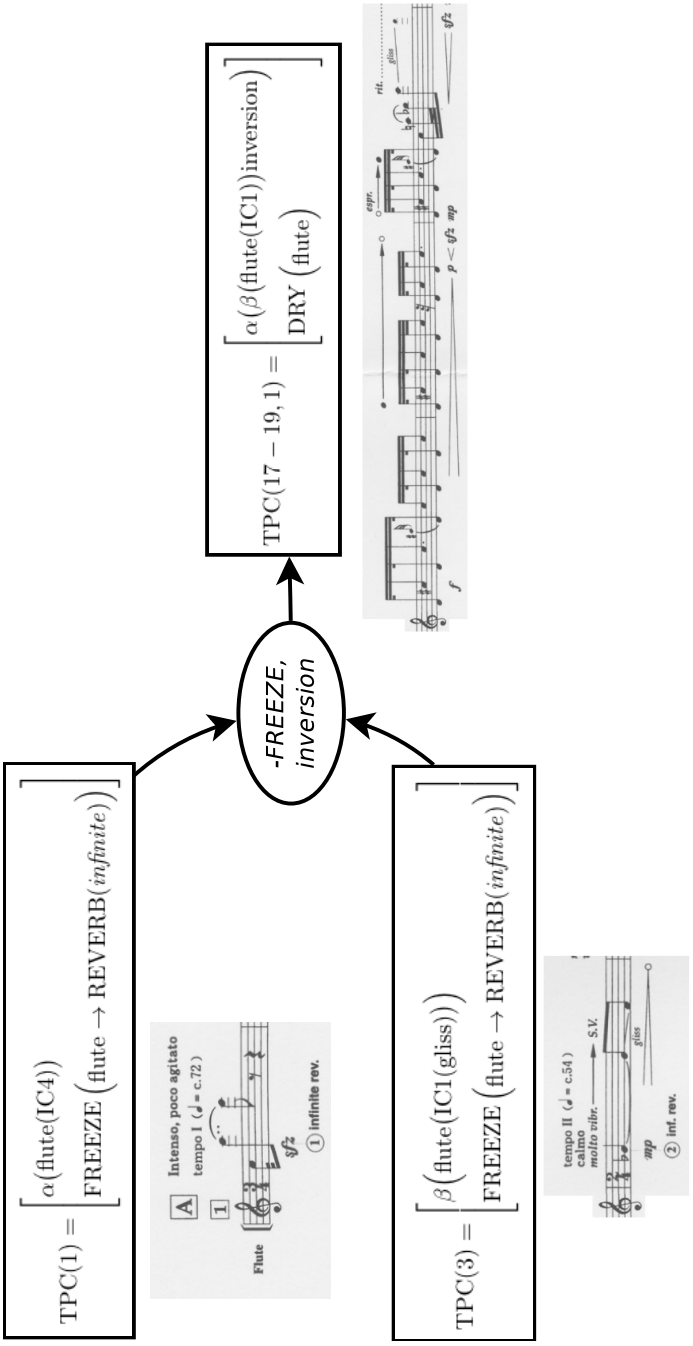

Figure 2.5: The [TPC(1) and TPC(3)]→[−*FREEZE, inversion*]⇒TPC(17–19,1) transformation paths in *NoaNoa*.

Continuing this approach to describing TPCs, I have described the rest of the score of *NoaNoa* in a similar manner (see appendix A.1). The resulting TPCs then form the points in the transformation space of my analysis. To examine the relations between the TPCs, I put the TPCs and connecting transformation paths (with concise notation) in a network diagram. I segmented the piece according to my interpretation of musical structure, defining 'passes' in the theoretical space of the piece.[16] Pass 1 in the transformation space of my analysis of *NoaNoa* is shown in Figure 2.6 (also in Appendix Figure A.1). In this network diagram the TPCs are shown in boxes, and the transformations are shown in ovals. Arrows between these elements show path directions of pass 1 in the transformation space. In the network diagram in Figure 2.6 we can then see the transformation paths from the 'inputs' TPC(1) and TPC(3), to other TPCs, including the path bar 3 to bar 5 previously referred to in Figure 2.3. These paths indicate transformations between points in the transformation space. I have indicated a lower-level categorisation of the TPCs in the transformation space according to pitch structures of the TPCs. These TPC-categories are shown with dotted-line boxes and labeled using transliterations of the greek symbols, such as 'alpha' for α and 'beta' for β, in order to better distinguish the transformation space TPC-categories from the pitch structure signifiers.

[16] I am here using Lewin's terminology of segmenting works into 'passes' in the 'theoretical space' or 'theoretical network space', but for the remainder of the thesis I will prefer using the terms 'passes' in the 'transformation space'. [Lewin, 2011*b*, 37–40]

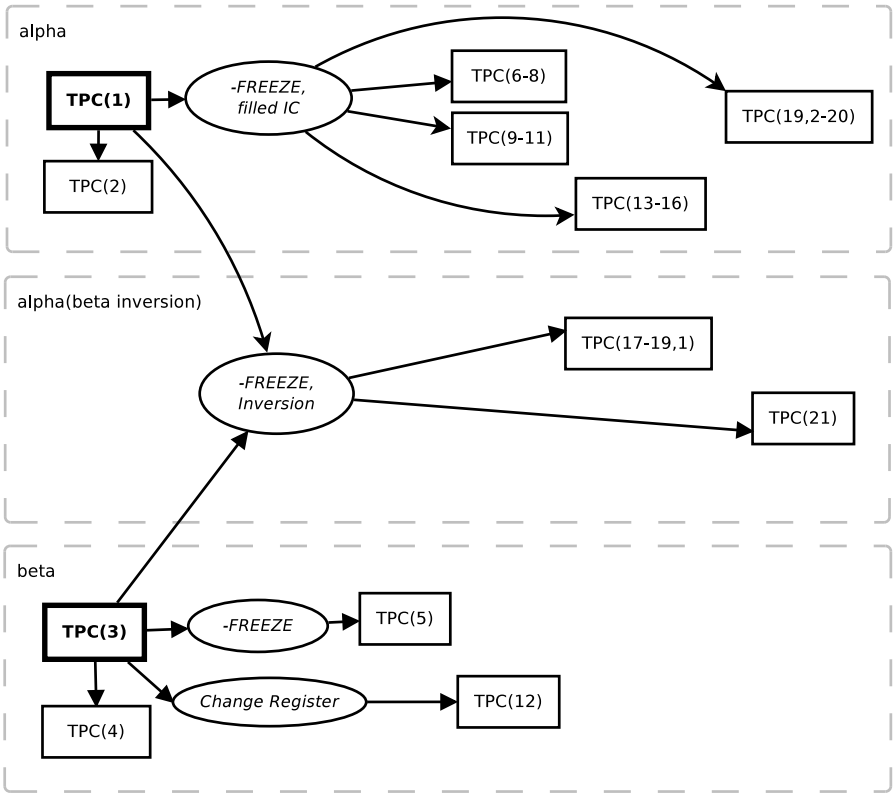

Figure 2.6: Transformation network pass 1 from *NoaNoa* (bars 1–21).

The TPC analysis of bars 22–47 (see Appendix A.1.2) shows an emphasis on new transformation types for β. My 'network sketch' (see Appendix Figure A.2) for these bars then becomes what Lewin would call a second 'pass' in the theoretical network space. [Lewin, 2011*b*, 37–40] This 'pass 2' is expanded by the addition of the pitch structures γ and δ and the new transformation functions applied to β as shown in Appendix Figure A.2. In this representation I am sometimes indicating transformation functions with chains of transformations (ovals connected by arrows). I use these as equivalent to single representations, and the chains are mainly indicated in order to simplify the diagrams as much as possible, for best visual clarity. The complete TPC and network analysis of the score *NoaNoa* is included in Appendix A.1, where all five network passes are diagrammed (Figures A.1, A.2, A.3, A.4 and A.5).

2.2 Some limitations of the analytical approach to *NoaNoa*

In bar 29, we are presented with what is arguably the first more obviously scalar 'filling-in' of the α pitch structure. The most complete presentation of such a synthetic scale is arguably in bar 87, but the musical gesture in this bar can also be heard as a 'filling-in' of pitches C to G, or IC5. Is the synthetic-scale gesture then a transformed (filled-in) version of the one in bar 29 or should bar 87 be understood as an *ur*-version of another compositional idea? The G♭ is prominently omitted in this synthetic scale, perhaps to give this pitch class a special weight in the hierarchy of Saariaho's pitch organisation in *NoaNoa*? Saariaho comments that the 'composition aid environment Patchwork is used at all stages of the development process', [Chabot et al., 1993, 210] and so I could be confident that the pitch structures were generated by some processes set up in that software environment by the composer. But to try to discover such processes and the compositional choices made about using this generated material lies outside the purpose and scope of the present analysis.[17]

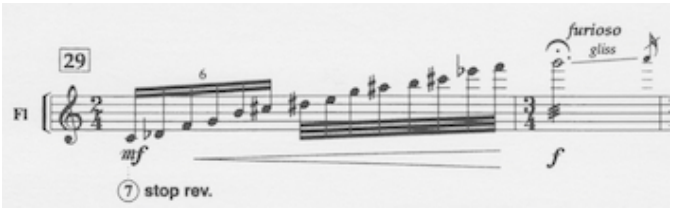

Figure 2.7: Bars 29–30 from *NoaNoa*.

[17]However, in section 7.5 I will return to the pitch materials in *NoaNoa* and use some ideas from that work as the basis for the pitch organisation in the portfolio work *Paese favola*.

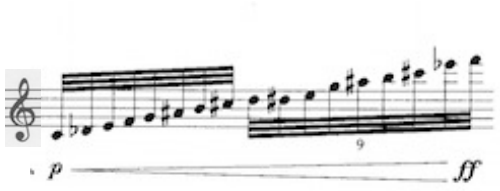

Figure 2.8: Bar 87 from *NoaNoa*.

My segmentation of *NoaNoa* into just four pitch structures (α, β, δ and γ) may appear to be a highly abstract and perhaps also at times a rather simplistic approach to addressing the motivic development in the piece. I argue that this reductionism has been useful for addressing the analytical aims of the research. My approach has been to describe only enough of the pitch structures in order for the TPC formulations to be recognisable in the score. In my analysis, rhythmic and dynamic aspects are often mentioned only in passing, and the rhythmic aspects of the gestures in *NoaNoa*, in particular, have sometimes been 'lumped together' into the pitch structures (α, β, δ and γ) through the segmentation into TPCs. The segmentation, however, is based in part on my interpretation of the rhythmic characteristics of the motifs, and so rhythm is an implicit defining aspect of the segmentation.

In some cases, varying dynamics in the instrumental part, that give varying inputs to a microphone, will substantially alter the electronic sound, for example: starting in TPC(22–28) the dynamics of the flute is used to modify the duration of a reverberation effect through the use of an amplitude envelope follower (see the TPC in Appendix expression A.13). In this kind of case, the dynamic variations are included as part of the Timbre components in the TPC description. In Chapter 3, my analyses of other works include spatialisation characteristics in the TPC Timbre components, adding to the potential complexity of the representation of these components. So my concept of Timbre component in the TPC is very wide, and can include most characteristics that are not explicit in the motif classification of the Pitch component.

My reductionism is a significant analytical bias, which certainly has an impact on the results of the analysis. But I argue that reduction is justified since the simplification of pitch organisation into a few contour motifs and inclusion of dynamics in the timbre component helps to expedite the limited analytical results, that I am seeking, in the work towards the typology of relations between acoustic instruments and electronics in mixed concert works. It would be interesting to distinguish between more kinds of components in the TPC, but this would lead to increased complexity in the exposition of the analysis, which I do not think would serve the results of the present research. Instead, expanding the TPC with a more nuanced view of components will be left as a possibility for enriching the analytical approach in future research.

2.3 Context of *The Ghost of Judith*: an autoethnographic perspective

The Ghost of Judith for voice and computer was the first work written for the portfolio. In consequence, the process of composition engaged with a very early stage of the typology development. This work was to be written for the occasion of a showcase concert of mixed music works at the Birmingham Conservatoire in 2011. The performer with whom I had the opportunity to collaborate with for this event was the soprano Olivia Hinman, who was at that time a postgraduate diploma voice student at Birmingham Conservatoire. She was very interested in performing contemporary music although she was specialising in performance of the mainstream operatic repertoire. The performance venue was to be the Recital Hall at Birmingham Conservatoire, which featured an eight speaker surround system which I wanted to take advantage of.

My theme for the work was focused around the absurdity of human death. Three different sources combined to initiate the compositional ideas in *The Ghost of Judith*:

1. I attended a performance of *Bluebeard's Castle*;[18] 2. I had personal emotions from mourning the death of my great-aunt;[19] 3. I had remnants of thoughts about a piece for a choreography project which had only reached the initial sketching stage, and had never been completed since the choreography production had been cancelled.[20]

Having seen a staged production of *Bluebeard's Castle*, the image of vertical bars and a woman alone in a prisoner's death suggested that the character of my new work could be 'Judith', or rather her ghost, after she had been killed by her evil husband Bluebeard. The absurdity of the death of the fictional character Judith was outrageous, and this seemed to echo the absurdity of the inevitability and finality of death for people in my own family. My great-aunt Kirsten was ill and disabled during the last years of her life, and spent these last several years in a nursing home. During my visits with her and the conversations we had during this final period of her life, I found that she felt outraged by the imprisonment to which her ageing body had condemned her mind.[21] This kind of frustration seemed reminiscent of the experience of my grandfather a few years before, and I speculate that it is not an uncommon experience for old, disabled people in European society who are put on what is in effect a kind of 'death row' in nursing homes.

[18]Béla Bartók's *Bluebeard's Castle* was given a '[n]ew semi-staged production with video projections' by the Philharmonia Orchestra (www.philharmonia.co.uk), with Esa-Pekka Salonen conducting, in Symphony Hall, Birmingham, UK, on October 21, 2011.

[19]My great-aunt Kirsten Petrine Jensen Aagaard died June 19, 2008 in a hospital in Randers, Denmark.

[20]This was a work that was to have been a choreographic reaction by Renata Chelichowska to the airplane attacks in New York City on September 11th, 2001.

[21]I include this personal information to illustrate the personal motivations that have affected my compositional choices in *The Ghost of Judith*. As a part of the autoethnographic strand of the narrative, relevant personal information offers 'specific knowledge about *particular* lives, experiences, and relationships rather than *general* information about large groups of people'. [Adams et al., 2015, 21] This is done in order to 'recogni[se] and [use] personal-cultural entanglements'. [Adams et al., 2015, 22] In this case, my personal entanglement with European culture and my empathy for the fates of my older relatives has given me motivations that I have used to rationalise my composition activity for the portfolio work.

The ‘Judith’ in my new piece was then also an ‘old’ Judith, who was frustrated by the shackles built into the final stage of her existence. The image of black ribbons in the text became both an image of the bars in a prison and a symbol for the mourning of death. The ‘black ribbons’ image originated in a collaboration with a choreographer which was stopped for various reasons and not developed.[22] The choreographer had talked about an image of a solo dancer, with many long, black ribbons hanging down on stage, with dramatic lighting.

The idea of a ghost seems to be a parody of both death and life; in popular culture it is sometimes described as some kind of ‘middle ground’ between life and death. It seems to me highly unlikely that ghosts in the popular sense could ever exist. But if one imagines the idea of someone that is dead, but somehow retains some part of being alive, how could this idea be convincing enough to allow suspension of disbelief, when transferred to musical work? This question was a thought experiment that was motivating for *The Ghost of Judith* and the musical work became my interpretation, an artistic view of this thought experiment. To address problems posed by the thought experiment, I established some metaphors for determining, or justifying, my musical-semantic choices for the work. The list of these metaphors included: fragmentation of images or moods; tension from frustration, rather than angst; impossibility of development, since growth is only possible in life; impossibility of resolution, there is no poetic justice in death, only the possibility of acceptance. These metaphors were parts of my compositional materials, and as a basis for some of my musical choices they formed part of the compositional process.

[22] I have made music and sound for several other dance works by the New York City-based choreographer Renata Chelichowska. See online info (accessed April 30, 2015): http://renemogensenmusic.freeiz.com/MusicforChoreography.html

2.4 Categorisation of relations between voice and electronics during composition of *The Ghost of Judith*

During the early stages of composing *The Ghost of Judith*, I used categorisations from earlier research, based on what I had called 'Four Basic Interaction Types' between acoustic instruments and computers. I had named these categories: *Monody*, *Accompaniment*, *Counterpoint* and *Generative Process*. [Mogensen, 2008] I had arrived at these types as a way of organising my thinking around the relations between acoustic instruments and electronics in my own compositions.[23] The types were based on analyses of a collection of my own works written in 2006–2008, and set into the context of Robert Rowe's categorisations (see discussion of Rowe's categories on page 15). I proposed definitions of the four type categories (*Monody*, *Accompaniment*, *Counterpoint* and *Generative process*), with examples from my works *Ares Dreams of Love* (2007) for eight trombones and computer, *WARNING: Flute at Large* (2007) for flute and computer and other works. [Mogensen, 2008] In my previous research these four types, briefly reviewed, were defined as follows:

> **Interaction Type *Monody*: includes timbre colouring by electronic effects, which generally will directly follow the performed instrumental or vocal sound.** These kinds of parallel concerted motions are generally perceived in a local way temporally. *Monody* also includes transformations of the 'illusionary' electroacoustic space with reverbs, short delays, harmonizers, and other effects, as well as use of other ambient sounds that may have a longer decay than the instruments. An example of this is found in bars 74–78 of *Ares Dreams of Love* (see Figure 2.9) where eight trombones are processed through a sustaining reverb.

[23] This work was documented in my thesis submitted for the degree Master of Electronic Music Composition (2008) at the Danish Academy of Music in Aarhus, Denmark. [Mogensen, 2008]

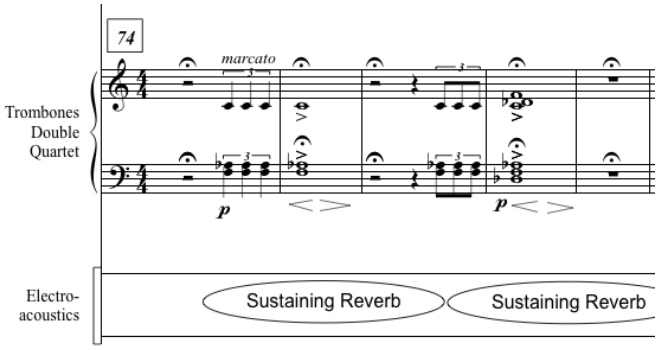

Figure 2.9: Bars 74–78 from *Ares Dreams of Love*.

Interaction Type *Accompaniment*: includes subordinate roles for the electronics which provide support for the instruments, but which have some independent identity. One technique for this type is transformed sample[24] playback where this sample playback is musically subordinate in its role to the acoustic instruments. Transformed delays can be short samples or continuous delay effects that are transformed and used as echoes, call-and-response patterns, or other imitative effects. An example of this is found starting in bar 160 of *Ares Dreams of Love* (see Figure 2.10) where a sample of the trombone sound is recorded. This sample is played back at half-speed (and transposed down an octave) in 'out-of-time echoes' that accompany a solo trombone line in the following three bars.

[24]I use the term 'sample' throughout the thesis to mean a recorded sound file, usually stored in a buffer in computer memory. This use of 'sample' does not imply a single audio sample, which is otherwise how it might be understood in the engineering context of audio signal processing.

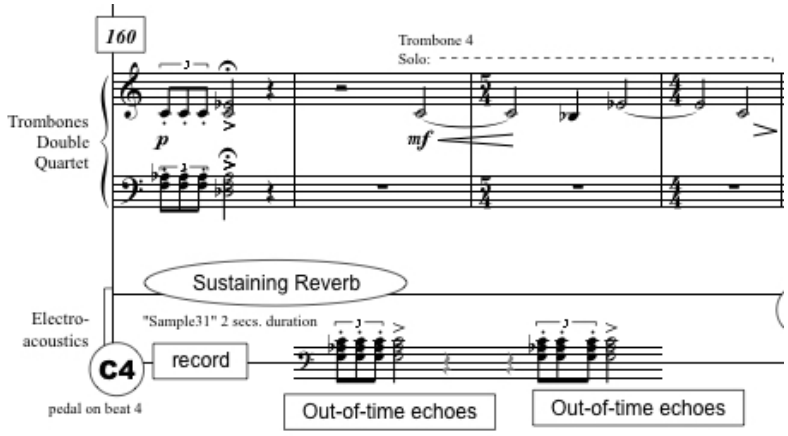

Figure 2.10: Bars 160–163 from *Ares Dreams of Love*.

Interaction Type *Counterpoint*: including flexible interactive electroacoustic progressions and textures that are coordinated with live musician performance, and where the roles of the individual strands or parts are more equal than in the *Accompaniment* type. I defined interactive electroacoustic *Counterpoint* as sounds that progress within a composed framework, but reactive to performance aspects of the acoustic instrument or voice. An example of what I meant by this was starting in A2 of *WARNING: Flute at Large* where there is a contrapuntal play between flute sounds and computer-generated additive synthesis (see Figure 2.11)

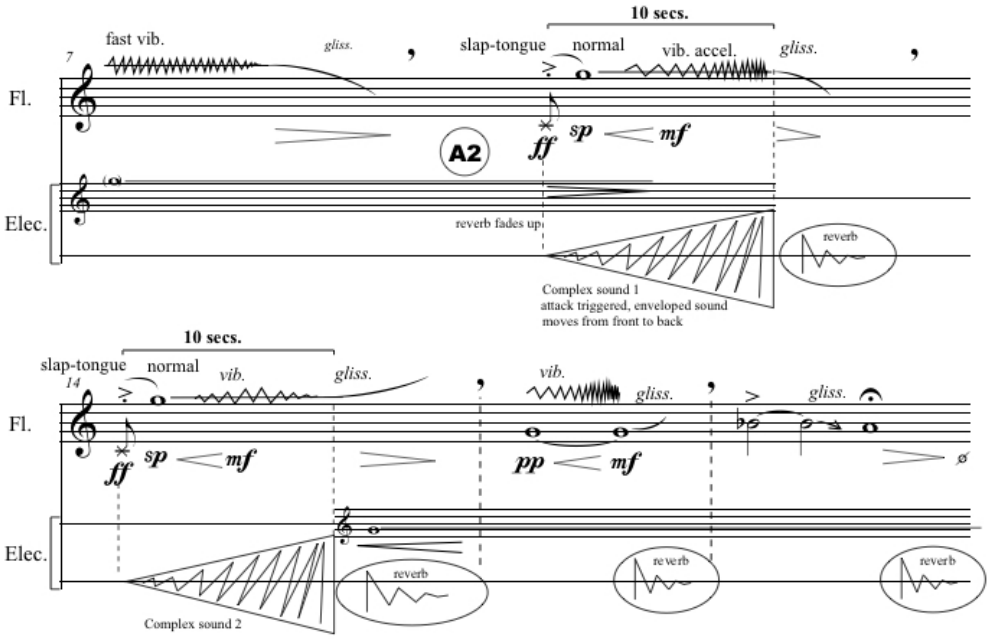

Figure 2.11: Trigger point A2 from *WARNING: Flute at Large*.

Interaction Type *Generative Processes*: that result in computer controlled sound constructions. These are generative processes that accept input from performers, and where the performer input affects the output of the generative process. In other words: algorithmic electronic music that is modified by performer input during the performance time. One generative technique includes sampling and storing acoustic analysis 'memories' during performance, and subsequent use of these for controlling parameters of sound textures (or 'sound clouds') later in the piece. An example of this is found in the third movement of *WARNING: Flute at Large* where at C1 the flautist plays glissandi which are recorded into a collection of samples. This collection of samples is played back with processing controlled by an 'analysis memory array' when the flute moves on to the following system of the score (see Figure 2.12). The 'analysis memory array' consists of an array of values from

analysis of the envelopes and centroid features of a previous section of the music.

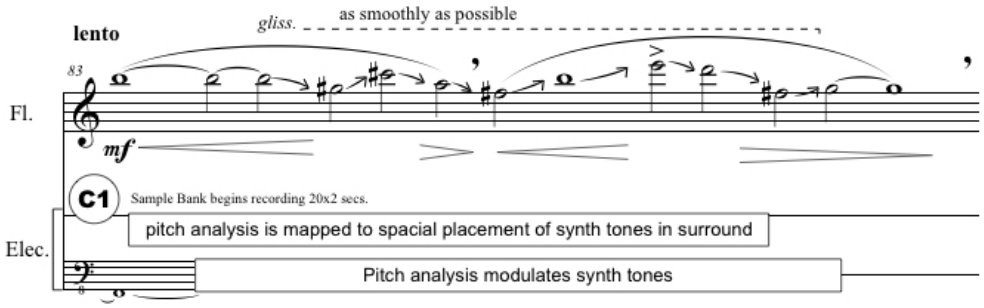

Figure 2.12: C1 from *WARNING: Flute at Large*.

Given these four categories, it should be obvious that my use of labels were referring to compositional ideas in general use: *monody*, *accompaniment*, *counterpoint* and *generative process*. However, the category definitions were limited and biased by being based exclusively on analyses of my own works, although they were perhaps productive for my compositional thinking at the time (during 2006–2008). My Four Interaction Types [Mogensen, 2008] were related to Robert Rowe's categorisations [Rowe, 2000] such that *Monody* and *Accompaniment* would 'tend towards' Rowe's 'instrumental paradigm' while my *Counterpoint* and *Generative process* would 'tend towards' Rowe's 'player paradigm'.[25] For the work on *The Ghost of Judith* I attempted to re-develop this approach, with an emphasis on identifying 'interactivity'. I tried to focus on identifying overlaps in time and apparent causal links between computer actions, performer actions and the listening perspective, as mapped in the diagram in Figure 2.13. In effect this was an attempt at defining 'interactivity' in the context of my own compositions. When trying to revise the Four Interaction Types I had changed the category *Generative Process* to *Intermixture*. This was a result of attempting to move the basis of the four categories away from the 'poietic' side and into the 'esthesic' side of the work, and this was problematic in that it

[25]See my discussion of Rowe's categorisations on page 15.

resulted in confusion of the category concepts. It did not give a convincing approach to understanding the relations between acoustic instruments and electronics.

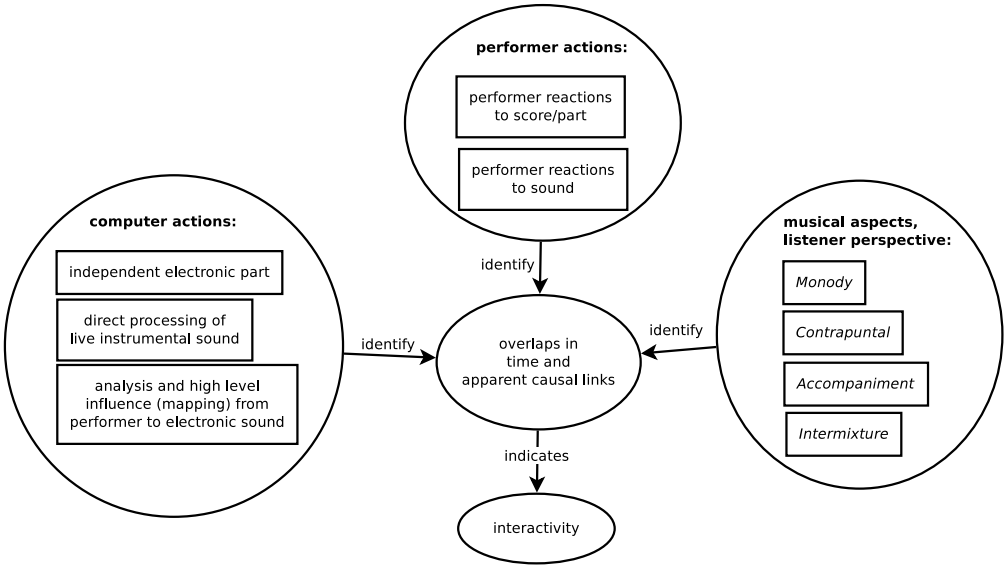

Figure 2.13: Overview of idea for identifying interactivity from early stages of the research project.

While developing the ideas to identify interactivity, I found the work of Tolga Tüzün who analysed timbral space in Tristan Murail's *Winter Fragments*.[26] I looked at *Winter Fragments* with the idea that Tüzün's timbral spaces could be aligned with my own soft system diagram of this composition (see Figure 2.14). The soft systems view by itself was too static, it did not seem to provide a clear view of changes in the relations between the acoustic instruments and the electronic sound. Eventually I turned to transformation analysis as discussed in section 1.3, and applied it to *The Ghost of Judith* as discussed in section 2.5.

[26]Tüzün's work was previously mentioned in relation to transformation analysis in section 1.3, page 27.

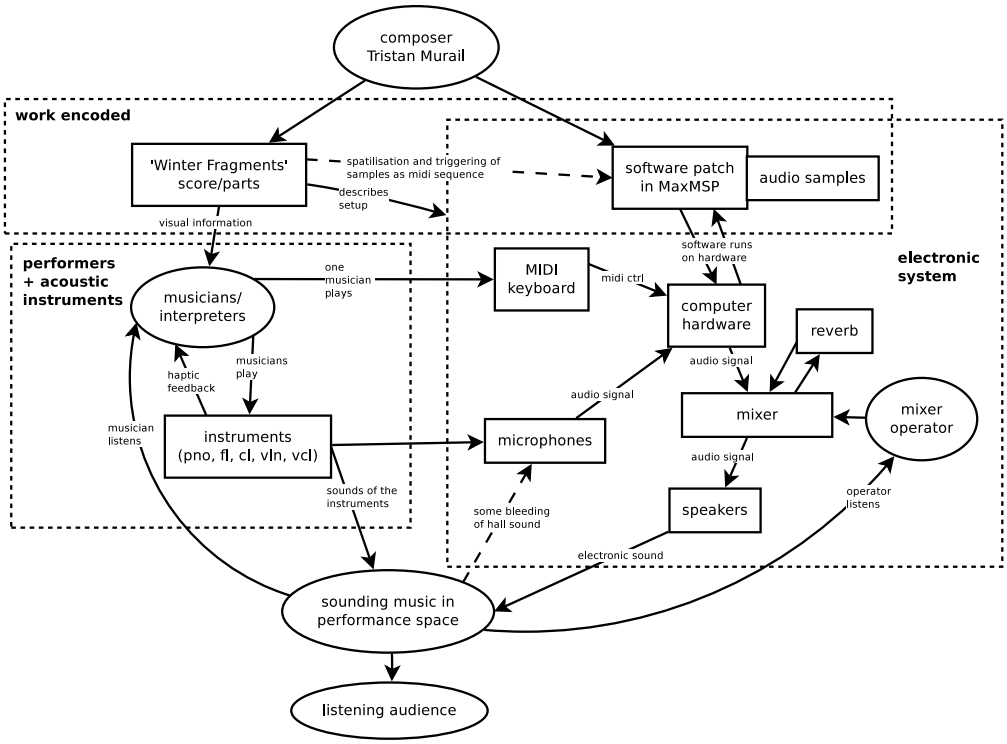

Figure 2.14: Soft system diagram of Murail's *Winter Fragments*.

In 2011, while working on *The Ghost of Judith* I found the Four Interaction Types to be of only limited use as a tool for developing compositional thinking. In relation to their use in the poietic processes of earlier composition (during 2006–2008) they could be examined as a kind of historical autoethnographic documentation of my attempts at integrating analysis with creative work; and they provided a point of departure from which to develop the current research.[27] Besides the inherent bias of being based on my own works, I found that the ambiguity and limited scope of the categories meant that attempting to apply them in my compositional process had little useful effect towards generating new ideas or developing new relations between acoustic instruments and electronics. The categories

[27]See discussion of autoethnography in the Introduction on page 4. For Nattiez's use of the term 'poietic' see the discussion in the Introduction, page 6.

did not seem to promote compositional productivity, although the categories did provide a way of organising some musical possibilities in relation to a technological basis.

During the current research I found a paradigm shift for my analytical approach, with the realisation of a way to apply Lewinian transformation analysis to the relations between acoustic instruments and electronics, as introduced in the discussion of *NoaNoa* in section 2.1. The Four Interaction Types can be seen as a subset of types within the typology, and can be translated into the notation from my transformation analysis of *NoaNoa* as shown in expressions (2.10), (2.11), (2.12) and (2.13) where ϵ is the pitch structure, x is the acoustic instrument(s), y is the electronics and z a set of composed materials.[28] In this translation I use VERTICAL, as a generic idea, to indicate that sound objects from both acoustic instruments and electronics occur simultaneously.[29] With this perspective I will relate some of the ideas of *The Ghost of Judith* to the Four Interaction Types. In section 2.5 however, I will examine a complete transformation view of this composition, from which I can extract elements for the typology.

$$\mathrm{TPC}(Monody) = \begin{bmatrix} \epsilon(x) \\ \mathrm{VERTICAL}\Big(x, \big(y = f(x)\big)\Big) \end{bmatrix}. \tag{2.10}$$

$$\mathrm{TPC}(Accompaniment) = \begin{bmatrix} \epsilon\Big(x, \big(y = f(x,z)\big)\Big) \\ \mathrm{VERTICAL}\Big(x, \big(y = f(x,z)\big)\Big) \end{bmatrix}. \tag{2.11}$$

$$\mathrm{TPC}(Counterpoint) = \begin{bmatrix} \epsilon(x,y) \\ \mathrm{VERTICAL}(x,y) \end{bmatrix}. \tag{2.12}$$

[28] In this context 'composed materials' (z) could be a precomposed sound/music sequence, a process generating a sound/music sequence, or some hybrid of these possibilities.

[29] A chord is sometimes referred to as a 'vertical pitch structure' in the context of non-functional harmony. My use of VERTICAL can include both pitch and timbre concurrence from two or more sources.

$$\text{TPC}(\textit{Generative process}) = \begin{bmatrix} \epsilon\Big(x, \big(y = f(z)\big)\Big) \\ \text{VERTICAL}\Big(x, \big(y = f(z)\big)\Big) \end{bmatrix}. \tag{2.13}$$

In my early ideas for *The Ghost of Judith*, the pitch structures were to have two contrasting types: 1. *simple melodic fragments*; 2. *free glissandi* with approximate pitch ranges indicated. The first type, the *simple melodic fragments*, was intended to convey a solemn quality, almost chant-like, but I also wanted to use the upper range of the soprano for dramatic effect, while still keeping each phrase fragment quite simple and expressive with a 'cold' character. The *free glissandi* were intended to give the performer more flexibility in interacting with the electronics, both in timing, pitch and voice character quality (including timbre and expression). In addition to these two pitch structure types, I also found it useful to employ *spoken words* that had no particular compositionally defined pitch structures. This allowed a simple view of vocal techniques for the portfolio work, which could be notated as three classes (α, β, γ),[30] as shown in Figure 2.15.[31]

[30]My assignments of these symbols (α, β, γ) are arbitrary, and so their references do not correspond with the use of the same symbols in the analysis of *NoaNoa* discussed earlier in this chapter. This is consistent with my interpretation of context-dependency of the analysis, and with Tymoczko's criticism of Lewin's formalism as discussed in section 1.3.

[31]I later developed *simple melodic fragments* for the voice further in the 2012 work *Three Old Inuit Warnings* (for voice and five instruments). In this work I used my own translations/adaptations of three old Inuit folk-sayings that were collected by Knud Rasmussen in western Greenland during the early 20th Century. [Rasmussen, 1979] For practical reasons regarding concert dates, it was not possible to include electronics in that work and so it did not become part of the portfolio. It was written for, and performed by the *Thumb ensemble* during concerts in Birmingham Conservatoire Recital Hall (June 11, 2011) and in London on October 10, 2012. See also the ensemble web site: www.thisisthumb.co.uk

$$\alpha = \textit{free glissandi}$$

$$\beta = \textit{simple melodic fragments}$$

$$\gamma = \textit{spoken words}$$

Figure 2.15: Three classes of vocal techniques in *The Ghost of Judith*.

How should I integrate the three vocal technique classes (α, β, γ) with computer sound? I decided to use a granular synthesis technique as a recurring element in the piece.[32] I had previously explored some possibilities with this kind of technique in works such as *Walls of Nicosia* [Mogensen, 2011*b*] and *Views from Plato's Cave*. [Johansen, 2016] In the context of composing *The Ghost of Judith* I emphasised the use of granular synthesis as part of various instances of the first three of the Four Interaction Types, as described in expressions (2.10) through (2.13). For example: one instance of *Monody* is found at pedal point D (see Figure 2.16), where the soprano sound is altered by processing with 'slap' delay and flanger effects. We can apply this in the general form shown in expression (2.14) where $\epsilon = \beta$ (melodic fragment), x = soprano sound, y = electronic sound that is a function of x.

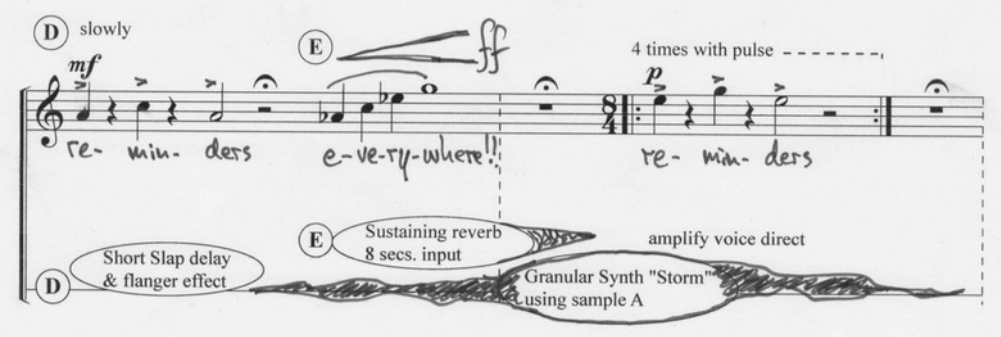

Figure 2.16: Pedal point D in the score of *The Ghost of Judith*.

[32] See for example Curtis Roads' book *Microsound* for discussions on techniques of granular synthesis. [Roads, 2004]

$$\mathrm{TPC}\big(\mathrm{D}(\mathit{Monody})\big) = \begin{bmatrix} \epsilon(x) \\ \mathrm{VERTICAL}\Big(x, \big(y = f(x)\big)\Big) \end{bmatrix}. \tag{2.14}$$

As a second example, at pedal point B (see Figure 2.17) I made an *Accompaniment* type in the granular synthesis: the granular texture is articulated by analysis of the envelope of the soprano sound (through the microphone). This means that the articulations of the granular synthesis are dependent on the articulations performed by the soprano, hence the electronic sound has a somewhat subordinate role as emphasised in my definition of this Interaction Type. We can apply this in the general form shown in expression (2.15) where $\epsilon = \alpha$ (glissandi), x = soprano sound, y = granular sound, z = analysis of soprano envelope, and w = predetermined parameters for the granular sound.

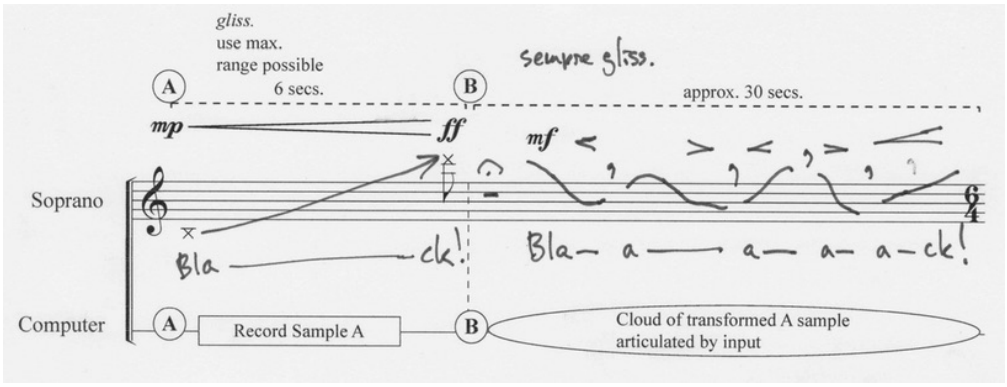

Figure 2.17: First system from the score of *The Ghost of Judith*.

$$\mathrm{TPC}\big(\mathrm{B}(\mathit{Accompaniment})\big) = \begin{bmatrix} \epsilon\Big(x, \big(y = f(x,z)\big)\Big) \\ \mathrm{VERTICAL}\Big(x, \big(y = f(x,z,w)\big)\Big) \end{bmatrix}. \tag{2.15}$$

One example of the third category *Counterpoint* occurs at pedal point G (Figure 2.18), where the soprano sings a melodic phrase, while the computer plays looping samples and filtered pink noise. While this might seem more like accompaniment than counterpoint

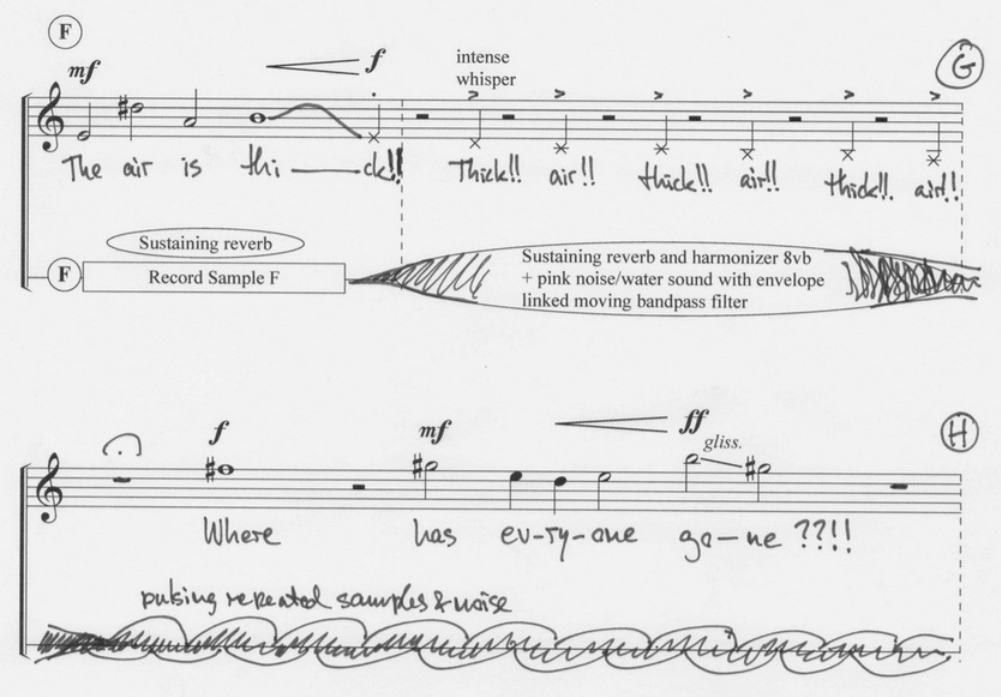

Figure 2.18: Pedal point G in the score of *The Ghost of Judith*.

from a more traditional perspective,[33] I would consider it a *Counterpoint* Interaction Type, since the computer part is not linked directly to the soprano sound – there is no analytic link, in contrast to pedal point B. The types emphasise technological relations between the acoustic instrument and the electronics, rather than traditional musical relationships which the labels might otherwise imply. We can apply this example in the general form shown in expression (2.16) where $\epsilon = \beta$ (melodic fragment), x = soprano sound, and y = electronic sound (that is not a function of x).

[33]Humphrey Searle's *Twentieth Century Counterpoint* is an example of a study of the use of counterpoint in the first half of the twentieth century (including the works of Stravinsky, Schoenberg, Webern, and other composers), but read in the present context it can qualify, in my opinion, as a traditional perspective on counterpoint. [Searle, 1955] Numerous works examine counterpoint from styles of earlier centuries including for example Kitson [1927] and Merriman [1982].

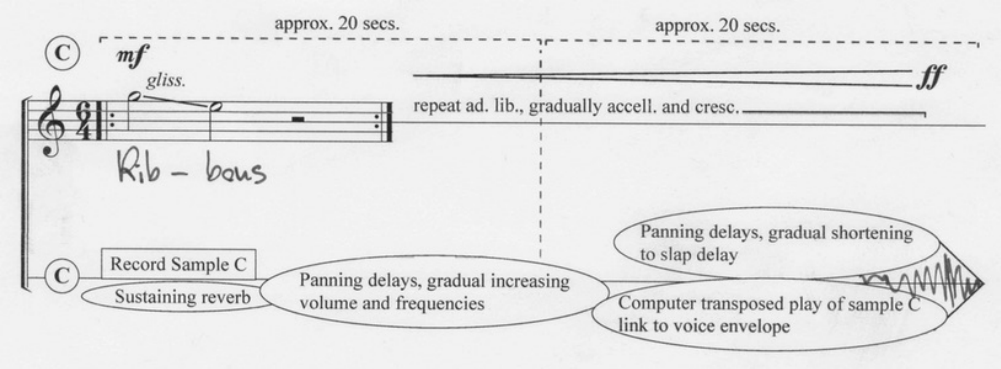

Figure 2.19: Pedal point C in the score of *The Ghost of Judith*.

$$\mathrm{TPC}\big(\mathrm{G}(\mathit{Counterpoint})\big) = \begin{bmatrix} \epsilon(x,y) \\ \mathrm{VERTICAL}(x,y) \end{bmatrix}. \tag{2.16}$$

In some segments of the piece the combinations of several software techniques make their descriptions using the Four Types more cumbersome than was the case in these first three examples. At pedal point C (Figure 2.19) there is *Monody*, where the soprano is routed through a sustaining reverb, afterwards the soprano sound is also routed through a 'panning' delay, another *Monody*. At the same time, the soprano sound is being recorded into an audio buffer, which is subsequently played back in a transposed loop. Whether this is *Counterpoint* or *Accompaniment* will depend on how one views the segmentation. The computer part is dependent on the soprano sound for its sample buffer, but the playback of the sample is not directly linked to the soprano performance with which it temporally coincides. In this kind of example, the Four Type categorisation system becomes ambiguous, even if based on the four defined prototypes. This ambiguity weakens the categorisation as an analytical tool. Transformation analysis, similar to that which was used for *NoaNoa* provides stronger analytic views of the music and I shall return to this in section 2.5.

2.5 Transformation analysis of *The Ghost of Judith* and the beginning of a typology hierarchy

I formulated a transformation space for *The Ghost of Judith* based on the approach taken in my analysis of *NoaNoa*. The TPC segmentation is shown in Appendix A.4. My resulting transformation space network diagram is shown in Figure A.12 (also in Appendix A.4). From the transformation network diagram I extract some paths that look similar to paths found in the *NoaNoa* analysis. For example, I extract expression (2.17) from the network diagram of *The Ghost of Judith* in Figure A.12.

$$\text{TPC}(\text{C}, 1) \rightarrow [-\textit{DELAY}, -\textit{FREEZE}] \Rightarrow \text{TPC}(\text{F}, 1). \tag{2.17}$$

This transformation function has the $-\textit{FREEZE}$ operation which is also found in *NoaNoa* TPC(3) to TPC(5) (see expression (2.7)). The points in the two transformation spaces of these two musical works appear dissimilar. The musical materials and the instruments are diverse and yet these transformation paths can be said to have an *equivalent* effect. The transformation paths both signify the transformation function: a change from a sustaining reverb to a relatively 'dry' sound. I will use this kind of equivalence to indicate that two instances of paths may be said to be of the same *type* of path. This *equivalence* and its opposing relation *non-equivalence* are then indicative of my dividing criteria for categorisation of types. While expression (2.17) includes $-\textit{DELAY}$, the path from *NoaNoa* (expression (2.7)) does not. Since the former (*The Ghost of Judith*: TPC(C,1) to TPC(F,1)) includes the transforming functions of the latter (*NoaNoa*: TPC(3) to TPC(5)), but has the additional function, I will consider the second to be of

a class that gives inheritance[34] to the class that includes the first, as indicated by the arrow in Figure 2.20.

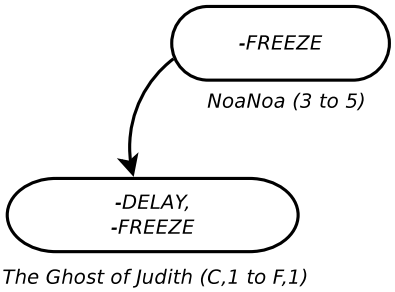

Figure 2.20: Initial elements of a typology organised by inheritance.

To begin to expand this inheritance hierarchy[35] other paths in *NoaNoa* and *The Ghost of Judith* can be compared. The path from pass 2 of *NoaNoa* in expression (2.18) and the path from *The Ghost of Judith* in expression (2.19) can be included in the hierarchy as shown in Figure 2.21. Both paths include $-FREEZE$. Both paths also add the use of samples, but employed in different ways: the PlaySAMPLE in *NoaNoa* TPC(45,2) is a playback of a prerecorded audio file, whereas the SYNTH in *The Ghost of Judith* uses a sample manipulated by a granular synthesis algorithm, and so I will consider them non-equivalent although they both have inheritance of the $-FREEZE$ component from *NoaNoa* path TPC(3) to TPC(5). In the hierarchy in Figure 2.21 I am omitting the transformation path component *ChangeRegister* from expression (2.19), since it arguable is not a necessary component for describing the relation between the flute and electronics in *NoaNoa*.

[34]The concept of inheritance is clarified by the general case: when A gives 'inheritance' to B, then the characteristics of B include the characteristics of A. In other words, the characteristics of A are a subset of the characteristics of B.

[35]I use the term 'inheritance hierarchy' to denote a system of organising elements according to relations of inheritance that exist between these elements.

$$\text{TPC}(3) \rightarrow \begin{bmatrix} ChangeRegister \\ -FREEZE \\ +PlaySAMPLE(PreRECORDED) \end{bmatrix} \Rightarrow \text{TPC}(45, 2). \tag{2.18}$$

$$\text{TPC}(\text{C}, 1) \rightarrow \begin{bmatrix} -FREEZE \\ -DELAY \\ +SYNTH(granular) \end{bmatrix} \Rightarrow \text{TPC}(\text{G}). \tag{2.19}$$

The analyses I wrote early in the research process tended to define prototypes (in the sense of Lakoff [1987]) for type categories against which I compared analyses done later in the process. This may have resulted in analytical bias: the categories I defined tended to limit my subsequent analytic possibilities, since I strove for some coherence in my categorisations. But as I have discussed earlier (see sections 0.4 and 1.3) the analytical approach is context-dependent, and the analytical results will be context-dependent as well. I am not proposing any kind of universal criteria for categorising, only attempting to extract a usable model of the repertoire that I am examining. Figure 2.21 is a preliminary version of the typology hierarchy which is developed in the following chapters. I argue that the final typology (shown in Appendix B) indicates patterns of practice in dynamic relations between acoustic instruments and electronics in the repertoire examined.

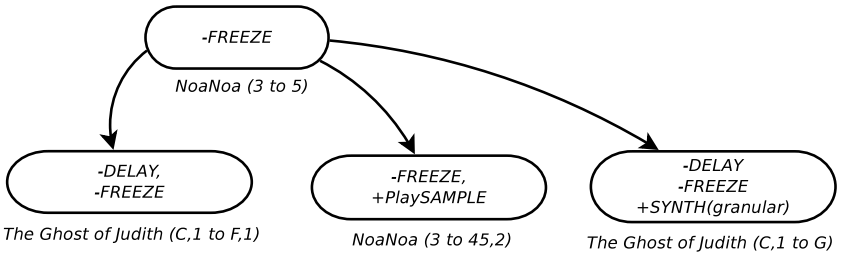

Figure 2.21: Initial elements of a typology organised in an inheritance hierarchy.

Chapter 3

Analysis and the composition of *Trio in 3 times 3 rooms*

In my personal experience, the concept of changing perspectives can be an important aspect of learning processes.[1] According to my own observations: different languages, cultures or viewpoints having differing perspectives tend to give different information about objects, ideas or other subjects.[2] This implies that most, if not all, perspectives are incomplete in their information regardless of subjects examined.

In the portfolio work *Trio in 3 times 3 rooms* I attempted to apply the concept of changing perspectives in a designed musical experience. I worked with the concept of changing the perspectives experienced by the audience through manipulating an immer-

[1] During my first 18 years, I attended schools in Denmark, Belgium, Greece, and in the US states of Pennsylvania, Missouri, Minnesota and New York. In a very literal sense my education was shaped by changing perspectives from these various cultures, languages, climates and school systems.

[2] This is of course also a significant aspect of the approach to this research project, evident in the use of a collection of analytical viewpoints as discussed in the Introduction and Chapter 1: transformation analysis, soft systems analysis, pitch class set analysis, autoethnography, and parody as analysis-based creative practice.

sive electroacoustic spatialisation.[3] I experimented with combining a surround sound setup, with additional speakers placed in physical spaces adjacent to the main performance space. With this multi-space setup, I imagined the physical building structure of a venue could be used as a site-specific mechanism, or filter, for changing the perspectives that the audience would experience. I imagined that the application of a concept of 'aural perspective' could be an effective compositional tool in concert music. I examine the composition of *Trio in 3 times 3 rooms* in sections 3.1 through 3.3, and point out some resulting typology elements in section 3.4.

3.1 A spatial composition system

Some of my ideas for the creation of changing virtual spaces included manipulating effects applied directly to the sounds of the performing acoustic instruments. Some composers have used direct effects extensively in concert works and one early example is George Crumb's *Black Angels* (1971) for 'amplified or electric String quartet'. I made a soft systems analysis of this work as shown in Figure 3.1, based on the instructions in the score. [Crumb, 1971]

[3]By 'immersive' I mean that the audience was to be 'enveloped in', or 'placed within' the sound, rather than allowing them to listen from a distance.

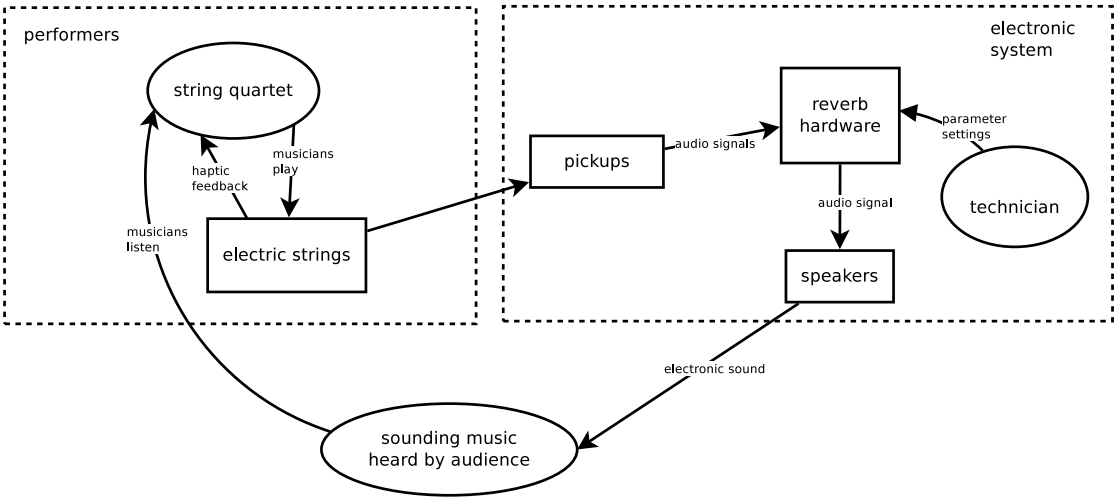

Figure 3.1: Soft system diagram of George Crumb's *Black Angels*.

The addition of electronic amplification with reverb to the string instruments in Crumb's work creates a perceived acoustic space that is markedly different from a potential non-electric version. The amplification with reverb is consistently applied throughout the piece, and so there is no effective change in the relations between the strings and the electronics. This means that transformation analysis as I have applied it to *NoaNoa* in section 2.1 will give a very limited result; my transformation space of *Black Angels* would consist of only one point: it is a static application of electronic effect on the string instruments. In this case the soft system diagram allows a view of the performance situation, which corresponds to this single point in the transformation space. The effect in *Black Angels* might be compared to the FREEZE in *NoaNoa* (see expression (2.1)) since in both instances a reverb effect is applied directly to the instrument sound. From the audience's perspective the two effects are rather different however: the FREEZE in *NoaNoa* has the effect of sustaining pitch and timbre with a very long decay, while the reverb in *Black Angels* does not sustain but instead alters the apparent sonic space in which the instruments are sounding in a more subtle way. I interpret the use of the reverb in *Black Angels* as a technique that creates a *virtual sonic space*, along with the

electronic alteration of the timbre of the string instruments. This enabled me to add a spatial dimension to the TPC point of this work and describe it as shown in expression (3.1). In the case of purely electric instruments, rather than traditional instruments with added pickups or microphones, the top element – strings(quartet) – could be removed from the vertical array, since the electric instruments would not be heard except through the speakers.

$$\text{TPC}(\textit{Black Angels}) = \begin{bmatrix} \text{strings(quartet)} \\ \text{ELECTRIC(strings} \rightarrow \text{pickups)} \\ \text{VIRTUALspace(strings} \rightarrow \text{Reverb}^{\text{space}}\text{)} \end{bmatrix}. \tag{3.1}$$

The concept of virtual sonic spaces was key to composing *Trio in 3 times 3 rooms*; in this portfolio work I employed what I thought of as a system of physical and virtual spaces that were to be seamlessly integrated from the audience's perspective. After being commissioned to write *Trio in 3 times 3 rooms* I had the opportunity to visit the concert venue some time before the concert[4] and could therefore investigate the acoustic qualities of the performance space as part of the compositional process. When I visited the space, I placed a stereo microphone pair in the 'sweet spot'[5] in the audience seating (in the *Refektoriesal*, see Figure 3.2), and recorded myself walking through various trajectories performing several sounds such as clapping, repeating words and loud footsteps at different tempi. I was also able to access several chambers adjacent to the main performance hall (*Bispeværelse*, *gang*, *vær. 1*, *vær. 2* and *vær. 3*, see Figure 3.2), and recorded myself walking through various spatial patterns in these. Such activities gave me a personal

[4]The premiere concert was in Aalborg Kloster, Aalborg, Denmark, December 6, 2011. See some documentation in Danish on the web page: www.se-sam.dk/niels-christian-rasmussen-2 (accessed May 5, 2015). Aalborg Kloster is an abbey from the 14th Century in the city centre of Aalborg, which is in the north of Jylland, in Denmark.

[5]The 'sweet spot' is a common sound engineer term for the position in the venue which should give the optimal experience for the listener.

'acoustic map' of the performance space which allowed me to better imagine how I might try to manipulate audience perceptions.

A central goal was to give the audience the experience of changing aural perspectives. I wanted the processes generating the electronic sound to be as transparent as possible to the audience, so they could fully focus on the experience of the sound, rather than be distracted by focus on identification of technological processes.[6] This attitude seemed necessary, as the idea was to make an experience-based art work, rather than a process experiment. In an attempt to achieve some degree of technological transparency I built the work with a mixture of recordings from various localities as well as electronic effects which will be discussed more in sections 3.2 and 3.3. Much of the electronic sound was constructed with the intent that it should be very suggestive of various physical spaces and activities; in other words a kind of sonic realism, which was intermingled with more abstract musical ideas that would sound from the acoustic trio and computer synthesis. Whether or not I was able to achieve technological transparency is an open question, I did not have the resources to survey the audience on their experiences. The question of technological transparency deserves further research but is beyond the scope of this thesis.

In order to organise the compositional process for *Trio in 3 times 3 rooms*, I mapped out the physical layout of the equipment in the performance situation as shown in the diagram in Figure 3.2. This was based on a floor plan (not to scale) that I had received from the venue.

[6] I wanted to avoid having the audience be distracted from the immersive experience by what Smalley might call '*technological listening*'. [Smalley, 1997, 109]

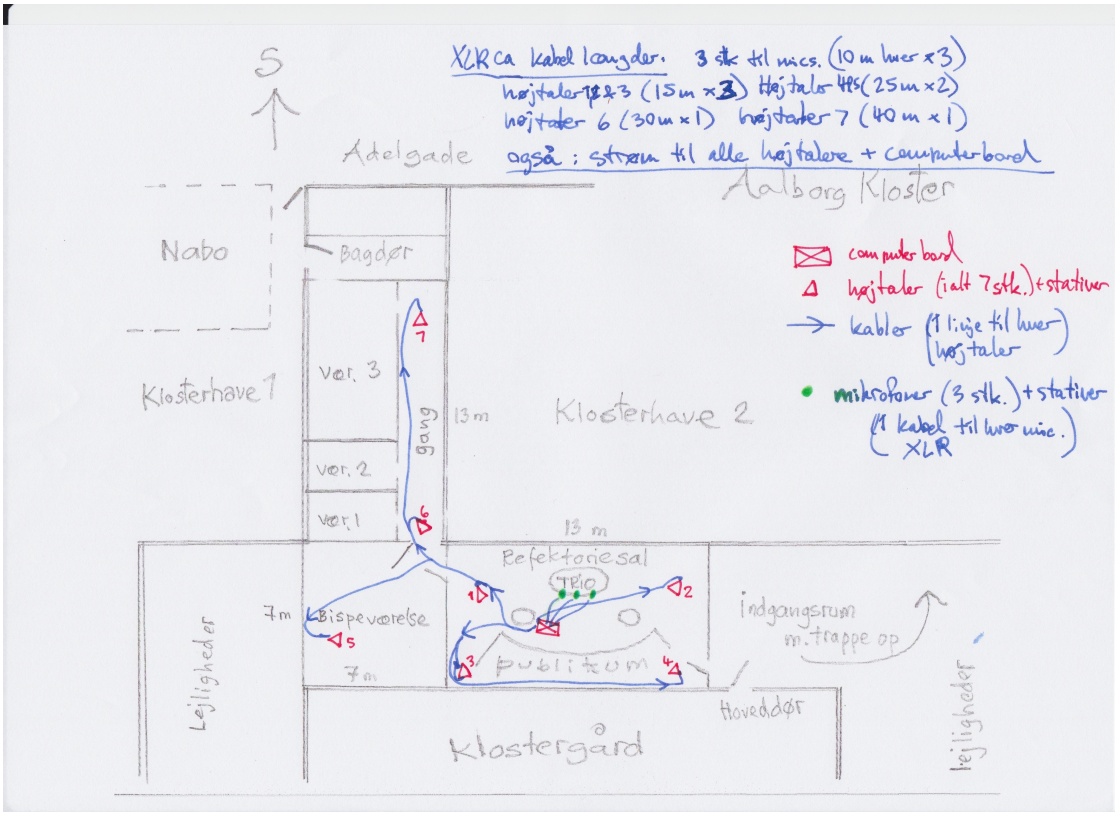

Figure 3.2: Physical layout diagram for *Trio in 3 times 3 rooms*, indicating cables in blue, microphones in green, speakers in red and computer table in red.

In the diagram I could place speakers and other equipment, but this did not give any visual sense of interaction between the acoustic instruments and electronics. To organise my thoughts about the spatial aspects of composition it seemed that a visualisation of the processes of interactions between the elements would be useful. In order to visualise the virtual spaces I traced areas (in red, green and yellow colours) on the floor plan to indicate areas of virtual relative proximity from the audience's perspective, as shown in Figure 3.3.

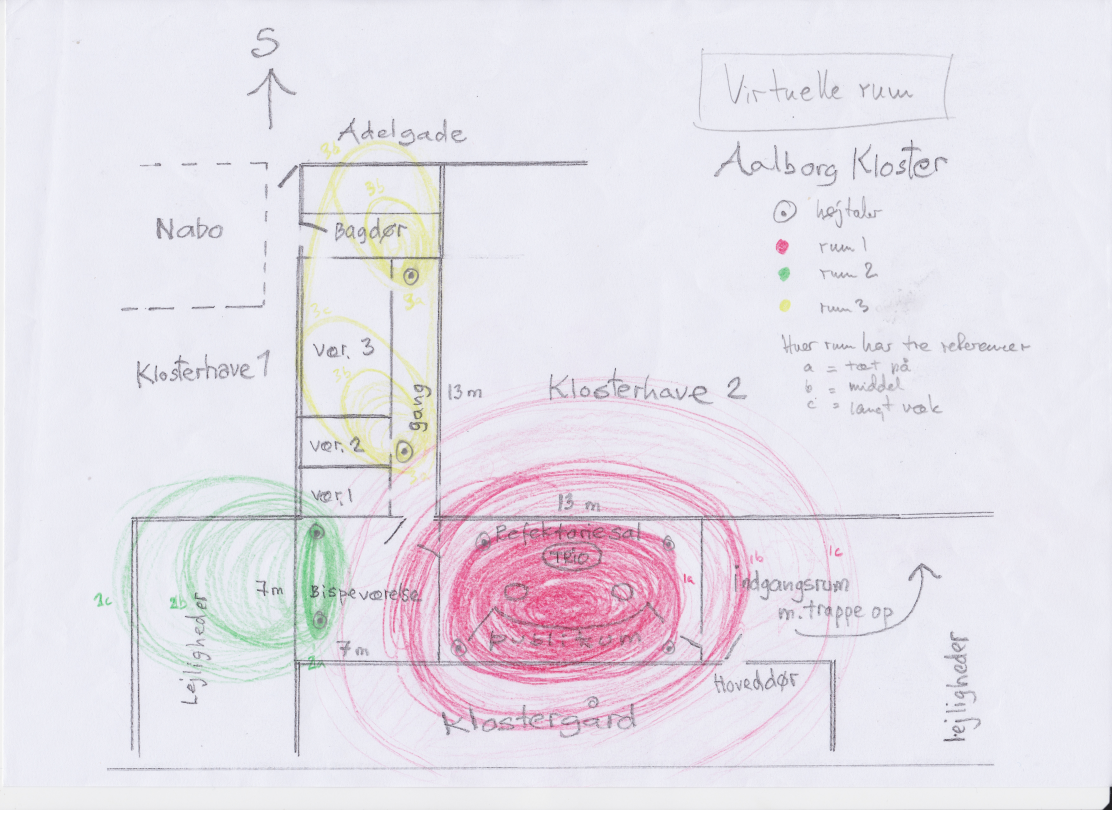

Figure 3.3: Sketch 1 of virtual spaces layout for *Trio in 3 times 3 rooms*.

I then made a simpler view of the virtual spaces, based on points representing the speakers. I removed it from the floor plan as shown in Figure 3.4, and thought of zones of greater or lesser proximity (to the centre of each of four virtual spaces) which I expected to create through spatialisation and varying uses of reverberation decay times. I used reverberation to produce perceived virtual spaces that would go beyond the physical spaces of the venue[7] and the intent was that the walls of the venue should add subtle

[7]The computer part for *Trio in 3 times 3 rooms* was written in MaxMSP 5, and most of the spatialisation was implemented using the vbap external from Ville Pulkki along with Lexicon reverb units. [Pulkki, 2000] An earlier vbap (vector based amplitude panning) implementation is described in Pulkki [1997]. The latest updates of vbap implementations for MaxMSP, PureData and CSound are available from http://legacy.spa.aalto.fi/software/vbap (accessed February 29, 2016). The spat~ implementation

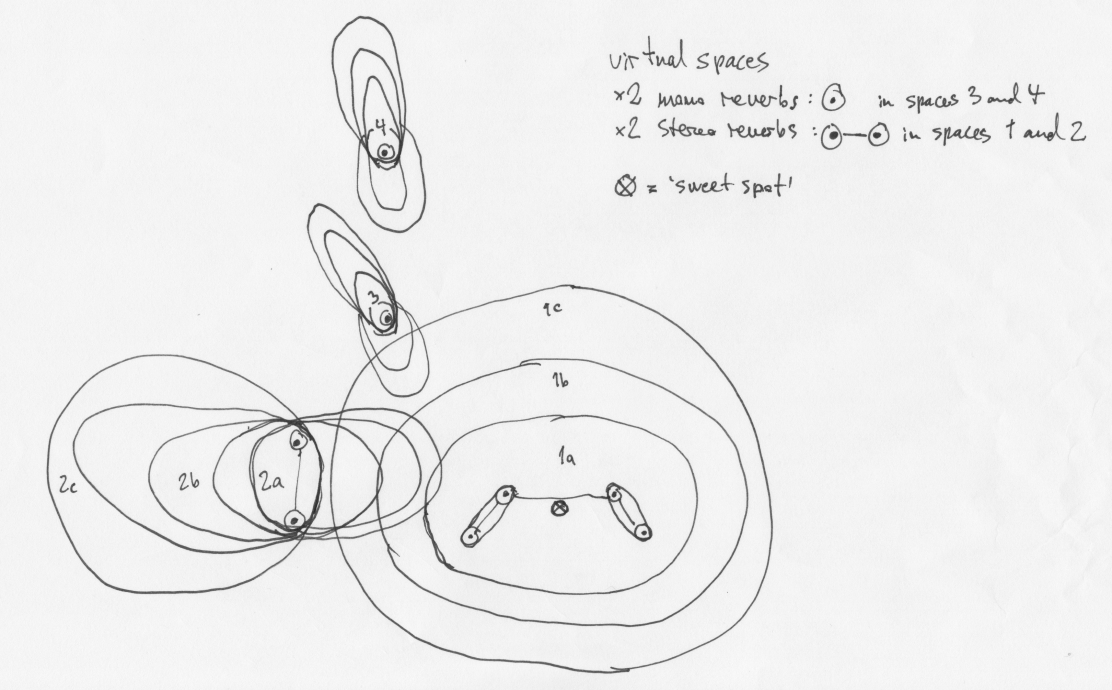

Figure 3.4: Sketch 2 of virtual spaces layout for *Trio in 3 times 3 rooms*.

filtering of sound from speakers in the adjacent rooms. With my plan for this spatial configuration I could then map out trajectories for 'sound objects' over time. Figure 3.5 is the first page of an early sketch, where such trajectories are shown. In this sketch cue numbers 1, 2, 3 and 4 correspond to the cue numbers shown in Figure 3.8.

I was hoping to find ways to create dramatic contrasts in perceived acoustic perspectives, and also wanted to think of the spatialisation of sound as taking a structural role over the duration of a performance. The approach illustrated in Figures 3.3, 3.4 and 3.5 was my system for taking compositional control of the spatialisation, while my early composition sketches used high-level abstractions representing trajectory-generating al-

is another approach to spatialisation including reverberation by Jean-Marc Jot and Olivier Warusfel. [Jot and Warusfel, 1995]

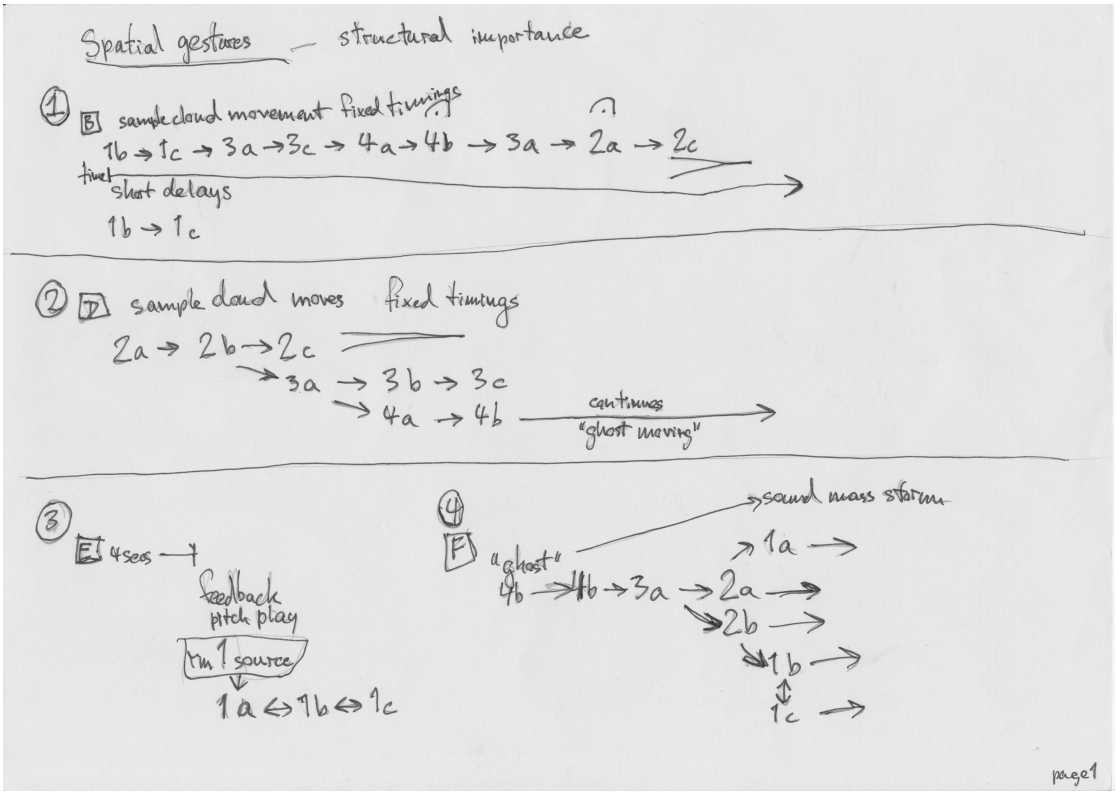

Figure 3.5: Sketch of virtual spaces trajectories in the beginning of *Trio in 3 times 3 rooms*.

gorithms (boids flocking,[8] movement with doppler effect[9] and linear panning[10]) as well as what I considered to be texture-generating algorithms (granular synthesis[11] and stochastic modulation[12]). These were techniques for controlling what I labeled 'sound objects' and 'sound object clouds' within the virtual and physical spaces in the score.[13]

Trio in 3 times 3 rooms includes a substantially more complex virtual and physical space than Crumb's *Black Angels* (see Figure 3.1 and expression (3.1)). I had previously applied soft systems analysis to *Mikrophonie 1* (1964) by Karlheinz Stockhausen (1928–2007) based on the score as shown in Figure 3.6. [Stockhausen, 1974] The relative complexity of my soft system analysis of the Stockhausen work gave some useful analytical parallels with the new portfolio work. In *Mikrophonie 1* there are two teams of three performers who operate two parallel *activity chains*[14] based on the tamtam sound. Two percussionists play on the same tamtam, and are each linked to one of the microphone

[8]I used a version of the 'boids' algorithm by Craig Reynolds. [Reynolds, 1987] In my MaxMSP performance patch (in Mac OS 10.6.8), I modified the java-script encoding of the 'boids' algorithm which was in the 'Boidroids, Max Javascript Examples' included in the MaxMSP(vers.5.1) package from www.cycling74.com (updated June 28, 2012).

[9]The 'Doppler effect' is the change in frequency of a sound wave for an observer moving relative to its source.

[10]Linear panning is a simple calculation of spatialisation, based on a straight-line crossfade between speakers.

[11]See Curtis Roads's book *Microsound* for an analysis of different forms of 'granular synthesis'. [Roads, 2004]

[12]Iannis Xenakis famously used stochastic processes in music-making as he discussed in his book *Formalized music*. [Xenakis, 1971]

[13]The concept of 'sound objects' is adopted from Pierre Schaeffer and subsequent literature. [Schaeffer, 2012, 1966; Schaeffer and Reibel, 1998] See discussion in section 1.4.

[14]In this context I consider an 'activity chain' as a system of activities where there is an ordered serial relationship between the elements, such that the actions of the first element in the chain will have an impact on the actions of the following elements in a specific stable sequence.

operators, who send audio signals to electronic filters which are controlled by another pair of operators. Both of the filtered audio streams are sent to a mixer, which is controlled by a single operator, who spatialises the audio signals to the speakers. All of the operators' actions are to be guided by following the score. 'The microphone operators also use a so-called "resonator", and in some passages excites the tamtam like the 1st. Player'. [Stockhausen, 1974, 10]

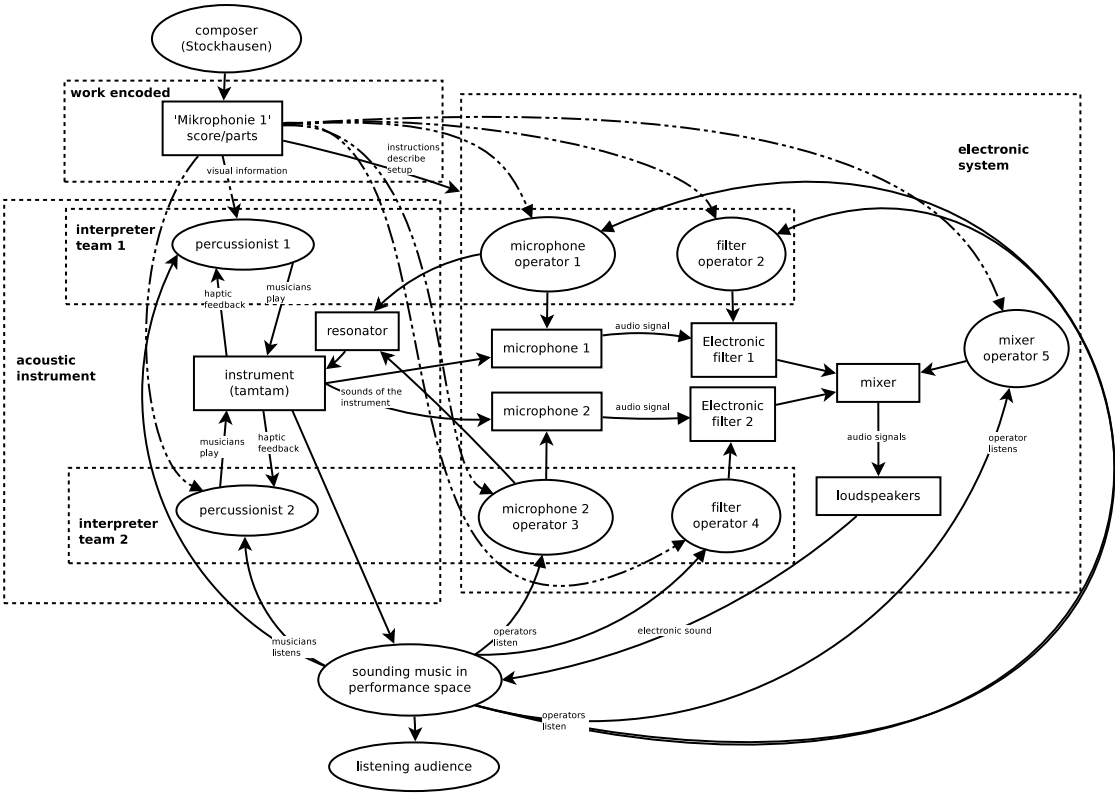

Figure 3.6: Soft system diagram of *Mikrophonie 1.*

From my soft system diagram of *Mikrophonie 1* in Figure 3.6 I extracted two System Signal Paths (SSP)[15] between the two percussionists and the electronics which represent the parallel *activity chains* as shown in expressions (3.2) and (3.3).

[15]This echoes my approach to soft system analysis applied to *NoaNoa* in section 1.2, where I also interpreted System Signal Paths.

$$\text{SSP}(1) = \text{musician1(tamtam)} \rightarrow \text{operator1(microphones)} \rightarrow \text{operator2(filters)} \rightarrow \text{operator5(mixer)} \rightarrow \text{soundingmusic} \rightarrow (\text{musicians(ears)} + \text{operators(ears)}). \tag{3.2}$$

$$\text{SSP}(2) = \text{musician2(tamtam)} \rightarrow \text{operator3(microphones)} \rightarrow \text{operator4(filters)} \rightarrow \text{operator5(mixer)} \rightarrow \text{soundingmusic} \rightarrow (\text{musicians(ears)} + \text{operators(ears)}). \tag{3.3}$$

The idea of parallel processing streams is useful in mapping a soft system diagram of the portfolio work *Trio in 3 times 3 rooms*. In this new work I also employ parallel activity chains, although these are encoded in the MaxMSP software, rather than depending on performer actions as they do in *Mikrophonie 1*. I have mapped out the system as shown in Figure 3.7 and mapped out software functionalities within the electronics part of the system. The connections between these functionalities show activity chains as four parallel audio streams in the computer system, one activity chain from each 'sound source'. There are also three acoustic instrument activity chains, one from each instrumental performer, but these are not emphasised in the diagram.[16]

3.2 This trio is *not* a 'Trio'

There are three acoustic instruments in *Trio in 3 times 3 rooms*, and during several sections, starting around cues D, I and S (score pages 2, 6 and 12) they play together, while in other sections they play solo or in duos with the electronics. So the trio does not fullfill the denotations of the term 'Trio' in the traditional Western classical musical sense, and we can consider my trio as a parody of such a traditional 'Trio' concept. This

[16]The soft system diagram of *Trio in 3 times 3 rooms* in Figure 3.7 is a revised version of early sketches that were used during the composition process.

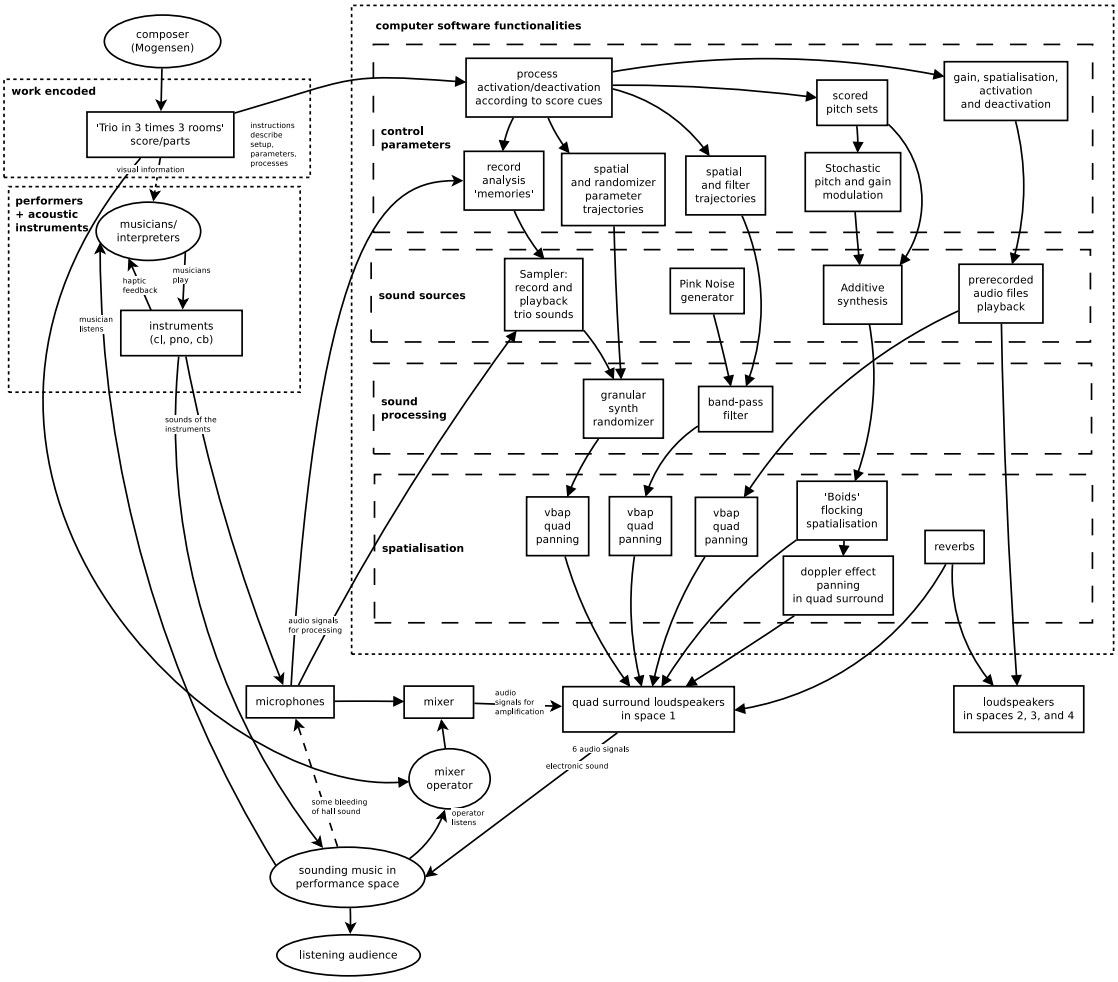

Figure 3.7: Soft system diagram of *Trio in 3 times 3 rooms*.

is arguably analogous to the series of paintings by René Magritte (1898–1967) which depict a pipe with the inscription that 'this is not a pipe': my work *Trio in 3 times 3 rooms* is not a 'Trio' although it *is* a work that includes three acoustic instruments and computer.[17] This becomes especially significant when considering the premiere performance context for which the work was commissioned. The music organisation *Selskabet Sesam*[18] commissioned *Trio in 3 times 3 rooms* from me, for the premiere in *Aalborg kloster*, in a concert where my work should function as a 'contrasting' work to a new Trio by Danish composer Niels Christian Rasmussen. His new work *Choral Abstractions* was described to me as being a Trio full of complex textures, but without any electronics.[19] The event concept was that my work should focus on electronic sound in a way that might complement the subsequent performance of Rasmussen's new Trio in the context of a one-hour concert.

In response to the commission, I developed a form in the instrumental parts which is essentially a theme with nine variations. The pitch structures of the entire piece are focused around one chord: the chord which starts the piece and is heard several times later on, while delimiting the form of some of the variations. Each variation offers one

[17]Belgian artist René Magritte's famous paintings of pipes with the words 'Ceci n'est pas une pipe' is part of his highly regarded 'surrealist' oeuvre; some titles in the series include *L'usage de la parole I* (1928–29), *L'air et la chanson* (1964) and *Les deux mystères* (1966). [Gablik, 1991, 128–19] Suzi Gablik, in her book *Magritte*, states: 'Like Wittgenstein, Magritte was concerned with the way in which logic could be used to break the tyranny of words and reveal the confusions which originate in the very forms of our language'. [Gablik, 1991, 126] We might say that Magritte parodied the common use of language and representation, as Hutcheon claimed: 'The work of Magritte provides a clear example of a parodic transgression of many levels of iconic norms that move beyond mere quotation' and that he made 'parody of the general conventions of reference'. [Hutcheon, 2000, 12–13] See also some discussion of Magritte's historical context by A. M. Hammacher. [Hammacher, 1986, 25–30]

[18]The music organisation *Selskabet Sesam* is based in Sæby, Denmark, see their web page for more information: www.se-sam.dk (accessed May 5, 2015).

[19]I exchanged e-mail correspondence with Niels Christian Rasmussen on this matter during 2011.

or more shifts in aural perspective. Figure 3.8 shows the first page of an early sketch for the time-structure, where cues 1, 2, 3, 5 and 6 indicate points where the instrumentalists were to play a concerted attack to start the chord and subsequently sustain it, at times with a gradual diminuendo (cues 1, 2 and 6) and at other times with a crescendo (cues 3 and 5).

One of the practical requirements or limitations of the commission was that there would be almost no rehearsal time with the musicians. The written parts had to be sight-readable, and instrumental performance complexity needed to be limited to ensure a convincing first performance, effectively without rehearsal. The other part of the concert was the new piece by Rasmussen, which was said to have a relatively complex instrumental score, and was given substantial rehearsal time. As mentioned above, the commission asked that my piece was to be a strong contrast to this other composer's work. I therefore limited my writing to relatively simple, very easily playable materials, and focused on giving the sounds of the trio instruments a 'companionship' role in relation to the audience through a 'JOURNEY' metaphor: the instrumental sound and the audience could take a 'journey' together through the shifting virtual aural spaces.[20] Following this metaphor, the instrumental trio would be a stable point of reference for the audience to 'hang onto', in some sense functioning as a metaphorical vehicle which could support them, while their perceived spaces shifted around them.[21]

[20]Lakoff and Johnson propose a 'basic metaphor is that of a JOURNEY, and there are various types of journeys that one can make: a car trip, a train trip, or a sea voyage.' [Lakoff and Johnson, 1980, 45] Lakoff and Johnson capitalise their labels for concepts such as 'ARGUMENT' and conceptual metaphors such as 'ARGUMENT IS WAR', and I will continue their use of capitalisation when referring to their concepts. [Lakoff and Johnson, 1980, 4]

[21]My distinction between the trio as a reference point and the shifting virtual sonic spaces may be mapped onto Simon Emmerson's 'Local/Field' distinction: the sound and direct electroacoustic effects of the trio can perhaps be seen as Emmerson's '*Local* controls and functions [that] seek to extend (but not to break) the perceived relation of human performer action to sounding result.' My virtual sonic

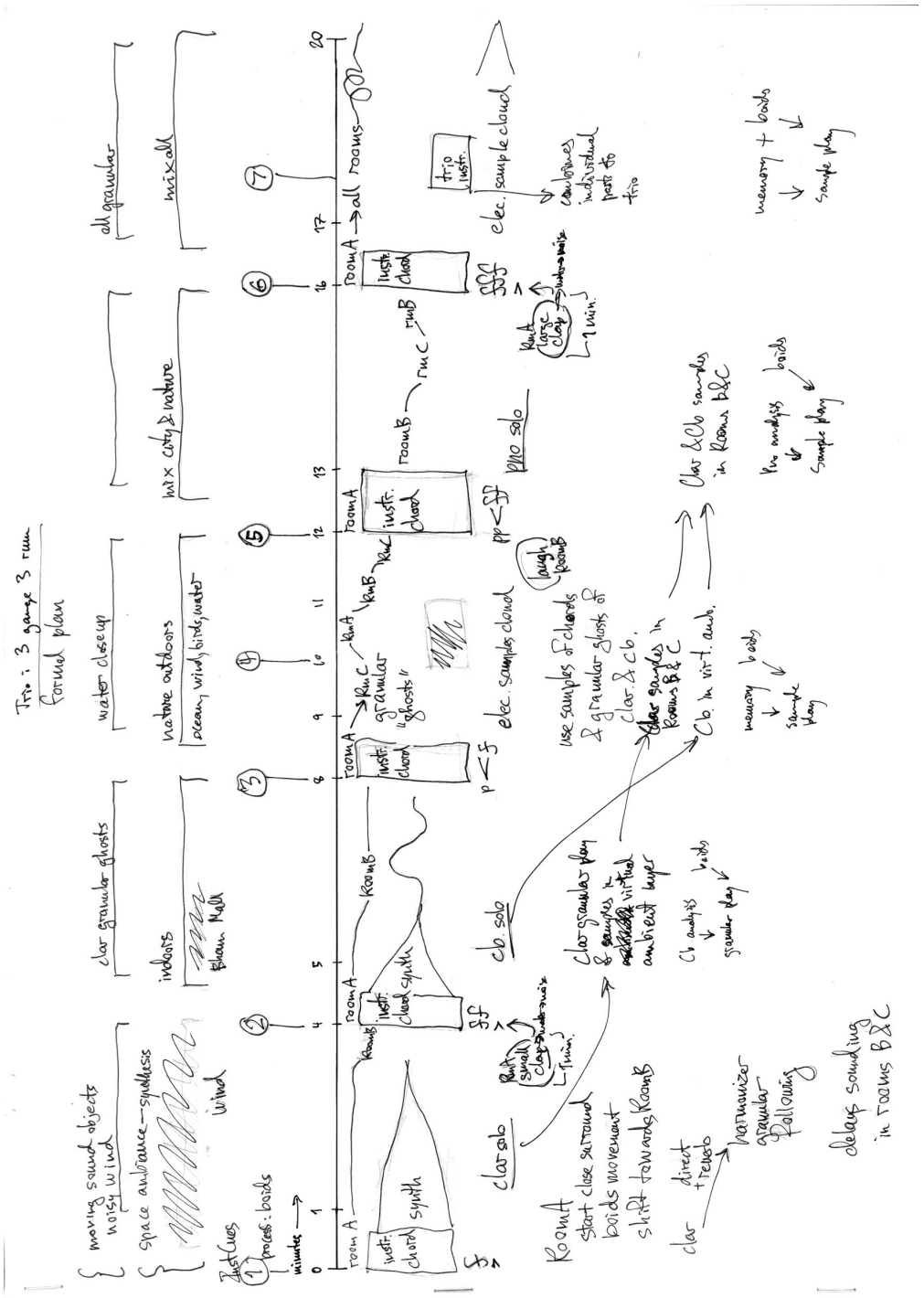

Figure 3.8: Page 1 of sketch of time structure for *Trio in 3 times 3 rooms.*

3.3 *Trio in 3 times 3 rooms*: morphology of sound and virtual space

The metaphorical JOURNEY through changing perspectives became the conceptual basis for *Trio in 3 times 3 rooms* and I looked for ways to support this concept in my sound design. I decided that the work should include ambiences from a number of localities that I had traveled through in recent years, including: a paddle in the shallow water of a quiet beach on the coast of Northern Cyprus; street ambience from Damascus, Syria; a walk inside a shopping mall in Birmingham, UK; mediterranean surf on a Southern Italian beach. I also explored various sonic materials which I thought of as high-level 'sound objects'[22] that would appear in different parts of the virtual spaces: the chord,[23] the recorded soprano saxophone, the clapping audience, filtered pink noise,[24] a closing door and a machine sound. In the system diagram these were all readily located within one of the four 'sound sources' in the software part as indicated in Figure 3.7.

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environments might be understood as examples of Emmerson's '*Field* functions that create a context, a landscape or an environment within which *local* activity may be found.' [Emmerson, 2007, 1994, 92] Taina Riikonen [2004, 239-240] used Emmerson's 'Local/Field' concept to examine flautist Petri Alanko's comments on performing *NoaNoa*.

[22]See discussion on Schaefferian 'sound objects' in section 1.4.

[23]The 'chord' is also played by the instrumental trio.

[24]Pink noise is '[n]oise which has a continuous frequency spectrum and where each frequency band of constant relative bandwidth $\Delta f/f$ contains the same power, e.g., each octave has the same power'. [Zölzer, 2011, 592]

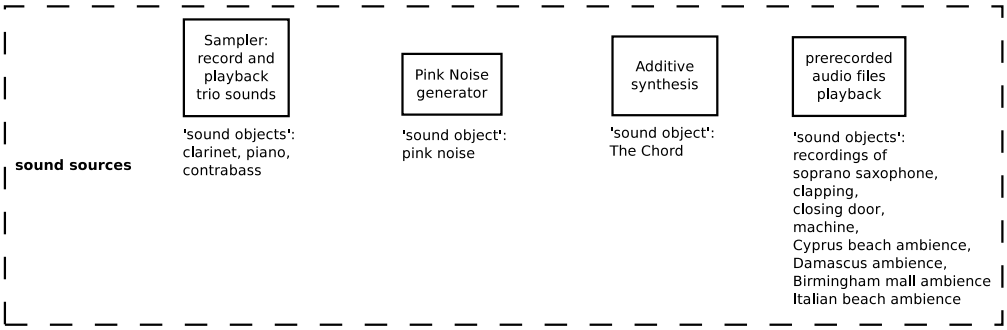


Figure 3.9: Four categories of sound sources in *Trio in 3 times 3 rooms*.

With the background of analysis work on *NoaNoa* and *The Ghost of Judith* in Chapter 2, I had developed a workable approach to managing part of the compositional development of the new work: the 'sound objects' were classifiable under the four sound sources as shown in Figure 3.9, and transforming parameters could be expressed as transformation paths. Transformations that I thought of as building blocks for the composition included cross-fading between acoustic instruments and electronic sound as well as between real and virtual acoustic spaces. Some sketches of the transformations I developed as ideas during composition of the trio included those shown in expressions (3.4), (3.5) and (3.6). I made these without attempting to conform to the notation of the developing typology and so these will not be used directly in the final typology. Instead I will use analysis of the resulting music to add elements to the typology as will be discussed in section 3.4.

Expression (3.4) – The attack and sustain with diminuendo of the 'chord' by the trio, which cross-fades with additive synthesis:

$$\begin{bmatrix} \text{TheChord(trio)} \\ \text{DRY(trio)} \\ \text{RealSpace(center)} \end{bmatrix} \rightarrow \begin{bmatrix} +Move(in\,VirtualSpace) \\ Change(SoundSource) \end{bmatrix} \Rightarrow \begin{bmatrix} \text{TheChord} \begin{pmatrix} \text{trio(fadeOut)} \\ \text{SYNTH(fadeIn)} \end{pmatrix} \\ \text{DRY(trio)} \\ \text{SYNTH(additive)} \\ \text{VirtualSpace1} \begin{pmatrix} boids \\ \text{quad surround} \end{pmatrix} \end{bmatrix}. \tag{3.4}$$

Expression (3.5) – The 'door slam' sample appears in various places through the virtual space:

$$\begin{bmatrix} \text{PlaySAMPLE(DoorSlam)} \\ \text{DRY(sample)} \\ \text{VirtualSpace}(1, \text{fixed}) \end{bmatrix} \rightarrow \begin{bmatrix} +Move(in\,VirtualSpace) \end{bmatrix} \Rightarrow \begin{bmatrix} \text{PlaySAMPLE(DoorSlam)} \\ \text{DRY(sample)} \\ \text{VirtualSpace} \begin{pmatrix} \text{spkr. } 2, 3, 4 \\ \text{fixed} \end{pmatrix} \end{bmatrix}. \tag{3.5}$$

Expression (3.6) – 'Machine' sample moves in virtual space:

$$\begin{bmatrix} \text{PlaySAMPLE(Machine)} \\ \text{Reverb} \\ \text{VirtualSpace}(1, \text{fixed}) \end{bmatrix} \rightarrow \begin{bmatrix} +Movement(in\,VirtualSpace) \end{bmatrix} \Rightarrow \begin{bmatrix} \text{PlaySAMPLE(Machine)} \\ \text{Reverb} \\ \text{VirtualSpace}(1, \text{moving}) \end{bmatrix}. \tag{3.6}$$

In the final version of *Trio in 3 times 3 rooms* I used techniques that I had also used in *The Ghost of Judith*: the additive synthesis consists of 'tones' that are constructed of several sine-tone partials. The frequencies and amplitudes of the partials are modulated stochastically within set limits (see flow chart in Figure 3.10).[25] Each synthesised tone is

[25] Frequencies of individual partials are varied iteratively by ± 5% and amplitudes of individual partials are varied iteratively by ± 5%, with changes taking place over intervals of up to 15 seconds.

assigned to an agent in the *boids* algorithm which provides spatial movement in the four speaker surround system (area 1 in Figures 3.3 and 3.4). Beginning at score letter 'N' the synthesis is put through a doppler spatialisation effect as a second layer of spatialisation, which expands the perceived horizons of the virtual space.

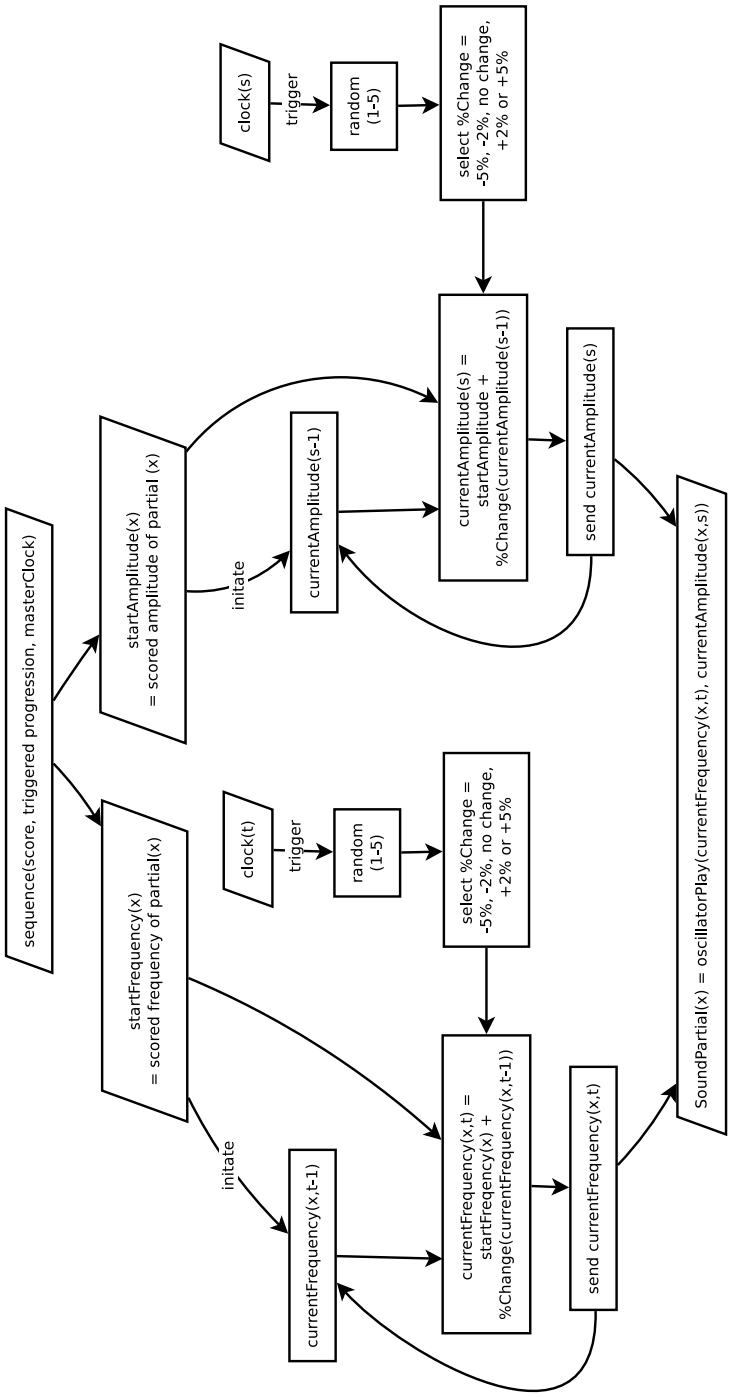


Figure 3.10: Flow chart excerpt from *Trio in 3 times 3 rooms*: LFO stochastic changes to additive synthesis partial.

3.4 *Trio in 3 times 3 rooms*: transformation path analysis

With the complete score and recording of *Trio in 3 times 3 rooms* I can identify some potential typology elements through transformation analysis with the same approach as applied to *NoaNoa* and *The Ghost of Judith* in Chapter 2. The idea in expression (3.4) can be described as an instance of FREEZE, where the additive synth is a transformative sustain of the instrumental chord. The technique employed to create this FREEZE is of course different from the FREEZE instances observed in *NoaNoa* where the sustain is created with a reverb. However, the FREEZE component in TPC(1) of *Trio in 3 times 3 rooms* is similar to that observed by Tüzün in his analysis of Murail's *Winter Fragments*: he uses FREEZE as the timbre space where violin and cello notes prolong a note in the flute melody, and where the key aspects are sustaining of pitch with transformation of timbre. [Tüzün, 2009, 62-70] With this in mind, my TPC analysis of the first bar of *Trio in 3 times 3 rooms* becomes expression (3.7). In this interpretation of TPC(1) the pitch structure, the chord I am calling α, is sounded by the trio and the additive synthesis, and the timbre is transformed from the trio sound to the additive synthesis by gradually increasing the amplitude of the synth while the instrumental sound decays (also called a cross-fade). The coordinated dynamics of this combination of acoustic and computer sound sources allow the sources to merge to become one 'sound object' when experienced by the audience and this merging is what allows the two separate sound sources to adequately approach my prototype concept of FREEZE.[26]

[26] This prototype concept comes from the analysis of *NoaNoa* as presented in Chapter 2. See also discussion of the 'sound object' and related concepts in section 1.4.

$$\mathrm{TPC}(1) = \left[\begin{array}{l} \alpha\Big(\big(\mathrm{cl}, \mathrm{pno}, \mathrm{cb}, \mathrm{SYNTH}(\mathrm{additive})\big) \Rightarrow \textit{Chord}\Big) \\ \mathrm{FREEZE}\left(\begin{array}{l} (\mathrm{cl}, \mathrm{pno}, \mathrm{cb}) \\ \downarrow \mathrm{crossfade} \downarrow \\ \mathrm{SYNTH}\left(\begin{array}{l} \mathrm{additive} \\ (\mathrm{pitch}, \mathrm{gain}) \leftarrow \mathrm{LFO}(\mathrm{stochastic}) \\ \mathrm{SPATIALIZE}(\mathrm{RoomA}, \textit{boids}) \end{array}\right) \end{array}\right) \end{array}\right]. \qquad (3.7)$$

I am not adding a separate spatialisation component to the TPC description in expression (3.7), which might otherwise have been implied by the draft ideas in expressions (3.4), (3.5) and (3.6).[27] Instead it will be simpler and more informative to apply the spatialisation as parameters within timbre components. This way, the spatialisation indications are attached to individual sound sources. For example, SPATIALIZE(RoomA, *boids*) is part of the SYNTH component in expression (3.7), and in that SYNTH component, the SPATIALIZE[28] part takes input from the *boids* algorithm, and operates in the virtual space 'RoomA' corresponding to speakers 1–4 in the *Refektoriesal* (see layout in Figure 3.2).[29] This approach should also facilitate notation of diverse spatialisations of simultaneous sounds such as in TPC(23–24) shown in expression (3.9).

In expression (3.7) from *Trio in 3 times 3 rooms* the $-$*FREEZE* transformation, fa-

[27]Unfortunately I only had the resources to record the premiere of *Trio in 3 times 3 rooms* in stereo, and this recording is included in the audio CD (see Appendix C).

[28]I am using SPATIALIZE rather than SPATIALISE, to better distinguish the label from the common-use meaning of the word. SPATIALIZE is a label specific to the context of the present research, as are the other TPC component labels.

[29]RoomA also corresponds to *rum 1* (in red) in Figure 3.3 and *Virtual Space 1* in Figure 3.4. In the TPC segmentation of *Trio in 3 times 3 rooms* (Appendix A.5) I furthermore use RoomB which corresponds to speaker 5 in *Bispeværelset* in Figure 3.3, *rum 2* (in green) in Figure 3.3 and *Virtual Space 2* in Figure 3.4. RoomC in the TPC notation corresponds to speakers 6 and 7 in *gang* in Figure 3.3, *rum 3* (in yellow) in Figure 3.3 as well as *Virtual Space 3* and *Virtual Space 4* in Figure 3.4.

miliar from the *NoaNoa* analysis, also appears: TPC(1–2)→[−*FREEZE*]⇒TPC(233). However, the SYNTH(additive), which is the electronic part of FREEZE in TPC(1–2), is built of sine-tone partials each of which is stochastically changed in pitch and amplitude parameters (Figure 3.10) and the resulting sound is defining for this instance of FREEZE. From this perspective I make an abstract transformation path supertype −*FREEZE* that is above the two instances which are differentiated as −*FREEZE(reverb)* and −*FREEZE(SYNTH(additive))* and add this to the typology hierarchy as shown in Figure 3.11.

I use β to designate the melodic motif played by the clarinet in bars 3–6, and then notate the description as shown in expression (3.8). The following bars continue from TPC(3–6), until TPC(23–24) where a 'panning delay' effect is added to the clarinet sound, as indicated in expression (3.9). This adds a new type of path which I am labelling as *+DELAY)* in Figure 3.11, from the path TPC(3–6)→[+*DELAY(ping-pong)*]⇒TPC(23–24). The complete TPC segmentation of *Trio in 3 times 3 rooms* can be seen in Appendix A.5 and I will include more paths from this analysis in the typology, without going into repetitive details of the analytical process.

$$\mathrm{TPC}(3-6) = \begin{bmatrix} \beta(\mathrm{cl}), \alpha\big(\mathrm{SYNTH(additive)}\big) \\ \mathrm{clarinet} \rightarrow \big(\mathrm{RecordSAMPLE(A1)}, \mathrm{RecordANALYSIS(A1)}\big) \\ \mathrm{SYNTH} \begin{pmatrix} \mathrm{additive} \\ (\mathrm{pitch}, \mathrm{gain}) \leftarrow \mathrm{LFO(stochastic)} \\ \mathrm{SPATIALIZE(RoomA}, \textit{boids}) \end{pmatrix} \end{bmatrix}. \quad (3.8)$$

$$\mathrm{TPC}(23-24) = \begin{bmatrix} \beta(\mathrm{cl}, \mathrm{DELAY}), \alpha\big(\mathrm{SYNTH}(\mathrm{additive})\big) \\ \mathrm{clarinet} \\ \mathrm{DELAY} \begin{pmatrix} \mathrm{cl} \rightarrow (\mathit{ping} - \mathit{pong}) \\ \mathrm{SPATIALIZE}(\mathrm{RoomA}, \mathrm{preset\ 4speaker}) \end{pmatrix} \\ \mathrm{SYNTH} \begin{pmatrix} \mathrm{additive} \\ (\mathrm{pitch}, \mathrm{gain}) \leftarrow \mathrm{LFO}(\mathrm{stochastic}) \\ \mathrm{SPATIALIZE}(\mathrm{RoomA}, \mathit{boids}) \end{pmatrix} \end{bmatrix}. \tag{3.9}$$

The initial inheritance hierarchy in Figure 3.11 along with the compositions *The Ghost of Judith* and *Trio in 3 times 3 rooms* constitute the results of the first two cycles of the iterative research- and practice-led process. The hierarchy as a typology is still of very limited scope at this point. To expand on this, the narrative of this thesis will turn its focus to comparative analysis of repertoire works in Chapter 4, without immediately addressing potential connections to further compositional work. These connections however, will be examined in the following Chapters 5, 6 and 7 where the repertoire analyses from Chapter 4 will reappear as key elements in the composition of the final three portfolio works.

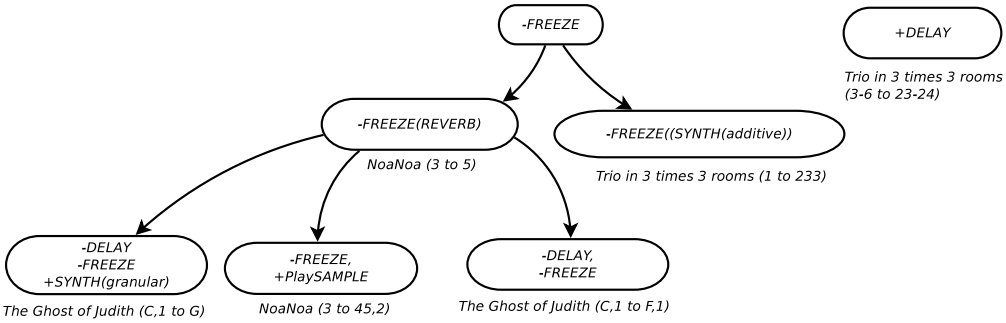


Figure 3.11: Initial inheritance hierarchy with elements added from analysis of *Trio in 3 times 3 rooms*.

Chapter 4

Typology development from comparative study of works by Saariaho, Berio and Harvey

In my analysis of Saariaho's *NoaNoa* in Chapter 2 and Appendix A.1, I identified a collection of paths in a transformation space and proposed that these paths could be considered as *types of changes* in the combinations of acoustic instruments and electronics used by the composer in that particular work. In this chapter, in order to identify more of such potential types of changes, I compare paths in *NoaNoa* with paths in *Altra voce* (1999) by Luciano Berio [Berio, 1999] and *Ricercare una melodia* (1984) by Jonathan Harvey. [Harvey, 1992] The results provide additional elements which expand the hierarchy of the typology. The analyses of these works will also provide materials and ideas that become significant in the composition of some of the later portfolio works, as detailed in the subsequent Chapters 5, 6 and 7.

4.1 Analysis of Berio's *Altra voce* (1999)

Altra voce for alto flute, mezzo-soprano and live electronics 'was developed by Luciano Berio from the scene *Il campo* in the musical theatre work *Cronaca del Luogo*'.[1] [Berio, 1999, Instructions p.2] An interesting feature of this piece is that it is claimed that the Instructions give 'all the necessary information for the realization of the electronic part', and also: '[t]he instructions are not bound to any specific technology'. [Berio, 1999, Instructions p.3] In this documentation, which gives instructions on how the work is to be performed, the electronic functionality is described in terms of parameters that are to be realised in sound, without naming the specific software or hardware necessary for this realisation.[2] To clarify this I turn immediately to my soft systems analysis as shown in Figure 4.1.

[1] See also notes on the Universal Edition web site at http://www.universaledition.com/Altra-voce-Luciano-Berio/composers-and-works/composer/54/work/1111 (accessed March 13, 2014)

[2] Giomi, Meacci and Schwoon quote Berio as stating that his use of technology is based on 'adaptability of the musical thought to different spaces and listening situations.' [Giomi et al., 2003, 30] Another potential reason for avoiding the prescription of specific technologies, is that digital equipment and software become obsolete very quickly, and therefore may become obstacles for potential future performances. For discussions of such issues see for example Bullock and Coccioli [2005], Emmerson [2006] and Wetzel [2006].

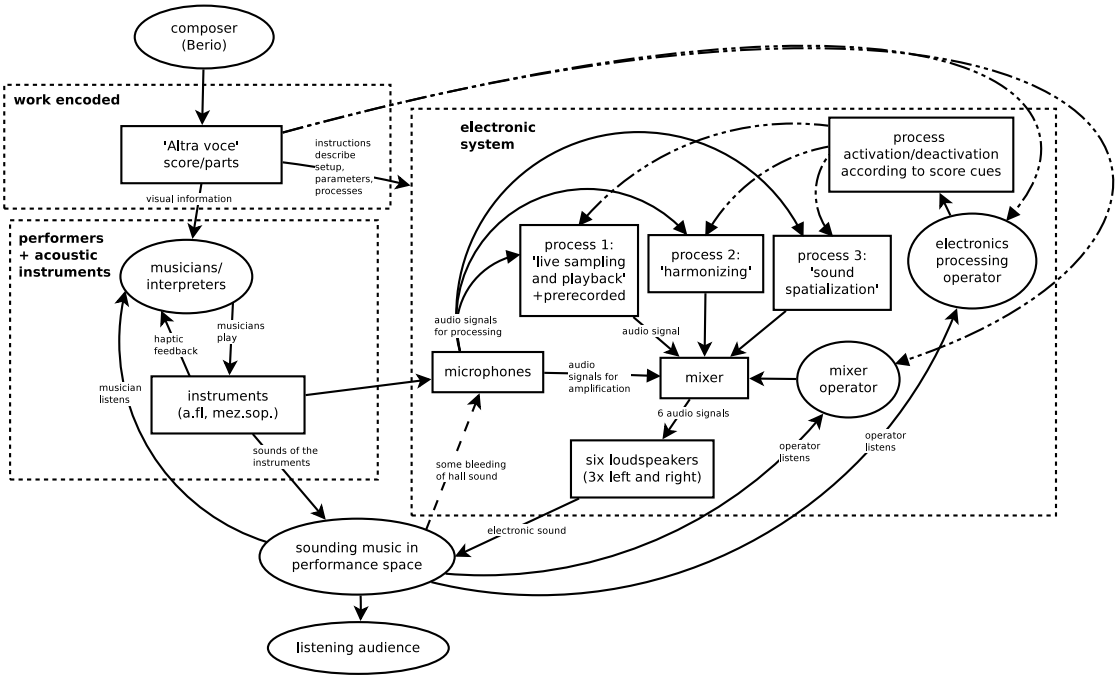


Figure 4.1: Soft system diagram of Luciano Berio's *Altra voce*.

In this soft system diagram of *Altra voce* I have indicated the virtual apparatus in the software. This is essentially a transcription of what Berio wrote in his 'Technical Manual' for *Altra voce*. In that document, which forms part of the published score, Berio describes 'three types of electronic transformation found in the score (spatialization, sampling, and harmonizing)'.[3] [Berio, 1999, Technical Manual p.3] Berio follows this by supplying lists of parameters that are to be applied to each of these three transformations as indicated by the cue points in the score. To make a soft system diagram of *Altra voce* as shown in Figure 4.1, it was necessary to indicate the three transformation types as elements in the electronic system, without indicating specific technologies. But these are virtual

[3]The Technical Manual for *Altra Voce* was prepared by 'Tempo Reale (www.temporeale.it), the centre for musical research, production and education founded by Luciano Berio.' This note then ends with: 'Francesco Giomi, Damiano Meacci, Kilian Schwoon, Florence, October 2008' indicating a collaborative effort. [Berio, 1999, Technical Manual p.12]

elements that might reside as functionalities in a software programme; indeed this would seem the most likely way to realise the work under current concert practice. In any case the virtual elements in software represent necessary functionalities in the system, and so can be mapped as part of that system. To examine how the relations between the acoustic instruments and electronics change over the course of the piece I turn again to transformation analysis, this time coupled with pitch-class analysis, as described in section 4.2.

4.2 *Altra voce* bars 1–19: pitch-class sets and TPC descriptions

Altra voce contains an F drone, which is present throughout the work, and which is initially played by the alto flute and then sung by the mezzo-soprano. The flute and mezzo-soprano sounds are sampled in bar 2, and played in loop by the electronics from bar 3 until the end of the piece. Berio's use of pitch materials around this F drone can be suitably described with pitch-class set (pc set) analysis.[4] My segmentation of bars 1–17 is shown in Appendix A.2 (Figures A.6, A.7 and A.8) where it is also aligned with the transformation analysis of pass 1 (see Figure A.10). In this first part of the work, there is a gradual enlargement of the pc set used, until bar 18, where 11 notes of the chromatic scale are used, and the remaining D♭ occurs in bar 19. There seems to be a clear buildup of pitch-classes, from a single F in the beginning, to the chromatic dyad, followed by pc sets 3-2, 5-29, 7-1 and so on,[5] until the full twelve notes are employed in bars 18 and 19.

[4] I have discussed my use of pitch-class set theory in section 1.5.

[5] The pc set names 3-2, 5-29 and 7-1 are Forte's 'prime forms' which are used for the sake of brevity, 'so that a pc set can be referred to without recourse to a cumbersome description of some kind'. [Forte, 1973, 11–12] Forte gives a full list of his prime form names in his book *The Structure of Atonal Music*. [Forte, 1973, 179–181]

This buildup of pitch-classes occurs partly in the acoustic instruments, but equally so in the pitch-classes sounded by the electronics. Samples are recorded and played back (in loops), building up from the F to the F–G♭ dyad and then to the pitch-class set 4-18, which is generated by three looping samples throughout bars 16–53. The building up of the texture of the music is reflected in visual layout of the pass 1 network diagram (Figure A.10), where the three samples are indicated as PlaySAMPLE(1,2,3).[6]

The analytical reduction of the pitches sounded by the electronics and acoustic instruments is segmented according to the bars in Berio's score as shown in Appendix A.2.2. One could argue for a segmentation that would put more emphasis on the gestures across bars, but I am interpreting the music as textural rather than gestural, showing my pragmatic bias in this analysis: the resulting bar segmentation seems adequate and provides a suitable alignment for the elements of the transformation space.

Bar 2 is recorded and becomes SAMPLE(1) which is played back repeatedly (in a loop) throughout the rest of the piece, and the tempo is indicated in bar 8 as one quarter-note (one crotchet) equals 66 bpm. There is no indication in the score that particular parts of the sample or harmonizer loops would be precisely coordinated with phrases by the acoustic instruments, and therefore I include all likely harmonizer-generated pitches in the pitch reduction. In practice however, slight deviations in tempi by the performers may exclude some of the potential harmonizer pitches. I will proceed to compare my analyses of *Altra voce* and *NoaNoa* in section 4.3 and I also return to my analysis of *Altra voce* in Chapter 6.1, where I discuss my use of the analytical results as material on which to develop compositional ideas for the portfolio work *Chasing the voices of windmills*.

[6] I am setting aside meanings of the poem that might potentially be connected with the formation of particular pitch structures.

4.3 Comparison between *Altra voce* and *NoaNoa* yields path type *+PlaySAMPLE*

The TPC descriptions of *Altra voce* (see Appendix A.2) all include *PlaySAMPLE*, with the exception of bars 1–2. Berio asks for live sample recording in *Altra voce*, in contrast to Saariaho who uses pre-recorded samples in *NoaNoa*. Both composers use sample playback, and transform the sample sounds in some way. In *Altra voce* the samples are played in repeated loops, and from bar 8 onwards there is the addition of a triggered spatialisation of the playback that oscillates between left and right sides of the audience according to time parameters set by the composer. But the path between TPC(2) to TPC(3) in the transformation space in *Altra voce* (see expression (4.1)) is comparable to the path of TPC(3) to TPC(45,2) in the analysis of *NoaNoa* (see expression (4.2)). These paths both add *PlaySAMPLE* to the components of the descriptions.[7]

[7] I use the *PlaySAMPLE* component to indicate a playback of some recorded (sampled) electronic sound.

Path[8] from *Altra Voce* score, TPC(2) to TPC(3):

$$\begin{bmatrix} \alpha \begin{pmatrix} (\text{a.fl.}, \text{mez.sop}) \\ \Downarrow \\ \text{PCset}[0] \end{pmatrix} \\ \text{DRY}(\text{a.fl.}, \text{mez.sop.}) \\ \text{RecordSAMPLE}(1) \end{bmatrix} \rightarrow \Big[+\mathit{PlaySAMPLE} \Big] \Rightarrow \begin{bmatrix} \alpha \begin{pmatrix} (\text{a.fl.}, \text{mez.sop}, \text{SAMPLE}(1)) \\ \Downarrow \\ \text{PCset}[0] \end{pmatrix} \\ \text{DRY}(\text{a.fl.}, \text{mez.sop.}) \\ \text{PlaySAMPLE}(1)\text{loop} \end{bmatrix}. \tag{4.1}$$

Path from *NoaNoa* score, TPC(3) to TPC(45,2):

$$\begin{bmatrix} \beta\Big(\text{flute}\big(\text{IC1}(\text{gliss})\big)\Big) \\ \text{FREEZE} \begin{pmatrix} \text{flute} \\ \downarrow \\ \text{REVERB} \\ (\mathit{infinite}) \end{pmatrix} \end{bmatrix} \rightarrow \begin{bmatrix} \mathit{change\ register} \\ -\mathit{FREEZE} \\ +\mathit{PlaySAMPLE} \end{bmatrix} \Rightarrow \begin{bmatrix} \beta\Big(\text{flute}\big(\text{IC1}(\text{gliss})\big)\Big) \\ \text{DRY}(\text{flute}) \\ \text{PlaySAMPLE} \begin{pmatrix} \text{PreRECORDED} \\ (\text{sampled flute}) \end{pmatrix} \end{bmatrix}. \tag{4.2}$$

Pointing out that two composers both use sample playback may at first seem a trivial observation. However, it is a step that can contribute significantly to establishing this approach for comparative analysis of the relations between acoustic instruments and

[8]One could argue against a DRY(a.fl.,mez.sop.) component since there is no use of any FREEZE component in my analysis of *Altra Voce* and therefore it should not be necessary to use the DRY component label in this context. However, I use the DRY component in *Altra Voce* in order to keep consistent notation across the works analysed in this thesis. The use of DRY in my analysis of *Altra Voce* arguably points to an intertextual link with my analysis of *NoaNoa* (at the TPC abstraction level), since DRY is included in the analytical context of *Altra Voce* because of the presence of FREEZE in the analytical context of *NoaNoa*. Other notational details that I have standardised across my analyses may indicate other intertextual links that I have constructed or discovered in my analyses. This standardisation of notation across the analytical contexts of various works may be considered a source of bias in the research, since such standardisation may tend to filter out contextual differences. But I argue that my analytical aim is precisely to filter out contextual differences to arrive at common patterns of practice.

electronics in music works by different composers. This helps set the context for non-trivial comparisons which will contribute to building a collection of elements for the typology of these relations.

Path from *Altra Voce* score, TPC(2) to TPC(8):

$$\begin{bmatrix} \alpha\big((\text{a.fl.}, \text{mez.sop}) \Rightarrow \text{PCset}[0]\big) \\ \text{DRY}(\text{a.fl.}, \text{mez.sop.}) \end{bmatrix} \rightarrow \text{RecordSAMPLE}(1)$$

$$\downarrow$$

$$\Big[+\mathit{PlaySAMPLE}(\mathit{spatialised})\Big]$$

$$\Downarrow$$

$$\begin{bmatrix} \alpha\Big(\big(\text{a.fl.}, \text{mez.sop}, \text{PlaySAMPLE}(1,2)\big) \Rightarrow \text{PCset}[0,1,3]\Big) \\ \text{DRY}(\text{a.fl.}, \text{mez.sop.}) \\ \begin{pmatrix} \text{PlaySAMPLE}(1)\text{loop} \\ \text{PlaySAMPLE}(2)\text{loop} \end{pmatrix} \rightarrow \text{SPATIALIZE}(\text{L}, \text{R})\text{loop} \end{bmatrix}. \tag{4.3}$$

Path from *NoaNoa* score, TPC(3) to TPC(46):

$$\begin{bmatrix} \beta\Big(\text{flute}\big(\text{IC1}(\text{gliss})\big)\Big) \\ \text{FREEZE}\big(\text{flute} \rightarrow \text{REVERB}(\mathit{infinite})\big) \end{bmatrix}$$

$$\downarrow$$

$$\begin{bmatrix} \mathit{transpose} \\ -\mathit{FREEZE} \\ +\mathit{PlaySAMPLE}(\mathit{modulated}) \end{bmatrix}$$

$$\Downarrow$$

$$\begin{bmatrix} \beta\Big(\text{flute}\big(\text{IC1}(\text{gliss})\big)\Big) \\ \text{DRY}(\text{flute}) \\ \text{PlaySAMPLE}\begin{pmatrix} \text{PreRECORDED}(\text{voice})\text{modulated} \\ \uparrow \\ \text{flute} \rightarrow \text{ANALYSIS} \end{pmatrix} \end{bmatrix}. \tag{4.4}$$

There is a *+PlaySAMPLE(spatialised)* transformation path between bars 2 and 8 in *Altra voce* (see expression (4.3)).[9] This is comparable to the transformation [*−FREEZE, +PlaySAMPLE(sample modulated)*] (see expression (4.4)) which is in pass 2 of the *NoaNoa* analysis. Both paths add electronic playback of recorded sound and modify the sound of the sample during playback. In *Altra voce* the modification of playback is done by shifting the electronic sound between the left and right speakers, giving a spatial modulation. In the *NoaNoa* path, the playback of the pre-recorded sound file is modulated in amplitude in inverse proportion to the amplitude of the live flute sound. These are two very different kinds of modification of the electronic sound: spatialisation versus amplitude modulation. However, these two paths in the transformation spaces of these two works can be considered comparable as versions of a more general and abstract type: *+PlaySAMPLE(modified)*. This could then be considered a possible super-type, from which the two types inherit some characteristics. The super-type *+PlaySAMPLE(modified)* inherits the *+PlaySAMPLE* characteristic from the path seen in *Altra voce* (expression (4.1)). In the earlier comparison between expressions (4.1) and (4.2) I will say that the *+PlaySAMPLE* transformation path occurs in both compositions and both are DRY so a super-type of these will be *+PlaySAMPLE*. These can then be placed above the *+PlaySAMPLE(modified)* in an inheritance-based hierarchy, as shown in Figure 4.2. I will expand further on this hierarchy with analysis of Jonathan Harvey's *Ricercare una melodia* in section 4.4.

[9] In expressions (4.3) and (4.4) I am presenting the paths vertically (top-down), rather than horizontally (left-to-right), only to ensure that they will fit on the page.

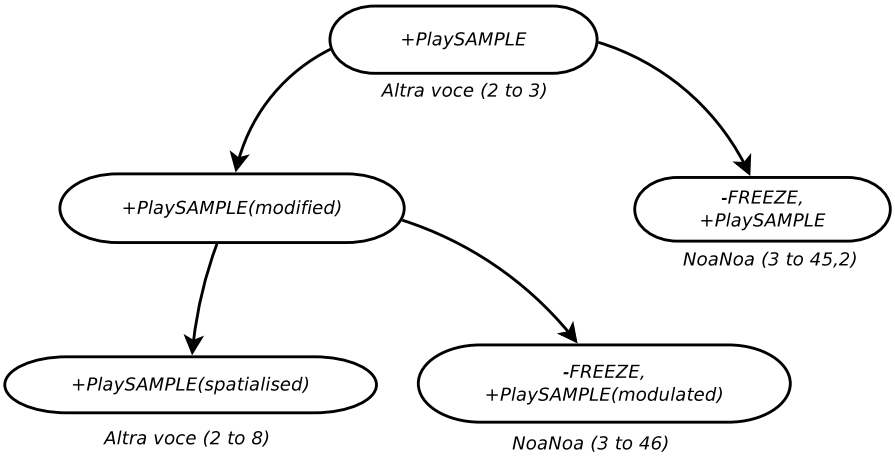


Figure 4.2: An initial inheritance-based hierarchy of types in *NoaNoa* and *Altra voce*.

4.4 Analysis of Harvey's *Ricercare una melodia* (1984)

Jonathan Harvey's *Ricercare una melodia* is one of only a handful of works for solo trumpet and (analogue) tape delay written during the 1970s–80s.[10] The technology of four track analogue reel-to-reel tape delay is generally considered obsolete, and would certainly be a relatively expensive setup to produce in concert.[11] A digital computer version producing the same delay effects is generally much more accessible and cheaper, although the potential visual impact of the equipment on stage would be different from

[10]Michael Edwin Barth has compiled a repertoire list of some 200 works for solo trumpet and electronics which is available online at http://michaelbarth.ca/research-2/ (accessed September 10, 2014). In Barth's listings, only five works, including Harvey's *Ricercare una melodi*, are included under the category of works for 'Trumpet with Tape Loop or Delay' (http://michaelbarth.ca/research-2/trumpet-with-tape-loop-or-delay/). The other four works are: Bernard Carloséma *Épigone* (1986); David Cope *Bright Angel* (1972); Ross Harris *Echo* (1979); Roger Smalley *Echo III* (1978).

[11]For discussion of issues regarding obsolescence of equipment see for example Emmerson [2006] and Wetzel [2006].

an analogue setup. The electronic part has been published as a computer program.[12] The score estimates the performance duration at 6 minutes [Harvey, 1992, title page] and it is intended for quadraphonic sound, i.e. using four speakers that are placed in the corners around the audience.[13] My soft system diagram of the work is shown in Figure 4.3.[14]

Harvey's *Ricercare una melodia*, has a three-part structure,[15] where the 'delay canon'[16] effect runs in the first part, is turned off and modified in the short middle part, and then returns in the third part, where it is effectively playing successive octaves lower than the trumpet, through the technique of slowing one of the tape recorders ('TR2') to half-speed. This change to half-speed is set on the recorder during the trumpet cadenza which is the middle part, bars 47–55 of the work.

[12]The CD-ROM includes a MaxMSP patch, with related externals, aiff files and text files. [Harvey, 2004]

[13]Four separate audio tracks are to be routed from the playback tape machine to four speakers, but the physical placement of the speakers seem to be flexible, according to the score's 'Performance Instructions'. In the instructions three possibilities are suggested: 1. quadraphonic sound; 2. four front speakers; 3. a stereo setup. [Harvey, 1992] An alternative performance possibility is specified using 'quadraphonic tape' suggesting that the quadraphonic setup is preferable. Also, the 'Read Me patch' file on the CD-ROM presents the speaker numberings in a four corner layout. In that file the authors use a track/speaker numbering layout that differs from the score, presuming audience orientation: left front, speaker 3; right front, speaker 1; left rear, speaker 4; right rear, speaker 2. [Harvey, 2004]

[14]I have used the recording of *Ricercare una melodia* on the CD *Wheel of Emptiness* as a reference. [Harvey, 2001, track 3]

[15]Barth analyses the form from a performer's perspective, and considers the work to consist of 'two large sections... that are separated by a cadenza.' [Barth, 2011, 83]

[16]I use the name 'delay canon' whereas Harvey writes that 'a five-part canon is obtained by means of a tape-delay system'. [Harvey, 1992, Programme Note] A 'delay canon' (now usually generated digitally) is used in a number of recent works, including my works *Sonata Neo-Schubert* (2010), *WARNING: Flute at Large* (2007) and *Floating Spaces* (2007). For discussion of some performance practice issues related to the 'delay canon' in *Sonata Neo-Schubert*, see my 2014 article. [Mogensen et al., 2014]

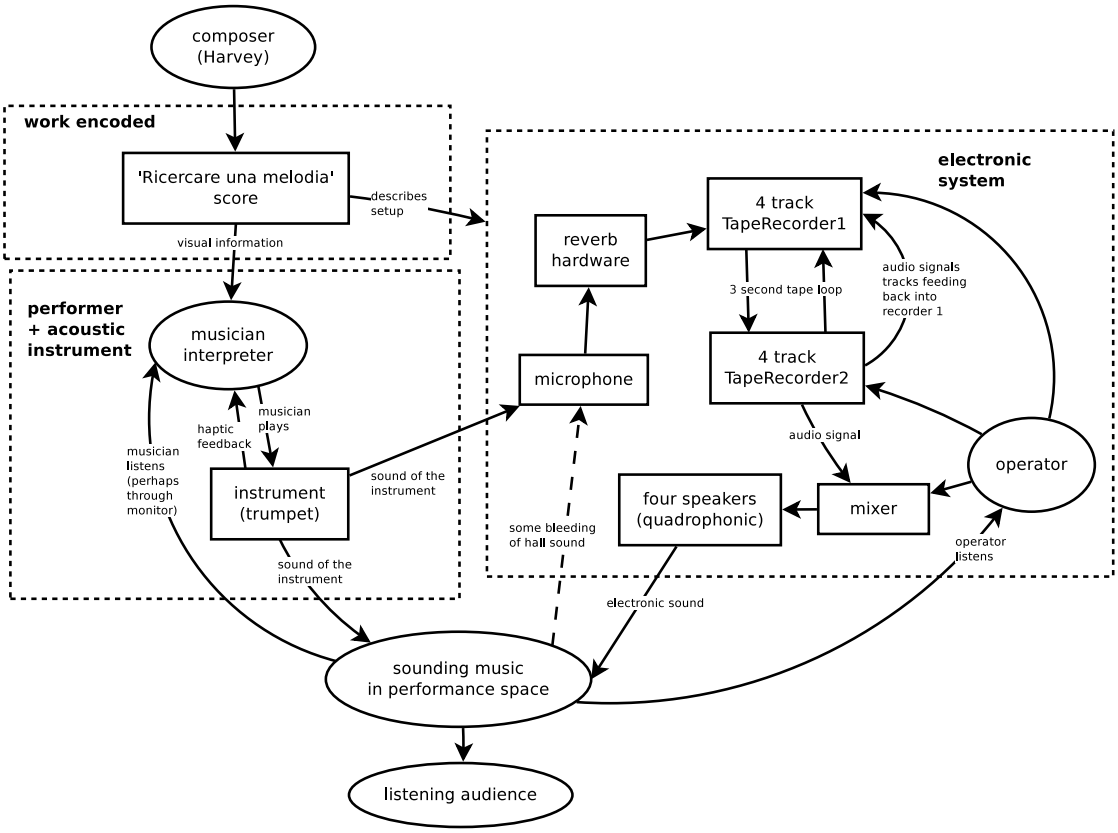


Figure 4.3: Soft system diagram of *Ricercare una melodia*, based on the published score.

Harvey creates significant timbral variety with the trumpet sound, through the 'especially elaborate' use of mutes, as well as other techniques, which Barth has discussed from a performer's perspective as 'Extended Techniques'. [Barth, 2011, 79–82] Harvey writes that he is 'fascinated by harmonic structures which radiate out from either side of a central axis in reflecting intervals.'[17] He also expresses this as: 'The bass moves into the middle: this is our musical revolution.' [Harvey, 1982, 2] This concept can be seen in the pitch structures in *Ricercare una melodia* and Barth uses this as a basis for his structural analysis of the work, where he proposes the hearing of B♭ and A pitches as the axes around which the pitch materials of the work are built. [Barth, 2011, 83–94] My TPC segmentation is listed in Appendix A.3 with my pass 1 transformation network shown in Figure A.11. In section 4.5 I compare transformation paths found in Harvey's work with paths found in *NoaNoa* by Saariaho and *Altra voce* by Berio.

4.5 Path comparisons with *Ricercare una melodia*

With Figures 4.4, 4.5 and 4.6 I examine examples of transformation paths in the works of Saariaho, Berio and Harvey. These are the same paths in *NoaNoa* and *Altra voce* that were compared in section 4.3 but now they are shown with the corresponding score excepts. Again I am looking at the similarity of the paths that contain a *+PlaySAMPLE* as the timbral transformation component. In each work the PlaySAMPLE component

[17]This can be interpreted as an expression of what Reginald Smith Brindle (1917–2003) called the 'Webern cult', which was focused around Anton Webern (1883–1945) and his 'endeavour to 'preform' [his working materials] (so that an entire work could be derived from a minimum of material) which so appealed to the young post-[World War II] generation.' [Brindle, 1987, 8–9] Harvey's symmetry around a central pitch resembles Webern's notes 'positioned so as to form a regular pattern around a central pitch', a kind of pitch structure of which Brindle points out an example of in bars 1–26 of Webern's Symphony Op.21. [Brindle, 1987, 11] Another example of Webern's symmetry is given by Lewin who points to the '[s]ymmetrical spacing of the total chromatic about the pitch-center B♭4–B4, at the opening of Webern op.10, no.3'. [Lewin, 2011*b*, 91]

includes playback of sampled sound, either prerecorded or live: in *NoaNoa* bar 45 a prerecorded sample is played back; in *Altra voce*, however, a sample is recorded in bar 2, which is played back in bar 3; meanwhile, in *Ricercare una melodia* a tape delay mechanism is used to record and play back the live sound as a canon. In all three cases the end point of the transformation path is DRY in the sense of not having any sustaining reverb. These commonalities of playing back a sample without a FREEZE suggests a super type of transformation paths, which I will name the *+PlaySAMPLE* super type.[18]

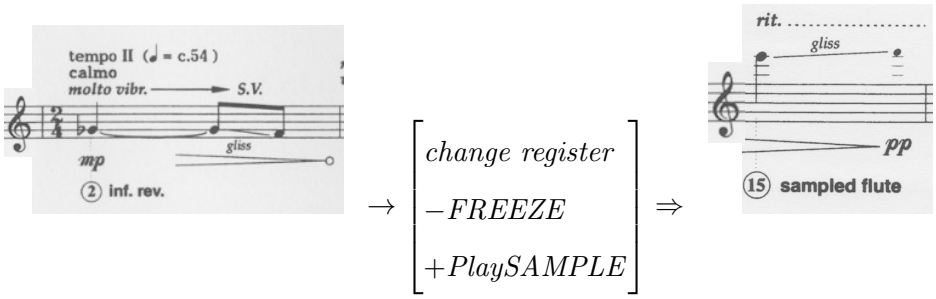


Figure 4.4: Transformation path TPC(3)→[-*FREEZE,+PlaySAMPLE*]⇒TPC(45,2) from *NoaNoa*.

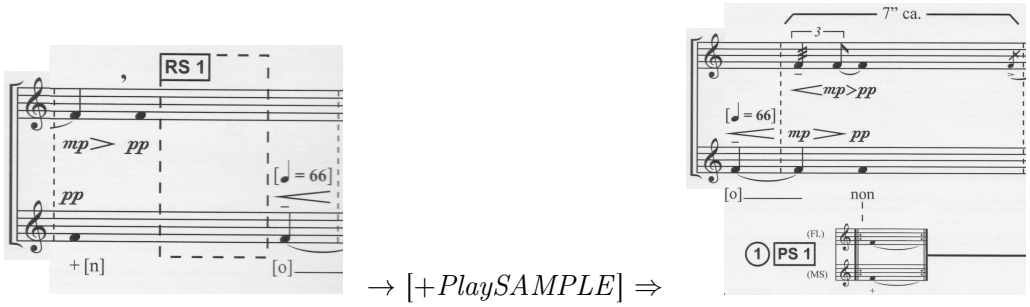


Figure 4.5: Transformation path TPC(2)→[*+PlaySAMPLE*]⇒TPC(3) from *Altra voce*.

[18]Starting the analytic work with *NoaNoa* has perhaps given too much weight to FREEZE, since it happens to be a characteristic of bar 1 of that work. Perhaps any starting point would tend to give some bias, but as the typology has developed, the importance of FREEZE has become less imposing.

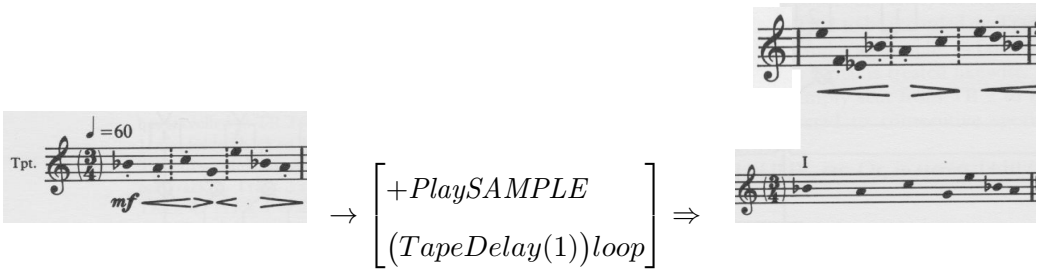


Figure 4.6: Transformation path TPC(1)→[+*PlaySAMPLE*]⇒TPC(2) from *Ricercare una melodia*.

Another set of comparable paths from the same three pieces is shown in Figures 4.7, 4.8 and 4.9, again with excerpts from the scores. These paths also show the similarity of containing a +*PlaySAMPLE* as a timbral transformation component, but the sample playback in each piece is modified and these modifications result in something sonically different, but conceptually comparable. In *NoaNoa* the amplitude of the playback of the prerecorded sample is modulated by a side chain comprised of an amplitude envelope follower on the live flute sound. In *Altra voce* the playback is modulated spatially in a set pattern of movement between left and right speakers. In *Ricercare una melodia* the volume settings controlling the four channels of playback from the tape delay, are manually changed 'in rapid succession across channels' by the technician. [Harvey, 1992] The similarity, of *modulations of the sample playback*, suggests the super-type which I called +*PlaySAMPLE(modified)*.

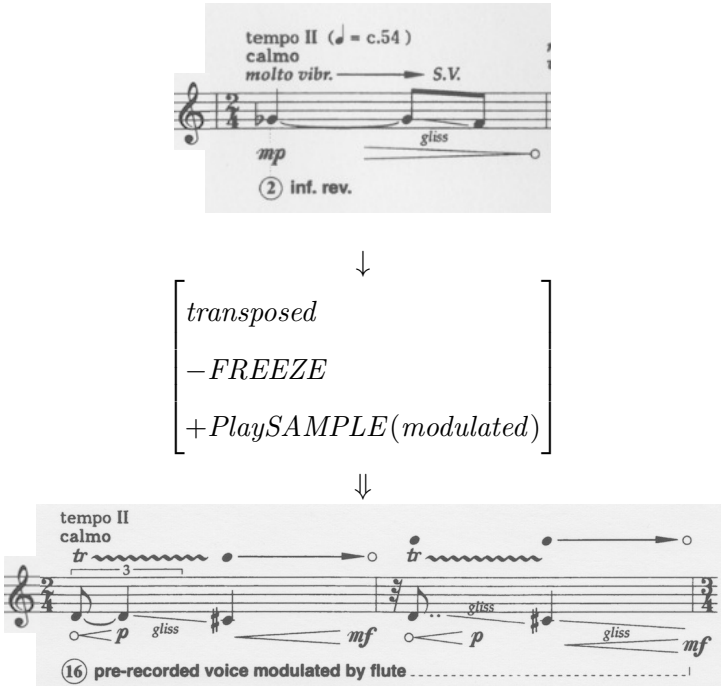


Figure 4.7: Transformation path TPC(3)→[−*FREEZE*,+*PlaySAMPLE(modulated)*]⇒TPC(46–47) from *NoaNoa*.

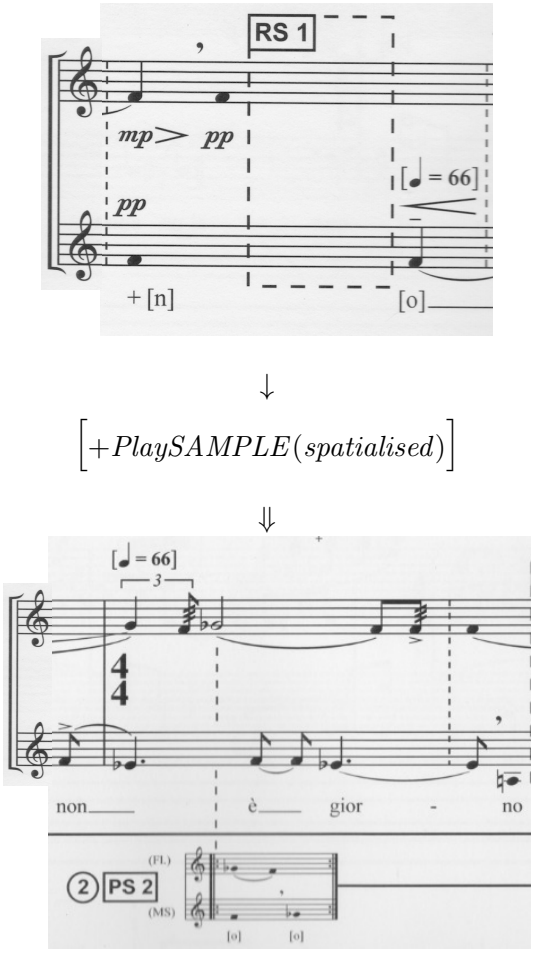


Figure 4.8: Transformation path TPC(2)→[+*PlaySAMPLE(spatialised)*]⇒TPC(8) from *Altra voce*.

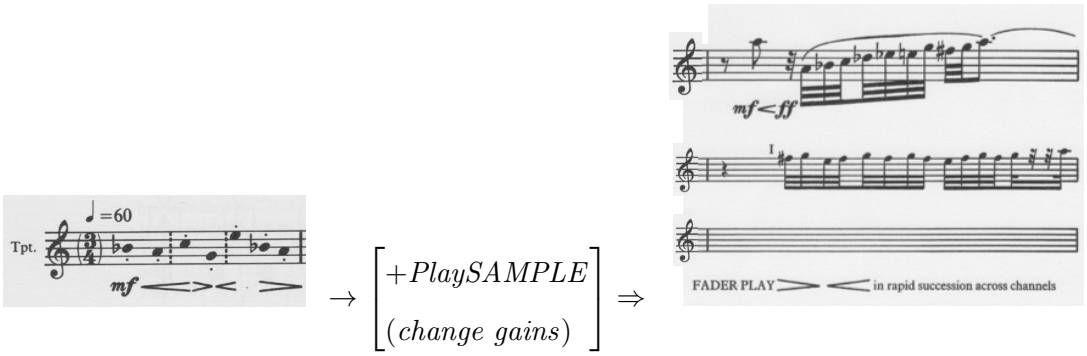


Figure 4.9: Transformation path TPC(1)→[*+PlaySAMPLE(gain changes)*]⇒TPC(34) from *Ricercare una melodia*.

The three works *NoaNoa*, *Altra voce* and *Ricercare una melodia* employ relatively simple electronic means compared to a work with a more complex software engine, such as Cort Lippe's *Music for clarinet & ISPW* from 1992.[19] [Lippe, 1992] To bring this into the comparison I describe an excerpt of the first two TPC(cue point)s in Lippe's work as shown in expressions(4.5) and (4.6). At cue 2 in Lippe's piece the sample that was recorded at cue 1 is played back in various transpositions, as can be head on the CD recording. [Chadabe et al., 1997, track 7] This gives another *+PlaySAMPLE(modified)* transformation path with 'transpose sample' as shown in Figure 4.10.

$$\text{TPC(cue1)} = \begin{bmatrix} \alpha\big(\text{clarinet(IC1)}\big) \\ \text{clarinet} \rightarrow \text{RecordSAMPLE(1)} \end{bmatrix}. \tag{4.5}$$

$$\text{TPC(cue2)} = \begin{bmatrix} \alpha\big(\text{clarinet(IC2)}\big) \\ \text{clarinet} \\ \text{PlaySAMPLE}(1, \text{transpose}) \end{bmatrix}. \tag{4.6}$$

[19] My recording reference of Lippe's *Music for clarinet & ISPW* is on the CD *The Composer in the Computer Age – VII* featuring Esther Lamneck on clarinet. [Chadabe et al., 1997, track 7]

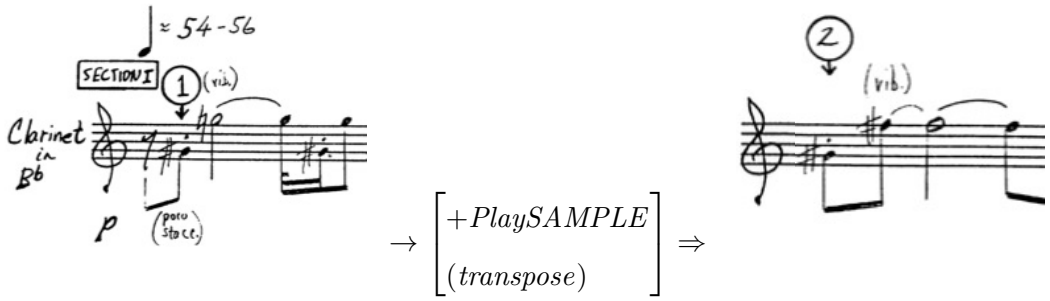


Figure 4.10: Transformation path TPC(cue1)→[+*PlaySAMPLE(transpose)*]⇒TPC(cue2) from Lippe's *Music for Clarinet & ISPW*.

Taking these comparisons, and also incorporating the elements from Figure 2.21 in Chapter 2 and Figure 3.11 in Chapter 3, I can expand the typology hierarchy as shown in Figure 4.11. This approach to comparative analysis is the basic method I have used for generating the hierarchy of the typology. New type elements and comparisons are added gradually through additional analytic work and during the composition processes of the portfolio works. The entire resulting typology is represented in Appendix B with a hierarchy map and the transformation path types catalogue.

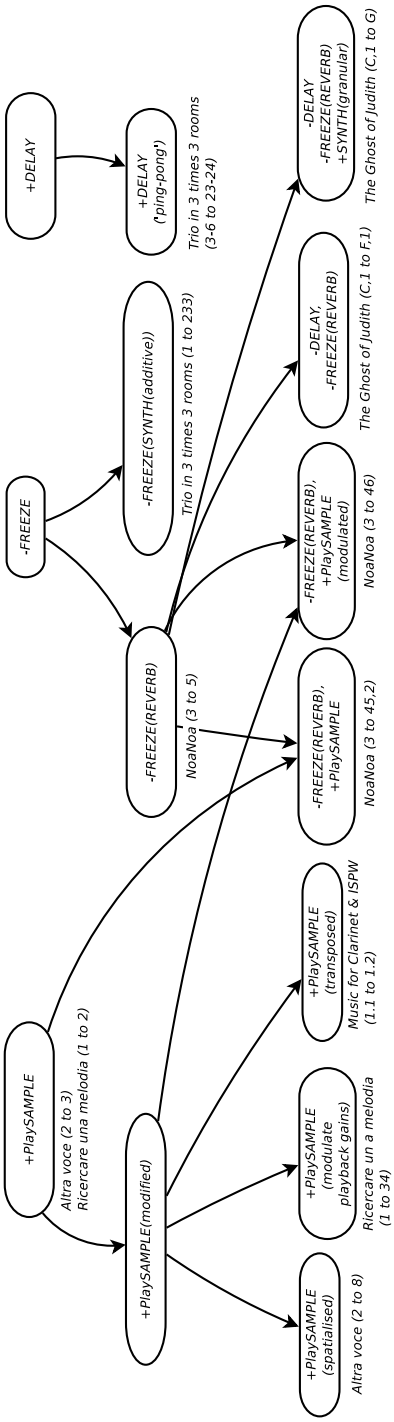


Figure 4.11: Inheritance-based hierarchy of some types in *NoaNoa*, *Altra voce*, *Ricercare una melodia* and *Music for Clarinet & ISPW*.

Chapter 5

Analytic view of form-structures in *NoaNoa* and the form in *Blandango Willow*

The analytical discourse in Chapters 2, 3 and 4 has focused on what may be considered 'surface level' phenomena: patterns of changes within the time-frame of a motivic or bar-line segmentation. It can however, also be instructive to examine large-scale patterns, or forms, that emerge from this same segmentation. In this chapter, I therefore extend the search for patterns in the TPC transformation space to a longer time scale, arriving at a level which may be considered analogous to a Schenkerian *middle-ground*.[1] I interpret *middle-ground* patterns in *NoaNoa* and apply these patterns as ideas for structures in the new portfolio work *Blandango Willow*. Having a stratified analytic view with 'surface level' and 'deeper levels' implies the assumption that useful concepts of structures can

[1]Schenkerian analysis was intended for analysis of tonal compositions. While my analysis here is not focused on tonal organisation, it arguably has borrowed from what Allen Forte called Schenker's '*concept of structural levels*'. [Yeston, 1977, 7]

be arrived at through a Schenkerian type of reductionism: that some inner 'skeleton' provides the support for the 'surface level' experience of the music. This kind of analysis seems a worthwhile project, as Allen Forte wrote in an anthology of Schenkerian studies:

> If it can be demonstrated that contemporary composition[s]... reveal significant similarities at other than the surface level, and if these similarities can be interpreted in an orderly fashion, while at the same time accounting satisfactorily for differences, a beginning will have been made toward a genuine technical history of contemporary music. [Yeston, 1977, 31]

The following analysis may serve as a small step in such a direction.

5.1 Analysis of *NoaNoa* pass 4, bars 94–109: development of α, β interlaced with γ

I continue in the manner of transformation analysis started in Chapter 2, and take bars 94–109 of *NoaNoa* as constituting the fourth pass through the transformation space; my resulting network diagram is shown in Appendix Figure A.4. In this pass in the transformation space, there are interesting combinations of the ideas from previous sections in the music. First, α and β alternate with instances of γ as can be seen in the TPC analysis in Appendix section A.1.4. In my diagram of pass 4 (Appendix Figure A.4) I indicate chains of transformations, and I align similar TPCs in vertical columns within each pitch structure area (α, β, γ).[2] These groupings indicate that there are frequent

[2]Whether the low C's in bars 94–96 are sustained enough to be considered 'drones' is arguable. The changes from 'normal tone' to 'breath tone' would also seem to diminish the drone-like character. But when looking in the score, the reference to the drones in previous instances of γ seem strong. Hence I use 'breath drone' in TPC(94–96) and in later TPC descriptions.

repetitions of the structures.[3] I interpret this as 'strands' that interlace, in other words they are brought to the surface-level in alternating patterns. To illustrate this idea, I reorganise the TPC and transformations from the beginning of pass 4 into the diagram in Figure 5.1. In bars 94–104 two strands of repeated structural ideas seem prominent and I name them *strand 1: gamma(DRY, PlaySAMPLE)* and *strand 2: alpha(DRY)*, according to their TPC elements. In Figure 5.1 the strands follow the time-line from top to bottom, and the alternating aspect of the TPCs emerges. The input TPCs and the TPCs in the strands are connected through the same transformations indicated in the pass 4 network (Appendix Figure A.4). To help clarify this I represent the interlacing strands in a complementary manner, divorced from a timeline, as a first draft of an *interlacing strands* type in Figure 5.2.

[3]I will ignore differences that might be pointed out with regards to the use of words versus consonant sounds in the voice, although I have noted some of these in the TPC descriptions in Appendix A.1. Jean Penny [2011, 186–187] has examined the effects of the words and vocal sounds in *NoaNoa* from a performer's perspective. While these different voice sounds certainly have different expressive consequences, such consequences do not seem crucial to exploring the relationships between acoustic instrument and electronics in the context of the present research.

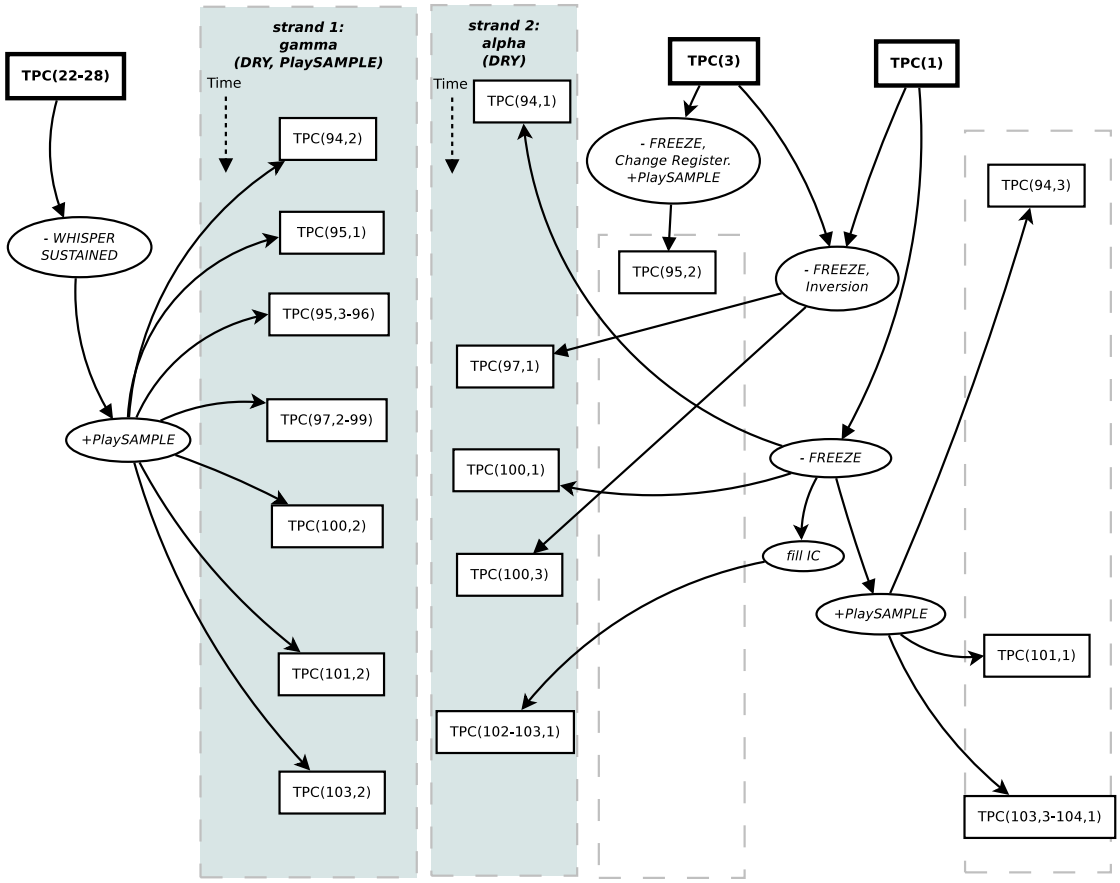


Figure 5.1: First part of transformation network pass 4 (bars 94–104) from *NoaNoa* reorganised to emphasise 'strands'.

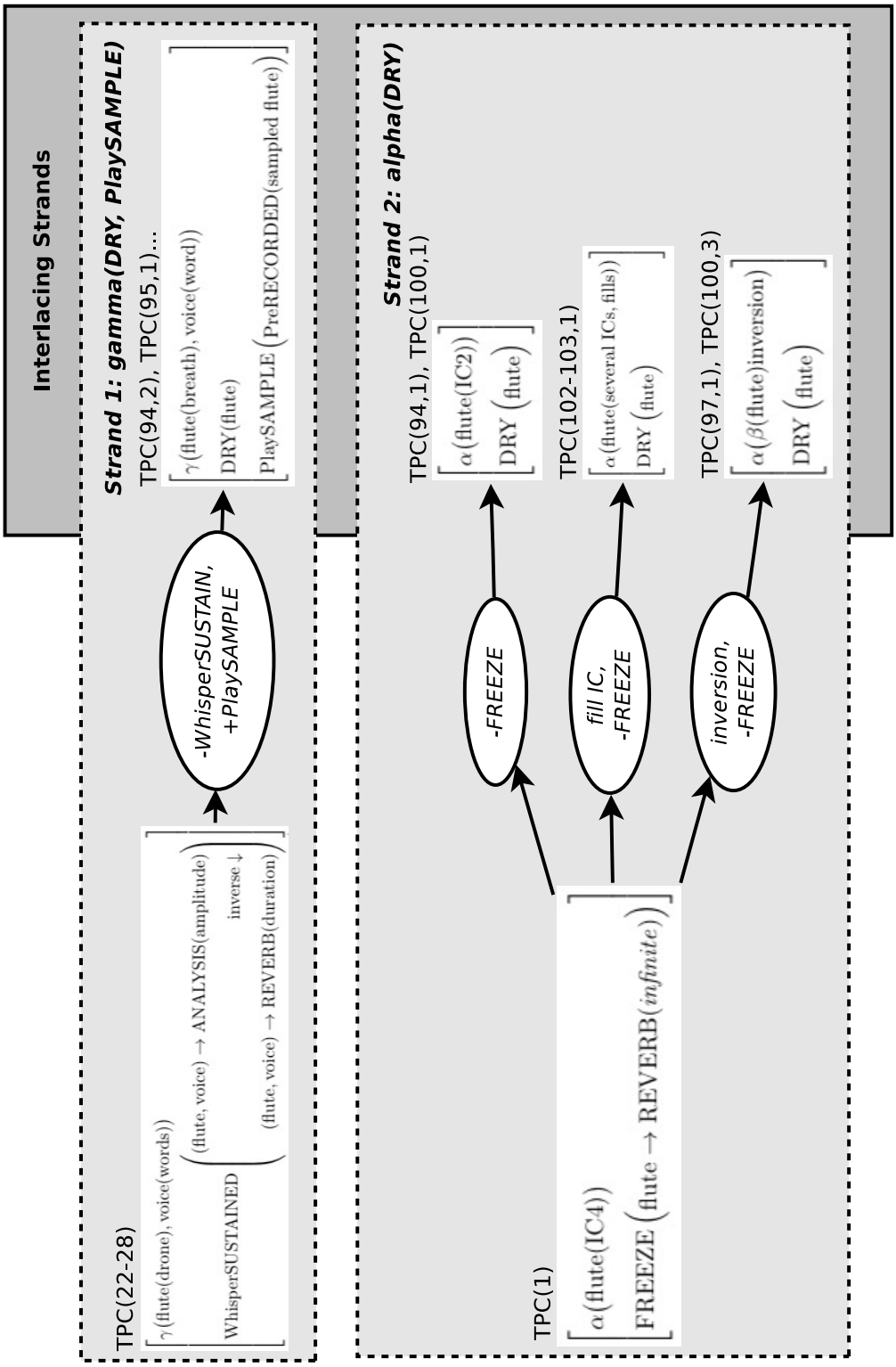


Figure 5.2: *Interlacing strands* type in first part of pass 4 from *NoaNoa*.

In the first strands type diagram (Figure 5.2), the transformations of α also included *fill IC* and *inversion*. The structure of the *interlacing strands* type is arrived at through the four indicated transformation paths, as well as by the interlaced positioning of the TPC instances following the timeline of the score. This analysis can be extended to include bars 94–109 in order to encompass the complete pass 4 in the transformation space. As a result, the strands diagram is expanded as shown in Figure 5.3.

The expansion of the analysis adds a [$-$*FREEZE,*+*inversion,*+*voice*] transformation path, resulting in TPC(105,3–106,1). For a more complete view of the section, TPC(95,2) should also be accounted for, which is a transformation of β, as well as TPC(101,1) and TPC(103,3–104,1) which are connected with TPC(1) through [$-$*FREEZE,* $+$*PlaySAMPLE*] transformation paths. To do so, I expand the *interlacing strands* type to a second draft as shown in Figure 5.4.

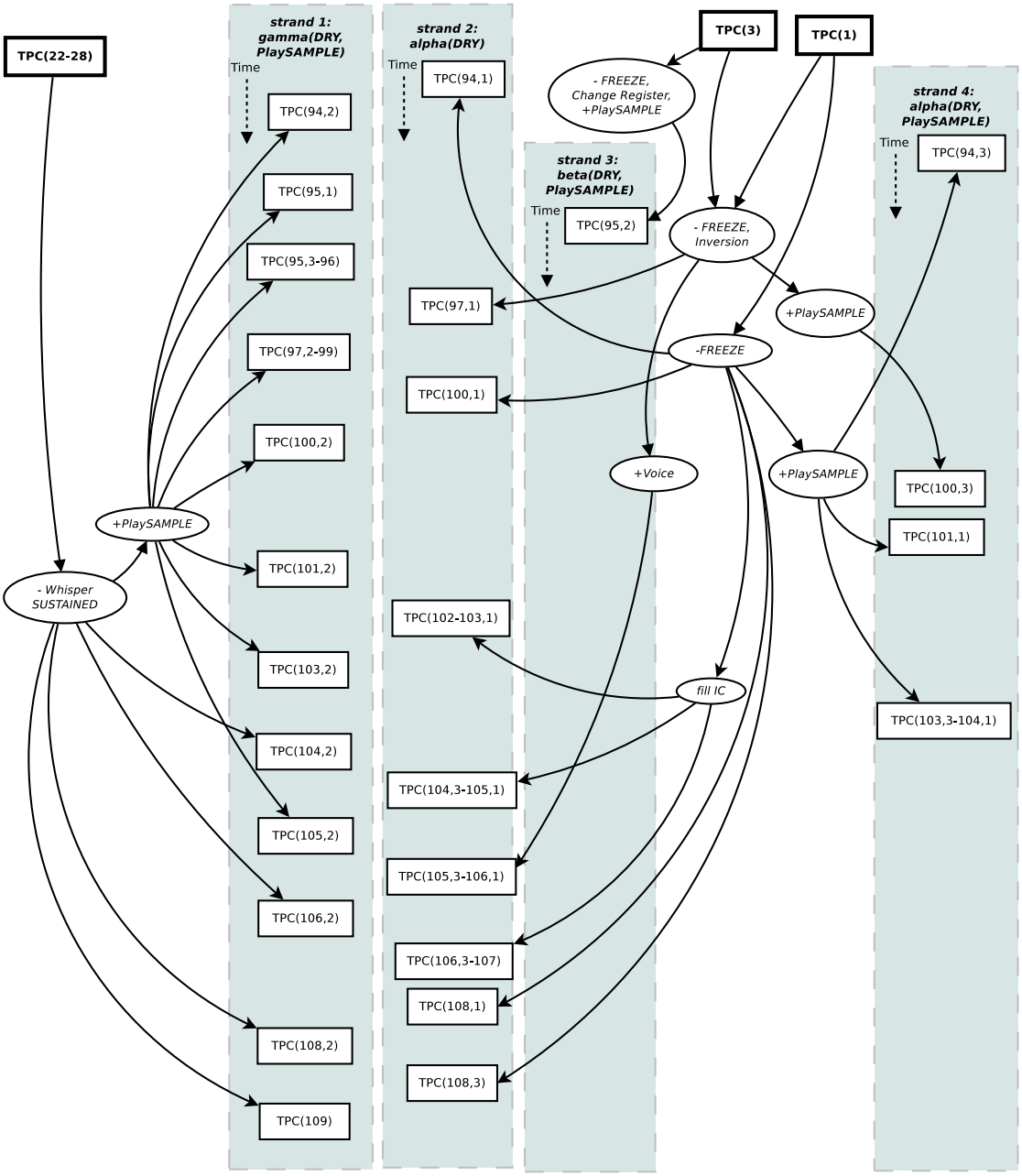


Figure 5.3: Full transformation network pass 4 (bars 94–109) from *NoaNoa* reorganised to emphasise strands.

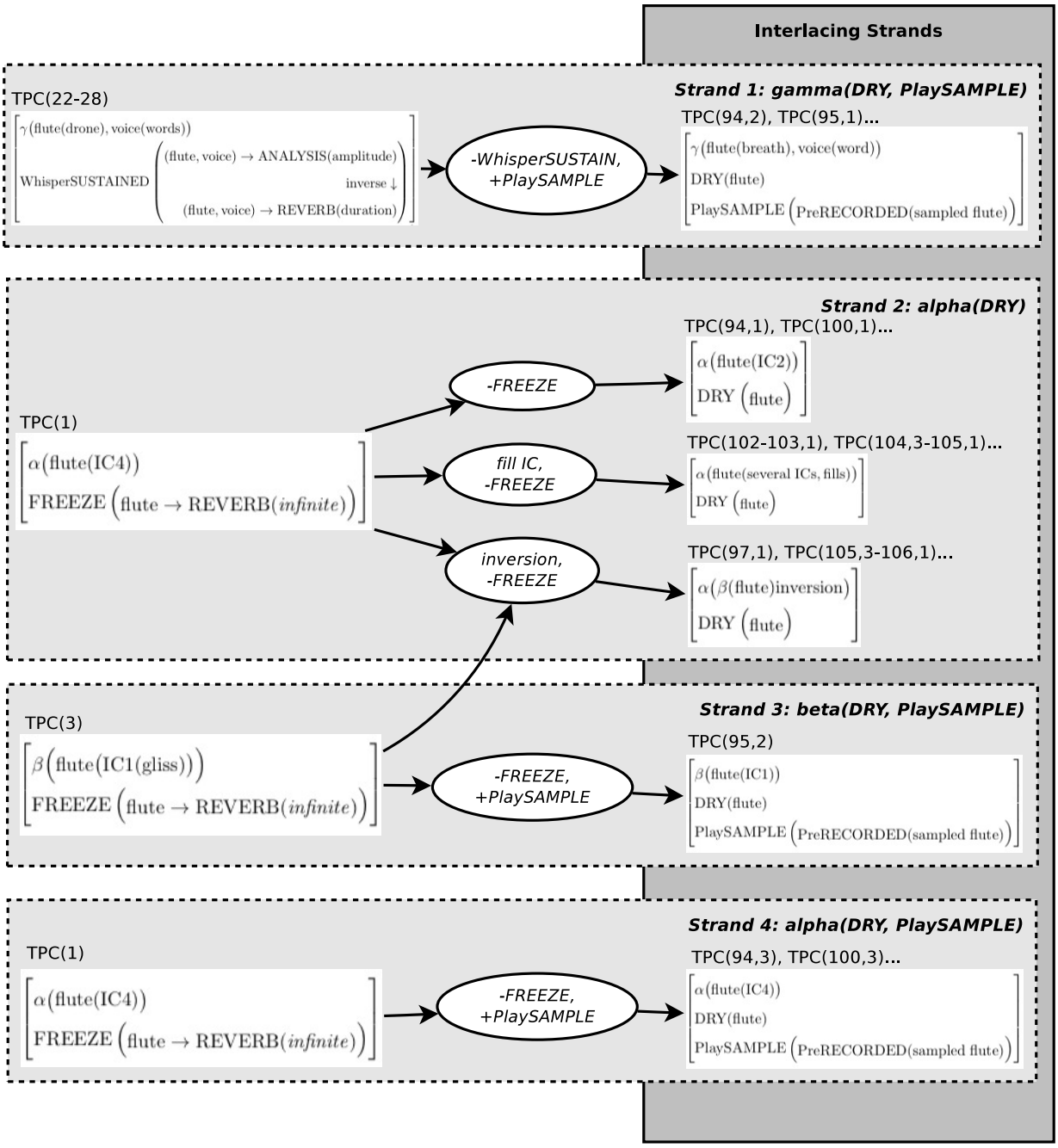


Figure 5.4: *Interlacing strands* type draft 2, from full pass 4 in *NoaNoa*.

5.2 Applying strand identification to passes 1–3; indicating a 'core strand'

Passes 1 and 2 can be reorganised in order to uncover a strand structure in these parts of the transformation space as shown in Figure 5.5. The four 'input' TPCs are at the top of some of the strands. One strand is a transformation of α-based TPCs while two others are strands based on transformations of β-based TPCs. The α-based structures are the most frequent TPCs in the resulting seven strand structure. There are alternations between strands over time, although perhaps the more 'tightly' interlaced structure in pass 4 (Figure 5.3) is more obvious.

Continuing the strand representation approach in pass 3 (bars 48–93), I arrive at Figure 5.6. Here the input TPCs are presented outside the strand groupings, since they do not occur in bars 48–93. I retain the numbering of the strands from the previous diagrams and indicate the new strands that emerge. *Strand 2:Alpha(DRY)* has the highest number of member TPCs in pass 3 (Figure 5.6), as it also did in passes 1 and 2 (Figure 5.5). Through the first four passes of *NoaNoa* there are a total of 32 TPCs in *strand 2: Alpha(DRY)*. The other strands take turns alternating with *strand 2: Alpha(DRY)* throughout the first 93 bars. Because of the frequency of *strand 2: Alpha(DRY)* TPCs, I would consider the metaphor that *strand 2: Alpha(DRY)* forms a *core strand* (or alternatively a *backbone*) for the first part of the piece, with which the other strands are interlaced.[4]

The eleven strands in bars 1–109 can be grouped according to their timbre component characteristics, yielding three strand groups as shown in Figure 5.7. This strand grouping emphasises that similar transformations are applied to the four different pitch structure types in the transformation space of *NoaNoa*. I will utilise the strand concept in the

[4]This pattern applies to the first 109 bars of *NoaNoa* but does not continue in pass 5 (bars 110–175) of the work (see Appendix Figure A.5). However, to delve further into these contrasts through structural analysis is beyond the scope of this thesis, and will be reserved for future research.

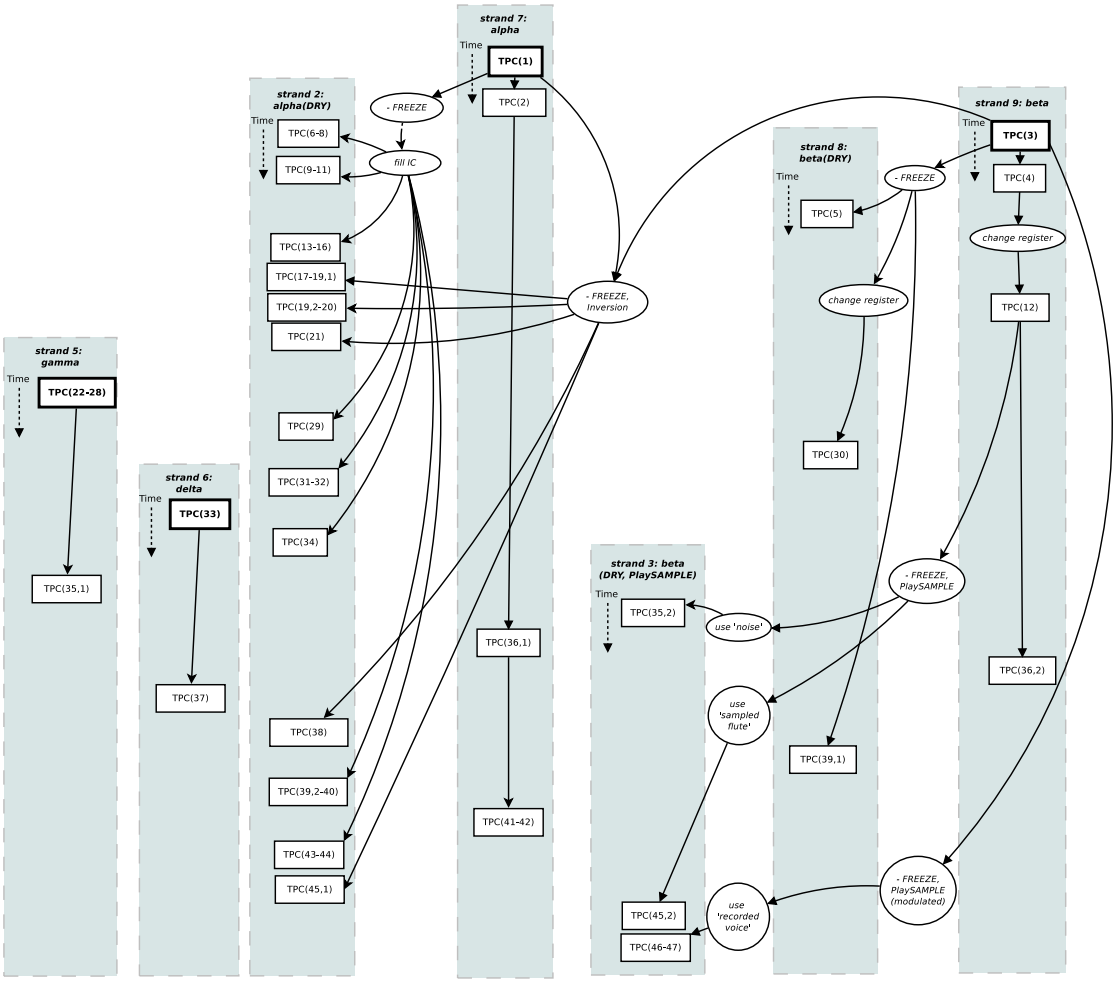


Figure 5.5: Transformation network pass 1 and 2 combined (bars 1–47), from *NoaNoa*.

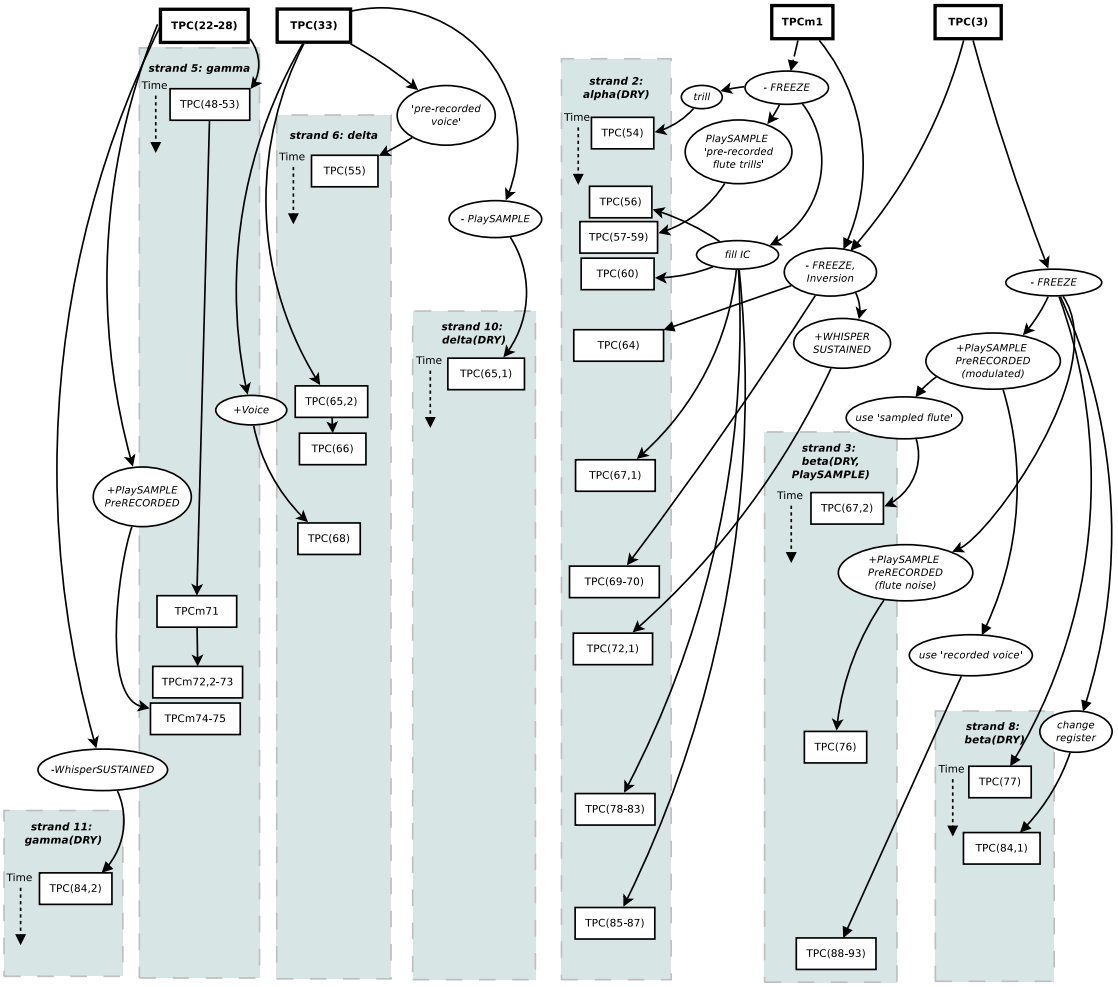


Figure 5.6: Transformation network pass 3 (bars 48–93) from *NoaNoa*.

composition of the portfolio works *Blandango Willow*, as described in section 5.3, and *Chasing the sounds of windmills*, as discussed in Chapter 6. Significant as this is, I will not engage in comparative studies of this concept with other repertoire works, nor develop the strand analysis as part of the typology, since this would go far beyond the scope of the dissertation. Instead, I will leave such possibilities for future work, and proceed to examine the composition of *Blandango Willow* in section 5.3.

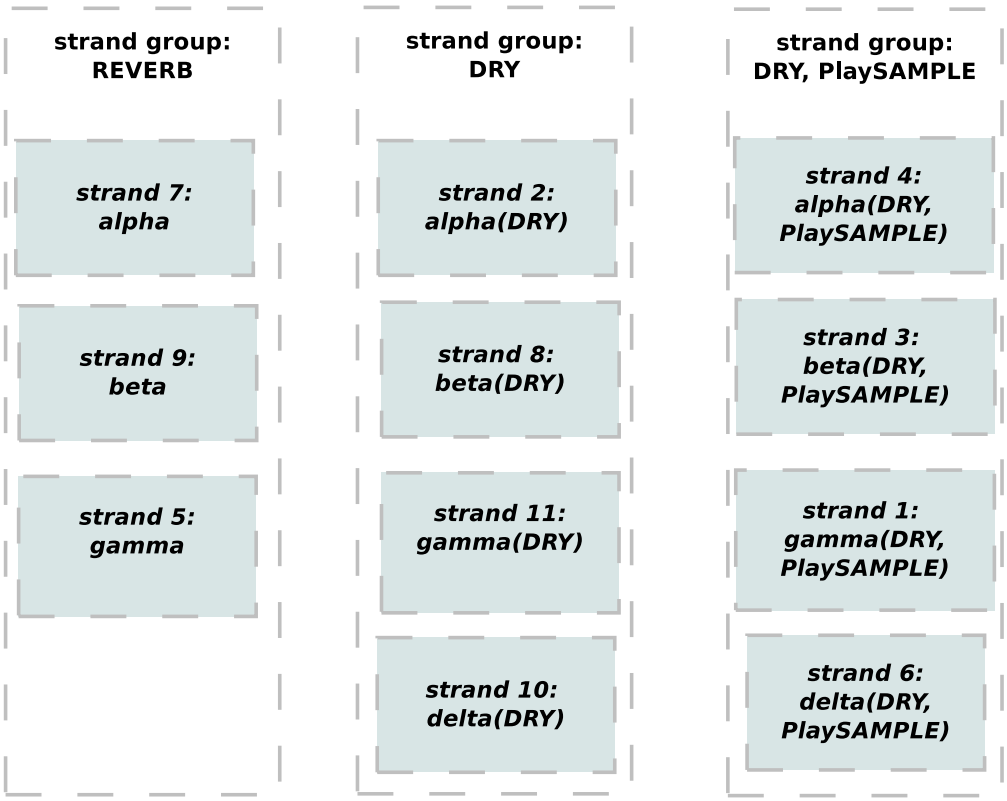


Figure 5.7: Strand grouping from *NoaNoa*.

5.3 Form in *Blandango Willow*

In the score of *Post Christmas Card*, which was performed in a workshop by the Birmingham Contemporary Music Group (BCMG), I explored some textures that combined collections of ostinati for chamber orchestra, using relatively static pc sets (see page 1 of

this score in Figure 5.8).[5] This work provided an experiment in instrumental textures that I developed further in *Blandango Willow* (for seven instruments and electronics).[6] In the score of *Blandango Willow* I wrote poly-metric textures for the acoustic instruments in a jazz style. I also developed notation 'circles' that provided an improvisational setting, while indicating pitch sets that the improvisers should focus on.[7] These pitch set indications were intended to result in 'guided improvisation', which should help give continuity to the performance while allowing flexible notation interpretations and improvisation. I expected that the notation could encourage the improvisers to further develop the poly-metric ideas heard in the non-improvisational sections of the piece. I planned three composition strands focused around the following three ideas: 1. poly-metric structures in the acoustic instruments; 2. computer-based sample recording analysis modifying MIDI instrument playback; 3. pitch-guided improvisational sound constructions.

Blandango Willow has a theme-and-variations form, which is a form common in much of the mainstream jazz repertoire. While the 'standard' 32 bar form in jazz is often segmented as variations of AABA, this new portfolio work is better described as variations of an ABC form. I use the Greek symbols for pitch structure ideas in a similar way to the previous analysis: α, β, γ.[8] Some electronic sounds are used to demarcate the

[5]Unfortunately the inclusion of electronics was not available for the reading session, so the work is not included in the portfolio.

[6]*Blandango Willow* was premiered by the ToneArt Ensemble (a group of professional, Copenhagen-based, jazz-oriented performers) with live action painting by artist Leif Sylvester, at Kulturhuset Islands Brygge, Copenhagen, Denmark, Friday September 13th, 2013. A recording of the concert is included on the portfolio documentation audio CD.

[7]This circular notation is similar to Schaeffer's 'Closed groove (symbolic notation)'. [Schaeffer, 2012, 31–32] Perhaps Schaeffer's notation could also be called a *notated loop*, although in my notation the intent is to suggest ordered pitch sets for improvisation, which does not necessarily result in the repetitive patterns usually implied by the term 'loop'.

[8]The use of α, β and γ, to signify the form sections in the analysis of *Blandango Willow*, is in a different context as compared to the analyses in Chapters 2–4. For example: in the analysis of *NoaNoa*

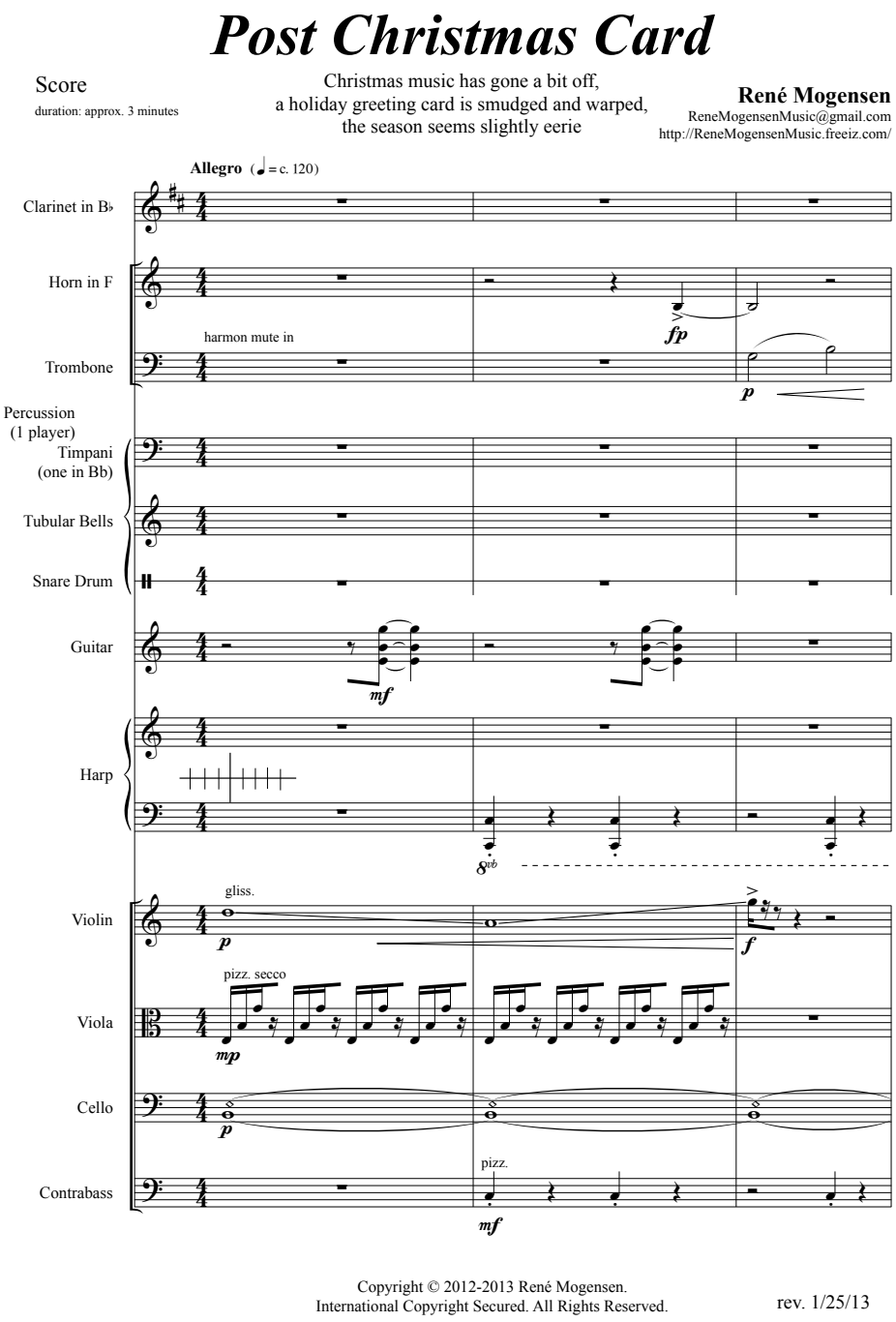


Figure 5.8: *Post Christmas Card* score, page 1

form in *Blandango Willow*, for example: a FREEZE component of relation between the instruments and the electronic sound tends to start at the beginning of the A sections. But this relation changes during the course of the work, and so we can see $-FREEZE$ paths in *Blandango Willow*, such as the path TPC(B)→[$-FREEZE$]⇒TPC(O) (see expression (5.1)), that is comparable to $-FREEZE$ paths in *NoaNoa* and *The Ghost of Judith*.

$$\begin{bmatrix} \alpha(\text{ts}, \text{trp}, \text{tbn}) \rightarrow \text{RecordSAMPLE(B)} \\ \text{FREEZE}(\text{ts}, \text{trp}, \text{tbn}) \end{bmatrix} \rightarrow \begin{bmatrix} -FREEZE \end{bmatrix} \Rightarrow \begin{bmatrix} \alpha(\text{ts}, \text{trp}, \text{tbn}, \text{pno}, \text{cb}, \text{ds}) \\ \text{DRY}(\text{ts}, \text{trp}, \text{tbn}, \text{pno}, \text{cb}, \text{ds}) \end{bmatrix}. \tag{5.1}$$

in section 2.1, the Greek symbols were used to signify pitch-motifs at the bar-line or gestural level. In the analysis of *The Ghost of Judith* in section 2.4, the Greek symbols were used to signify classes of vocal techniques. In the analysis of *Trio in 3 times 3 rooms* in section 3.4, the Greek symbols signify pitch-structure motifs that were used over longer timespans in the work. In the comparative analyses in Chapter 4, the Greek symbols were again used as signifiers at the bar-line or gestural level. Each use of the Greek symbols in a work is only applicable within the context of that particular work, and this echoes Tymoczko's critique of Lewin's formalism as discussed in section 1.3. I argue that this context-dependent use of the Greek symbols is acceptable, since the Greek symbol signifiers can generally be read as placeholders for the pitch structures which are not compared between works, and these placeholders tend to have little impact on the typology elements (transformation paths) that I have extracted from the analyses.

$$\left[\begin{array}{l}\gamma\big(\text{pno, vc, cb, PlayMIDI(9)}\big)\text{improv}\\ \text{DRY(pno, vc, cb)}\\ \text{PlayMIDI}\left(\begin{array}{c}\text{instrument 9(pitch)}\\ \uparrow\\ \text{ANALYSIS}\\ \uparrow\\ \text{PlaySAMPLE(B)}\\ \text{internal}\end{array}\right)\end{array}\right] \rightarrow \Big[+DELAY\Big] \Rightarrow \left[\begin{array}{l}\gamma\big(\text{pno, vlc, cb, PlayMIDI(9)}\big)\text{improv}\\ \text{DRY(pno, vc, cb)}\\ \text{DELAY}\big(\text{vc} \rightarrow (\text{ping} - \text{pong})\big)\\ \text{PlayMIDI}\left(\begin{array}{c}\text{instrument 9(pitch)}\\ \uparrow\\ \text{ANALYSIS}\\ \uparrow\\ \text{PlaySAMPLE(B)}\\ \text{internal}\end{array}\right)\end{array}\right]. \tag{5.2}$$

The idea of interlacing strands, discussed in section 5.1, aligns very clearly with the theme and variations form used in *Blandango Willow* as shown visually in Figure 5.9. In this transformation space we have three input points TPC(B), TPC(C) and TPC(D) which are the three parts of the ABC form, and TPC(D) is transformed to TPC(E) via a $+DELAY$ path: TPC(D)$\rightarrow$[$+DELAY$]$\Rightarrow$TPC(E) shown in expression (5.2).

There is arguably a difference in the structural levels of the two cases of interlacing strands. According to my segmentation, the interlacing strands in *NoaNoa* occur at the motivic (surface) level whereas in *Blandango Willow* the interlacing is at a longer timescale and at what I would consider a middle-ground level. As a result, the concept of form in the interlacing strands type may be applicable at several structural levels, although it is beyond the scope of the dissertation to investigate this further. Instead this will be left for future research.

I interpret *Blandango Willow* in a soft systems analysis diagram (shown in Figure 5.10) which is very similar in layout to the analysis of Berio's *Altra voce* (see Figure 4.1). In both these works there are three processes in the electronic system that are operator controlled, and which utilise the sounds produced by the musicians, as captured by

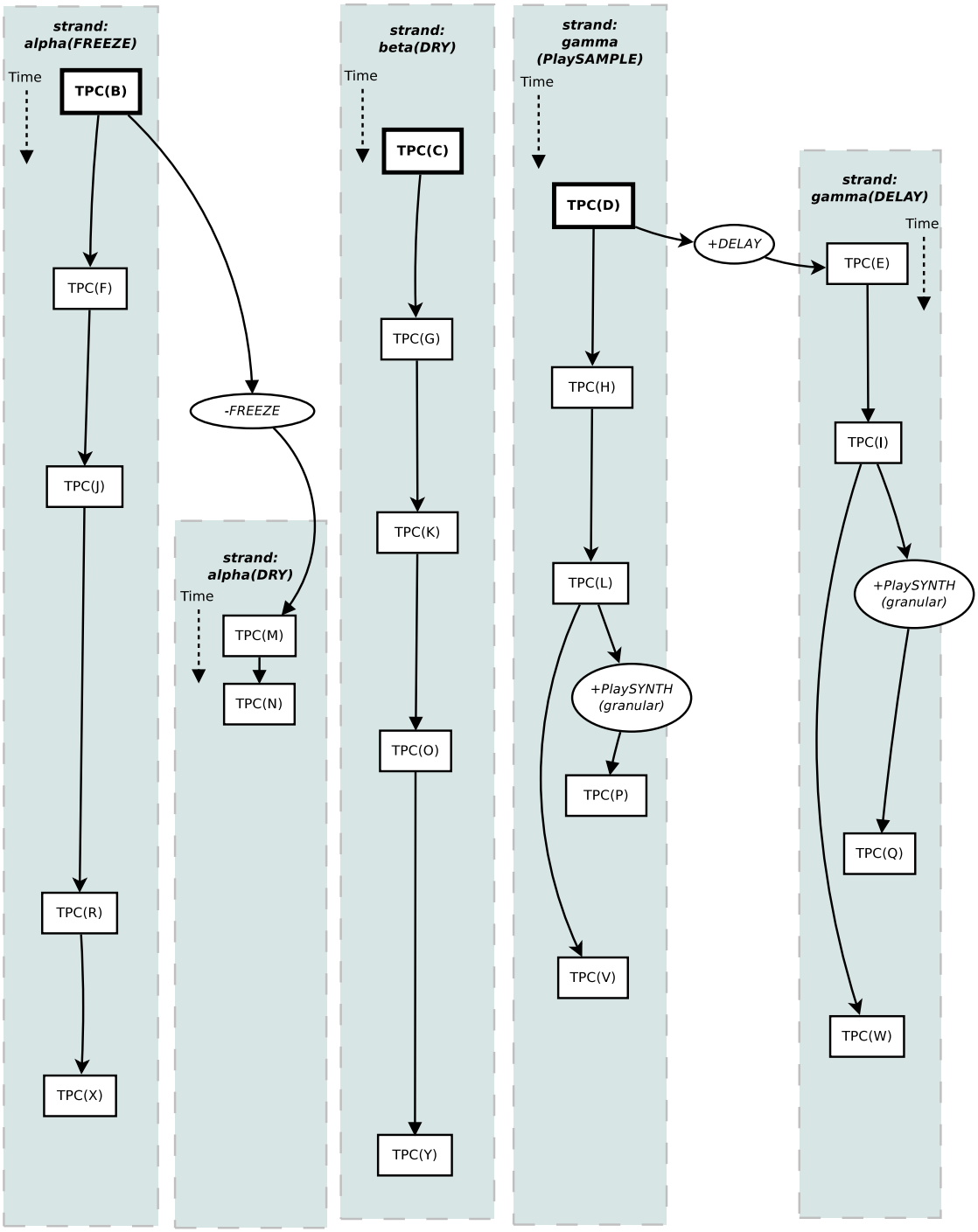


Figure 5.9: Strands from *Blandango Willow* score.

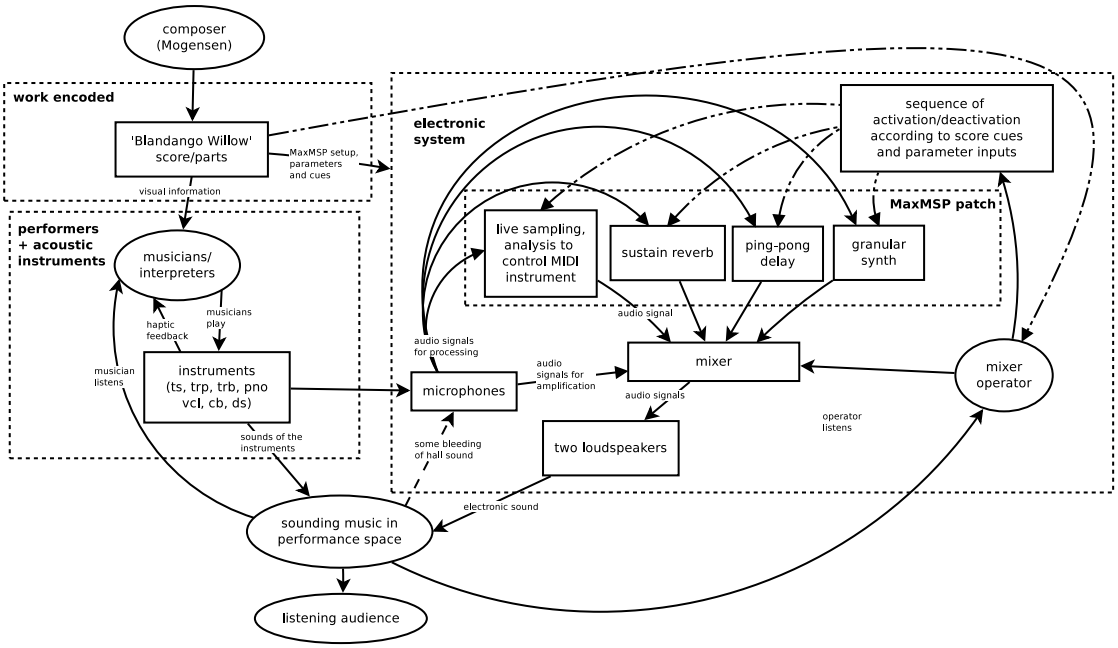


Figure 5.10: Soft systems view of *Blandango Willow*.

microphones. In *Blandango Willow* the 'ping-pong' delay effect works by recording an audio sample (of a set duration) and then playing back this audio sample repeatedly, with some decay and with spatial modulation between the speakers. The process repeats while the effect is active, and therefore it is a kind of modified sample playback that is looped. This means I could put the *ping-pong* delay in the hierarchy inheriting from *+PlaySAMPLE(spatialised)*, but it seems more useful to keep the *+DELAY(ping-pong)* designation, since this is a common-use term. So the distinction between components PlaySAMPLE(spatialised) and DELAY(ping-pong) in technological terms is perhaps mainly a matter of the time that elapses between recording and playback, and perhaps also of the duration of the sample, but the experiential differences seem to justify separations of these categories. It is entirely possible that my interpretation of such experiential differences is coloured or biased by my *habitus*[9] from years of working with

[9]See my introduction of Bourdieu's concept of *habitus* on page 4.

effects processing in performances and studio recording contexts. Certainly such experience informs my analytical interpretation and forms part of the context of the analytical results. However, given this contextual qualification, the analysis of *Blandango Willow* allows me to expand the hierarchy as shown in Figure 5.11.

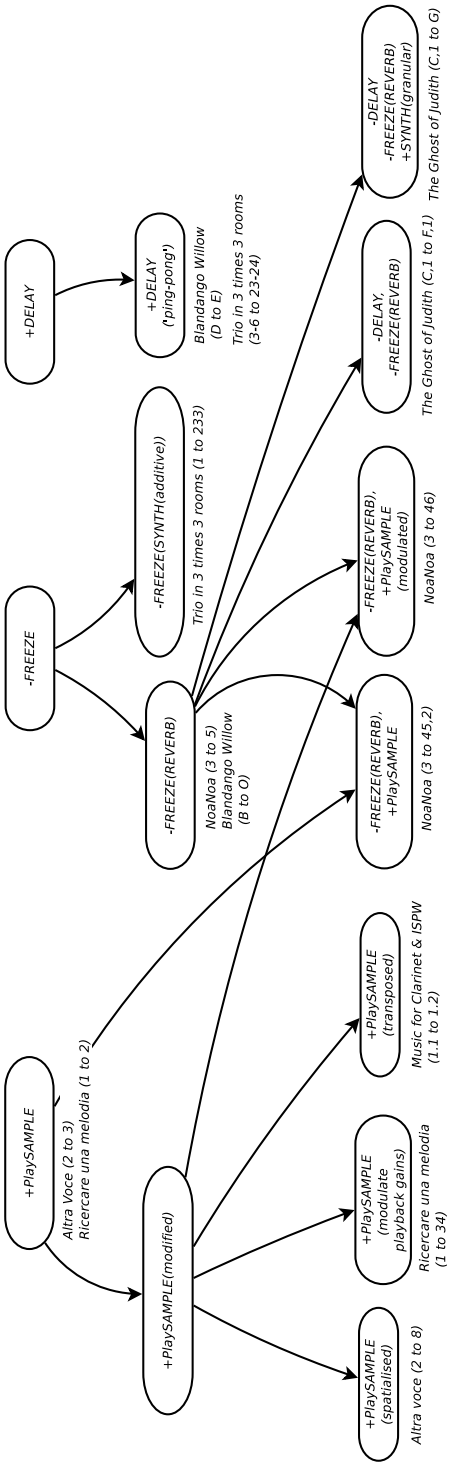


Figure 5.11: Inheritance-based super type hierarchy expanded from Figure 4.11 with added analysis of *Blandango Willow*.

Chapter 6

Integrating analytic views in the composition process of *Chasing the voices of windmills*

When composing the portfolio work *Chasing the voices of windmills* I drew heavily on my analyses of the works *Altra voce* by Berio and *Ricercare una melodia* by Harvey, as introduced in Chapter 4. I used ideas derived from analyses of the works from both of these composers in choosing pc set manipulations; I also adapted some of the relations between acoustic instruments and electronics these composers had employed, using the typology elements as tools to control the relations between the trombones and computer in the new portfolio work. Several other themes gave fuel to the creative process, and in this chapter I describe the key points most relevant to understanding the reasoning I applied in developing the piece. The work on *Chasing the voices of windmills* has resulted in new additions to the typology catalogue, some of which are put in focus during the autoethnographic narrative.[1]

[1] See the discussion of my use of autoethnography in the Introduction starting on page 4.

6.1 *Chasing the voices of windmills*: based on analysis of works by Berio and Harvey

In May of 2014, Professor Niels-Ole Bo Johansen[2] asked me to compose a new work for two trombones and computer of around 5 minutes duration, to be premiered in Birmingham in October of the same year. The new work was to be written for performances by the two trombonists Professor Johansen and Professor Chris Houlding,[3] for premieres in concerts at Birmingham Conservatoire (October 28, 2014) and Guildhall School of Music, London (October 29, 2014). I have worked with Johansen on a number of projects since 2006, and have written several new works for him, including *Views from Plato's Cave* for solo trombone and computer.[4] As part of my preparations for composing this earlier work I had studied Berio's *Sequenza V* for solo trombone,[5] [Berio, 1966] and in my music I referenced some of Berio's uses of the trombone such as growling, singing while playing and other extended techniques. In the new portfolio work for two trombones I wanted to further develop the use of extended techniques for trombone and dynamic mute manipulations that I had explored in the work for solo trombone and computer. I also wanted to challenge and engage both Niels-Ole and Chris, to showcase their virtuosic abilities, and hopefully make the work fun to play for these two professional soloists.

[2]Niels-Ole Bo Johansen is professor of trombone at the Royal Academy of Music in Aarhus, Denmark. See his web site for more information: http://n-obj.dk/wp (accessed February 17, 2016).

[3]Chris Houlding is Head of Brass at the Birmingham Conservatoire, UK. See his web site for more information: www.chrishoulding.com (accessed February 17, 2016).

[4]Johansen's recording of *Views from Plato's Cave* is released on Classico. [Johansen, 2016] Johansen premiered the work in a concert December 5, 2009, at the Royal Academy of Music, Aarhus, Denmark, with my assistance in managing the electroacoustic sound. This work for trombone and computer received its UK premiere in a concert in the *16th London New Wind Festival*, 2013, performed by trombonist Alan Tomlinson, where I also assisted as computer technician.

[5]I have been in the audience of several concerts where Johansen performed Berio's *Sequenza V*.

I immediately began to shape this new work starting with a combination of structures that I had derived from analysis of two repertoire works discussed in Chapter 4: in my analysis of Berio's *Altra voce* for mezzo soprano, alto flute and electronics, I heard the beginning as a building up of pitch material to the twelve-note pitch-class set in bars 18–19 (see the discussion of the work in section 4.1); in my analysis of Harvey's *Ricercare una melodia*, I noticed that this work for trumpet and tape-delay has a three-part form, where the delay effect runs in the first part, is turned off and modified in the short middle part, and returns in the last part, where it effectively plays successive lower octave transpositions in each of the four tape voices (see more on my analysis of the work in section 4.4). It seemed that a two-part hybrid of these two forms could produce dramatic effect: the new portfolio work would build up to a large pc set over a drone using sample playback and in a second part the sample playback would be transposed one or more octaves lower, along with other added processing in a MaxMSP patch. I also imagined using additive synthesis building on the techniques I had used in the previous portfolio works *The Ghost of Judith* and *Trio in 3 times 3 rooms*. Furthermore, the synthesis could be placed in an interlacing strands structure (see analysis of *NoaNoa* in Section 5.1) together with the recording and playback of samples. The synthesis would start by imitating the timbre and phrasing of the trombones, but this similarity would disintegrate in the second half, where the playback processing morphology could become more dramatic. With the divergences in timbres and registers between trombones and computer sound, I thought it could be musically effective for the combined local pitch structure to converge into a small pitch-class set at or near the end of the piece and

perhaps even return to a unison.[6] These form ideas can be summarised as indicated in the table in Figure 6.1.

	part 1		part 2
pc sets	[0]→[0,1,2,... 11]	→	[0,2,4,6,8,10]→[0,2,4]→[0]
sampling	RecordSAMPLE→PlaySAMPLE	→	processed PlaySAMPLE (transpostions, etc.)
additive synthesis	SYNTH imitating trombone sound, but distinct	→	SYNTH develops more separateness in timbre and phrasing
strands structure	*interlacing* strands of samples and synth	→	*interlacing* or *parallel* strands in samples and synth

Figure 6.1: Summary of initial form ideas.

Having established these initial ideas, I began to develop pitch structures that could embody a gradual building up of musical texture from the unison to the twelve-note pc set. This was to be the first part of the new work, in effect making a kind of palimpsest[7] or parody, using the structure from my analysis of the beginning of Berio's *Altra voce* (see Appendix A.2). I started by choosing a central pitch class A, which could take the function of a drone, around which the other pitch classes could 'revolve'.[8] The pitch A (220Hz) below the piano's middle C, is in the middle of the range of the tenor trombone,

[6]Flo Menezes [2002] argues for using the terms 'contrast' and 'fusion' to designate extremes of 'absolute distinction' to 'absolute similarity' between acoustic instrument sound and electronic sound in mixed works. My use of synthesis 'imitating' timbre and phrasing of the trombones is similar to Menezes's 'fusion' and my use of 'divergence' in timbre and register is similar to Menezes's 'contrast'.

[7]One definition of 'palimpsest' is: 'Something reused or altered but still bearing visible traces of its earlier form' (from www.oxforddictionaries.com, accessed Nov.12, 2015).

[8]I apply here the term 'revolve' with creative license, as a transforming metaphor. I did not derive this metaphor from my analysis of Berio's *Altra voce*.

and can be taken from either 2nd or 6th positions[9] on a standard slide trombone.[10] Using two trombones, these positions on the slide would allow glissandi and/or microtonal stepping both up and down from the central pitch, which seemed to suggest interesting possibilities relating to Harvey's ideas of symmetry as discussed in Chapter 4.[11]

I imagined the first part of the new work could have a clear rhythmic character, while expanding from a single pitch to the twelve-tone pc set. One rhythmic conception could refer to a work such as *Jackdaw* (1996) for trombone and tape by Wayne Siegel (1953–),[12] although in my imagination I preferred to aim for less metric 'crispness', and a somewhat more 'floating' rhythmic texture. I imagined that perhaps I could develop a rhythmic texture somewhere in between the more 'messy' quality of Berio's *Altra voce* and the crispness of Siegel's work.[13] Siegel's *Jackdaw* is a work for bass-trombone and audio recording, having a ternary (ABA′) form. The relations between the trombone and the recording can therefore be summarised for the entire piece as shown in expression (6.1). This is clearly an extreme simplification, similar to the level of reduction in my analysis

[9] A useful 'Trombone Slide Position Chart' which indicates normal slide positions for the usable pitch range of the 'standard straight' tenor trombone is available from www.norlanbewley.com (accessed September 24, 2014).

[10] This assumes a trombone without the F attachment. See for example the orchestration text by Kennan for discussion of basic trombone instrument characteristics. [Kennan and Grantham, 1997, 147–152] Older orchestration texts that also discuss the trombone include those by Forsyth [1982], Piston [1961] and Rimsky-Korsakov [1964].

[11] In rehearsal of the final score a trombone technical issue came up: I had asked for the use of mutes in the first part of the score, but in rehearsal the trombonists suggested that it would be more effective to make changes in the timbres by changing their embouchures. The resulting effect was in line with what I had imagined in the score, but was physically more efficient for the performers.

[12] Johansen has recorded Siegel's *Jackdaw* on the 2001 CD *Trombone and electronics*. [Johansen, 2001, track 1]

[13] I use the terms 'messy', 'floating' and 'crispness' with some reservation, for lack of better terms, but in a positive and creative metaphorical sense.

of Crumb's *Black Angels* (see section 3.1), but this kind of simplification is suitable for confining the research focus to the relations between the acoustic instrument and the electronics. In the case of a work for instrument and recording (or 'tape'), what is described is a relatively simple relation: I consider PlayRECORDING as a PlaySAMPLE with a sound file (sample) of duration equal to the duration of the piece. As was the case with Crumb's *Black Angels* my theoretical space of *Jackdaw* has only one point – the trombone with 'tape' – so no transformation paths can be extracted.

$$\mathrm{TPC}(\textit{Jackdaw}) = \begin{bmatrix} \mathrm{ABA}'(\text{bass trombone, recording}) \\ \text{bass trombone} \\ \text{PlayRECORDING} \end{bmatrix}. \tag{6.1}$$

6.2 Part 1 of *Chasing the voices of windmills*

I started work on *Chasing the voices of windmills* with a progression of pitch structures which I adapted from the pc set progression of the first 19 bars of *Altra voce* as discussed in the analysis in section 4.1. This gave me a basic pitch structure progression in eight parts as shown in Figure 6.2.

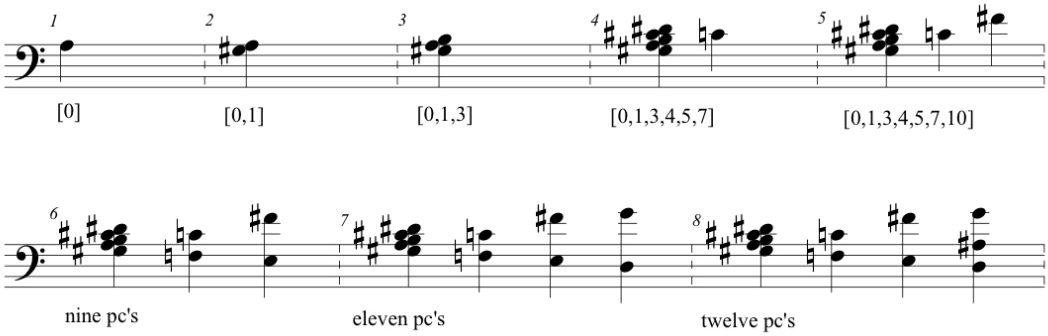


Figure 6.2: Basic eight-part pitch-structure progression for the first section of the new work.

In the Berio piece, a drone is established by playing looped samples of the first pitch from the sample recorded of the alto flute and mezzo-soprano (see analysis in section 4.4). I adapted the idea of the drone in the first section of the work, but I decided to try using additive synthesis instead of looped sample playback.[14] This would give timbres that were different from the trombone sound, and would facilitate articulations other than those that are technically easy with the use of samples. Such differentiation could help give the texture what I thought of as more 'crispness'. It also allowed me to avoid having to state the pure A pitch for a long duration in the trombone parts, instead I could almost immediately (starting in bar 2) have them play glissandi upwards and downwards from the A pitch. The stable A would primarily be played by the synthesis part on the computer, and I could use the two trombones to vary pitches symmetrically outwards, in reference to Harvey's 'symmetrical mirroring structures' around the synthesised central pitch.[15] This meant that I did not start the work with a *+PlaySAMPLE* transformation seen in the beginning of *Altra voce* (see section 4.1 and Appendix A.2). Instead, in my work I applied an $+SYNTH(additive)$ transformation, as shown in expression (6.2).

$$\mathrm{TPC}(1-11) = \begin{bmatrix} \alpha \begin{pmatrix} \mathrm{trombone1}\big([0]\ldots[0\ \mathrm{gliss} \rightarrow 7]\big) \\ \mathrm{trombone2}\big([0]\ldots[0\ \mathrm{gliss} \rightarrow 5]\big) \end{pmatrix} \\ \mathrm{DRY}(\mathrm{trombone1}, \mathrm{trombone2}) \rightarrow \begin{cases} \mathrm{RecordANALYSIS(a)} \\ \mathrm{RecordSAMPLE(A)} \end{cases} \end{bmatrix}$$

$$\downarrow$$

[14] I have used additive synthesis in a number of works, for example to generate a drone in *Walls of Nicosia* for arpeggione and computer. [Mogensen, 2011*b*] That work had a different background context however, since I used the drone as part of my adaptation of Cypriot folk music.

[15] I discuss this idea briefly in section 4.4. See Harvey's 1982 article for more on his ideas. [Harvey, 1982]

$$\Big[+SYNTH(additive)\Big]$$

$$\Downarrow$$

$$\mathrm{TPC}(12-20) = \begin{bmatrix} \alpha \begin{pmatrix} \mathrm{trombone1}\big([0 \text{ gliss} \rightarrow 2] \ldots [0 \text{ gliss} \rightarrow 3]\big) \\ \mathrm{trombone2}\big([11 \text{ gliss} \rightarrow 5] \ldots [11 \text{ gliss} \rightarrow 3]\big) \\ \mathrm{SYNTH}\big(\mathrm{additive}, [0]\big) \end{pmatrix} \\ \mathrm{DRY}(\mathrm{trombone1}, \mathrm{trombone2}) \\ \mathrm{SYNTH}(\mathrm{additive}) \end{bmatrix}. \tag{6.2}$$

With the parody that I was building – a hybrid of ideas from Harvey's and Berio's works – it seemed fitting that the title of this new portfolio work should be built through an analogous intertextual approach. It had often seemed to me something of a quixotic endeavour to write this kind of music, and I wanted to bring in a hint of humour to the project. 'Chasing', or charging at windmills, was an activity in which Cervantes's character Don Quixote was famously engaged.[16] Don Quixote performed what amounts to parodies of the activities of the mythic noble errant knights, and I read this in part as a satire of an obsessive ideologue or perhaps of a fanatic.[17] I also used 'Chasing' in my title as a reference to Harvey's 'Ricercare' which he translates as 'to seek'. [Harvey, 1992, Programme Note] The 'voices' in my title refer to Berio's title 'Altra voce' or 'other voice' (my English translation). Given my appropriation of structural ideas from the works by Berio and Harvey, it seemed consistent to construct the title by adopting ideas from the

[16]See the 2003 edition of John Rutherford's translation of Cervantes's *Don Quixote* Part I, Chapter VIII. [Cervantes Saavedra, 2003, 63–66]

[17]Linda Hutcheon wrote 'of *Don Quixote*: the parody of the epic and chivalric romance conventions interacts with the satire against the one who feels that such heroicization in literature is potentially transferable to reality.' [Hutcheon, 2000, 26] My personal reading is, of course, a modern reading of Rutherford's (2003) translation of Cervantes's 410 year-old fiction. Rutherford's translator notes have influenced my reading of his translation of the novel, but I will not attempt to investigate how Cervantes's text should or could be interpreted in other contexts or from other perspectives, as this would be far beyond the scope of the present project.

same sources. The reference to the episode in Cervantes's story of *Don Quixote* gave a programmatic form that coexists with my structuralist musical references to the works by Berio and Harvey, and in making these compositional choices I explored the theme of parody through the application of analysis which remained central to this research project (see section 1.6 for discussion of 'parody').

6.3 A transition from part 1 to part 2 in *Chasing the voices of windmills*

In *Ricercare una melodia*, Harvey uses the cadenza as a transition, which gives the operator time to adjust the settings of the analogue tape play-back machine to create the subsequent lower octave transpositions in the tape parts (see analyses in section 4.4 and Appendix A.3). So his cadenza for the trumpet, with silence in the tape, is included partly for technical necessity, but in my opinion it is realised with convincing artistic intent. In my transition between parts 1 and 2 of the new work, the same technical requirement, or limitation, was not present. However, my subjective sense of musical form suggested that the buildup of the texture in part 1 could be well served by a subsequent 'release' into a texture that was suddenly much less dense, along with significant changes in timbre. At the same time, I could use octave transpositions of trombone samples freely, since the more rigid timing of analogue tape delay did not need to be a factor in my computer-based sound.

The term 'release' used above, probably indicates, in Lakoff's terms, an 'orientational metaphor' [Lakoff and Johnson, 1980, 14-24] and perhaps also a 'JOURNEY' metaphor. [Lakoff and Johnson, 1980, 45] This could seem somewhat incongruent with Harvey's thoughts that the use of 'symmetrical mirroring structures', by its nature, 'necessitates a more static music in some respects'. Harvey proposed that 'it seems as though the music is more contemplative than active in spirit; more concerned with space than time, with

being rather than becoming'. [Harvey, 1982, 4] Harvey's static conception would not seem to allow my notion of 'release' as this term seems to imply a gestural aspect that perhaps echoes the 'tension' and 'release' of harmonic theory.[18] But the pitch dimensions are the 'static' part in Harvey's discourse. In my transition, the dramatic change would be in dimensions of timbral and textural density. I would argue that the Quixotic JOURNEY metaphor[19] of this new portfolio work consists of travels in dimensions of timbre and texture, through both instrumental techniques, computer sound, and the relations that I constructed between the trombones and the computer.[20] Harvey also theorised about creating 'movement' in his music, for example he wrote that 'in symmetrical mirroring structures... focal attention is forced into the axial middle, because all relationships converge there: the sounds *point* to it'. [Harvey, 1982, 2] So in practice his ideas do not seem to exclude description through movement and/or orientational metaphors.

Moving on with the concrete ideas for the new work, it seemed that the glissandi in part 1 would create something I might metaphorically name 'potential energy'[21] in relation to the static 'central axis' of the A pitch. I wanted to continue this 'potential energy' into the transition, while creating the dramatic contrasts mentioned above; I imagined this could be achieved by what I thought of as 'hyperactive' glissandi in the trombones. This was indicated in an early sketch I made of the transition, as shown in Figure 6.3. To decide the starting pitches for these hyperactive glissandi I used a pitch progression based on the gradual addition of pitch-classes, that formed the basis for part 1, as shown in Figure 6.2. In pitch space, the transition section would also become a kind of variation

[18]This could be functional harmony as encoded in textbooks such as *Harmony and Voice Leading* by Aldwell and Schachter [1989] or a more context-dependent coloristic interpretation of harmony, such as described by Persichetti [1961] in *Twentieth-century Harmony*.

[19]The concept of a JOURNEY is also reminiscent of Don Quixote's wanderings.

[20]I conceptualised the relations through the typology elements.

[21]I propose using 'potential energy' rather than the more commonly used term 'musical tension', in order to accommodate Harvey's concept of a 'static music'. [Harvey, 1982, 4]

of the beginning, although I would not expect this similarity to be particularly prominent from the audience perspective.

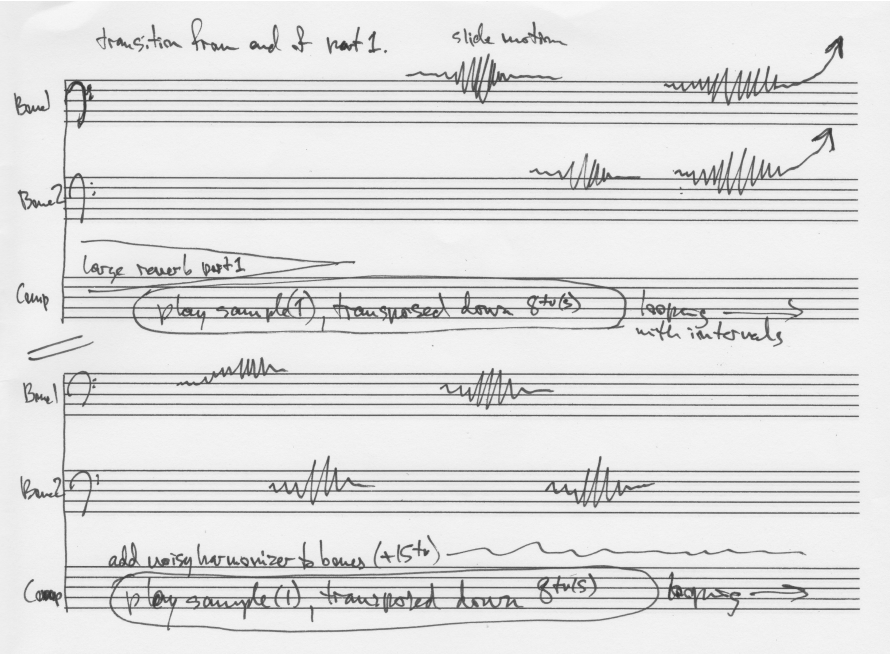


Figure 6.3: Excerpt of the first sketch for the transition section from the end of part 1, before part 2 in *Chasing the voices of windmills*.

As I developed and revised the transition idea and materials, my imagination started to impose[22] the form from Berio's work on this section: I developed a gradually growing texture through looped and transposed playback of samples. If we consider the hyperactive slide as a motif β, then the transformation path at pedal point J to K, TPC(J) $\rightarrow$ [*+PlaySAMPLE(transposed)*] $\Rightarrow$ TPC(K), can be described as shown in expression (6.3).

[22]From an 'objective' stance it would probably make more sense to say that I *choose* to superimpose the form from Berio's work. However, as part of the autoethnographic narrative strand, my subjective experience of this 'choice' was that some part of my mind 'imposed' the idea on the model of the work that I carried in my imagination during the composition process.

$$\begin{bmatrix} \beta \begin{pmatrix} \text{trombones}(1,2) \\ \Downarrow \\ (\text{PCset}[0,1], \text{hyperactive}) \end{pmatrix} \\ \text{trombones}(1,2) \\ \text{RecordSAMPLE(J)} \end{bmatrix} \rightarrow \begin{bmatrix} +\mathit{PlaySAMPLE} \\ (\mathit{transposed}) \end{bmatrix} \Rightarrow \begin{bmatrix} \beta \begin{pmatrix} \begin{pmatrix} \text{trombones}(1,2) \\ \text{PlaySAMPLE(A)} \end{pmatrix} \\ \Downarrow \\ \text{PCset}[0,4,5] \end{pmatrix} \\ \text{trombones}(1,2) \\ \text{PlaySAMPLE(A, 8tvBelow)} \end{bmatrix}. \tag{6.3}$$

6.4 The performance system of *Chasing the voices of windmills*

I started with the same *Max*-patch layout that I used in *Ghost of Judith* (see Chapter 2) which facilitated the triggering of various processes according to a compositionally defined progression (see *Max 6* screen shots in Appendix section A.7.5). I included an external hardware reverb, as I have done in other pieces, to create a basic virtual acoustic space for the work:[23] I had a Lexicon MX200 available, and this supplied a convincing sounding, adjustable reverb, which could be easily routed into the sound mix.[24] Sending both electronic sound and acoustic instruments through the same subtle reverb should allow a more effective blending of speaker sound with the acoustic instrument sound. In

[23] See also the brief discussion of Saariaho's use of reverb on page 48.

[24] *Chasing the voices of windmills* was, as mentioned, included in two concerts with Houlding and Johansen, on October 28th in Birmingham and 29th in London, 2014. In both concerts I acted as computer technician, and directed the technical audio setup in collaboration with the house technicians. I found I could reduce the weight of the equipment that I had to bring, by using the reverb included in the MOTU 828mk3, rather than the external Lexicon MX200. While the MOTU reverb was not as flexible in parameter control as the Lexicon, as a subtle reverb it was an adequate substitute during those events.

the new work I included a sustaining reverb, much like the FREEZE component used by Saariaho in *NoaNoa* (see expression (2.2)). This could be done in software within MaxMSP, but for this reverb I also chose to use an external hardware effects unit, the Lexicon MPX100. I had an MPX100 available, and it had a good sounding 'infinite reverb' setting which was useful for the sustaining effect. Reverb units are particularily demanding on CPU resources, so it made practical sense to route these types of effects out to external processors when possible, thereby keeping CPU processing power overhead free for other more customised functionalities.[25]

Given the instrumentation and basic approach to the computer part, I drew a soft system diagram for the performance situation as shown in Figure 6.4. It is very similar to the soft systems diagrams of *NoaNoa* (Figure 1.1) and *Altra voce* (Figure 4.1). The system view of Harvey's *Ricercare una melodia* differs mainly due to the analogue tape technology employed in the original version of his piece (Figure 4.3). After drafting ideas for the first part and transition, I made a second-level soft system diagram indicating the necessary software components and connections as shown in Figure 6.5. Similar in concept to Berio's descriptions of processes in his 'Instructions' to *Altra voce*, my diagram of 'software components' does not specify particular hardware or software.[26] This soft systems diagram could then provide a general plan for programming the functionalities in the software patch that would run the computer part of the music.

[25]I do not insist on a particular reverb hardware for future performances, since the desired effects can be created on many hardware and software reverb units, and each concert will require a customised reverb setting in order to accommodate the acoustic characteristics of the performance space.

[26]See discussion of Berio's instructions for *Altra voce* in section 4.1.

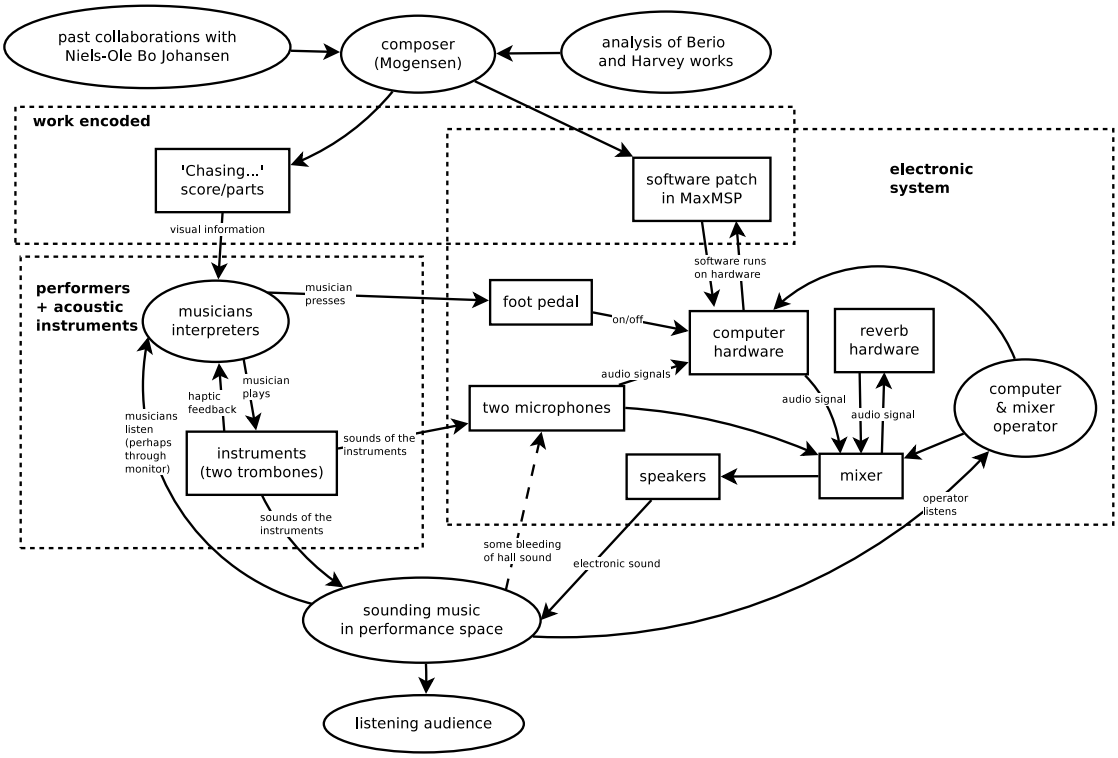


Figure 6.4: Draft system view of the new portfolio work: physical components of *Chasing the voices of windmills*.

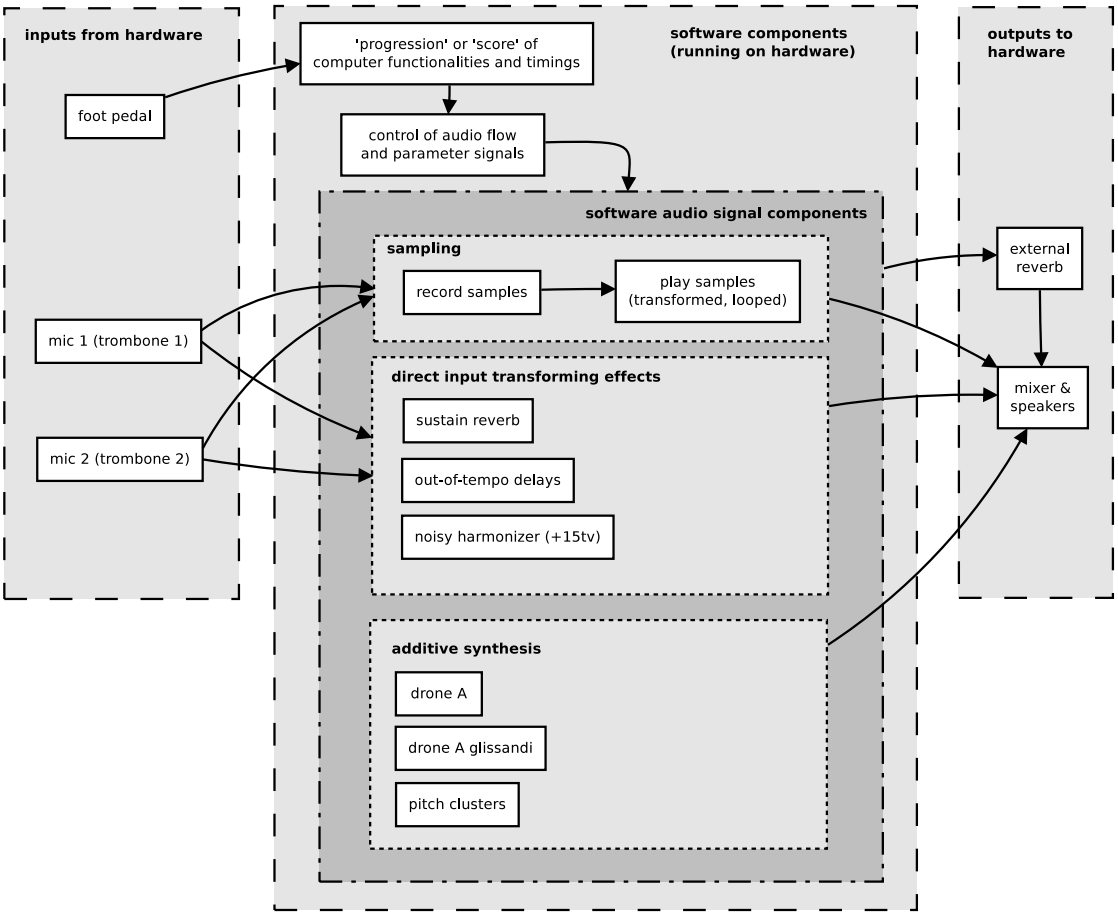


Figure 6.5: Draft system view of the new portfolio work: software components of *Chasing the voices of windmills*.

6.5 Development of *Chasing the voices of windmills*

After having formulated my initial ideas for the new portfolio work I started to set up the necessary progression of functions in MaxMSP. I also made a mockup of the trombone parts, played with MIDI instruments, using the software *Finale*[27] which I could use as audio input to the computer in place of the acoustic instruments, in

[27] *Finale* is a commercially released music notation software, see more information on the web page: http://www.finalemusic.com (accessed November 29, 2015).

order to troubleshoot and debug my MaxMSP patch. First, I implemented sample recording in the beginning, and used looped playback subsequently, as indicated in the path TPC(1–11)→[*+PlaySAMPLE,+PlaySAMPLE(transpose),+SYNTH(additive)*] ⇒ TPC(42–47) which is shown in expression (6.4). The *+PlaySAMPLE* is comparable to Berio's use of sampling in the beginning of *Altra voce* as is illustrated by transformation paths in expressions (4.1) and (4.3) in section 4.3. The *+PlaySAMPLE(transpose)* is comparable to Lippe's use of this transformation (Figure 4.10) as discussed in section 4.5

$$
\mathrm{TPC}(1-11) = \begin{bmatrix} \alpha \begin{pmatrix} \mathrm{trombone1}\big([0]\ldots[0\ \mathrm{gliss} \rightarrow 7]\big) \\ \mathrm{trombone2}\big([0]\ldots[0\ \mathrm{gliss} \rightarrow 5]\big) \end{pmatrix} \\ \mathrm{DRY}(\mathrm{trombone1}, \mathrm{trombone2}) \rightarrow \begin{cases} \mathrm{RecordANALYSIS(a)} \\ \mathrm{RecordSAMPLE(A)} \end{cases} \end{bmatrix}
$$

$$
\downarrow
$$

$$
\begin{bmatrix} +PlaySAMPLE \\ +PlaySAMPLE(transpose) \\ +SYNTH(additive) \end{bmatrix}
$$

$$
\Downarrow
$$

$$
\mathrm{TPC}(42-47) = \begin{bmatrix} \alpha \begin{pmatrix} \mathrm{trombone1}[6,9] \\ \mathrm{trombone2}[2,3,6] \\ \mathrm{SYNTH}\big(\mathrm{additive}, [0,3,6,11]\big) \end{pmatrix} \\ \mathrm{DRY}(\mathrm{trombone1}, \mathrm{trombone2}) \\ \mathrm{SYNTH(additive)} \\ \mathrm{PlaySAMPLE(D)loop} \\ \mathrm{PlaySAMPLE} \left(\mathrm{A}, \begin{pmatrix} \mathrm{transpositions} \\ \uparrow \\ \mathrm{ANALYSIS(a)loop} \end{pmatrix} \right) \mathrm{loop} \end{bmatrix}. \qquad (6.4)
$$

Given the sketches of part 1 and the 'transition', I proceeded to develop part 2 where I used the programmatic background as an intertextual source: in the Quixotic adventures, pragmatic characters laugh with the reader at the anachronistic naivety of Don Quixote, the fool who believes himself to be an errant knight. But even so, the priest from Quixote's hometown seems impressed that '[s]o long as you don't get him going on his chivalry, nobody would say that he wasn't a man of excellent understanding.' [Cervantes Saavedra, 2003, 279] So Quixote is acknowledged as being intelligent and admirable despite of his madness, and his madness lies only in his obsession with being a knight errant. Perhaps in the new portfolio work, I could take a cue from a sound association, a programmatic listening interpretation: the turning blades of the windmill in the beginning of part 1 are amplified, and accumulate in a mass of sound, to be 'released' into a 'manic state' in the transition. Then what follows, in the mad Quixotic mind, would perhaps be the charge, the attack on these 'giants' to 'engage them in fierce and arduous combat.' [Cervantes Saavedra, 2003, 64]

I found a metaphorical rationalisation for the compositional choices through an interpretation of a more abstract notion: Quixote's obsession with ideas, such as the idea of being a 'knight errant', blinds him to the more pragmatic attitudes that flourish in the other characters who are laughing at him. If obsession with an idea is madness, then perhaps part 1 of *Chasing the sounds of windmills* could metaphorically represent the confrontation of the environment with the obsessed mind; the transition could represent the moment of realisation and/or decision for action and then part 2 would be the mad action. But the madness of Quixotic action is internal, the rationalisation of the action is internal, and so it would seem in concept to be an implosion, which reverberates in the environment, in spite of its apparent disconnection with the realities of this environment. Quixote did not perform 'glorious' battle with giants, he merely ran his lance

into the wing of a windmill, and was thereby thrown from his tired old horse. I used the 'implosion' idea to develop part 2.

Given the obsession metaphor I used in this work, part 2 had to be based on something that could programmatically be an *imploding* structure: perhaps by moving the drone A into extremes of high and low registers, this could conceptually provide a pitch-space 'frame' within which I could invert Harvey's symmetric 'harmonic structures which radiate out from either side of a central axis'. [Harvey, 1982, 2] Instead of 'radiating out', the structures could implode within the A pitch over several octave equivalent drones. A climax could then result not from any 'organic' growth or process but as a reaction to part 1. The last part, although intensive, would from the outside seem a parody of climax, an implosion, perhaps an anti-climax, in the end a caricature fuelled by obsession with an idea. This rationalisation through metaphor gave me the structure for *Chasing the voices of windmills*.

In part 2 of this new portfolio work I initially imagined continuing the A pitch as the central axis, in the same manner as I had done in part 1. I planned to apply the interlacing strands of sampling/playback and additive synthesis, in parallel with the trombone parts. I also wanted to add a parallel 'delay canon' strand, based on the trombone sounds, including octave transpositions in homage to Harvey's work. Under the initial ideas for the form, part 2 was to a have a 'dissolving' pitch-class set, moving from the chromatic set (which formed the basis for the transition) to [0,2,4,6,8,10] → [0,2,4] → [0]. However, in the final score of *Chasing the voices of windmills* it is clear that already beginning in bar 2, I have broken away from [0], with glissandi in both trombones, giving a [0,1,2] pitch profile to this measure, the glissandi giving a continuous rather than a discrete pitch structure. This continues throughout part 1 (bars 1–57) and the 'transition' (bars 58–67). The contours of the glissandi have become a structural part of the pitch space for the piece. The pc set progression of part 1 carry what I will call a 'skeletal' role in

the pitch formations.[28] After having sketched part 1 and the transition, at least four possibilities seemed immediately evident as approaches to shaping the pitch structures in the second part:

1. Pitch structures could continue using this same pitch space, and dissolve according to a skeletal progression of [0,2,4,6,8,10]→[0,2,4]→[0].

2. A subset of the pitch space could be brought to the musical foreground, either emphasising the continuous (glissandi) or the discrete (pc sets).

3. Strands of contrasting subsets of the pitch space could be intertwined over the duration of the second part.

4. A different pitch space could be developed.

I choose the first of these four possibilities: dissolving the pitch space according to the skeletal progression. The first draft of part 2 consisted of a contracting pitch structure, with SYNTH(additive) drone and a two part 'call and response' idea in the trombones. A basic 'call and response' idea gave the skeletal structure to be developed (see Figures 6.6 and 6.7) This was, in its first draft, a mapping out of the processes of the music in their unmediated forms, it was a sketch of what I could call the 'pure' form of the process. This pure form of the processes was then to be moulded by my compositional judgements. I proceeded to shape this skeleton with rhythmic variation, cutting section durations down and merging some formerly distinct segments in the trombone parts, as can be seen in the final score beginning at letter N until the end. The pc set [0,2,4,6,8,10] starts from bar 82, reaches a kind of climactic point just before bar 120, and then converges on pitch class [0] at bar 156, where the 'response' idea is completely removed.

Figures 6.6 and 6.7 are variations of the α structure from part 1, and as such they are symptomatic of the paths in the pitch transformation space that I have employed during the composition of the portfolio work. To build the strands structure, I merged develop-

[28]The role is 'skeletal' in that the pc sets provide starting or ending pitches for the glissandi and so provide discrete pitch space contours for the glissandi.

ment in the pitch space with paths in the TPC space. So in the return to α in part 2 the variations in the relations between the trombones and the computer were paths such as TPC(1–11)→[+*DELAY(ping-pong)*,+*PlaySAMPLE(transpose)*]⇒TPC(67–71) as shown in expression (6.5). My complete TPC segmentation of *Chasing the voices of windmills* is listed in Appendix A.7 and I have mapped out my transformation network in Appendix Figure A.16. Using this analysis of the portfolio work I have added some path types to the typology hierarchy in Figure 6.8.

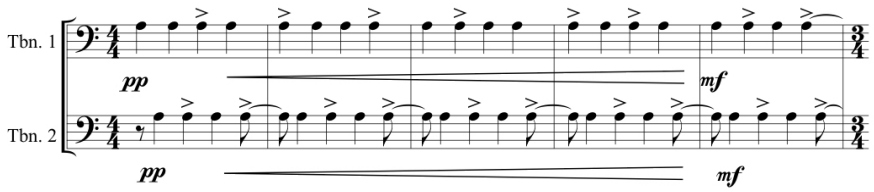


Figure 6.6: *Chasing the voices of windmills*: basic 'call' idea of part 2.

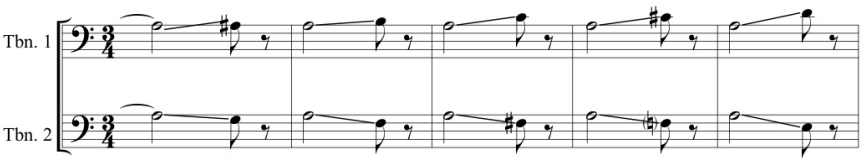


Figure 6.7: *Chasing the voices of windmills*: basic 'response' idea of part 2.

$$\mathrm{TPC}(1-11) = \begin{bmatrix} \alpha \begin{pmatrix} \mathrm{trombone1}\big([0]\ldots[0\ \mathrm{gliss} \rightarrow 7]\big) \\ \mathrm{trombone2}\big([0]\ldots[0\ \mathrm{gliss} \rightarrow 5]\big) \end{pmatrix} \\ \mathrm{DRY}(\mathrm{trombone1}, \mathrm{trombone2}) \rightarrow \begin{cases} \mathrm{RecordANALYSIS(a)} \\ \mathrm{RecordSAMPLE(A)} \end{cases} \end{bmatrix}$$

$$\downarrow$$

$$\begin{bmatrix} +DELAY\,(ping-pong) \\ +PlaySAMPLE(transpose) \end{bmatrix}$$

$$\Downarrow$$

$$\mathrm{TPC}(67-71) = \begin{bmatrix} \alpha \begin{pmatrix} \mathrm{trombone1}[0] \\ \mathrm{trombone2}[0] \end{pmatrix} \\ \mathrm{DRY}(\mathrm{trombone1}, \mathrm{trombone2}) \\ \mathrm{DELAY}(\mathrm{trombone1}, \mathrm{trombone2}) \\ \mathrm{PlaySAMPLE}\big((\mathrm{A})\mathrm{transposed}\ -8\mathrm{tv}, \mathrm{backwards}\big)\mathrm{loop} \\ \mathrm{PlaySAMPLE}\big((\mathrm{I})\mathrm{transposed}\ -8\mathrm{tv}, \mathrm{backwards}\big)\mathrm{loop} \\ \mathrm{PlaySAMPLE}\big((\mathrm{A})\mathrm{transposed}\ -15\mathrm{tv}, \mathrm{backwards}\big)\mathrm{loop} \\ \mathrm{PlaySAMPLE}\big((\mathrm{I})\mathrm{transposed}\ -15\mathrm{tv}, \mathrm{backwards}\big)\mathrm{loop} \end{bmatrix}. \qquad (6.5)$$

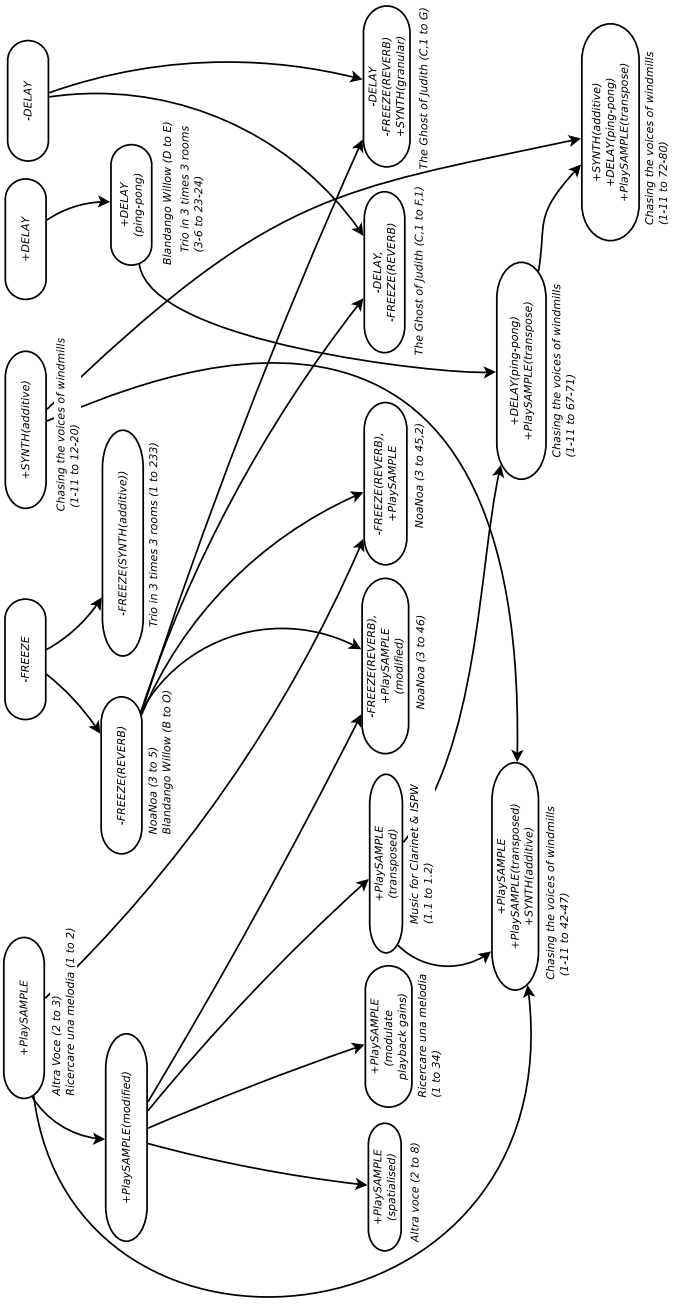


Figure 6.8: Inheritance-based hierarchy, including some types in *Chasing the voices of windmills*, building on types from Figure 5.11.

Chapter 7

Integrating analysis in the composition process for *Paese favola*

Paese favola became the last piece of the portfolio, both within the chronology of the work completions, and in the sequence of the narrative in this thesis. In this piece I returned to my analytic interpretation of Saariaho's *NoaNoa*. The composition process was relatively long, and resulted in two works without electronics that became studies for ideas in *Paese favola*, as is discussed in this chapter. The typology was more extensively developed when I started work on this composition, as compared to the other portfolio works, and the creative work benefitted substantially from the analytical input. The final version of *Paese favola* is examined in section 7.5 and resulting additions to the typology are included in Appendix B.

7.1 Context for composing *Paese favola*

My initial thought for the new work *Paese Favola* was to make a palimpsest of Saariaho's *NoaNoa*, based on my own analysis of that work, as I have discussed in its various aspects in Chapters 2, 4, 5 and as TPC analysis in Appendix A.1. My first sketch for the new work was for solo soprano saxophone with computer. I started the draft of the beginning, notating pitch collections, indicated within a circular staff, developing the notation technique that I previously explored in *Blandango Willow* (see section 5.3), while striving to extend this notation to a more visually fluid style. I also added a version of the analytic notation for electronics reminiscent of the timbre components of the analysed TPCs in *NoaNoa*. The initial three systems of the first score draft are shown in Figures 7.1 and 7.2.

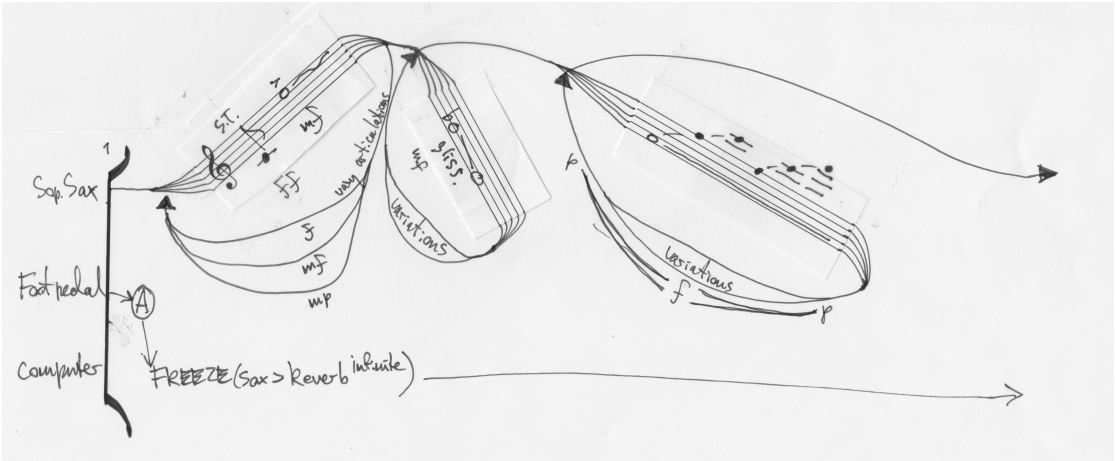


Figure 7.1: *Paese favola* first sketch, system 1.

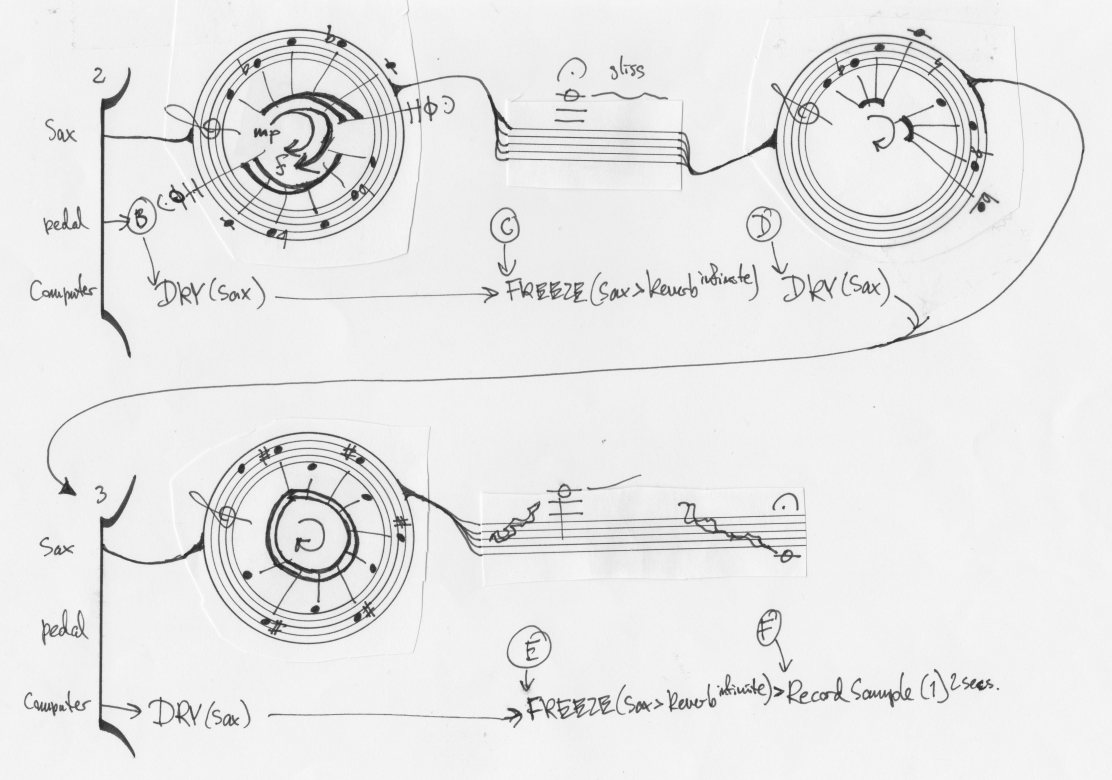


Figure 7.2: *Paese favola* first sketch, system 2 and 3.

With reference to the score of *NoaNoa*, my first sketch for *Paese Favola* expresses my analytic interpretation of pc sets from *NoaNoa* but in a more fluid, improvisational context. The relations between the saxophone and the electronics were also transferred and adapted from *NoaNoa* in this sketch. Thus I can think of the TPC descriptions of the first two 'looped bars' in my sketch as shown in expressions (7.1) and (7.2). These are equivalent to the descriptions of bars 1 and 3 of *NoaNoa* (listed in Appendix A.1), but the notation in my first sketch encourages, and even demands, an improvisational attitude from the performer, which is something the score of *NoaNoa* does not. In its final form *Paese favola* was developed into a structured improvisation for saxophone and electronics with a relatively compact score, but I will return to discussing this in section 7.5 after more of the preceding compositional process has been described.

$$\mathrm{TPC}(1,1) = \begin{bmatrix} \alpha\big(\mathrm{Sop.Sax.(IC4)}\big) \\ \Big(\mathrm{FREEZE}\big(\mathrm{Sop.Sax.} \rightarrow \mathrm{Reverb}(\textit{infinite})\big)\Big) \leftarrow \mathrm{Footpedal(A)trigger} \end{bmatrix}. \tag{7.1}$$

$$\mathrm{TPC}(1,2) = \begin{bmatrix} \beta\big(\mathrm{Sop.Sax.(IC1}\textit{gliss}\mathrm{)}\big) \\ \mathrm{FREEZE}\big(\mathrm{Sop.Sax.} \rightarrow \mathrm{Reverb}(\textit{infinite})\big) \end{bmatrix}. \tag{7.2}$$

Saariaho took the title 'NoaNoa' from a woodcut by the French artist Paul Gaugin (1848–1903). 'It also refers to the traveling diary of the same name, written by Gaugin during his visit to Tahiti from 1891–93. The fragments of phrases selected for the voice part in the piece come from this book.' [Saariaho, 1992, Introduction] I have adapted this approach to the title and text of my own work, but by taking a different perspective, I expanded the concept of palimpsest to these dimensions of the work. Thus I took 'Paese favola' from the title of the poem *Il paese della favola* by the Danish poet Else Mogensen (1943–2012) which expresses part of her engagement with an area in Southern Italy where she spent the last years of her life. [Mogensen, 2011*a*, 12] I also decided to attempt to use one or more fragments of her poem as sound sources in the portfolio work.

7.2 Compositional strand from analytic view of Lewis's *Voyager* (1987)

I had long been intrigued by George E. Lewis's work *Voyager*, and made a soft systems analysis of this work, (see Figure 7.3) informed by published information from Lewis.[1] I was interested in applying his concept of 'an automatic composing program that generates

[1]See Lewis's 2000 article, [Lewis, 2000] and the web site http://www.ubu.com/sound/lewis.html (accessed June 20, 2011).

complex responses to the musician's playing'[2] in the new work *Paese Favola*. I did not have access to the software code for *Voyager*,[3] but a series of recordings were available on the internet, in which Lewis was improvising on trombone with the system.[4] I made a speculative analysis in the form of a diagram (Figure 7.4) of what seemed to be the central software functionality which Lewis described. [Lewis, 2000] His system was intended as an improvising 'player' in the sense of Rowe's 'player paradigm'.[5] I was not interested in trying to reinvent Lewis's improvising machine. However, I did want to make something that could generate a complex texture related to instrumental input, and also give the electronics subtle unpredictability that would add variation, and all of this in a piece that would be somewhere between a scored composition and an improvisation. As a concept for the new portfolio work, I could adapt ideas from my analysis of *Voyager*'s central software functionality in order to create a simpler mechanism that could be used in *Paese Favola*.

[2]See Lewis's comments about his work *Voyager* on http://www.ubu.com/sound/lewis.html (accessed March 11, 2016).

[3]Although '*Voyager*'s top-level phrase behavior word, written as a FORMULA active process' is reprinted in his 2000 article in the *Leonardo Music Journal*. [Lewis, 2000, 35] 'FORMULA (*Fo*rth *Mu*sic *La*nguage) is a programming environment for computer music.' [Anderson and Kuivila, 1991, 1]

[4]Recordings of *Voyager* are available at http://www.ubu.com/sound/lewis.html (accessed March 11, 2016).

[5]Lewis states that: '[i]n Rowe's terms, *Voyager* functions as an extreme example of a "player" program'. [Lewis, 2000, 34] See also my brief discussion of Rowe's classifications in section 1.1.

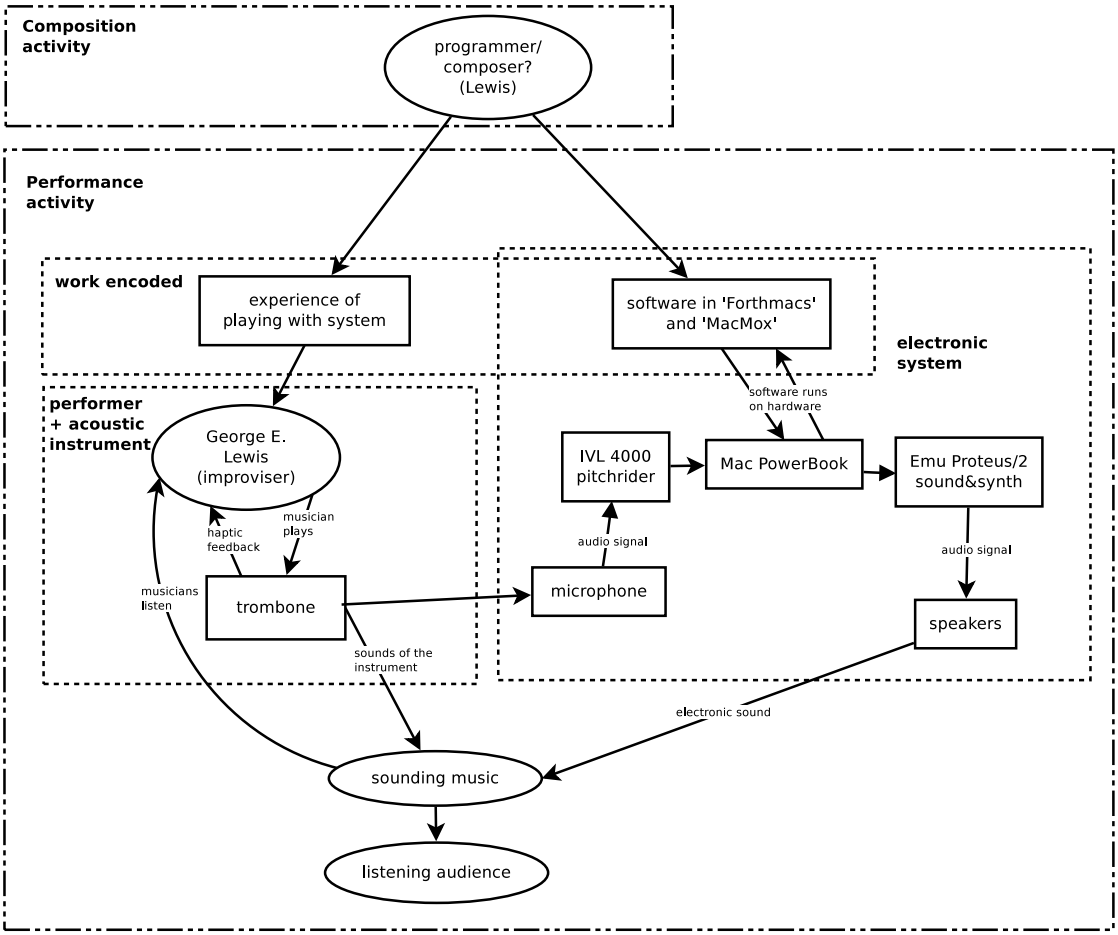


Figure 7.3: My soft system analysis of George E. Lewis's *Voyager*.

The analysis in Figure 7.4 is understood as follows: I represent Lewis's 64 'players' as $A[1..64]$ and these players are placed into Lewis's 'behavioural groups' which I call $B[1..n]$. I indicate n behavioural groups since Lewis does not specify how many there are. The placements of players $A[1..64]$ into behavioural groups $B[1..n]$ are made dynamically by the software, recalculated at time t every 5 to 7 seconds, according to a parameter derived from analysis of pitch input (from the musician), and this parameter (at time t) is represented as $C(t)$. As a result, any one particular group $B(s,t)$, where $1 \leq s \leq n$, at time t may be calculated by the sum of functions f_s with inputs from the players $A(p,t)$ and pitch analysis $C(t)$ at time t. Lewis mentions that the system chooses among

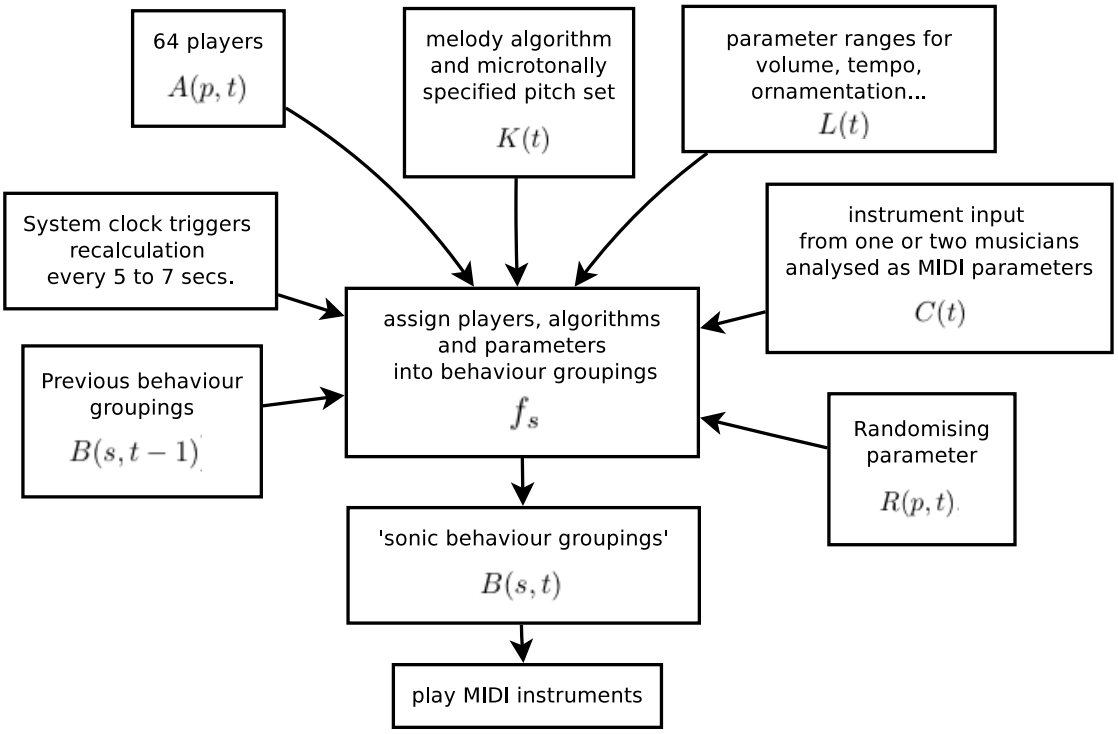


Figure 7.4: My analytical view of software functionalities in George E. Lewis's *Voyager*.

'15 melody algorithms', '150 microtonally specified pitchsets', and and number of MIDI parameter ranges, and assigns these choices to the 'behavioural groups'. [Lewis, 2000, 35] I will represent these choices as $K(t)$ and $L(t)$ which are also inputs to f_s.

However, it seems likely that some randomising parameter, perhaps with individual weightings for each player, would occur in *Voyager*, and so I represent this random element $R(p,t)$ for each player $A(p)$ which might be applied within any or all f_s functions, with recalculations at each time t. It also seems likely that Lewis's algorithm will take into account what has just been played, in order to determine what the next activity is to be for the electronic part, and so finally I also include $B(s,t-1)$ as an input into f_s. This analysis gives the expression (7.3) for each individual Behaviour Group s at time t, and the resulting 'improvised action' to be implemented by the Electronic Orchestra at time t is then represented by the sum of the behavioural groups as shown in expression (7.4), which is recalculated every 5 to 7 seconds. The *Voyager* system is a Markov Chain, given the assumed dependence of $B(s,t)$ on $B(s,t-1)$ shown in expression (7.3). *Voyager* also appears to be a third order system, in other words an algorithm having two levels of nested input sets, since the players $A(p,t)$ are nested within the behavioural groups $B(s,t)$.

$$B(s,t) = \sum_{p=1}^{64} f_s\big(A(p,t), C(t), K(t), L(t), R(p,t), B(s,t-1)\big). \tag{7.3}$$

$$\text{ElectronicOrchestra}(t) = \sum_{s=1}^{n} \big(B(s,t)\big). \tag{7.4}$$

Using this analysis, I describe a TPC at time t from *Voyager* using the vertical array format as shown in expression (7.5), where α represents pitch structures.

$$\mathrm{TPC}(t) = \left[\begin{array}{l} \alpha(\text{Trombone}, \text{E.Orch.}) \\ \\ \text{E.Orch} = \sum_{s=1}^{n} \left[\begin{array}{l} B(s,t) = \sum_{p=1}^{64} f_s \left[\begin{array}{l} A(p,t) : \text{Player}[1..64] \\ C(t) : \text{PlayerAssign} \leftarrow \text{ANALYSIS(tbn)} \\ K(t) : \text{algorithms} \\ L(t) : \text{parameters} \\ R(p,t) : \text{random generator} \\ B(1,t-1) : \text{parameters (time } t-1) \end{array}\right] \end{array}\right] \end{array}\right]. \tag{7.5}$$

Voyager responds to input in what Lewis has determined to be the optimal way, according to his compositional/improvisational intentions. I argue that as an expert improviser, Lewis has encoded his own (analytic) view of improvisation in the software for *Voyager*.[6] My first sketch for *Paese Favola* (Figures 7.1 and 7.2) illustrates that I was experimenting with visual aspects of the notation, in order to encourage an improvisational approach to interpreting the score. I also wanted to introduce an improvisational character to some of the electronic part by adopting some TPC constructions from my analytic model of *Voyager* in Figure 7.5. These experiments could project an extended notion of Harvey-like 'symmetry',[7] as an improvisation around an axis; and the idea of an axis would then relate to the written score as a static object, while the improvisations would, metaphorically, be 'fluid' and 'revolving' around this static score-object. The textures of the new work could develop ideas from *Chasing the sounds of windmills* which were discussed in chapter 6, and so the improvisation around a scored 'axis' could characterise a strand in the new work.

[6] Lewis argues that his system 'is a nonhierarchical, interactive musical environment that privileges improvisation'. [Lewis, 2000, 33]

[7] Although this is of course a very different dimension of the music than the pitch structures addressed by Harvey's symmetries. See my brief discussions of Harvey's notions of symmetry in sections 4.4 and 6.1.

7.3 Compositional strand of a complex fanfare-like texture

In my study for orchestra entitled *Gamma Etude* (2012) I employed a motif consisting of a short diatonic scalar fragment and a jump of an interval of a perfect fifth, or Interval Class 5 (IC5).[8] Sounding in several voices, across the instrumentation of the orchestra, this motif became a building block for what I thought of as a fanfare-like texture, which was static in pitch content, but propelled by dynamic rhythmic syncopations (see page 1 of the score of *Gamma Etude* in Figure 7.5). The motif can be heard as a variation of the opening motif (α) from *NoaNoa* (see Figure 2.1) which has a major fifthteenth interval jump (IC4) up, to a sustained note.

I used the IC5 jump to create shifting syncopated accents, modelled on the opening of *Gamma Etude*. But to achieve this in chamber music rather than in an orchestral context, I imagined the use of multiple delays, for example: with a saxophone quartet the use of multiple delay lines on each of the four saxophones could result in a complex texture of syncopated high pitches. This could take the form of a collection of delay canons[9] with poly-metric delay times. I expressed this in a general form with several delay lines for instruments $[1..n]$, as a transformation path from the TPC with DRY(instrument) to the TPC with DELAY(instrument), shown in expression (7.6). I could also use the IC4 jump from the opening of *NoaNoa* with a sustaining reverb, a very different texture from the IC5 delay line texture described above. This can be described for a group of n instruments as shown in expression (7.7). These ideas are aligned with the materials

[8] I wrote *Gamma Etude* for the *Toy Sound Circus Orchestra*, which premiered it in a concert at Birmingham Conservatoire, May 4, 2012. It was not possible to include electronics with this work and so it does not feature in the portfolio.

[9] See my discussion of 'delay canon' in *Sonata Neo-Schubert*: 'it involves the use of an electronic delay (recording and playing back with a time delay) to create some of the voices in a canon-like structure.' [Mogensen et al., 2014, 550-552]

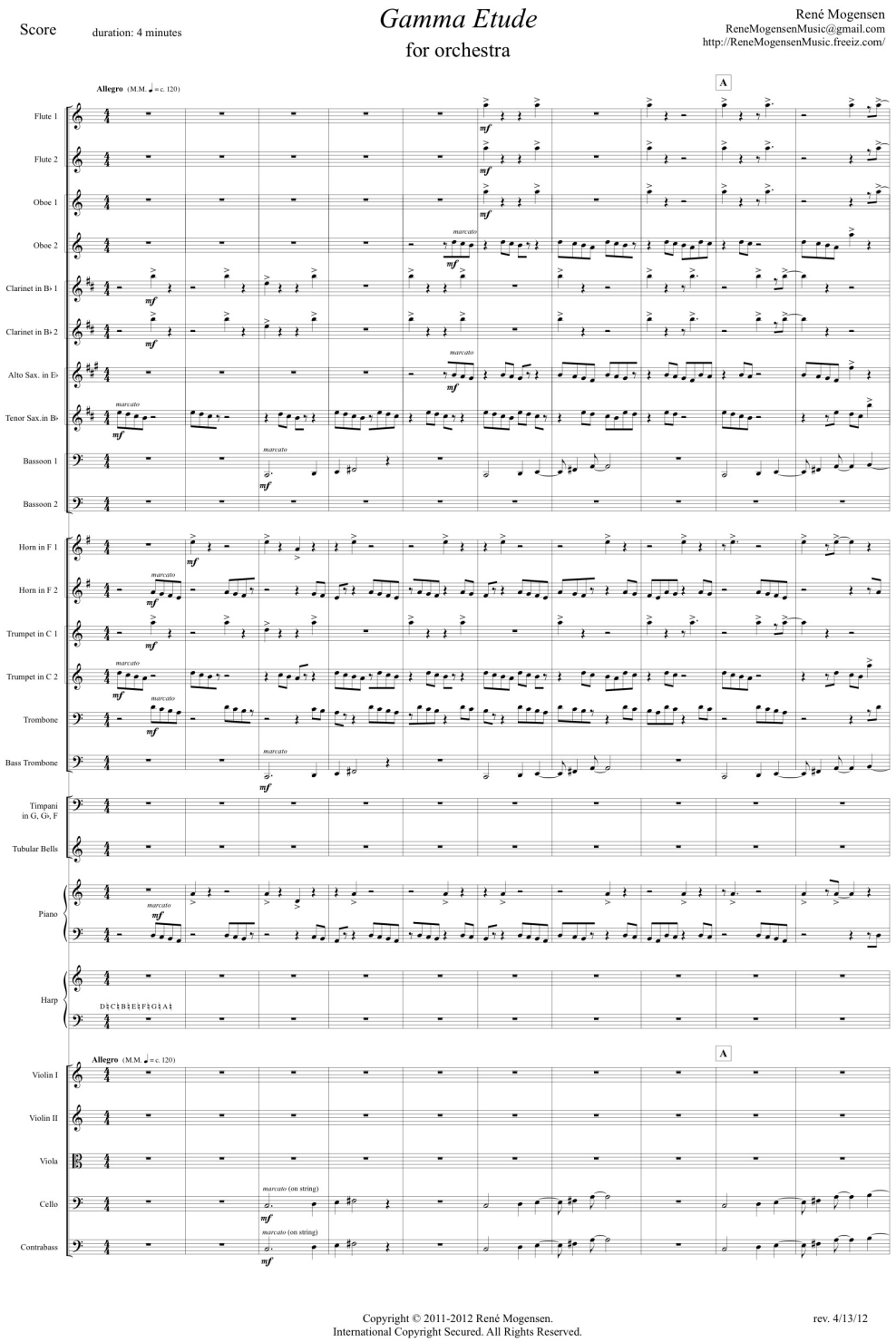


Figure 7.5: First page of *Gamma Etude* for orchestra.

from the previous sections in an overview of the compositional strands as is discussed in section 7.4.

$$\begin{bmatrix} \mathrm{x}\big(\mathrm{instr.}([1..\mathrm{n}], \mathrm{IC5})\big) \\ \mathrm{DRY}(\mathrm{instr.}[1..\mathrm{n}]) \end{bmatrix} \rightarrow \Big[+\mathit{Delay\ Canon} \Big] \rightarrow \begin{bmatrix} \mathrm{x}(\mathrm{instrument}[1..\mathrm{n}], \mathrm{delay\ outputs}) \\ \mathrm{DELAY} \begin{bmatrix} \mathrm{input}(\mathrm{instruments}) \\ \downarrow \\ \mathit{delay\ canon}([1..\mathrm{n}],\ \mathrm{polymetric}) \end{bmatrix} \end{bmatrix}. \tag{7.6}$$

$$\begin{bmatrix} \mathrm{x}\big(\mathrm{instr.}([1..\mathrm{n}], \mathrm{IC4})\big) \\ \mathrm{DRY}(\mathrm{instr.}[1..\mathrm{n}]) \end{bmatrix} \rightarrow \Big[+\mathit{FREEZE} \Big] \rightarrow \begin{bmatrix} \mathrm{x}\big(\mathrm{instrument}([1..\mathrm{n}], \mathrm{IC4})\big) \\ \mathrm{FREEZE}(\mathrm{instrument}[1..\mathrm{n}] \rightarrow \mathrm{Reverb}(\mathit{infinite}) \end{bmatrix}. \tag{7.7}$$

7.4 First draft of *Paese favola*

I summarised the compositional strands mentioned above as shown in Figure 7.6 and this formed the basis for my development of the composition. I received a commission for percussion and saxophone quartet in the autumn of 2014, giving a context for which I could attempt to develop the ideas. The project title was: *Marilyn Mazur and United Notions plays ToneArt Music.* This was a quintet which would premiere my work in a concert on December 14th, 2014 in Copenhagen. The fact that one of the saxophonists in this group had been in the septet which premiered *Blandango Willow* in 2013, and several of them had taken part in other previous collaborations performing my compositions, gave me confidence in trying to stretch the limits in the notation and improvisation approach explored in *Blandango Willow.*[10]

[10]Previous performances with some of these musicians included *Black and White* for Big Band, premiered by the Niels Gerhardt New Music Orchestra May 3, 2012 in Hillerød Denmark, as well as *Win-*

strand	description	sources
1	fluid notation as an 'axis' for improvisation	develop further from *Blandango Willow*
2	'symmetrical' improvisation	Harvey's ideas of symmetry
3	*Voyager*-influenced machine improvisation	analysis of Lewis's *Voyager*
4	IC5 → add 'delay canon'	texture from *Gamma Etude*
5	IC4 → *+FREEZE*	effect from *NoaNoa* TPC(1)
6	text fragment(s)	reading of poem 'Il paese della favola'

Figure 7.6: Table of initial ideas for strands in *Paese Favola*.

I started with the layout of the software patch (in MaxMSP) from *Chasing the voices of windmills*, since I planned to use a similar trigger-based progression for the overall form of the piece. Given the strand ideas in Figure 7.6, it became necessary to think about the form in terms of a timeline, or progression, assuming there would be some changes in the way the strands would function over the duration of a performance. My first sketch was in a four-part form. These four parts would be roughly delineated by textural changes in the sound. The first part would change in the rhythmic dimension along a vector of increasing intensity, in a way analogous to the build-up of pc sets in the pitch space of *Altra voce*, and used directly in *Chasing the voices of windmills*.[11] In *Paese favola* I planned to build up noisy and breathy sounds with an increasing tempo and rhythmic complexity. This is something I had experimented with in the work *Steel Butterfly*.[12] In that old work I mapped some of the performer input to an accellerando

dowpane for voice and octet premiered by the ToneArt ensemble in the Copenhagen Jazz Festival, July 9, 2011.

[11]See the discussion in chapter 6.

[12]I developed the first versions of *Steel Butterfly* in 2001–2002, during composer residencies at computer

in the computer sound file playback tempo, which I can now summarise as shown in expression (7.8).[13] I experimented with implementing a similar process in the new work, which would link performer activity with breathy sounds in the computer part: I imagined spoken fragments of the text would emerge in the breathy crescendo, through granular re-synthesis as is summarised in expression (7.9).

$$\mathrm{TPC}([1..n]) = \begin{bmatrix} x\big(\mathrm{performer}, \mathrm{PlaySAMPLE}(\mathrm{breath})\big) \\ \mathrm{PlaySAMPLE} \begin{bmatrix} \mathrm{PreRecorded}(\mathrm{breath}) \\ \mathrm{breath}(\mathrm{tempo}) \leftarrow \mathrm{performer}(\mathrm{amplitude}, \mathrm{sensors}) \end{bmatrix} \end{bmatrix}. \tag{7.8}$$

music centres DIEM in Aarhus, Denmark, and STEIM in Amsterdam, The Netherlands. DIEM has since become part of the Danish Academy of Music in Aarhus, while STEIM continues as an independent institution (www.steim.nl) for digital arts. I workshopped *Steel Butterfly* with several dancer-choreographers, including Douglas Dunn and Renata Celichowska, using the DIEM dance-suit. For information about the DIEM dance-suit see the article by Wayne Siegel [2009]. *Steel Butterfly* was a computer music work that was to be interactive with input from movement sensors on modern dancers or movement performers and the piece had a fixed form with sections of flexible durations. The sound was generated using mostly prerecorded samples that were manipulated by granular synthesis and variable speed audio playback. The input from four bending sensors on a dancer's body was linked in various ways to direct manipulations of granular re-synthesis, and also to arrays of variables, which would change in values over time, depending on input. These variables would determine some parameters of sample manipulations.

[13] In the first section of *Steel Butterfly* certain directions of movement measured by the dance-suit would, when crossing thresholds, trigger either an increase or a decrease in a variable. This variable would be mapped onto the speed of the breath-sample playback.

$$\mathrm{TPC}([1..n]) = \begin{bmatrix} x \begin{bmatrix} \mathrm{sax}(\mathrm{breaths}) \\ \mathrm{perc}(\mathrm{noises}, \mathrm{soft}) \\ \mathrm{PlaySAMPLE}(\mathrm{breath}) \\ \mathrm{SYNTH}\big(\mathrm{granular}(\mathrm{voice})\big) \end{bmatrix} \\ \mathrm{AMPLIFIED}\big(\mathrm{saxophone}(\mathrm{breaths})\big) \\ \mathrm{DRY}(\mathrm{perc}) \\ \mathrm{PlaySAMPLE} \begin{bmatrix} \mathrm{PreRecorded}(\mathrm{breath}) \\ \mathrm{breath}(\mathrm{tempo}) \leftarrow \mathrm{ANALYSIS}(\mathrm{saxophones}) \end{bmatrix} \\ \mathrm{SYNTH} \begin{bmatrix} \mathrm{granular}\big(\mathrm{sample}(\mathrm{voice})\big) \\ \mathrm{granular}(\mathrm{parameters}) \leftarrow \mathrm{ANALYSIS}(\mathrm{saxophones}) \end{bmatrix} \end{bmatrix}. \quad (7.9)$$

The percussionist in the premiere of the new work was to be the well-known improvisor Marilyn Mazur[14] and I expected to feature her as a soloist improviser. So in the third section of the form, I imagined a structured improvisation, where the percussionist would be accompanied by the granular voice re-synthesis, which would respond to her playing while having some independence, in effect 'improvising' in the sense of Lewis's piece *Voyager* (see section 7.2). I also imagined 'clouds' of saxophone sound with additive synthesis playing sustained pitch collections[15] that would add an effective accompaniment to the percussionist and machine improvisations. I further envisioned a fourth and final section where there would be large, rhythmically concerted, breathy sound-clusters, while the percussion and machine improvisations would continue with a gradually diminishing range of bandpass filtered sound, eventually diminishing to nothing; the whole effect being analogous to the movement of a visual object disappearing beyond the horizon. I

[14]See Marilyn Mazur's web site: www.marilynmazur.com (accessed Nov.16, 2015).

[15]By pitch collections I mean 'vertical' pitch structures, a generalised concept of a 'chord' from common-practice harmony.

made a pictographic[16] sketch with comments (see Figure 7.7) to summarise and visualise the ideas of this four section form over the approximately 5 minute long time-scale of the new piece.

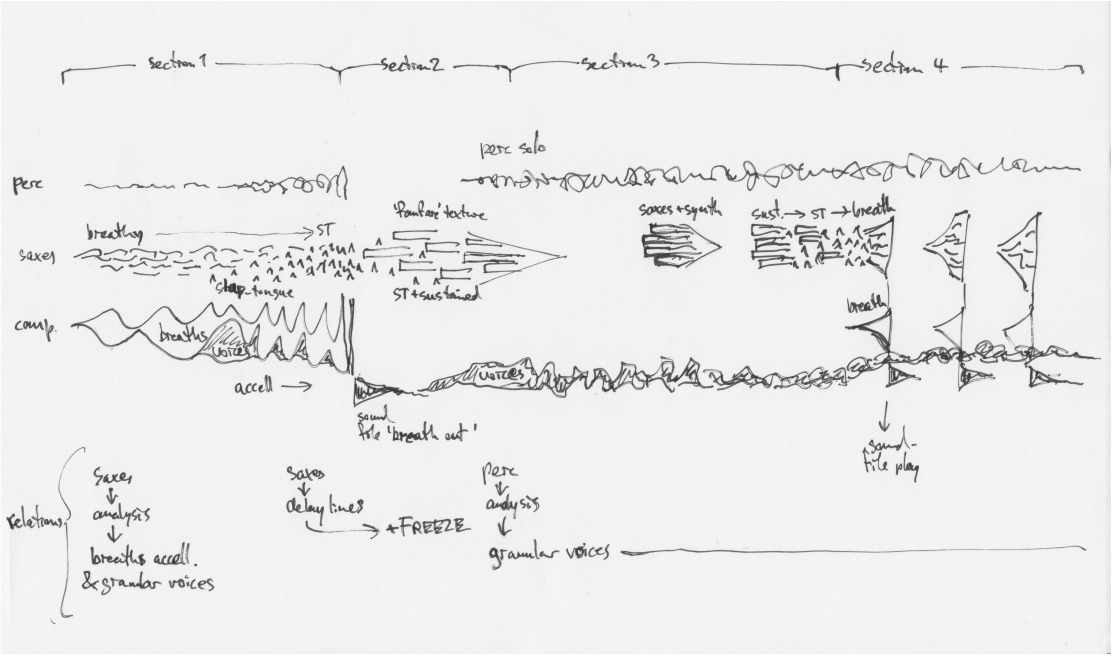


Figure 7.7: Pictographic representation with comments of ideas in the time-domain for a quintet draft of *Paese favola*.

The delivery deadline (November 28, 2014) for the *United Notions* commission did not give much time in the calendar for composing the work, as it also overlapped with the deadline and concert of *Chasing the voices of windmills*. I found that it became impractical to submit *Paese favola* as a piece for this group with computer. I simply needed more time to work on the ideas integrating the instruments with computer sound. In order to meet my obligation for the commission, I then wrote a different score, *U do*

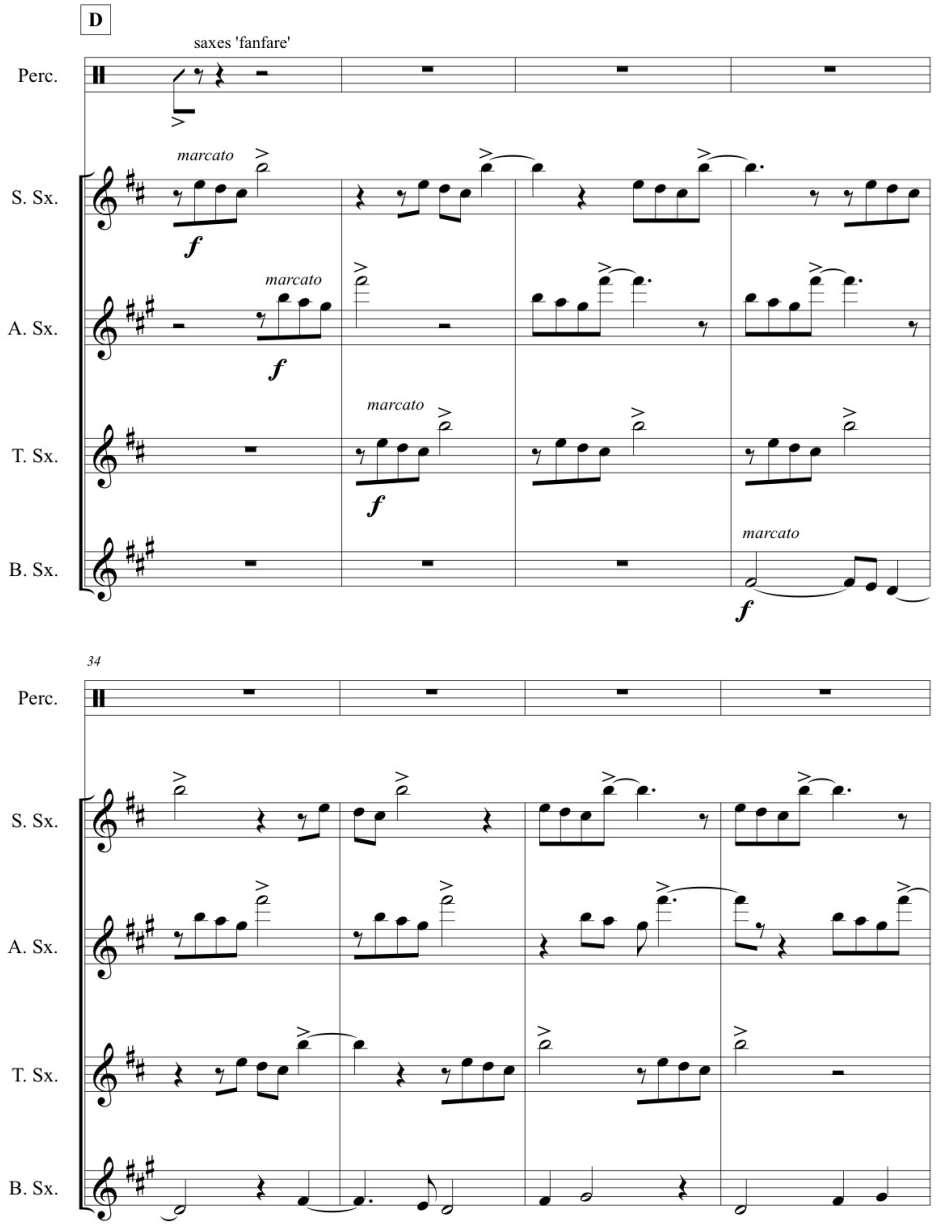
[16]See my discussion of pictographic vs. symbolic representation of sound in the Introduction and my article on this area of research. [Mogensen, 2016]

Dat,[17] for percussion and four saxophones, without any electronics. This score would not become part of my portfolio, but in it I worked out another version of the 'fanfare' texture that I explored in *Gamma Etude*, as discussed in section 7.3. The beginning of the quartet 'fanfare' texture is shown in the score excerpt in Figure 7.8.

7.5 Rethinking *Paese favola* for one saxophone

After having written the *U do Dat* quintet, there was no longer an opportunity for a performance of a quintet version of *Paese favola*, and so I decided to return to the single saxophone for this portfolio work as discussed in section 7.1, and compose a piece that I could perform myself. With reference to the strands in Figure 7.6, I developed the 'fanfare' texture (Strand 4) from *Gamma Etude* and *U do Dat*, using pitch organisation from *NoaNoa* and by expanding these textures using DELAY(saxophone). I stretched the improvisational features further than in *Blandango Willow* (Strand 1) with the notated score being an 'axis' around which the performer could work while incorporating some computer 'improvisation' features in the electronic sound (Strand 3). I also used a fragment from the poem *Il paese della favola* (Strand 6). After revising my ideas, the soft systems diagram of *Paese favola* in Figure 7.9 became very similar to the diagram of *NoaNoa* (Figure 1.1).

[17]The title *U do Dat* is inspired by some of the expressions which my two-and-a-half year-old son liked to use at the time I was composing it.



René Mogensen:***U do Dat***, Score p.4

Figure 7.8: Excerpt of 'fanfare' texture from page 4 of *U do Dat*.

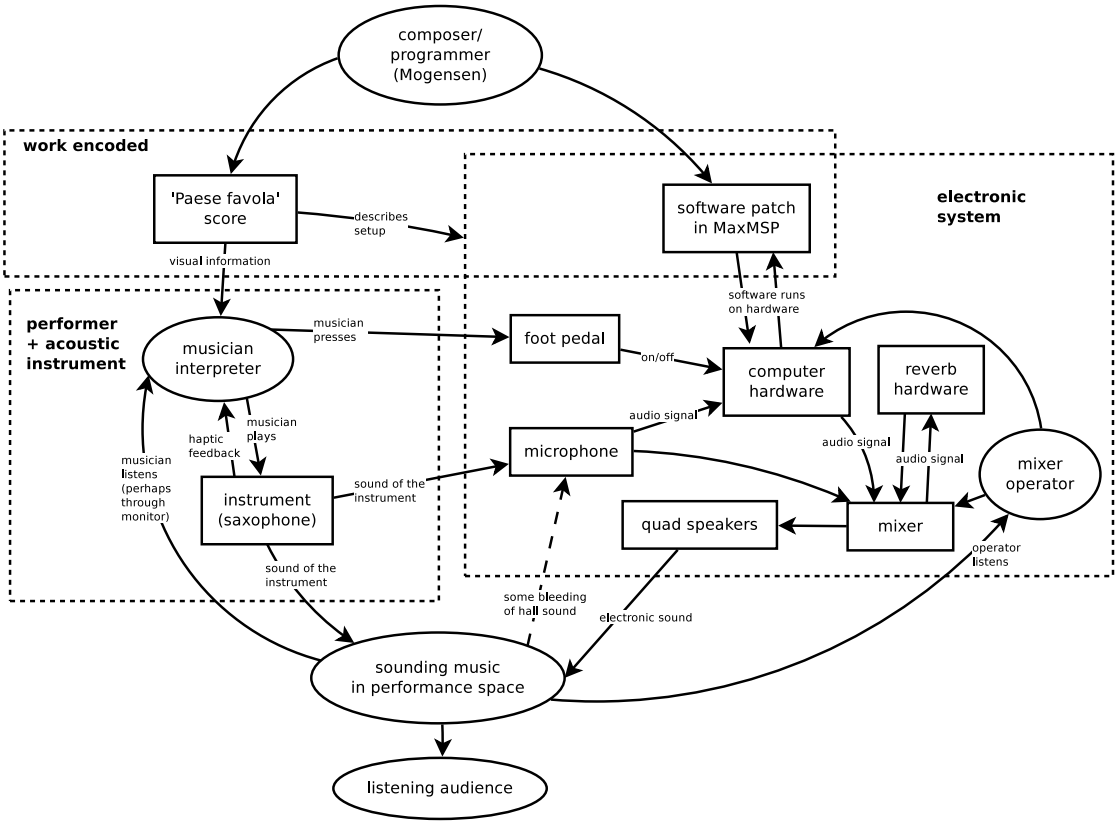


Figure 7.9: Soft system diagram of portfolio work *Paese favola*.

I had wanted to explore some 'extended techniques'[18] in the saxophone sound; but in the final score of *Paese favola* I have omitted effects such as multiphonics (which Saariaho included in *NoaNoa* for the flute) since I deemed these unnecessary for the musical ideas expressed; although the improvising performer could potentially choose to include such effects anyway. Instead, the material in the structured improvisation for soprano saxophone is based on pitch motifs from *NoaNoa* and is a continuation of the pitch collections used in the first draft as discussed in section 7.1.

I designated four pitch motifs by the Greek letters $(\alpha, \beta, \gamma, \delta)$ that also served as pitch

[18]See Weiss' and Netti's 2010 book *The Techniques of Saxophone Playing* for a compendium of extended saxophone techniques. [Weiss and Netti, 2010]

motif designators in my analysis of *NoaNoa* in Chapters 2 and 5. In *Paese favola* the α motif is taken from bar 1 and the β motif is taken from bar 3 of *NoaNoa*, and so these two instances of α and β are equivalent across the two works. The subsequent *Paese favola* α-type pitch collections (at letters B, C, F, and G) are adaptations from the pitch collections in *NoaNoa* bars 9–17. The minor 2nd intervals at letters D and H are transpositions of β from the second part of letter A. The δ motif departs from the *NoaNoa* model, and designates the algorithm that determines the chord pitches played via additive synthesis as notated in expression (7.10). This calculation takes the pitch class played by the saxophone and combines it with two variables generated for each one of six boids agents in a swarming algorithm, giving six pitches in total.[19] I decided on this algorithm through experimentation and subjective evaluation to find a sound that seemed convincing as accompaniment to what was played in the saxophone part. The γ motif designates the poem fragment spoken and recorded into sample E, which is subsequently used as the buffer for the SYNTH(granular) in letters E, F and G.

$$\begin{aligned}\text{MIDIpitch}(n,t) = \\ &\Big(\text{PitchClass}\big(\text{PitchTrack}(t)\big) \times \text{Distance}\big(\text{BoidsAgent}(n,t)\big) \times 12\Big) \\ &+\Big(\text{Azimuth}\big(\text{BoidsAgent}(n,t)\big) \times 8\Big) + 36, \\ &\qquad\qquad \text{where } n = [1..6] \text{ at time } t. \qquad (7.10)\end{aligned}$$

Expression (7.10) can be seen as a transformation of the result of my analysis of Lewis's *Voyager* (in expressions (7.3) and (7.4)), which is distilled to result in the SYNTH(additive, at time t) shown in expression (7.16). The SYNTH(additive, at time t)

[19] In my MaxMSP patch for *Paese favola* I used the java script code from *Trio in 3 times 3 rooms*: a version of the 'boids' algorithm by Reynolds as mentioned in section 3.1. [Reynolds, 1987] Tim Blackwell [2007] has documented various approaches to using swarm algorithms in computer music, but I have not attempted to apply his approaches or theories in the present research.

is the relation of saxophone and electronics which results in the δ motif in *Paese favola* and the implementation of the δ motif is represented by the algorithm in expression (7.10). Expression (7.11), (7.12), (7.13), (7.14) and (7.15) outline the transformation relationships from the components of the *Voyager* analysis to the components of the algorithm used to control the additive synthesis in *Paese favola*.

$$\text{Pitch analysis input} : C(t) \Rightarrow D(t) = \text{PitchClass(instrument) at time } t. \tag{7.11}$$

$$\text{Players} : A(p,t) \Rightarrow \text{BoidsAgent}(n,t), \text{ where } n = [1..6] \text{ at time } t. \tag{7.12}$$

$$\text{Pitch set and parameters} : \left.\begin{matrix} K(t) \\ L(t) \end{matrix}\right\} \Rightarrow \text{MIDIpitch}(n,t), \text{where } n = [1..6] \text{ at time } t. \tag{7.13}$$

$$\begin{aligned} &\text{Random parameters :} \\ &R(p,t) \Rightarrow Q(n,t) = \begin{pmatrix} \text{Distance}\big(\text{BoidsAgent}(n,t)\big) \\ \text{Azimuth}\big(\text{BoidsAgent}(n,t)\big) \end{pmatrix}, \\ &\qquad\qquad \text{where } n = [1..6] \text{ at time } t. \end{aligned} \tag{7.14}$$

$$\text{Markov chain effect} : B(s,t-1) \Rightarrow \textit{not applied}. \tag{7.15}$$

$$\begin{aligned} \text{ElectronicOrchestra}(t) \Rightarrow \text{SYNTH(additive,}t) &= \sum_{n=1}^{6} f\big(D(t), Q(n,t)\big), \\ &\text{where attack is triggered by EnvelopeFollower(instrument).} \end{aligned} \tag{7.16}$$

From an analytical perspective, I segmented the new work as shown in Appendix A, expressions (A.280) to (A.288). This results in a transformation space with a collection of paths as shown in Figure 7.10. I entered these paths into the typology and they can be found in the typology hierarchy map and catalogue (Appendix B).

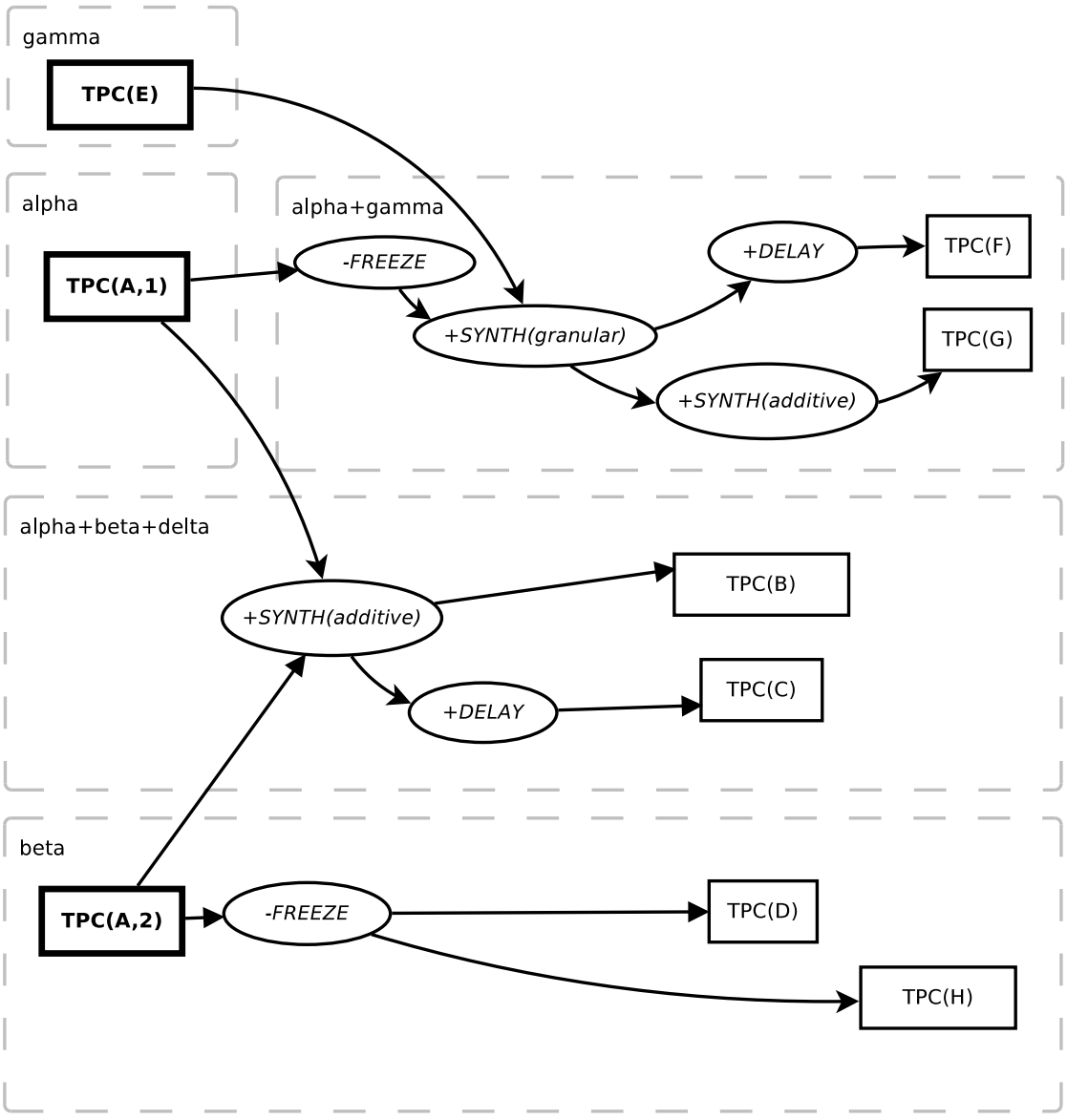


Figure 7.10: Transformation network from portfolio work *Paese favola*.

The notation of the final score of *Paese favola* is conceived almost entirely in terms of the analytical approaches used previously in the research, and so offers an example of nearly complete integration of the strands of the research project: interlocking analysis and composition which results in an expansion of the typology in parallel with the composition of a new portfolio work. The structured improvisation which is encoded in the score is based on background knowledge of the research described in this thesis. I am both the composer and intended performer of this work, and so the *habitus*[20] may be a strong factor in the way the work is realised in the recorded version, which is included on the audio CD. However, *Paese favola* is a successful finish to this thesis since it illustrates a process of creative music-making which integrates the analytic approach of the research, thereby confirming the potential of the intertwining process of practice-based research and research-based practice. Documenting this process is a significant contribution of the research, as will be discussed further in Chapter 8. The analysis of *Paese favola* as shown in Figure 7.10 also contributes to the typology, giving instances of the five types listed below in Figure 7.11 that are included as part of the final typology shown in Appendix B.1.

1. $-FREEZE(reverb)$
2. $+SYNTH(additive)$
3. $[-FREEZE(Reverb),\ +SYNTH(granular),\ +DELAY]$
4. $[-FREEZE(Reverb),\ +SYNTH(additive),\ +SYNTH(granular)]$
5. $[\ +SYNTH(additive),\ +DELAY]$

Figure 7.11: Five path types from *Paese favola*.

[20] *Habitus* is Bourdieu's term; see discussion in Introduction, section 0.4.

Chapter 8

Conclusions and evaluations

I now return to two questions set out in the Introduction and investigated through the thesis: 1. Has this research identified patterns of practice in composers' shaping of relations between acoustic instruments and electronics? I would say yes: I have identified transformation paths that occur in the works of several composers. The comparative analysis of these paths indicate *types* of changes in the relations between acoustic instruments and electronics, as realised by these composers in their musical works. These *types* represent patterns of practice. 2. Can the encoding of such patterns of practice be applied as compositional tools for creating new mixed works? Again, I would say yes: I have integrated the analytical tools and utilised the *types* in my own compositional processes resulting in the five portfolio works. The contributions of the research can be summarised as comprised of three parts: 1. the typology; 2. the portfolio of original works as praxis; 3. the autoethnographic account of the practice- and research-based process.

The process involved in this research has emerged as an important contribution, and also as a potential basis for future work. By this statement, I do not mean to imply that the iterative practice- and research-based process itself is original. However, the

application of this process in order to answer the research questions of this thesis, with its critically examined analytical approach and autoethnographic narrative, is an original contribution. When writing the present text, my intent was that the research should make as clear a statement of the iterative analytical-compositional process as possible and that this exposition could show the results to be a potential practical tool for composers and music analysts. The resulting typology is shown in Figure 8.1 (also replicated in Appendix B.1) and I propose it as an open-ended tool that can be useful in the expressive and intellectual activities that may constitute part of the process of composing a new work that integrates acoustic instruments with electronics. This kind of application has been illustrated by my use of typology elements in composing the portfolio works. The approach may also be useful as a purely analytical tool for comparative study as was pursued in Chapter 4. The typology elements represent patterns of practice, but the research does not provide any theory explaining why such patterns of practice occur, nor does it trace any historical development of this practice. Such a theory and historical narrative is beyond the boundaries of the present thesis.

In Figure 8.1 the path types and super-types, that have been discussed in Chapters 2 through 7, are organised in an inheritance-based typology hierarchy map. The super-types are at the top, and below these are path types with inheritance from the super-types. The types are grouped in dotted-line boxes so that path types in each box can have inheritance from the boxes above it, for example: 'Types (level 2)' can inherit from 'Types (level 1)' and 'Super-types', but not from 'Types (level 3)' or 'Types (level 4)'. The arrows indicate inheritance directions between super-types and path types. Below most of the path types are listed transformation paths from one or more of the music works discussed in the text and these are included in the map as example instances of the path types. The path types and super-types indicate patterns of practice in composers' shaping of the relations between acoustic instruments and electronics. Patterns of practice are also evident in the inheritance relations between path

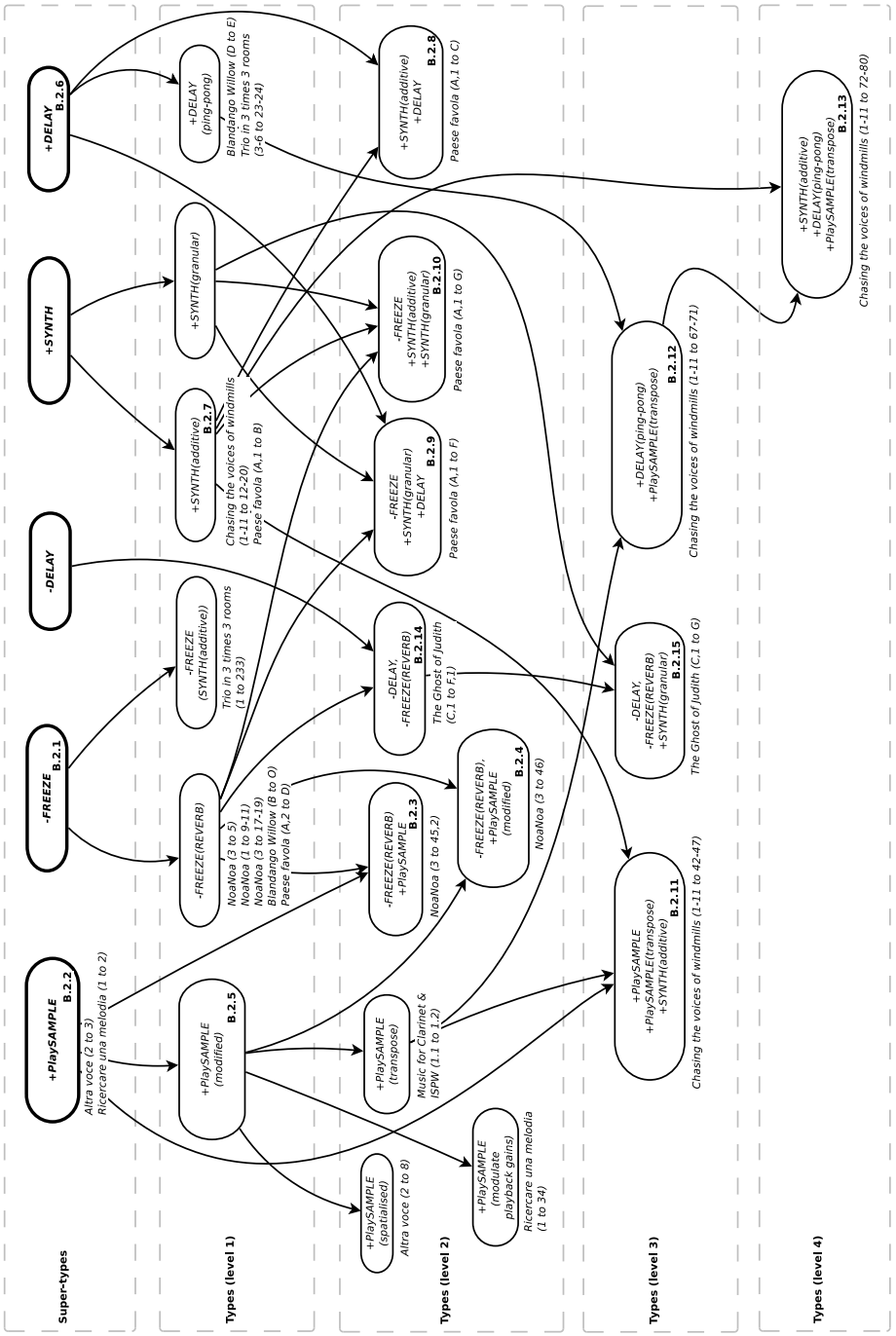


Figure 8.1: Typology hierarchy map

types and super-types; for example the super-type *+PlaySAMPLE*, in the top left of the map, indicates a transformation path equivalence, hence an equivalent practice, between the instances *Altra voce* TPC(2)→[*+PlaySAMPLE*]⇒TPC(3) and *Ricercare una melodia* TPC(1)→[*+PlaySAMPLE*]⇒TPC(2). This super-type gives inheritance to the path type [*−FREEZE(REVERB), +PlaySAMPLE*] (in the group 'Types (level 2)') and this link by inheritance indicates a commonality of practice between the two instances of the super-type and a third path type instance from *NoaNoa*: TPC(3)→[*−FREEZE(REVERB), +PlaySAMPLE*]⇒TPC(45,2). The typology hierarchy map is an exposition of examples of these kinds of patterns of practice, across the included compositions, which has emerged from the analytical work.

I have attempted to develop the most clear and simple notation for the TPC and transformation path descriptions through a process of gradual revision, as I accumulated results of analyses of repertoire and my portfolio works. I have aimed for consistent use of symbols and markings, while allowing flexibility for use in varying contexts. Initially I represented TPCs as horizontal arrays, but later in the research I found that a vertical array gave a more easily readable notation, and so I adapted vertical array notation in all the analyses as well as in the typology catalogue. The typology (Figure 8.1) includes five super-types shown as bold ovals at the top of the diagram: *+PlaySAMPLE*, *−FREEZE*, *−DELAY*, *+SYNTH* and *+DELAY*. The types are shown as non-bold ovals with Appendix sections (B.2.1, B.2.2. and so on) indicated for cross-referencing to the catalogue (Appendix B.2). Instances from the works analysed are listed below the types, corresponding to the entries in the catalogue. The hierarchy and type catalogue in Appendix B form a presentation of the patterns of practice as interpreted through the research and organised as a typology, giving a formulation of the analytical results of the research. The process of building the typology has been described in detail during the narrative of Chapters 2–7. The presentation of this typology, in spite of its limitations, is an important result of the research.

Analytical activity is by its nature interpretative, at least to some extent, and so the typology artefact resulting from the research is shaped by personal decisions of the analyst. The typology results are also context-dependent according to repertoire and the analytical approaches employed: in the present analyses of works by Saariaho, Berio, Harvey, myself and others, I cannot claim any strong objectivity or generalisability regarding the typology elements that I have arrived at. Evaluating the degree of subjectivity in the research is not a simple task, but my *habitus*, to bring back Bourdieu's term (see page 4), has certainly had a significant influence on my analytical interpretations which have formed the basis for the typology. However, the process of the research, using the analytical approach, could be duplicated by other composers or musicologists, interested in mixed works, who may in turn generate other typologies from other repertoires. In this sense the research approach conforms adequately to canons of reproducibility and generalisability for qualitative research as outlined by Strauss and Corbin. [Strauss and Corbin, 1998, 266]

Alternative typologies from other repertoires might be consistent with the present typology given explicit acknowledgements of the variations in the contexts in which the analytical and creative approaches are applied. The present study includes a number of composers and their works (see Introduction page 1), which cover a time span from 1971 to the present, yet this represents only a minute sample of the mixed music repertoire. This sample repertoire is almost certainly not representative of the entire spectrum of mixed music. Examinations of repertoire from other composers might demand revisions of the approach, but this would not necessarily reduce the applicability of the present results regarding the repertoire examined here. One example of future work that could serve to expand the search for patterns of practice and to test the typology approach would be comparative analyses of several works for cello and electronics such as Todor

Todoroff's *Evanescens* (2012),[1] Natasha Barrett's *Rhizaria (Barely_ part 4)* (2007–2008)[2] and Prof. Michael Clarke's *Enmeshed 3* (2013).[3] Such future analytical research could perhaps also be connected to composers who were examined in the present research by extending the comparative study to Saariaho's *Petals* (1988),[4] Harvey's *Advaya* (1994)[5] and my own work *All Numbers Language* (2006). [Mogensen, 2009]

The segmentation of works into TPCs which include pitch components, in the present research, does not imply that the analytical approach requires a focus on pitch. Discrete pitches feature prominently in most of the repertoire analysed in the present thesis, but I would argue that other component classes could be used if the music examined provided a sufficient contextual basis for such use. One example of another class of component could be a 'spatial' component, which I did use in some sketches for *Trio in 3 times 3 rooms* (see expressions (3.4), (3.5) and (3.6) in section 3.3). However, in the present typology I merged these kinds of spatialisation ideas into the timbre components as discussed in section 3.4 as this was sufficient for the analytical aims. I speculate that another class of components could be based on pictographic sound representations or other graphics, given some 'inventory of morphological units'. [Roy, 2003, 201-214] These kinds of morphological units could be represented by symbols such as α, β and so on, in order

[1]See the project web page at: www.evanescens.net; and for more information about Todoroff see the web page: http://www.compositeurs.be/fr/compositeurs/todor_todoroff/48/ (accessed November 19, 2015).

[2]For more information see the web page: http://www.natashabarrett.org/rhizaria.html (accessed November 19, 2015).

[3]For more information see the web page: http://eprints.hud.ac.uk/22175/ (accessed November 19, 2015).

[4]See the web page: saariaho.org/works/petals (accessed November 19, 2015).

[5]See the publisher's web page: www.fabermusic.com/repertoire/advaya-2593 (accessed November 19, 2015).

to analyse graphic scores for instrumentalists with electronics.[6] Alternative symbolic representations of sound, such as proposed by Thoresen,[7] could also potentially inform component classes for segmentation. For the repertoire analysed in the present thesis it has not been necessary to use such alternative pictographic or notational systems, as was discussed in section 1.4. I argue that the analytical approach can be combined with any representation, of mixed music, as long as that representation supplies sufficient information relevant to the relations between acoustic instruments and electronics. Analytical testing of these possibilities is beyond the scope of the present thesis but indicate potential directions for future work.

The TPC segmentation of a music work, organised as 'points' in a theoretical transformation space, represents schemata of the timbre and pitch forming activities performed by instruments and electronics and therefore omits many musical details.[8] The schemata can include both trigger- or event-driven music as well as musical processes that do not readily reduce to discrete events. One example of a process described through this segmentation is the changing additive synthesis in bars 1–33 of *Trio in 3 times 3 rooms* which I have segmented into 15 TPCs (see Appendix A.5.1). In the 'Additive Synth Chord 1' of those bars, there are gradual changes in pitch and a 'swarming' development in spatialisation. While this process defines only parts of the musical texture, it seems likely that a composition based entirely on processes without any event-driven progression could also be segmented with this approach. In addition, I speculate that a new 'process-component' class in the segmentation could be useful in analysing contemporary music that is strongly process-oriented. However, to verify this is beyond the scope of the present thesis. The analytical goal of the segmentation in this research is to identify the relations between acoustic instruments and electronics. The descriptions of processes

[6] See discussion of Roy's 'inventory of morphological units' in section 1.4, page 33.

[7] See discussion of Thoresen's notational system and 'Sonova' font in section 1.4, page 32.

[8] The reductionism in the analysis is also discussed in sections 1.5 and 2.2.

and events in the analysis are primarily important as support for the analytical goal of identifying elements for the typology. I argue that the transformation analysis approach, with the narrow focus on the relations between acoustic instruments and electronics, can complement other music-analytical tools that focus on other aspects of music such as pc set analysis, aural sonology or spectromorphology.[9]

A route to build further on the present results could be within an appropriate educational setting, where the analytical work could be shared with students of composition, performance and music technology, and these students could potentially test the usability of typology elements within their own creative practices. Moving the work beyond my own creative practice could greatly expand the grounding of the approach from an empirical perspective and could perhaps drive the research into new directions.

Adams, Jones and Ellis propose four goals for evaluating autoethnographic research, of which one is '[v]aluing the personal and experiential'. [Adams et al., 2015, 102] I have attempted to incorporate this goal in writing the thesis: in my discussions in Chapters 2, 3, 5, 6 and 7 I have included narratives regarding the motivations, personal reactions, thoughts and ideas that have entered into the composition processes of the portfolio works. These narratives have formed a backdrop upon which I could explain the analytical development and compositional use of the typology elements as integral parts of the compositional processes that resulted in the portfolio works. Using the autoethnographic basis has made the typology development more than an analytic or compositional exercise, it has documented the typology as part of my practice- and research-based creative process across 2011–15. This creative process has been commandeered by my own personal and entirely subjective input, and some of the portfolio works have been featured in concerts by professional musicians of high international calibre. These concerts have been contributions to the cultural life both in the UK and in Denmark. Some parts of the autoethnographic narrative have been concerned with compositional work that has only

[9]See discussion of Thoresen's 'aural sonology' and Smalley's 'spectromorphology' in section 1.4.

indirectly resulted in portfolio works, such as for example the discussions of the works *Gamma Etude* and *U Do Dat* in sections 7.3 and 7.4. But these discussions are relevant to giving an account of the practice-as-research, by indicating a few of the possibilities that were removed during the compositional processes of the portfolio works.

Taking an autoethnographic stance has removed any pretence of 'strong' objectivity in my composing activity. However, the analytical and autoethnographic parts of the work have been clearly differentiated, although the analytical narrative has been embedded in the autoethnographic narrative. The differentiation has allowed the analytic work to achieve 'a certain degree of distance from the research materials' which I argue is a 'weak' objectivity. [Strauss and Corbin, 1998, 35] I have freely pointed to themes that have focused my creative interests as a composer in each musical work, but I have also sought to maintain strict consistency in my use of analytical tools and thereby gain coherence in the analytical results across all the repertoire and portfolio works included in the study. The research approach and its results are shown as consistent with the analytic stance taken: there is coherence within this emergent typology as well as between the qualities of the portfolio works and the focus in the narrative concerning the analytical and compositional approaches. The success of the overall iterative approach is a significant contribution of the research.

I have used soft system analysis [Flood and Carson, 1993] and transformation analysis [Lewin, 2011*a*,*b*] as complementary tools. The first tool is useful in interpreting the elements involved in the performance situation, while transformation analysis indicates changes in how these elements are used in the timeline of a musical work. Transformation analysis has been the key tool for the typology development, while soft systems analysis has fulfilled a secondary role in supporting the discussions of the transformation analysis. In practice, it is mainly the *concept* of transformations as indicators of theoretical structures that I have adopted from Lewin; little else would be recognisable in my analyses from a purely Lewinian point of view. In particular I have not attempted to define

numerical intervals as parameters in the theoretical spaces, nor have I applied set manipulations such as Lewin would do; for example as he did to formulate his interpretation of pitch-class set transformations in Stockhausen's *Klavierstück III* (1952). Lewin represented pitch-classes by integers and his transformation paths represented mathematical manipulations of these integer values. [Lewin, 2011*b*, Chapter 2] In my typology-related analyses I have not sought any way of quantifying intervals to represent the differences between various TPCs in a transformation space.[10] Instead, my transformation paths are based on qualitative experiential differences between the various TPC segments in such a space, while including references to the underlying techniques or signal paths in the electronics. These experiential differences (such as DRY compared to FREEZE) are described in terms of what Nattiez would consider the material 'trace' of the work and Thoresen would qualify as the 'observable aspects of the esthesic and poeïtic domains'. [Nattiez, 1990, 10-17] [Thoresen, 2007*a*, 5]

In some instances the prototype[11] ideas were difficult to apply: for example in *Trio in 3 times 3 rooms* TPC(1) there is a crossfade between the instrumental trio (cl,pno,cb) and the synthesis (SYNTH(additive)). In this instance, is the FREEZE *one* entity where the cross fade is internal, or should this be interpreted as *two* separate FREEZE entities that are crossfading? I choose to notate it as a single FREEZE component as shown in the Appendix expression (A.184) since I heard it as a single 'sound object' in the sense of Pierre Schaeffer.[12] The SYNTH component of the TPC is only part of the sound

[10] As mentioned in section 1.3 I am not adopting Lewin's 'Cartesian perspective' of quantifying intervals in the transformation spaces, instead my approach in this research is 'purely transformational'. [Lewin, 2011*a*, 157–160] Tymoczkov questions Lewin's proposed equivalence of transformational and 'Cartesian' perspectives, and he argues that 'in avoiding interval labels, we have described intervals entirely by their transformational properties: rather than associating them with numbers, we simply describe *what they do* to the objects in the space'. [Tymoczko, 2008, 165]

[11] 'Prototype' in the sense used by George Lakoff. [Lakoff, 1987, Chapter 3]

[12] See my discussion of the Schaefferian 'sound object' concept in section 1.4.

object in TPC(1), but SYNTH figures as a super-type in the hierarchy as well. This overlap of labels might indicate an inconsistency in the metaphors that I use for prototyping the elements of the typology. In TPC(3–6) (see Appendix expression (A.186)) the SYNTH continues but I remove the FREEZE part, when the clarinet enters with a β motif. Arguably the FREEZE continues, certainly the SYNTH as a 'sound object' is not interrupted. But the stochastic variations are increased in the pitch and gain parameters that control the SYNTH component's software oscillators. My analytical interpretation takes this as a transformation of the SYNTH sound object such that it no longer is experienced as a sustaining of the *Chord* pitch collection, and instead has been morphed into something else with new trajectories in pitch and spatialisation. This kind of morphology could perhaps be more clearly represented with a 'lower' structural level of analysis, akin to the 'strands' analysis discussed in Chapter 5. A sound object having morphology that results from processes such as the additive synthesis in *Trio in 3 times 3 rooms* could be heard as a strand which might be intertwined in some pattern with other process strands such as development of instrumental pitch structures, spatialisation and associations of the ambient sound recordings. To test such an approach to lower level analysis in comparative study with repertoire works is beyond the scope of the present thesis but is a clear topic for future research.

My use of SYNTH as a timbre component-label may be indicative of a researcher bias towards what Zölzer would call 'classification based on underlying techniques' as opposed to 'classification based on perceptual attributes'. [Zölzer, 2011, 5–14] Another question arising from examining the typology might be how the differentiation between *+PlaySAMPLE* and *+DELAY* was determined, since the underlying technique in a DELAY component resembles continuous sampling and playback (as indicated in expression 8.1 where $\Rightarrow$ indicates a continuous throughput of audio). In my interpretation however, the experiential results of those two super types are different, hence I separate the two and this may again be indicative of a researcher bias, in this case towards what Zölzer

would call 'classification based on perceptual attributes'. [Zölzer, 2011, 7–14] In future work, I can attempt to resolve these kinds of issues in more decisive ways.

$$\text{DELAY} \approx [\text{RecordSAMPLE(continuous)} \Rightarrow \text{PlaySAMPLE(continuous)}]. \tag{8.1}$$

Practical applications of typology elements as tools for composition have emerged during the research process. For example in *Chasing the voices of windmills*: the gradual building up of the texture in 'part 1' is informed in part by pc set analysis of the beginning of Berio's *Altra voce* but also by analysing his changing uses of the relations between the acoustic instruments and electronics; the transformation paths in the transformation space of *Altra voce* are integral to the pitch-structure development evident in the beginning of that work. These analytical insights along with the resulting typology elements gave a concrete footing for my development of the first part of *Chasing the voices of windmills*. Another example of application of the typology has been the TPC segmentation of Saariaho's *NoaNoa* along with the related transformation network, which gave a template for the relations between acoustic instruments and electronics. With this template I built *Paese favola* in its final form with a palimpsest concept, realised as a structured improvisation for saxophone with computer.

In many of the considerations involved during the processes of composing the portfolio works (as described in Chapters 2, 3, 5, 6 and 7) I have employed the gradually growing typology as a tool for managing the relations between the acoustic instruments and electronics. In parts of the compositional processes I have used the same analytical approaches that I applied to established repertoire (such as discussed in Chapter 4); and the analytical work was incorporated into the compositional processes. This can be seen as an iterative exchange between creative and analytical work; perhaps as a kind of 'dialogue' between analysis and composition. Such a 'dialogue' fits well with an 'intertextual' interpretation of the portfolio works and provides a highly self-conscious

submission by the composer to the 'Text' of the Western music tradition. This kind of submission to tradition should perhaps be labelled 'high-postmodernism': innovation is found through interaction with, and by reworking of, the established canon. Perhaps a codification of practice, such as the present typology, can provide a stepping-stone for innovation in future creative work.

Given the intimate exchange between analytical listening and composition described above, it may appear that in this context Nattiez's semiotic tripartition is imploding: if the esthesic act of listening also *is* the poietic act of creating, then the distinction between these two semiotic concepts begins to look arbitrary.[13] Of course, with this statement I am intermingling the poietic and esthesic parts of an older piece with the poietic part of a new composition, such as was the case in using analysis of *NoaNoa* to fuel the composition of *Paese favola*. From the stance of an *aleatoric* intertextuality, where chronology of works can be disregarded, this kind of semiotic implosion would seem unproblematic.[14] A Barthian intertextual view that the old and new works are both part of a bigger cultural Text gives a context for suggesting that the compositional act involved in the new piece is equivalent to a listening act applied to the older piece. In other words, the listening action *is* a compositional action: the new work produced would then be a trace of this listening action and the 'compositional process' then becomes 'merely' an exercise necessary to transfer the listening action into a physical manifestation that can be shared with other listeners.

Perhaps we might reconsider the title 'composer' as having the meaning: the listener

[13]Klein notes that a consequence of Lewin's structuralism is that '[a]nalyzing, composing, performing, and perceiving collapse into one another as the faces of musical behavior'. [Klein, 2005, 24] Klein aligns this 'collapse' with the argument by Benjamin A. Boretz for '[l]istening reconstructed as do-it-yourself composing. Composing revitalized as speculative listening, inspired rather than repressed by subsisting in the environment of existing other music.' [Boretz, 1989, 113]

[14]Klein examines an '*aleatoric* intertextuality that roams freely across time' and that is not bound by chronology of musical works. [Klein, 2005, 12]

who provides a trace of her or his listening act. To distinguish the composer from the critic we might have to specify that the trace is in a 'musical' medium, in whatever way that might be defined. But the more interesting aspect of this semiotic implosion is the consequence that anyone who engages in a listening act potentially is also engaging in a compositional act and, as a result, listening is necessarily a creative activity. This would seem to underline the potential importance, to every person, of the activity of creating the trace that allows sharing of listening, in other words the importance that new compositions are created. The point of this conjecture is not to propose a thorough semiotic analysis, nor to fully explore the issues of intertextuality, but a concept of the composer as being primarily an analyst and a listener is interesting in my opinion, and implies a problem deserving attention in future work. This opinion may be symptomatic of a bias in my attitudes as a researcher and creative practitioner and it would seem to reflect my Bourdieu-esque *habitus* as evident in my choice of using analysis so extensively in my compositional practice, as illustrated by this thesis.

For anyone familiar with the repertoire it will not come as a surprise that Saariaho applies reverberation (FREEZE), Harvey uses delay effects (DELAY) or Berio includes sample playback (PlaySAMPLE) in their works.[15] Nor is it a new insight that these composers change the ways in which they apply these and other electronic effects within the duration of a musical work (which is evident in the paths in the transformation spaces of these works): this research has not focused on discovering new techniques for integrating acoustic instruments with electronics. Instead, the contribution of the typology, the portfolio and the research text is the development of a systematic approach to understanding established patterns of practice; through an iterative process, of practice-led research and research-led practice, with the goal of developing a consis-

[15]Instances of TPCs with these components (FREEZE, DELAY and so on), as extracted through analysis of composers' works, are listed in Figure B.1 and in more detail in Appendix section B.2.

tent but context-dependent typology of the relations between acoustic instruments and electronics in mixed works.

I emphasise again that the transformation paths shown in the typology are patterns of the changes that can be interpreted between two or more states in the relations between acoustic instruments and electronics. This means that the focus of the typology has been on comparing patterns of change (transformation paths) rather than the patterns of system characteristics such as those shown in soft systems diagrams. This distinguishes the approach from the work by other writers such as Rowe whose classifications have focused on system characteristics (see discussion in section 1.1), but this distinction does not exclude compatibility of my typology with other approaches such as the taxonomy by Rowe. [Rowe, 1993, 2001]

Future work by myself and/or other scholars and composers can expand the study of these patterns of practice to include more electronic effects and computer music practices. Future work may also include testing the typology as a tool through use in teaching analysis and composition. In any case, the typology, portfolio and approach to process found in this research can contribute to an understanding of the growing repertoire and creative activity that combines acoustic instruments with electronics.

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