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Composing with Time

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Accompanying Digital Files

Ensemble Spacing.maxpat

Max/MSP patch used to determine and demonstrate ensemble spatialisation in *Antikythera*.

N.B. Requires Max 8 or later, with IRCAM's SPAT5 package installed.

Ensemble Spacing Max Output.mp4

Video of the output from 'Ensemble Spacing.maxpat'.

Gruss Project

Ableton Live session used to produce the final mix for *Gruss*. During playback, audio should be routed through Max/MSP to 'Gruss Player.maxpat'. Alternatively, audio may be outputted directly from Ableton Live without any spatialisation.

N.B. Requires Ableton Live 10 or later.

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Max/MSP patch used for spatialised playback of *Gruss*.

N.B. Requires Max 8 or later, with IRCAM's SPAT5 package installed.

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All recordings used with kind permission of the performers, in accordance with the research ethics policies of the Guildhall School of Music and Drama.

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Declaration

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Abstract

This research investigates the manipulation of time as a primary organising factor in musical composition. Through a series of compositions which exhibit and combine together various different ways in which musical time can be perceived, I aim to confront, interrogate, and in some cases subvert my own past tendencies in search of a music whose engagement with time is lively and multidimensional. The first chapter of this thesis considers the ways in which past composers and theorists have investigated and understood musical time, focussing in particular on ideas put forward by Gérard Grisey and Jonathan Kramer. The following four chapters detail the ways in which developments upon these ideas were generated by and implemented in my compositional output. Finally, the sixth chapter discusses the principal research outcomes which were arrived at over the course of this project.

Research Questions

1. How can new ways of manipulating musical time be found and integrated into a musical composition?

2. How can different concepts of musical time be combined in a musical composition?

3. What are the larger implications of temporal manipulation on my practice?

1. Literature Review and Theoretical Exposition

In this research, many of the concepts explored in the music composed were formed through a detailed consideration of the literature on this topic and consequently discussion of my own theoretical constructs is inseparable from the literature review. The following chapter therefore reflects this dual function.

1.1 Context and Rationale: A Brief Personal History

When as a young student composer my music moved away from a harmonic syntax derived from a late adaptation of Western tonal practices,[1] towards fresh chordal and structural possibilities outside of that framework, I immediately found that my music's sense of dynamic forward motion through time, the keystone of my previous practice (albeit one which remains a crucial ideal in my composing), was significantly curtailed. It appeared nearly impossible in practice to maintain large-scale momentum and goal direction in a sound world seemingly lacking any inherent goals or directional harmony. In seeking over the following years to reclaim this lost temporal dynamism, possibilities for the flow of musical time, other than the relentless forward drive I had hitherto sought, opened up. The present research represents a more conscious and purposeful effort to understand and enrich this most essential element of my work.

This project has some parallels with recent research undertaken by Cécile Marti, whose findings show how the consideration of different types of time can expand a composer's field of possibilities, leading to a variety of fresh musical consequences.[2] My own project differs substantially from that of Marti in its attempts to synthetise different concepts of time rather than to explore the compositional possibilities of different temporalities individually. Nevertheless, I consider Marti's findings as expressed in her commentary and her music to be some of the most perceptive in the field of musical time.[3]

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[1] Prior to 2011, I composed using large scale harmonic structures which were constructed in a manner akin to Nielsen's use of 'progressive tonality' as described by Robert Simpson, with a surface harmonic language not unlike Simpson's own works. See Robert Simpson, *Carl Nielsen: Symphonist* (Kahn & Averill, 1979).

[2] Cécile Marti, *Seven towers: an orchestral cycle focused on different musical temporalities*, (Unpublished Post-Doctoral thesis, Guildhall School of Music and Drama, 2017), 79.

[3] This thesis interrogates other source material, some of it common to Marti, some not.

1.2 Literary Context and History

Gérard Grisey's paper 'Tempus ex Machina'[4] and Jonathan Kramer's book *The Time of Music*,[5] two of the most significant contributions to the field of musical time, were written almost concurrently during the 1980s.[6] To a considerable extent, both authors' texts rest upon the (somewhat generalised) premise that, in contrast to the linear unfolding which typically characterises tonal composition, non-tonal scores very often feature a high degree of non-directionality, lacking the sense of large scale motion which the tonal system was predisposed to generate. As examples of this non-directionality, Kramer refers specifically to Schoenberg's early atonal compositions such as Op. 19, No. 1,[7] whilst Grisey refers to post-war European serial music.[8] Whilst Kramer constructs a theoretical framework to explain this, and with it categorise and explain other types of musical time,[9] for Grisey the purpose of 'spectral music'[10] – not so named in his article but later (somewhat grudgingly) accepted by him as the technical term for what the article proposes compositionally[11] - was ultimately to create a sense of "extended time and continuity"[12] which was in contrast to the "spatial and static vision of time" espoused by many of his contemporaries and immediate forebears.[13] Such matters are akin to my own compositional preoccupations, and so have acted as a

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[4] Gérard Grisey, 'Tempus ex Machina: Réflexions d'un compositeur sur le temps musical' in *Écrits ou l'invention de la musique spectrale*, ed. Guy Lelong (Éditions MF, 2008), 57-88. This is not to be confused with Grisey's musical composition for six percussionists also entitled *Tempus ex Machina*.
[5] Jonathan D. Kramer, *The Time of Music* (Schirmer Books, 1988).
[6] Grisey's paper was first presented in Darmstadt in 1980 before its revision in 1985 for publication in English in 1987. For an account of Grisey's 1980 paper as presented at Darmstadt, see Anne Lebaron and Denys Bouliane, 'Darmstadt 1980', *Perspectives of New Music*, Vol. 19, No. 1/2 (Autumn, 1980 – Summer, 1981), 420-442, 426-430. However, many of the ideas explored in 'Tempus ex Machina' were first discussed in two earlier essays by Grisey written in 1978 and 1979, and indeed some passages from 'Tempus ex Machina' quote directly from these earlier essays. See Grisey, 'Devenir du son' in *Écrits*, 27-33; and Grisey, '[Réflexions sur le temps]' in *Écrits*, 39-44. Meanwhile, many of Kramer's ideas which would later be substantiated in *The Time of Music* were first presented in a journal article entitled 'New Temporalities in Music' in 1981, see Jonathan D. Kramer, 'New Temporalities in Music', *Critical Inquiry*, Vol. 7, No. 3 (Spring, 1981), 539-556. *The Time of Music* was finally published in 1988, one year after 'Tempus ex Machina'.
[7] Kramer, *The Time of Music*, 170-183.
[8] Grisey, 'Tempus ex Machina' in *Écrits*, 61.
[9] See Section 1.4.
[10] The term 'musique spectrale' was coined by Hugues Dufourt in Hugues Dufourt, 'Musique spectrale', Paris, Société Nationale de Radiodiffusion, Radio France/Socété Internationale de Musique Contemporain (SIMC), 1979 III, 30-32.
[11] "It's just a label which dates from a certain period." Original text: "Ce n'est qu'une etiquette qui date d'une certaine période." (My translation). Grisey, '[Répondre à la nature du son]: Entretien avec David Bündler' in *Écrits*, 265-273, 267.
[12] Original text: "le temps dilaté et la continuité" (my translation), ibid.
[13] Original text: "vision spatiale et statique du temps" (my translation). Grisey, 'Tempus ex Machina' in *Écrits*, 61.

creatively productive framework in developing and attuning my own treatment of time in my compositions.

Any discussion of musical time must distinguish clearly between the various levels on which time operates in music, from the most immediate short term to the largest time proportions. Grisey envisages time as a living body, and in 'Tempus ex Machina' his arguments progress from the surface features of rhythm and pulse ("the skeleton of time"), through the structural level ("the flesh of time") and finally arriving at the way time is organised within the mind of the listener ("the skin of time"). Like Kramer's *The Time of Music*, my research focusses upon what Grisey terms the "flesh of time", i.e. the way time functions on a structural level. However, matters of rhythm and pulse cannot be divorced entirely from structural implications and are therefore touched upon within this commentary, and they form a significant part of the music composed.

1.3 Structuring Time

Grisey's exploration of 'the flesh of time' in 'Tempus ex Machina' is somewhat equivocal. Though his writing is both speculative and insightful it only points towards various possible definitions of "the flesh of time" rather than providing a clear explanation. The same lexical ambiguity afflicts many of Kramer's concepts.[14] In Grisey's case, two short essays from 1978 and 1979 set out many of the ideas which would later become "the flesh of time".[15] Ideas pertaining to "the skeleton of time" and "the skin of time" are not explored here, suggesting "the flesh of time" as the ultimate *raison d'être* from which these theories emerged. In his 1979 essay, '[Réflexions sur le temps]', Grisey briefly sets out his notions of directionality and non-directionality, and states forcefully that his own music is "resolutely and consciously" directional.[16] Such context illuminates a key passage from earlier in his 1978 essay, 'Devenir du son', which was later incorporated almost verbatim into 'Tempus ex Machina':

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[14] Kramer states that the lack of clear and unambiguous definitions for many of his concepts is, at least in part, deliberate so as to avoid comparisons between temporal categories. However, this is contradicted by the fact that comparing temporal categories is precisely what *The Time of Music* does. See Kramer, *The Time of Music*, 8.

[15] Indeed, both articles employ the (somewhat revealing) subheading 'Tempus ex Machina'. C.f. Grisey, 'Devenir du son' in *Écrits*, 31 and Grisey, '[Réflexions sur le temps]' in *Écrits*, 41.

[16] Original text: "résolument et consciemment" (my translation). Grisey, '[Réflexions sur le temps]' in *Écrits*.

"From now on it is impossible to think of sounds as defined objects which are mutually interchangeable. They strike me rather as force fields given direction in time. These forces – I purposely use this word and not the word form *– are infinitely mobile and fluctuating; they are alive like cells, with a birth, life and death, and above all tend towards a continual transformation of their own energy. There exists no sound which is static, immobile, any more than the rock strata of mountains are immobile."*[17]

This vivid description touches precisely upon an essential element of my own composition practice, whereby any musical object I conceive must interact with other musical objects within the overall discourse of the piece in a manner which lends it a sense of vitality and energy, actively sustaining the flow of time and propelling the music forwards. For Grisey, this is born of a fundamentally dynamic conception of time, a view to which I would previously have subscribed. However, I no longer feel that stasis is merely the absence of dynamism. On the contrary, in an overall static context a sense of vitality and energy which runs through musical objects is paradoxically necessary in order to hold time in suspension. Truly static music does not simply allow time to pass by, rather it actively creates and sustains a suspension of disbelief in which the passage of time appears to be annihilated as a result of the manner in which musical objects interact with each other throughout a piece. In order for a static piece to be compelling therefore, it does not suffice to assemble a collection of similar musical objects which together result in an absence of overall dynamic change, and therefore the ordering of events in such music is not arbitrary as Grisey suggests. Rather, those musical events must respond to their context within the piece and must actively contribute to the focussed prolongation of stasis.[18]

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[17] Original text: "Il est désormais impossible de considerer les sons comme des objets définis et permutables entre eux. Ils m'apparaissent plutôt comme des champs de forces orientées dans le temps. Ces forces – c'est à dessein que j'emploie ce mot et non le mot forme – sont infiniment mobiles et fluctuantes; elles vivent comme des cellules avec une naissance, une vie et une mort, et surtout tendent à une transformation continuelle de leur énergie. Le son immobile, le son figé n'existe pas, pas plus que ne sont immobiles les strates rocheuses des montagnes." Grisey, 'Tempus ex Machina' in *Écrits*, 79. Translated by S. Welbourn in the English translation of 'Tempus ex Machina', see Gérard Grisey, 'Tempus ex Machina: A composer's reflections on musical time', *Contemporary Music Review*, Vol. 2, Issue 1 (1987), 239-275, 268.

[18] Even in modular scores, the ordering of events is not truly arbitrary as this decision is deferred to the performer of the work concerned.

1.4 Temporalising Structure

Kramer's *The Time of Music* is primarily concerned with temporality as a quality of musical structure. This differs fundamentally from Grisey's approach, as while Kramer considers time as a function of form, Grisey considers form to be a function of time.[19] Kramer breaks down structural musical time into five basic subcategories ("temporalities") with different musical and structural effects, primarily confronting issues of linearity and nonlinearity.[20] Some of these temporalities are not clearly defined in *The Time of Music* and so for the sake of clarity are briefly summarised by me here. The musical examples cited are mine, not Kramer's, since the musical examples cited in *The Time of Music* at times appeared less than obvious. The five temporalities form a continuum of linearity, progressing from Goal-Directed Linear Time as most linear to Vertical Time as the most nonlinear.

Goal-Directed Linear Time

A linear progression through time towards a predictable arrival point which exerts a gravitational pull upon the syntax of the music.[21] This is the temporality which best describes Grisey's entire approach.

E.g. Scelsi, *String Quartet No.4*

Nondirected Linear Time

A linear progression through time whose arrival point is not predictable*,* or which features no clear point of arrival.[22] Though Kramer's definition is clear, the terminology is somewhat misleading as such music can indeed be 'directed', despite not featuring an arrival point.

E.g. Ligeti, *Lontano*

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[19] Grisey explains that spectral music integrates "time as the very object of form." Original text: "temps comme objet même de la forme." My translation. Grisey, 'Vous avez dit spectral?' in *Écrits*, 121-124, 123. Hugues Dufourt further explains that "Grisey prioritised the process of development, not the forms". Original text: "Grisey valorisait le devenir, non les forms." (My translation). Hugues Dufourt, 'Le sens de l'œuvre de Gérard Grisey' in *La musique spectrale: Une révolution épistémologique* (Éditions Delatour France, 2014), 375-383, 378.

[20] Cécile Marti's research project was to a great extent informed by Kramer's temporal categories, with the music composed in that project using temporal categories adapted by Marti from those of Kramer. See Marti, *Seven towers*, 14-24.

[21] Kramer, *The Time of Music*, 25.

[22] Ibid., 39-40.

Multiply-Directed Linear Time

Multiple linear time streams moving in different directions simultaneously.[23] Kramer refers specifically to the disruption of a linear time stream by a second linear time stream, causing the former time stream's progress to be postponed and resumed at an unexpected point later in the music's structure. Kramer suggests that in order for time to be multiply-directed, the streams must all themselves be goal-directed. However, one could well envisage a piece comprised of multiple strata of several differing temporalities, where indeed the sense of temporal multiplicity could be rendered all the more acute. Furthermore, no mention is made by Kramer of 'layered' music, in which multiple strata are present simultaneously, which does feature in my music.

E.g. Birtwistle, *The Mask of Orpheus*

Moment Time

Describing time in Stockhausen's 'moment form', a collection of discrete 'moments' which exist as objects unto themselves with no sense of overall linear progression.[24]

E.g. Stockhausen, *Kontakte*

Vertical Time

Also referred to as 'static' or 'timeless', a complete absence of any musical progression through time in favour of an 'eternal present'.[25]

E.g. La Monte Young, *Composition 1960 #7*

A notable omission from this list is Circular Time. Though Kramer mentions it briefly, it is never discussed in depth despite its considerable influence upon 20th century music. It shall be discussed in Section 1.5 below as it is a central feature of the music I have composed as part of this research project.

In 'Tempus ex Machina', Grisey establishes a similar quinquepartite 'scale of complexity' on which to map degrees of rhythmic complexity as part of a continuum, in a manner analogous to the degree of harmonicity of a sound.[26] Thus, equivalences may be drawn between perceived degrees of complexity in different musical parameters, as seen in Fig. 1.

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[23] Ibid., 46. Of Kramer's five temporalities, multiple time is by far the most problematic, and shall therefore later be discussed in detail.

[24] Ibid., 201

[25] Ibid., 376.

[26] Grisey, 'Tempus ex Machina' in *Écrits*, 63.

a. Periodic   maximum predictability   ORDER

b. Dynamic – Continuous   average predictability
  - continuous acceleration
  - continuous deceleration

c. Dynamic – Discontinuous   slight predictability
  - acceleration or deceleration
    by step or by elision
  - statistical acceleration or
    deceleration

d. Static   zero predictability
  - completely unpredictable
    distribution of durations
    (maximum discontinuity)

e. Smooth
  - rhythmic silence   DISORDER

Fig. 1. Grisey's scale of complexity.[27]

The constituent steps on this scale are, by the author's own admission, somewhat arbitrary, as one could conceptualise different steps which link the two extremes equally well. For Grisey though, the significance of this was the idea of thinking in continua rather than in dualisms,[28] with the same concept allowing for similar continuous scales in different parameters.[29] Kramer's five temporalities are also considered as waypoints on a continuous scale, progressing from extreme linearity to extreme nonlinearity, rather than as discrete categories. Therefore an indirect comparison may be drawn between Kramer's continuum of linearity and Grisey's scale of complexity (see Fig. 2).

Kramer (Structure)	Grisey (Rhythm)	Predictability
Goal-Directed Linear Time	Periodic	Maximum
Nondirected Linear Time	Dynamic - Continuous	Average
Multiply-Directed Linear Time	Dynamic - Discontinuous	Slight
Moment Time	Static	Zero
Vertical Time	Smooth	Maximum

Fig. 2. Comparison of Kramer's and Grisey's scales

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[27] Ibid. (My translation).

[28] Ibid., 62.

[29] P.A. Castanet and Jonathan Fineberg, 'Gérard Grisey and the foliation of time', *Contemporary Music Review*, 19:3 (2000), 29-40, 34-35.

1.5 Circular Time

Circular Time retraces the same musical journey repeatedly, and therefore incorporates both linear and static elements. Whilst the moment-to-moment elements of the music progress in a linear fashion, as the music constantly returns to its starting point the overall impression of Circular Time is static. Though not discussed extensively in *The Time of Music*,[30] many widely used forms in Western music such as rondeau, ritornello, rondo, strophic, and variation forms are by definition fundamentally based upon circularity, with such forms often incorporating a degree of dialogue between Circular Time and Linear Time.

During the twentieth century, composers have frequently sought further means of exploring the possibilities afforded by such temporal dialogues. James Hepokoski has suggested that many of Sibelius's later works (from 1912 onwards) make extensive use of what Hepokoski terms 'rotational form', whereby a pattern of thematic or rhetorical materials is cycled through repeatedly, substantially changed upon each iteration.[31] Hepokoski points out that such processes, though cyclical, nonetheless progress towards an ultimate goal (Hepokoski uses the term '*telos*'), by way of planting a motivic seed in an early rotation which is developed through subsequent rotations until it is "fully unfurled – as the *telos* – in the final one".[32] Under this cumulative strategy, Circular Time and Goal-Directed Linear Time are absolutely integrated such that as the music progresses, one feels time tightening like a corkscrew. This very specific treatment of time poetically contributes to the music's ruggedly elemental qualities which are so apparent in Sibelius's idiosyncratic uses of texture and orchestration, in a manner reminiscent of the natural phenomena which were, for Sibelius, a source of lifelong fascination.

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[30] Circular Time is briefly mentioned by Kramer in connection with Balinese Gamelan and considered to be a form of nonlinear time, with both Kramer and Grisey both suggesting that circular and other nonlinear temporalities are typical of non-western musics (c.f. Kramer, *The Time of Music*, 24; and Grisey, '[Réflexions sur le temps]' in *Écrits*, 41). More recently however, ethnomusicologists have critiqued this notion as a reductive invention by western interpreters which is not necessarily representative of how musicians of such cultures conceive of their music. Andrew Clay McGraw, for example, is specifically critical of Kramer's typecasting of Balinese Gamelan, see Andrew Clay McGraw, 'Different Temporalities: The Time of Balinese Gamelan', *Yearbook for Traditional Music*, Vol. 40 (2008), 136-162, 140. For a more general discussion of this tendency with respect to a variety of global music traditions, see Martin Clayton, 'The time of music and the time of history' in Philip V. Bohlman (ed.), *The Cambridge History of World Music*, (Cambridge University Press, 2013), 767-785.
[31] James Hepokoski, *Sibelius: Symphony No. 5* (Cambridge University Press, 1993), 23-26 and 58-84; and James Hepokoski, 'Rotations, sketches, and the Sixth Symphony' in Timothy L. Jackson and Veijo Murtomäki (eds.), *Sibelius Studies* (Cambridge University Press, 2001), 322-351.
[32] Hepokoski, *Sibelius: Symphony No. 5*, 26.

Grisey takes a similar approach to Sibelius in *Les Espaces Acoustiques*,[33] whereby a dynamic process is articulated through a circular structure.[34] In addition, the musical forces involved expand with each new piece in *Les Espaces Acoustiques* from solo viola in *Prologue* to large orchestra in *Transitoires*, resulting in a very direct sense of cumulative linear growth which pervades the work as a whole. Each of the constituent pieces comprises repeating patterned cycles which are akin to a tripartite scheme of respiration, with each iteration comprising inhalation, exhalation, and rest. Inhalation is manifest through an increase in tension in all parameters according to Grisey's scale of temporal complexity (see Fig.1). Exhalation is represented by the release of this tension towards a period of rest and stability, which is marked by repetition and consonance.[35] Throughout *Les Espaces Acoustiques* therefore, the degree of tension oscillates like a sine wave, with the temporal distribution of musical tension analogous to the areas of high and low air pressure in a physical sound wave. The shape of time itself is thus linked to the music's own melodic,[36] rhythmic, and harmonic materials, and to the work's overall aesthetic preoccupation for deriving musical structures from acoustic phenomena.

Many further interactions of Circular Time with other temporalities are possible. In Birtwistle's *The Triumph of Time*, linear and circular time streams are layered atop each other rather than integrated, creating a dramatic structure which is the result of a lively counterpoint of different temporalities.[37] By contrast, Feldman's *For Philip Guston* combines Circular Time with Static Time. Here, the irregular patterning of recurring materials over vast durations (performances typically last over four hours, meaning that materials can recur well over an hour after they are first heard) behaves like a slow-motion kaleidoscope, becoming a

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[33] *Les Espaces Acoustiques* is a cycle of six pieces comprising *Prologue* (1976), *Périodes* (1974), *Partiels* (1975), *Modulations* (1977), *Transitoires* (1981), and *Épilogue* (1985).

[34] Though Grisey frequently emphasises his music's dynamic and directional characteristics, no direct mention is made of Circular Time in his writings.

[35] François-Xavier Féron, 'Sur les traces de la musique spectrale: Analyse génétique des modèles compositionnels dans "Périodes" (1974) de Gérard Grisey', *Revue de Musicologie,* T. 96, No. 2 (2010), 411-433, 425. See also: Yves Krier, 'Partiels, de Gérard Grisey, manifestation d'une nouvelle esthétique', *Musurgia*, Vol. 7, No. 3/4 (2000), 145-172.

[36] The melodic contour of the five note neume which opens *Les Espaces Acoustiques* is in the shape of a sine wave. Martin Suckling demonstrates that the same shape is replicated in various forms at different levels in the structure like a fractal across the first five sections of *Prologue*. He stops here, but could have gone further as this shape forms the overall structure of the piece, and indeed the cycle of pieces of which it is part. See Martin Suckling, 'Radulescu: The other spectralist', *Tempo*, Vol. 72, Issue 285 (July 2018), 20-40, 38-40. See also: Jeffrey J. Hennessy, 'Beneath the Skin of Time: Alternative Temporalities in Grisey's "Prologue for Solo Viola"', *Perspectives of New Music*, Vol. 47, No. 2 (Summer 2009), 36-58.

[37] See Martin Kier Glover, 'The Drama of Harrison Birtwistle's 'The Triumph of Time'', *Tempo*, Volume 66, Issue 262 (October 2012), 2-11.

disorienting foil for the listener's memory which contributes to the music's hypnotic sense of timelessness.

1.6 Disruptive Time and Layered Time

Kramer describes Multiple Time as arising when disruptive elements cause the music to resolve in unexpected places.[38] However, one may also imagine Multiple Time as two or more musical superimposed musical layers which move in different directions simultaneously, a notion which is not explored by Kramer. In bars 453-465 of Elliott Carter's *Double Concerto*, for example, an accelerando on the piano is layered against a ritardando played by the harpsichord.[39] This has proved a highly effective stimulus for my own work, which is often concerned with superimposed strata moving at different speeds or in different directions, as it has for many other composers.[40] These two related but distinct phenomena shall be termed 'Disruptive Time' and 'Layered Time' respectively. Whilst multiple time streams exist in both temporalities, Disruptive Time differs from Layered Time as the multiple time streams are not continually present as they are in Layered Time.
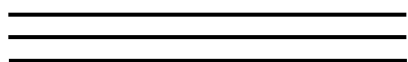
Layered Time: Disruptive Time:
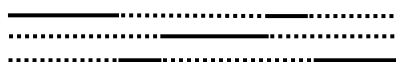
Fig. 3. Combinations of time streams in Layered Time and Disruptive Time.

In Variations 7 and 9 of Carter's *Variations for Orchestra* for example, three time streams are present, played by each of the main sections of the orchestra.[41] These are a long, unfolding melodic line played by woodwind, heavy chordal material for the brass, and recitativo lines played across multiple octaves by the strings. In Variation 7, Carter uses Disruptive Time as the three material types alternate with each other, never sounding simultaneously. In Variation 9, Layered Time is used, as Carter uses the same three material types as in Variation 7, but the materials are sounded simultaneously. In both variations, the listener is aware that three time streams are present, but the manner of combination is

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[38] See Section 1.4. See also: Kramer, *The Time of Music*, 46.
[39] Elliott Carter, *Double Concerto* (Associated Music Publishers, Inc., 1961), 101-112.
[40] See, for example, George Benjamin's *Sudden Time* (Faber Music, 1993) which consists entirely of superimposed layers of linear musical development.
[41] Elliott Carter, *Variations for Orchestra* (Associated Music Publishers, Inc., 1993), 72-76 and 85-96.

completely opposed, being horizontally achieved in the former case, vertically achieved in the latter.

This leads to a number of fundamental musical differences between Layered and Disruptive times. Whilst Layered Time tends towards unbroken passages of continuous development in order to allow the music's multiple strata to unfold, Disruptive Time by its nature results in fractured, discontinuous musical forms which lend themselves to more overtly dramatic expression.[42]

1.7 Hierarchical Levels of Time

The temporality of any given piece is not necessarily uniform. Most pieces inhabit a complex network of temporalities, active at various points within the piece. Furthermore, the temporality exhibited at a momentary local level might not necessarily match that of its surrounding musical context, or indeed the temporality of the piece as a whole. Multiple temporalities may be active at various hierarchical levels within a piece, which may be summarised in a manner loosely analogous to Heinrich Schenker's concept of harmonic functions operating at different hierarchical levels:[43]

Temporal Foreground
The Temporal Foreground is represented by the temporality most immediately perceived at any given moment in the music, irrespective of its surrounding context.

Temporal Middleground
The Temporal Middleground is represented by the temporality of larger passages of music taken in immediate context. Depending on the length and complexity of the music, there may be, as with Schenkerian analyses, more than one middleground layer.

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[42] These aspects of Multiple Time are explored musically in *Marangona* (Layered Time) and *Thymiaterion* (Disruptive Time). See Sections 2.2.1 and 2.2.2.

[43] This analogy considers temporal structures somewhat in the way Schenker considers harmonic structures. However, it is separate from and therefore not directly analogous to a Schenkerian harmonic reduction per se, i.e. the Temporal Background does not describe the Ursatz – rather the Temporal Background is to time as the Ursatz is to harmony. For Schenker's theories, see Heinrich Schenker, *Free Composition (Der freie Satz)*, trans. Ernst Oster (Longman Inc., 1979). Although Kramer makes use of similar terminology upon which this concept expands, the precise definitions of foreground, middleground, and background as used by Kramer are somewhat equivocal, and it is unclear as to whether he is referring to a (quasi-)Schenkerian understanding of those terms. See Kramer, *The Time of Music*, 61-62 and 221-285.

Temporal Background

The Temporal Background is a wholistic view of the entire work, and as with the overall structure of a piece, is only perceivable in retrospect. It is the guiding principle which governs the whole.

As the music psychologist Eric Clarke points out in a paper published in 1987 in the same journal issue as the English translation of Grisey's 'Tempus ex Machina', the consideration of musical time as consisting of multiple hierarchic structural levels has numerous precedents, with Clarke citing examples dating back as far as 1960 before going on to posit his own hierarchy-based theory. Clarke further explains that although scholars generally differ in their interpretations of which hierarchical levels exist in music and how they might be defined, they are in broad agreement that such hierarchies do exist.[44] However, such studies have only examined rhythm and meter (i.e. Grisey's "the skeleton of time"), and the focus tends to be on short phrases, with its application to larger stretches of music or entire movements being patchy at best.[45] By contrast, my own application of hierarchic concepts to time considers the way time operates on a broader, more structural level (i.e. Grisey's "the flesh of time"). Consequently, it is less well suited to the examination of short phrases but can be used to describe the interactions of different temporalities in larger passages.

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[44] Eric F. Clarke, 'Levels of structure in the organisation of musical time', *Contemporary Music Review*, Vol. 2, Issue 1 (1987), 211-238, 211.

[45] To take three notable examples, see Grosvenor Cooper and Leonard B. Meyer, *The Rhythmic Structure of Music* (The University of Chicago Press, 1960); Fred Lerdhal and Ray Jackendoff, *A Generative Theory of Tonal Music* (The MIT Press, 1983); and Carl Schacter, 'Rhythm and Linear Analysis' in *Unfoldings* (Oxford University Press, 1999), 17-117. These matters are also briefly discussed by Kramer in *The Time of Music*, 98-120.

2. *Marangona* and *Thymiaterion*

Marangona *and* Thymiaterion *are a pair of individually composed companion pieces which may be performed separately or together.[46] Each piece is a study of bells and their timbral evolution through time. In* Marangona*, the first to be composed, a single bell strike has been slowed down and magnified, to explore the internal world of the bell in all its intricacies. The many different types of material in* Marangona *exist in different temporalities, moving at different speeds and crossing over each other.* Thymiaterion*, meanwhile, explores the sonic colours and cultural and emotional associations of bells, juxtaposing different materials suggestive of these qualities in rapid succession. Taking its name from an ancient Greek incense burner, it was the image of variously shaped plumes of scented smoke drifting in different directions at multiple speeds which proved most suggestive of how such sonic colours could be made to move and interact through time.*

Topics explored: Time compression/dilation, 'Circular Time', aspects of 'Multiple Time', Temporal Hierarchisation

2.1.1 Time Compression / Dilation in *Marangona*

Partly prompted by my experience of sound stretching software,[47] *Marangona* takes the form of a journey through a single bell strike, with the imaginary bell sound stretched out to last the entire duration of the piece. This conceptual flexing of time, whereby the structure of a piece can be derived from a sonic temporal process, was also suggested by Grisey and forms the basis of *Le temps et l'écume*:

> *"That which is extremely interesting now, is to arrive at perceiving that a note on an instrument can become a gigantic spectrum spread over several minutes, that a simple melody can become a succession of masses also stretched over several minutes. And*

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[46] When performed together, *Thymiaterion* is performed first, and segues directly into *Marangona* without a break at the start of bar 96 (omitting bars 96-111). To date, the two pieces are yet to be performed together in this manner, and in such an instance the point of intersection between the two pieces would require minor modifications to ensure smooth continuity. A mock-up of the two pieces as performed together is provided on Track 3.

[47] The software used was *Paul's Extreme Sound Stretch*, developed by Paul Nasca and available at <http://hypermammut.sourceforge.net/paulstretch/> [accessed 04 April 2019]. This software uses spectral granular resynthesis to allow an audio file either to be compressed up to a tenth of its original duration, or to be expanded up to one billion times its original duration, with no change in pitch.

that which was only a figure can become the form of a piece in its entirety or a compressed and noisy punctuation."[48]

This concept of sonic magnification, allowing for close examination of the physical properties of sound, was a central concern for 'spectral' composers such as Grisey, but in *Marangona*, the cultural resonances and associations of bells are considered alongside their acoustic properties. These are explored through the referencing of different global traditions of bell ringing (e.g. English change ringing (bar 22), German tower bells (bar 30), Russian Orthodox ringing (bar 35)), and through the evocation of sonic phenomena frequently found within the vicinity of the bells concerned (e.g. birdsong (bar 38), wind (bar 42), waves (bar 56), and café musicians in a Venetian square (bar 56)).[49] The development and unfolding of the musical materials which constitute these thus forms an extended metaphor for the imaginary journey through the bell sound's evolution over time.

Marangona explores time dilation through three main sections, each of which traverses a different period in the bell sound's acoustic envelope:

Section 1, bars 3-21: Transient attack.[50]

Section 2, bars 22-81: Steady state.

Section 3, bars 82-96: Lingering resonance.

Outside of this scheme, a short fragment of Section 3 is heard at the opening of the piece (bars 1-6), implying a time loop whereby the imaginary bell is being struck repeatedly. The piece explores only one such strike, catching the lingering resonance of the previous strike.

As well as dilated time, Grisey cites its opposite, compressed time, and 'normal' time as constituting the "three types of time" present in *Le temps et l'écume*, which the

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[48] Original text: "Ce qui est extrêmement intéressant maintenant, c'est d'arriver à faire percevoir qu'une note d'un instrument peut devenir un spectre gigantesque étalé sur plusieurs minutes; qu'une simple mélodie peut devenir une succession de masses étalées aussi sur plusieurs minutes. Et que ce qui n'était qu'une figure peut devenir la forme de la pièce dans sa globalité ou une punctuation compressée et bruitée." (My translation). Grisey, '[Le compositeur présenté par son éditeur]: Entretien avec Ivanka Stoïnova' in *Écrits*, 243-248, 248.

[49] Such a scheme is in contrast to that of Grisey, who firmly rejected extra-musical elements. See Grisey, 'La musique: Le devenir des sons' in *Écrits*, 45-56, 53.

[50] In acoustics, a 'transient' is split-second moment at the very onset of the sound, with acoustic properties (depending on the nature of the attack of the sound) which are distinct from the sustained sound.

piece navigates between.[51] In Section 1 of *Marangona*, these three temporal experiences are superimposed and heard simultaneously, with stretched time forming the overall structure of the section and compressed time forming the texture, while 'normal' time anticipates the start of Section 2.

On a structural level, Section 1 stretches the imaginary bell's transient by hundreds of times so as to last approximately a minute. Spectral analysis of bells reveals that bell sounds begin with an abundance of white noise, with the upper partials appearing immediately and dying away quickly and the lower partials evolving more slowly, as shown in Fig. 4.

Fig. 4: Spectrogram of a small modern church bell made in 1984 by John Taylor & Co., analysed using SPEAR. (Recording included, Track 6).

To create this effect on the orchestra, the harmony gradually descends over the course of Section 1, from an extremely high pitch chromatic cluster at bar 3 towards the bell-like chords which characterise Section 2 (see Fig. 7). The manner in which this process imitates a bell sound's evolution through time is twofold. Firstly, the gradual descent of the harmony from the extreme top register of the violins towards their middle register two octaves lower mimics the initial presence and subsequent gradual disappearance of the higher partials present in a bell's transient attack. Secondly, the gradual transformation of the chromatic cluster in bar 3, representational of white noise, into bell-like chords,

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[51] Original text: "trois types de temps" (my translation). Grisey, '[Le compositeur présenté par son éditeur]' in *Écrits*, 247.

such that the degree of harmonicity increases over time, mimics the manner in which a bell's transient attack gives way to the steady state of the sound.

This harmonic scheme is articulated by a micropolyphonic texture on the first violins, with each line descending through the pitches of each chord at a different speed. These descending lines mimic 'rounds' (repeatedly ringing of a number or bells in sequence from the highest in pitch to the lowest, forming descending scales), played at many simultaneous speeds by the *divisi* first violins. Players at the front of the first violin section play the fastest layers, with the layers becoming progressively slower further back in the first violin section. The fastest of these layers, played by Violin I Player 1a, represents an extreme compression of time, with each 'round' lasting approximately a second. Meanwhile the slowest layer, played by Violin 1 Desk 7, represents a dilation of time, forming a single 'round' which lasts over a minute, the entire duration of the section.[52] Between these extremes, bell chords are heard in bar 11 on the harp, piano and glockenspiel, chiming at a speed which is analogous to that of bell ringing as ordinarily perceived in anticipation of the start of section 2.

2.1.2 Time Dilation in *Thymiaterion*

Just as *Marangona* is modelled on the temporal envelope of a single time-stretched bell strike, *Thymiaterion* is modelled on three such strikes of a tolling bell, each forming a section. The overall form is therefore cyclical (see Section 1.5), as the music traverses the same essential process in each section, albeit in a different manner upon each iteration. As with the overall shape of *Marangona*, each section begins in the orchestra's uppermost register (representing the bell's transient attack), gradually descends and fills the registral space (representing the steady state of the sound) and ends with the same refrain (representing the bell's lingering resonance). The three sections are:

Section 1, bars 1-13
Section 2, bars 14-50
Section 3, bars 48-111[53]

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[52] This texture whereby an extremely elongated line lasting for an entire section is polyphonically enveloped by other lines moving at faster speeds is ultimately derived from medieval organum, as typified especially by Pérotin.
[53] Sections 2 and 3 overlap with each other for three bars (bars 48-50).

2.1.3 Cycles and Paths

When the two pieces are performed together, the resulting structure consists of four gradually expanding cycles, akin to a continual process of temporal magnification of the time stretched bell which like an imaginary sono-temporal microscope reveals different layers of detail at each stage as it zooms in. This articulation of a linear process through an overall cyclical structure has its roots in Sibelius's use of rotational forms and Grisey's use of respiratory cycles (see Section 1.5).
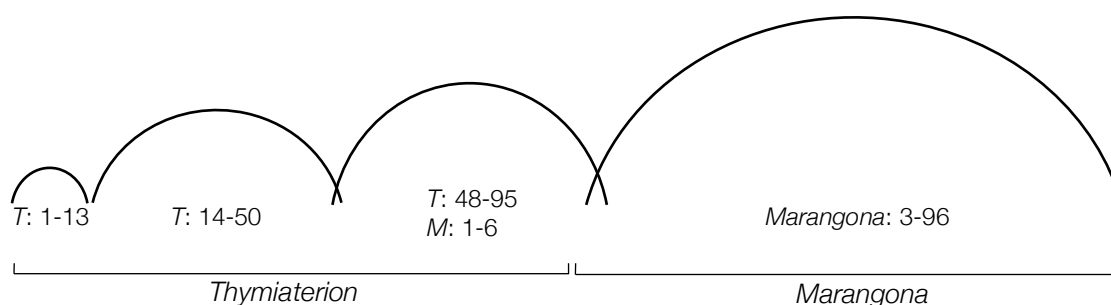

T: 1-13 *T*: 14-50 *T*: 48-95
M: 1-6 *Marangona*: 3-96

Thymiaterion *Marangona*

Fig. 5. Expanding structural cycles when the two pieces are performed together.

However, it was Harrison Birtwistle's strategy of finding different routes between the same two locations in *The Shadow of Night* and *Night's Black Bird*, a pair of orchestral works which share identical openings and endings but which take different paths between them, which proved the most suggestive when considering how *Thymiaterion* might act as a companion piece to *Marangona*.[54] The lyrical 'resonance' material which starts and ends *Marangona* (bars 1-6 and 82-96) is used, almost verbatim, as the refrain in *Thymiaterion* (bars 12-13, 45-50, 97-111), and the two pieces share the same ending (compare *Marangona* bars 82-96 and *Thymiaterion* bars 97-111). Although Birtwistle's strategy is used to link my two pieces, *Thymiaterion* goes further by using this idea within the piece itself, with each of the three sections representing a different path on the same journey through time from high transient attack to low lingering resonance.

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[54] Birtwistle used 'left over' material from *The Shadow of Night* to compose *Night's Black Bird*. Thus his compositional situation was not unlike my own. However, it was from Paul Klee's notion of "taking a line for a walk" that Birtwistle ultimately developed this formal strategy. See NMCRecordings, "NMC – Harrison Birtwistle: Night's Black Bird, The Shadow of Night", 4 May 2011, [online video], available at: <https://www.youtube.com/watch?v=ea2ibugnj0o> [accessed 23 January 2019]. See also: Paul Klee, *Pedagogical Sketchbook*, trans. Sibyl Moholy-Nagy, (Praeger Publishers, 1960), 16-19.

2.2 Multiple Time

Together, *Marangona* and *Thymiaterion* examine two different facets of Kramer's Multiply-Directed Linear Time, representing Layered Time and Disruptive Time respectively. Both pieces consist of different types of material which have tendencies either to speed up or to slow down. Such a scheme represents a manifestation of the placement of Kramer's time categories along a Grisey-esque scale, as discussed earlier (see Section 1.4), and creates a dialectic out of the traversing of this scale. Each piece is therefore an exploration of two opposite tendencies within a single musical structure, becoming increasingly active, flowing, and linear in some areas whilst becoming increasingly static and nonlinear in others. The two pieces achieve this through vastly different means, leading to highly contrasting musical results, as will be discussed.

2.2.1 Layered Time in *Marangona*

As discussed above, in Section 1 of *Marangona* materials moving at different speeds simultaneously are layered on top of each other with no temporal transformation as the section progresses. In Section 2 however, three independent layers gradually evolve out of the same time stream and proceed by changing their speeds in opposite directions, causing the music to simultaneously accelerate and decelerate. At the start of this section in bar 22, seven bell chords are presented in repeating succession, as an orchestral representation of 'change ringing'.[55]
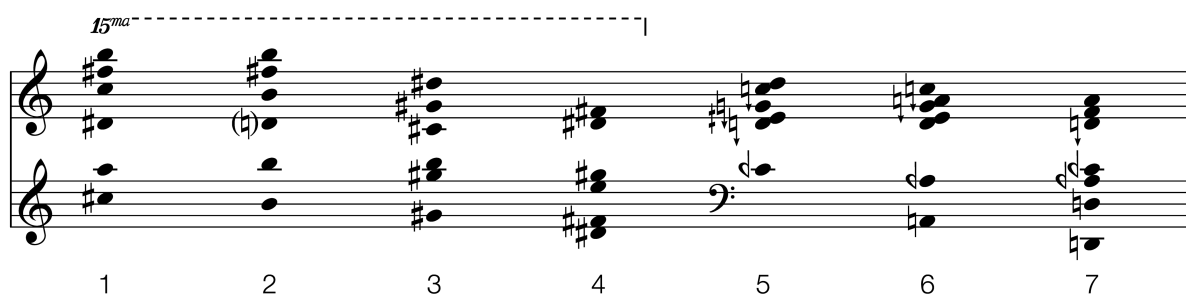

Fig. 6. Bell chords used in Marangona*, as presented in bar 22.*

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[55] In 'change ringing', a group of bells is rung in sequence, with the order in which the bells are struck permutating upon each iteration of the sequence. See Track 7 on the accompanying CD for a recorded example of change ringing.

As the passage progresses, the seven imaginary bells split into three sub-groups whose developmental courses diverge over time, eventually giving rise to three independent layered strata (see Fig. 7):

Group 1, Bells 1-4: This group accelerates over time, eventually becoming a tremolo (bar 40) and transforming into birdsong[56] (bar 37).

Group 2, Bell 5 only: Bell 5 maintains a steady periodic pulse regardless of other tempo changes occurring around it, imitating a steadily tolling bell.

Group 3, Bells 6, 7: The lowest two bells slow down over time, whilst simultaneously disintegrating as the chords begin to be arpeggiated rather than struck cleanly (bar 36 onwards), eventually transforming into large waves (e.g. bars 56-58).

This temporal diverging of layers heightens the music's sense of temporal multiplicity, reflecting the cornucopial nature of the sonic materials referenced within the piece. However, the fact that the materials are universally present and in a constant state of transformation effectively rules out possibilities for flexibility and moment-to-moment dialogue within the harmonic structure, as the materials must each follow a continuous path in order for such transformations to be perceived. Although the strong prevalence of A and D (the bass pitches of Bells 6 and 7 respectively) does indeed allow for the lowest layer of the music to be heard as more static, the result is that the piece as a whole is perceived as harmonically static too, undermining the rapidly changing nature of its upper layers and, by extension, the piece's fantastical aspirations.

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[56] Whilst listening to and making recordings of bells, I found that it was near-impossible to hear church or carillon bells in complete isolation except in a belfry, with birdsong forming a ubiquitous backdrop.

Fig. 7. Temporal divergence of the seven bells from a single line to multiple strata in Section 2 of Marangona. Bar numbers and rehearsal letters correspond with those in the full score.

2.2.2 Disruptive Time in *Thymiaterion*

In exhibiting Disruptive Time, *Thymiaterion* is far closer to Kramer's own definition of Multiply-Directed Linear Time, which Kramer identifies the dislocation and reordering of a sequence of events.[57] In *Thymiaterion*, this is achieved through the relative brevity of individual passages of music and the postponing of their continued development. For example, the passage from bars 28 to 43 features a number of goal-directed processes which on a local level lend the music a strong sense of dynamism, linearity, and directionality. These include a constant accelerando, an overall crescendo produced by a thickening of orchestration, an increase in harmonicity towards an overtone series on A♭, and a gradual transformation of the periodic quaver impulses which characterise the start of this passage into swirling arabesque-like material. The culmination of all these linear processes is cut off at bar 44 and postponed until bar 87. This has the effect of creating multiple time streams which exist simultaneously throughout the piece. The interaction of these time streams and the way the music switches between them is the central premise of this piece, which assumes a quasi-dramatic expression in the music.

Although Kramer states that a precondition for his Multiply-Directed Linear Time is that all the individual streams be goal-directed, *Thymiaterion* explores a combination of streams which inhabit different temporalities, including Goal-Directed Linear Time (as mentioned) and Static Time (see Fig. 8). The processional music which forms the first section of the piece (bars 1-13) exhibits a tendency to become static through an absence of evolving processes. This music is characterised by chant-like melodic material and bell-like inharmonic sonorities. Like the dynamic passage mentioned above, this passage is cut off at bar 13, only to be resumed briefly at bars 25-28 and bar 54, and more substantially in bars 66-76. The prevalence of deep, inharmonic sonorities is further taken up at bar 87 by the lower instruments of the orchestra. As bar 87 also acts as the culmination point of *Thymiaterion's* more active and goal-directed time streams, it serves as the temporal focal point for the piece's principal musical arguments.[58]

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[57] See Section 1.4, see also: Kramer, *The Time of Music*, 46.

[58] This passage (bars 87-96) was modelled on the sound of 'Pachinko' (Japanese slot machine arcades), which feature a combination of extremely loud and chaotic noise with many more 'musical' or otherwise pitched sounds which are themselves layered chaotically atop one another. See Track 8 on the accompanying CD for a recorded example. I found this unusual and dramatic combination of noise (of a particularly colourful variety) with harmonic sounds (i.e. the two extremes of Grisey's scale of harmonicity) highly suggestive, so explored this sonority in the final movement of *Bonsho*, which itself served as a study for the passage concerned in *Thymiaterion*.
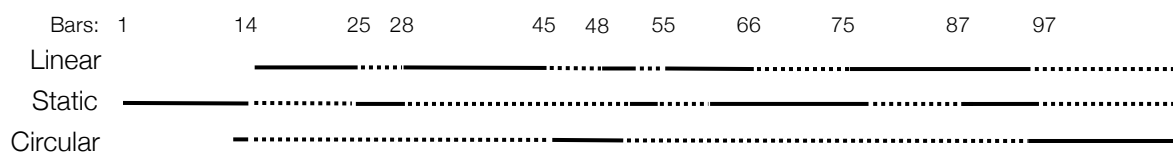
Bars: 1   14   25 28   45 48   55   66   75   87   97

Linear

Static

Circular

Fig. 8. Multiple Time Streams in Thymiaterion.

In *Thymiaterion*, these dual tendencies towards the active and the static are articulated largely through the manipulation of pulse which is supported through the music's harmonic structure. In a manner akin to Nielsen's use of 'progressive tonality',[59] the music which is slow and static falls into the orbit of D as a pitch centre, while music which is active and changeable tends towards A♭.[60] Of the three main sections of the piece, the processional first section of the piece has a tendency to become more static over time. It establishes a low D at figure A, while the second violin melody is formed out of the 3rd, 5th, and 9th harmonics (A, F♯, and E of that pitch). The second section, by contrast, has a tendency to become increasingly active, and the harmony moves towards the near establishment of an overtone series on A♭ by bar 43.

Beyond this scheme, the lyrical refrain passages at the end of each section exist in Circular Time owing to the constantly repeating nature of its materials, a compromise between the two opposing tendencies which constitute the principal musical argument as Circular Time incorporates both linear and static elements (see Section 1.5). Although the material itself is circular, this music also reinforces the notion of larger structural cycles as the overall form of the piece as this material recurs, almost entirely unchanged, at the end of each section.

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[59] In 'progressive tonality', individual (tonal) keys take on specific associations and functions within the musical argument, as though characters in a drama. For a full examination of its implementation in Nielsen's symphonic works, see Robert Simpson, *Carl Nielsen: Symphonist* (Kahn & Averill, 1979). The term 'progressive tonality' is commonly attributed to Simpson, but it was probably first introduced in Dika Newlin, *Bruckner, Mahler, Schoenberg* (King's Crown Press, 1947), 179. A further implementation of this concept is discussed in relation to *Antikythera* (see Section 4.5 below).

[60] Simpson similarly identifies the key of F major as representing a state of 'inertia' in Nielsen's *Symphony No. 5*, while movement into other key areas generates a contrasting sense of movement and development (*Carl Nielsen: Symphonist*, 92-110). This generates a musical argument which is at a fundamental level between different temporalities, articulated by a tonal structure.

2.3 Temporal Hierarchisation

A number of different temporalities have been discussed in connection with *Thymiaterion*, including Linear Time, Static Time, Disruptive Time, and Circular Time. Each of these operates in different ways and at different levels in the music's structure. There is therefore a hierarchy of temporalities present (see Fig. 9): Linear Time, Static Time, and Circular Time form a Temporal Foreground (see Section 1.7), as they are the most immediately perceived temporalities. The constant intersection of these different temporalities results in an overall prevalence of Disruptive Time, which thus forms the Temporal Middleground. Beyond this, and especially when the two pieces are performed together, the global form of the piece(s) gives rise to the Circular Time as an overall Temporal Background (see above, section 2.2).

2.4 Temporal Combination

Although both *Marangona* and *Thymiaterion* combine opposing temporal tendencies towards the linear and the static, the manner of their combination affects the pieces' differing musical possibilities at a fundamental level. In *Marangona*, extensive layering creates complex orchestral textures, but the capacity for the music to change course is limited by the necessity for linear continuity which hopefully ensures listener comprehensibility of the multiple time streams at work. In *Thymiaterion*, vertical complexity is reduced in order to grant a more malleable musical structure which allows the music to change direction more readily, resulting in a less predictable and more dramatic course within the piece.

2.5 Future implications

Following the composition of these two linked pieces I imagine that they could form part of a far larger orchestral suite, consisting of many ever-expanding cycles. Such a project would be beyond the scope of this doctorate, and indeed a project of this scale and complexity would necessarily take cues from the research outcomes of this doctorate.

Foreground | Middleground | Background

Thymiaterion

Bar: 1   14   25 28   45 50 54 55   66   75

S   L   S   L   C L S   L   S   L

Disruptive Time   Circular Time

Marangona

1   22   82

S/C⟶L   L/S   C

Layered Time
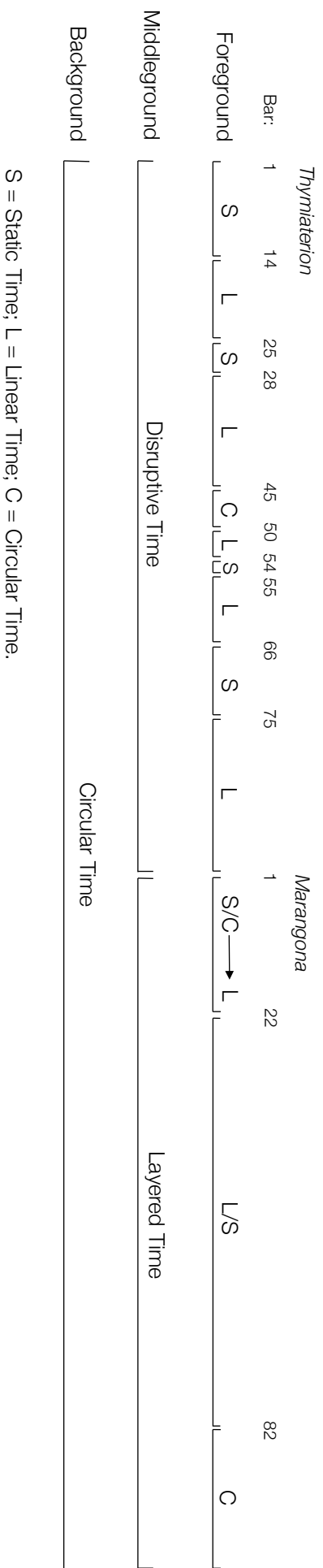
Fig. 9: Temporal Hierarchies in Thymiaterion and Marangona when the two pieces are performed together.

S = Static Time; L = Linear Time; C = Circular Time.

3. *Bonsho*

Inspired by a miniature bonshō (Japanese temple bell) which I bought from a market in Tokyo, Bonsho *is a set of six miniatures for piano with a bell-like refrain between each movement. Reflecting my experience of Tokyo itself as a city of sharp contrasts of character, each movement forms a short study in a given temporality in order to explore these individual temporalities in a focussed manner, as well as to explore the effects arising from their abrupt juxtaposition. Composed after* Marangona *but before* Thymiaterion, Bonsho *also acted as a proving ground for materials and concepts which would later be used in both* Thymiaterion *and* Antikythera*.*

Topics explored: Contrasting temporalities, 'Circular Time'

3.1 Overview

In contrast with the other works presented in this research, each of the movements in *Bonsho* seeks to inhabit one temporality discretely, as part of an exploration of Kramer's temporal species (see section 1.4 above). These are:

1. *Haiku*: Goal-Directed Linear Time
2. *Crossing*: Directed Linear Time / Transforming Time
3. *Wind Chimes*: Circular Time
4. *Escalier*: Multiply-Directed Time
5. *Bonsho*: Directed Linear Time
6. *Pachinko*: Disruptive Time

Operating beyond this scheme, a near-identical refrain is used between each pair of movements and at the end of the piece, with the effect of generating 'Circular Time' as a Temporal Background. [61] As *Bonsho* contains no linear through-development across its structure as a whole, prohibiting any sense of 'journey', the refrain acts as a central static element to which the music constantly returns. Although I found this to be a useful device for

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[61] See bars 11-12, 40-41, 59, 107-108, 124-125, 140-142.

creating a clear overall structure within which diverse elements may be contained, it is the very lack of temporal complexity and ambiguity which ultimately renders its deployment here overly predictable. Whereas a similar refrain structure was used in *Thymiaterion*, in that work the refrain itself is subject to a process of linear growth which interacts with the circular nature of its repetition, thereby creating an impetus for its recurrence (see section 2.1.3 above) which is not present for the near-identical refrain in *Bonsho*.[62]

3.2 Movement-by-movement commentary

1. *Haiku*: Goal-Directed Linear Time

Haiku takes its cue from the shift in perspective and retrospective understanding generated through the structure of many haikus, whereby the meaning of the first parts of the poem falls into place only after reading the final line. Although *Haiku* begins in a rather static manner owing to its extremely slow rate of activity, the very gradual accumulation of new pitches as the movement progresses, followed by the sudden release of tension at bar 10, allows the movement to be viewed retrospectively in 'Goal-Directed Linear Time'.

2. *Crossing*: Directed Linear Time / Transforming Time

In *Crossing*, a traditional Theme and Variations form is taken in miniature, as a vehicle for exploring a series of rapid transitions which generate Transforming Time. A simple descending harmonic sequence with contracting intervals (Fig. 10) is used as the theme to facilitate the clear presentation of a high density of musical information within a compressed time frame.[63]

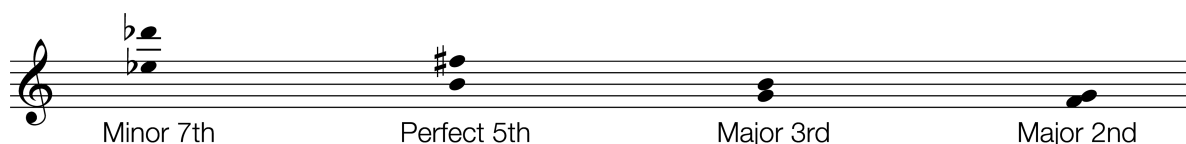Minor 7th   Perfect 5th   Major 3rd   Major 2nd

Fig. 10: Descending harmonic sequence in Crossing

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[62] The interaction of Circular Time with other temporalities was further explored in *Antikythera*. See section 4.1 below.

[63] The use of a descending harmonic sequence as the theme is modelled on Bach's *Goldberg Variations.*

Although this harmonic framework ensures a degree of formal clarity, the manner in which the music adheres to the framework in too obvious and rigid a manner which in turn renders the harmonic background of this movement static, undermining the sense of drama and chaos present in the music's foreground. Although much of my research in this PhD focusses upon productive combinations of temporalities, in the present case Static and Linear Time work against each other to cancel each other out in a way which undermines the effect of both. In terms of experimental research, this discovery was useful for my later work even whilst the musical result here is less than fully satisfactory.

3. *Wind Chimes*: Circular Time

Wind Chimes consists of five interlocking loops in the form of imaginary wind chimes, which rotate around each other at different rates. A sixth rotating element is used in the form of 'pedal wind', a deep noise-like effect produced by vigorously pumping the una corda pedal. The presence of 'pedal wind' also acts as a compositional *deus ex machina*, rendering other materials more active through the use of louder dynamics and longer durations in imitation of the effect that wind has upon wind chimes.

Although a dynamic and ever-changing musical surface was intended through the use of this looping structural scheme, the lack of clear contrast between the five rotating 'wind chime' materials ultimately renders this structure near-imperceptible, with the result in performance appearing closer to Static Time than Circular Time. Nonetheless, the failed execution of this concept would prove a valuable experience as I returned to it in *Antikythera*.[64]

4. *Escalier*: Multiply-Directed Time

In *Escalier*, a single pitch (D2) is used to suggest multiple directions simultaneously by traversing multiple 'scales' in different sonic parameters. These are:

1. Gradual acceleration (scale of tempo);
2. Gradual loss, and subsequent regaining, of rhythmic predictability (scale of periodicity);[65]

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[64] See section 4.4 below
[65] See Grisey's scales of temporal complexity (Fig. 1), as discussed in Section 1.4

3. Gradual increase in spectral richness (scale of timbre), as the upper partials of the note are revealed due to the increasing forcefulness and rapidity with which it is struck. The 14th partial of this pitch, found through experimentation to be especially prominent, is stated explicitly at bars 87-95 to reinforce this process.[66]

In performance, the intended sense of multiplicity is somewhat lost as each of the parameters has a tendency towards accumulation, resulting in an overall sense of Goal-Directed Linear Time rather than Multiply-Directed Time. However, a deeper sense of temporal multiplicity is generated through the contrast between the frantic and goal-directed activity of the music's surface with the static nature of its pitch material. This unexpected by-product is a positive feature of the final result, which is explored more thoroughly in *Gruss* (see Section 5.2).

5. *Bonsho*: Directed Linear Time

This movement exploits the harmonic sequence already used in the second movement, enacting a gradual descent in register from the uppermost octaves of the piano to the lowest. Both of these factors generate a strong degree of predictability in the fifth movement. The result is a clear sense of linear progression, directed towards the concluding refrain. Whereas the refrain had previously been placed between movement, its repositioning as the conclusion of the 5th movement creates a new, quasi-concluding function for it. This generates a false sense of conclusion to the set of pieces as a whole, which is in turn used to facilitate the unexpected and violent contrast with the following movement (the true conclusion to the work).

6. *Pachinko*: Disruptive Time

Inspired by the fantastically loud and chaotic coloured noise generated by Pachinko parlours (Japanese slot machine arcades), *Pachinko* denies any sense of neat resolution, contributing to the sense of vibrancy intended to characterise the set as a whole through the use of a deliberately inappropriate intrusion to the pensive conclusion achieved at the end of the previous movement. The unexpectedly loud and extravagant performance style which

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[66] On all pianos experimented upon, the 14th partial of D2 was found to be extremely flat and sounded as a B natural instead of a slightly flat C.

Pachinko demands is itself disrupted by the perfect cadence which ends the movement.[67] This tonal cadence results in Linear Time in the Temporal Foreground as motion is directed towards the tonic chord, with Disruptive Time in the Temporal Middleground as it serves as a stylistic intrusion within an otherwise non-tonal context.

It is this abrupt manner in which Pachinko appears within *Bonsho*, generating Disruptive Time, that would ultimately serve as a cue for the more systematic exploration of Disruptive Time as a Temporal Middleground in *Thymiaterion*.[68] Furthermore, it was the chaotic surface of this movement and of the sound upon which it is modelled that would give rise to the idea of reproducing this playfully chaotic effect using an orchestra, forming a climax and focal point for *Thymiaterion*.[69]

3.3 Singularities and Multiplicities

My attempt in *Bonsho* to interrogate individual temporalities as discrete entities yielded a number of useful points for reflection as discussed in the preceding commentary, and at least one unexpected positive result arising from the combination of Static and Linear time in the fourth movement. In spite of the temporal contrasts between movements, the singularity of temporal vision within each movement ultimately renders *Bonsho* as a whole one-dimensional. Once any given temporality is established, its continued existence can only become predictable and stale without any further modification or subtle interaction with other temporalities.[70] Although this represents a significant compositional failing, it also precipitated a far more fundamental shift in my research focus, away from the expression of individual temporalities and towards the manner in which temporalities may be meaningfully combined to produce music whose internal structure is as colourful and multiplicitous as its external surface. This realisation, along with the ensuing exploration of temporal pluralism in *Thymiaterion* and *Antikythera*, ultimately represents the most crucial finding in this research.

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[67] The sequence of chords is a quotation from the end of the folk song *Auld Lang Syne*, recordings of which are often played in Tokyo shops and other public venues to signify closing time. Here, *Auld Lang Syne* heralds the closing of the Pachinko parlour, and with it the end of *Bonsho* as a whole.
[68] See Section 2.2.2 'Disruptive Time in *Thymiaterion*' above
[69] Ibid. In both *Bonsho* and *Thymiaterion*, it was the apparent absurdity and inappropriate nature of replicating such a sound and placing it within the concert hall at all that initially prompted its inclusion.
[70] This is in contrast with the other works presented as part of this research, each of which exhibits a complex hierarchical layering of temporalities, allowing for a more sophisticated interaction of temporalities which ultimately leads to more varied and compelling musical results.

4. *Antikythera*

Antikythera *is modelled upon an Ancient Greek geared device designed to track the motions of celestial bodies and predict solar or lunar eclipses.*[71] *More temporally expansive than any other work I have composed, at over forty minutes,* Antikythera *combines several musical materials existing in multiple temporalities in a manner akin to the turning of a complex geared mechanism, its wheels and cogs revolving around each other at various speeds, influencing different hierarchical levels in the music's structure. This layered use of Circular Time in order to generate multiple narrative streams which traverse the structure is dramatised through the use of spatialisation and the physical layout of the performance space.*

Topics explored: Time compression/dilation, 'Circular Time', 'Multiple Time', Temporal Hierarchisation

4.1 Circular Time

Antikythera takes Circular Time as its primary focus of temporal investigation. Whilst Circular Time was considered as a Temporal Background in *Marangona* and *Thymiaterion*, *Antikythera* explores circularity at almost every hierarchical level of its form, from its large-scale structure down to the formation of melodic motifs, and up to the physical layout of the performance space. The circular structures are as follows:

Rotations

As a whole, the piece is cast in five large 'Rotations', labelled A to E, each of which shares a similar form but contains vastly different material.[72] E.g. bars 1-215, 216-278. See Fig. 11.

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[71] For an in-depth study of the Antikythera Mechanism, including its history and internal structure, see: Alex Jones, *A Portable Cosmos* (Oxford University Press, 2017). See also: Tony Freeth and Alex Jones, 'The Cosmos in the Antikythera Mechanism', *ISAW Papers 4* (February, 2012), available at: http://doi.org/2333.1/xgxd26r7 [accessed 1 September 2021].
[72] The term 'Rotation' is borrowed from James Hepokoski's analysis of the large-scale structure of Sibelius' Symphony No. 5. For a further discussion of Hepokoski's theory, see Section 1.5 above. See also: Hepokoski, *Sibelius: Symphony No. 5*, 23-26.
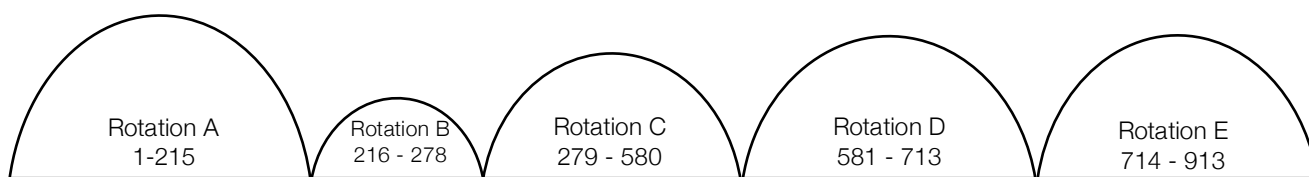
Fig. 11: Rotation Structure in Antikythera with corresponding bar numbers

Cycles

Each of these Rotations is formed of a number of smaller 'Cycles' which act as time pockets for those materials. E.g. bars 1-24, 25-37. See Fig. 12.

Loops

Each Cycle is in turn comprised of a series of loose 'Loops', through which motifs or short fragments are repeated and transformed at a micro-structural level.[73] E.g. bars 2-5, 6-9. See Fig. 13.

Conceptually, 'Rotations', 'Cycles', and 'Loops' are in many ways near-identical, though distinct terminology is employed here to clarify their hierarchical relationship, to distinguish between the ways these structures operate on different hierarchical levels of the music's surface and/or larger-scale form (see Section 4.3 below). These nests of Circular Time combine to create a quasi-fractal structure, akin to a set of Matryoshka dolls, whereby multiple circular time streams operate inside each other. Ultimately such a scheme is loosely analogous to the Antikythera Mechanism itself, whereby the turning of a large gear may set in motion many smaller, faster turning gear trains.

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[73] The melodic content of these loops takes the form of an oscillation, a rising and falling akin to a sine wave (i.e. a linear manifestation of a circle). This melodic shape, as well as the nature of its subsequent development which expands its dimensions in duration and register, bears some similarity to Grisey's *Prologue* for solo viola. See Martin Suckling, 'Radulescu: The other spectralist', *Tempo*, Vol. 72, Issue 285 (July 2018), 20-40, 38-40.
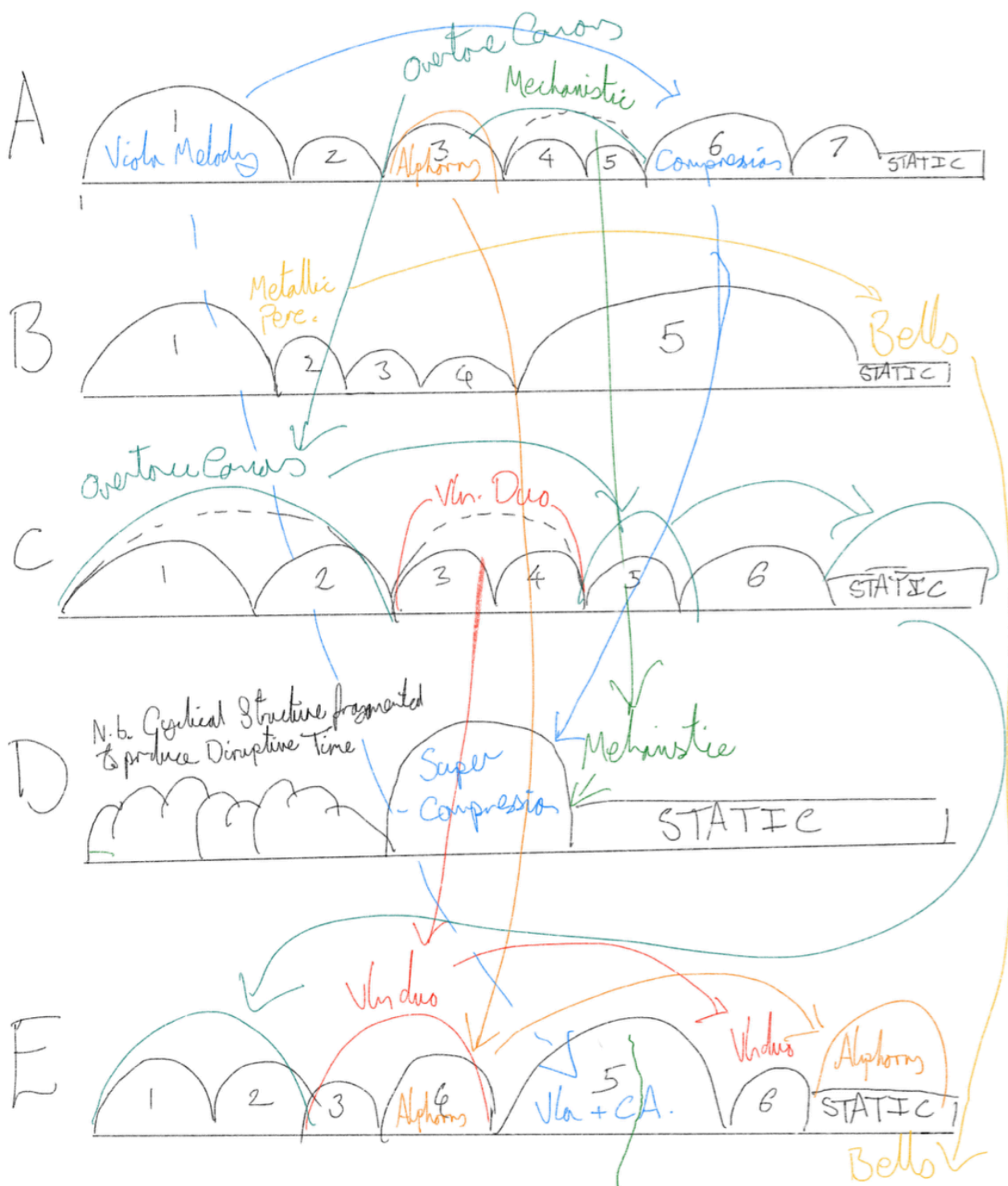
Fig. 12: Composition sketch for the Cycle structure in Antikythera. Each Rotation is labelled in uppercase letters at the left side of the page, whilst individual Cycles within Rotations are numbered. The Rotation / Cycle structure is shown in black, whilst other colours depict materials which cut across this underlying structure (see Section 4.4).

Fig. 13: Loop structure of Rotation A, Cycle 1 in Antikythera, shown here within the viola's melody at the start of the piece. Individual Loops are surrounded by boxes and labelled in lowercase letters.

4.2 Circular Space

The use of Circular Time in *Antikythera* is dramatised through the physical layout of the performance space. There is no conventional performance stage for this piece: the audience are sat in concentric rings of seats which are surrounded by the ensemble (see Fig. 14). Over the course of the piece, the musicians in the ensemble are asked to orbit around the audience, with each musician moving at a different average speed. This spatial circularity has multiple functions in addition to its acoustic qualities:

- Echoing the revolutions of gears in the Antikythera Mechanism and the motions of the celestial bodies they represent, traversing the heavens at multitudinous rates;[74]
- Forming an analogy with the manner in which Circular Time is used as the guiding structural tenet of the work as a whole.

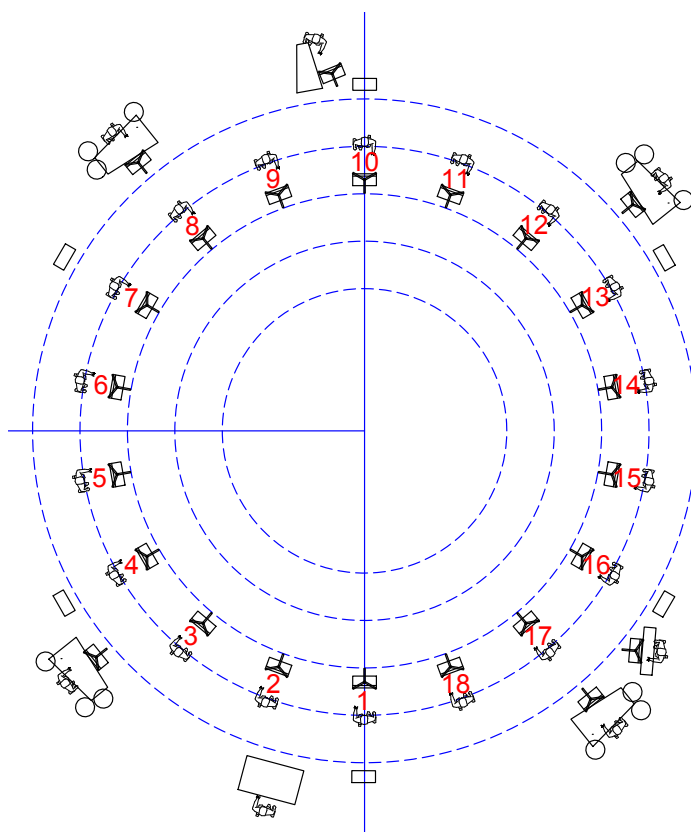*Fig. 14: Floorplan of the performance space for* Antikythera. *The ensemble is spaced around the music stands numbered 1-18, surrounding the audience.*

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[74] No attempt is made to directly copy the motions of individual components within the Antikythera Mechanism itself, rather it was the idea of wheels simultaneously turning at multiple speeds that served as a point of creative departure.

As a result, the overall sound of the ensemble is in constant flux, with different spatial relationships between each of the instruments emerging over the course of the piece. In order to aid planning, in tandem with the large-scale structural planning stage for the music, a Max/MSP patch was devised to chart the motions of each of the instruments in relation to each other.[75] This allowed for the starting position and average speed of each performer to be manipulated, and the resulting layout of the ensemble at any given moment of the piece's duration to be observed. In some cases, I aimed for certain parts of the ensemble to reach certain configurations at certain moments which were of importance to the music's overall structure, such as the equidistant configuration of the brass ten minutes into the piece (bar 198).[76] In other cases, however, it was the instrumental combinations produced by the output of this Max/MSP patch which gave rise to the unfolding of narrative streams within the musical structure. This yielded a number of instrumental combinations which would become landmarks throughout the piece, around which much of the structure would coalesce. As noted at the time of planning, these were:

- The two violins: starting opposite each other, these come together spatially at 18', for a duet; they end the piece standing opposite again, with another duet.
- Viola and Cor Anglais always exactly opposite, almost (but not quite) ending where they started.
- String Quartet comes spatially together at 10'.
- Brass are equidistant at 10', come together at 25'.
- Upper woodwind start equidistant and end equidistant, but also come together at 25' opposite the brass.
- Bassoon and Trombone both very slow, only ever completing half a rotation. Bassoon chases Trombone, but never catches up.
- The two horns start opposite and end together, getting closer throughout the piece.
- The two percussionists start opposite, Percussion 2 catches Percussion 1 and overtakes at 24'. Both play bells at 15' and 38', though they swap positions.

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[75] A video of the output of this patch (Ensemble Spacing Max Output.mp4) is included in the accompanying digital files, along with the original patch (Ensemble Spacing.maxpat). One second in the video corresponds to one minute in a performance of the piece.
[76] This moment forms an homage to Stockhausen's *Gruppen* for three orchestras, during which a chord on the brass is passed from orchestra to orchestra in such a way as to appear to zoom around the concert hall. See Karlheinz Stockhausen, *Nr. 6 Gruppen für drei Orchester* (Universal Edition, 1963), pp. 95-96, Fig. 119. See also: Karlheinz Stockhausen, *Stockhausen on Music* (Marion Boyers, 1989), 135.

The resulting correspondences between similar materials across different parts of the final piece may be observed in Fig. 12 and in Fig. 15. These instrumental relationships and the materials associated with those relationships recur at intervals which are independent of the underlying Cycle/Rotation form. Together, these materials produce multiple narrative strands, which are draped over the existing circular design described in Section 4.1. In this way, they suggest further possible circular structures, lending a greater fluidity to the form as a whole.

4.3 Temporal Hierarchisation

Whilst *Marangona* and *Thymiaterion* primarily explored Layered and Disruptive Time respectively as vehicles for the combination of multiple temporalities, *Antikythera* uses Circular Time as its vector for temporal combination. This technique for the creation of structure was arrived at through the process of composing *Marangona* and *Thymiaterion*. Here, I found that Circular time had sufficient flexibility as to carry multiple temporalities within its bounds. As well as using Circular Time as a container for many other temporalities, in *Antikythera* Circular Time is manipulated itself in various ways. At certain points, it engenders a cumulative, goal-directed linear tendency, while at others a more strictly repetitive tendency towards stasis is generated.[77] This inherent contradiction within Circular Time is among the prime topics of investigation in *Antikythera*.

Each of the Rotations in Antikythera is therefore given the flavour of another temporality which act through Circular Time. These are:

Rotation A: Goal-Directed Linear Time
Circular Time is used to gradually ratchet up the amount of tension, enacting a gradual accelerando and crescendo which pervades the entire Rotation, moving towards a focal point at bar 198.

Rotation B: Nondirected Linear Time
The Cycles are considered as a set of variations, which are blended together to create a series of continuous transformations with no inherent sense of directionality.[78]

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[77] See Section 4.4 below

[78] This scheme of continuously transforming variations bears similarity to the second movement ("Crossing") in *Bonsho* (see section 3.2 above).

Rotation C: Static Time

Repetition is used to create an absence of large-scale progression.

Rotation D: Disruptive Time

The Cyclical structure is all-but destroyed, as Cycles are chopped up and recombined in a seemingly random order, interrupting and crossing over each other to produce Disruptive Time.

Rotation E: Multiply-Directed Linear Time

The final Rotation brings together materials from throughout the piece to move linearly towards a conclusion, contributing to the overall sense of linearity (see Fig. 15). It functions as an end-point for many of the materials used. This generates a strong overall sense of linearity, like a drawing together of tributaries.

The nested structure of Rotations, Cycles, and Loops is analogous to the notions of a Temporal Background, Middleground, and Foreground respectively. However, the vastly expanded duration of *Antikythera* as compared with my previous work also allowed for a deeper exploration of temporal hierarchisation than was previously possible. Here, the considerably greater difference in proportion between moment-to-moment events and the total duration of the piece creates space for a greater number of temporal layers between the Temporal Foreground and the Temporal Background. As a result, whilst *Marangona* and *Thymiaterion* had one Temporal Middleground layer, *Antikythera* has capacity for multiple Temporal Middleground layers.

4.4 Interactions of Time Streams

The greater number of materials which may be housed within a piece of longer duration produces greater scope for the creation of multiple lines of musical development which traverse the piece. The perceptual immediacy of the instrumental relationships outlined in Section 4.2 above places such relationships firmly in the music's foreground, especially when material associated with those relationships is repeated. The unfolding of such lines of development transcends the prevailing Circular formal scheme described above (Section 4.1), producing a complex web of interactions, as they interweave with the Circular formal scheme and with each other. The interactions produced can be seen in Fig. 15. This results in an overall structure which mimics the rotating of variously sized gears moving at different rates in the Antikythera Mechanism.

The multiple lines of development which unfold across the piece constitute 'structures within a structure'; as such they have their own set of temporal hierarchies associated with them. The manner in which these time streams are formed, and their means of interaction with the form as a whole, are investigated in the following two case studies.

Fig. 15: Correlations of materials and instrumental relationships as compared with the Rotation form

Key

Red: Opening material and subsequent time compressions

Blue: Static Moments

Purple: Monophonic Canons

Green: Violin Duos

Orange: Horn duos

Yellow: Percussion Duos

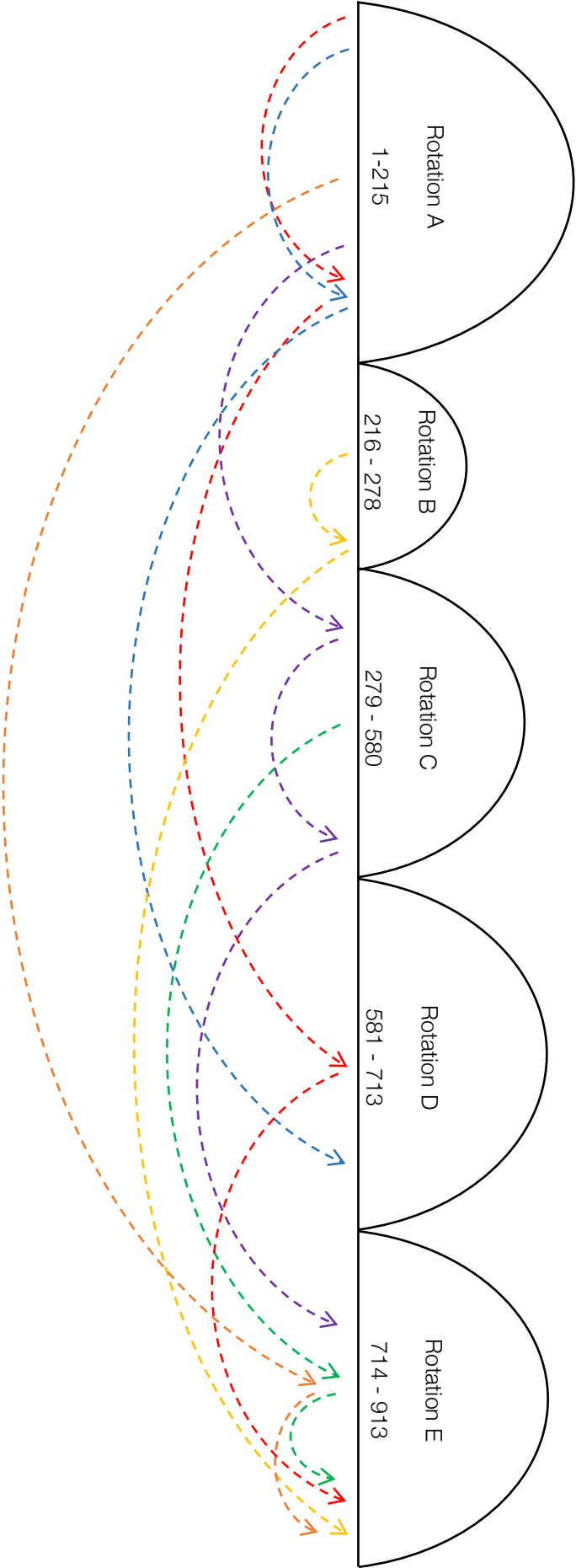Rotation A
1-215

Rotation B
216 - 278

Rotation C
279 - 580

Rotation D
581 - 713

Rotation E
714 - 913

4.4.1 Unfolding Time Streams Case Study No. 1: Static Moments

Through the piece, there are three moments of pure stasis which comprise very little internal change, here referred to as 'Static Moments'.[79] These are:

Static Moment 1: Bars 22 - 25   (Duration 10 Seconds)
Static Moment 2: Bars 198 - 215   (Duration 1 Minute)
Static Moment 3: Bar 713   (Duration 5 Minutes)

The recurrence of Static Moments which punctuate the structure implies a circularity, while the gradual increase in duration upon each occurrence implies linear growth. This combination of temporalities results in a fourfold temporal hierarchy:

Temporal Foreground: Static Time
due to the unchanging surface of these moments.

Temporal Middleground I: Circular Time
due to the way the Static Moments recur several times throughout the piece.

Temporal Middleground II: Linear Time
due to the way the Static Moments grow in duration over the course of the piece, an obvious linear process.

Temporal Background: Disruptive Time
due to the way the Static Moments interact with the other music present in the piece, interrupting the otherwise more active music to present a 'structure within a structure'.

This structure was plotted at the earliest stages of composition, allowing Static Moment 3 to fall approximately two thirds into the total duration of the piece, at the point where the climax of a piece might most conventionally occur. Modelled on the idea of an eclipse, a phenomenon the Antikythera Mechanism set out to predict, Static Moment 3

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[79] There are many other moments of relative stasis throughout the piece, e.g. bars 36-37, 576-580, etc. These are related to the Static Moments but are not a part of the scheme considered here which examines only those moments which are comprised of a single held chord with a near complete absence of internal change for an unexpectedly long duration within the immediate musical context.

constitutes an anti-climax into which time is dissolved. This gives rise to a paradoxical situation in which a significant culmination point for the music's dynamic, linear processes is embodied in stasis. To generate purely Static Time would be uninteresting to me, and is a far from novel idea, having been explored extensively by numerous composers over the past century.[80] Rather, Static Time exists only as a surface here, and it is the fact that it exists in tension with other temporalities that attracts me to this scheme.

4.4.2 Unfolding Time Streams Case Study No. 2: Time Compressions

Whilst the replication of formal shapes at various levels of the musical structure constitutes in itself a stretching and compression of time, such temporal manipulation is realised more plainly through two direct Time Compressions of whole passages of music into diminutive temporal frames.

At bars 171-197 a repetition of the entire piece thus far, comprising around eight minutes of music, is compressed into one minute. This is achieved through an increase in tempo and the elimination of repetitious material. The degree of compression is increased as the passage proceeds, by increasing the amount of eliminated material. This is coupled with a raising of pitch, up a fourth as compared with the original, mimicking the raising of pitch which results from faster playback speeds on analogue sound systems. A similar process is employed at bars 668-702, this time compressing a repetition of the preceding 25 minutes of music into one minute. Here, the pitch is raised again by another fourth to reflect the greater degree of compression.

These Time Compressions serve multiple functions. They act as clear waypoints starting with material repeated from the opening of the piece, similar to the repeat of the exposition or start of the recapitulation in a sonata form.[81] Rather than providing a verbatim repetition, the rapid nature of these compressed repetitions replicates the way in which the listener's memory might skim over the piece as a whole in an attempt to grasp its overall shape.

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[80] Among many notable examples is La Monte Young's *Composition 1960 #7,* which is comprised solely of two pitches which are sustained for an unspecified long duration. Performances of this work typically last up to several hours.

[81] Indeed, sonata form is considered by James Hepokoski and Warren Darcy to be a rotational scheme owing to the manner in which sequences of material recur throughout the structure. This aspect of sonata form is developed at length in James Hepokoski and Warren Darcy, *Elements of Sonata Theory*, (Oxford University Press, 2006).

In following a preconceived trajectory in a fast and frantic manner, these passages are able to acquire a strong sense of forward motion, being among the most strongly directed passages in the piece. In each case, they precede the most dilated, static moments in the piece at bars 198 and 713, discussed above (section 4.4.1). The violent temporal contrasts generated by these juxtapositions emphasise the extreme temporal qualities of all the passages concerned.[82]

4.5 Harmonic Structure and Linear Time

In starting this research, I set out to challenge, interrogate, and subvert my own past tendencies as a composer, which favoured an almost exclusively linear progression through time. Although *Antikythera* began as an exploration of Circular Time, the extent to which large-scale linear processes, resembling those which had underpinned my approach to composition prior to this doctorate, emerged was a considerable surprise. In contrast with those juvenile works which made use of Western tonal practises in order to enact a form of 'progressive tonality', whereby the interaction of tonal areas could act as the prime impetus for musical arguments,[83] in *Antikythera* individual pitch centres, along with the harmonic approaches and temporalities associated with them, are placed in dramatic opposition to create a linear directionality which drives the form as a whole.   These harmonic approaches are:

Material centred around the pitch class D
Material based around D is stable, using long 'tonic' pedals and predominantly making use of Circular Time. Harmonic materials are largely derived from the overtone series of D and make use of microtones in order to generate a clear sense of harmonic identity which is in contrast to many other materials which use 12-tone equal temperament. The stability of this pitch class is prefigured through its ubiquitous presence in *Gruss* (see section 5.2 below). E.g. Bars 1-38.

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[82] The use of stark contrasts in motion as a structural device is drawn from Beethoven's late string quartets. In *String Quartet No. 14, Op. 131*, for example, the use of such abrupt shifts is at times extremely jarring (e.g. the sudden move from the brooding first movement to the blithely folkish second) and contributes to the tempestuous drama and expression of that piece.
[83] As explained throughout Robert Simpson's book *Carl Nielsen Symphonist*, and as expanded through Simpson's own compositional work.

Material orbiting around the pitch classes B and F

B and F produce unstable material, predominantly making use of Linear Time. Less harmonically fixed than the material which orbits D, these pitch classes act as a destabilising influence to disrupt and uproot the prevalence of D. Pitches which are not prevalent within the overtone series on D are featured heavily, with harmonic materials largely formed from the all-interval tetrachord 4-Z15 (see Fig. 16).

Fig. 16: 4-Z15 containing both B and F

Various iterations of this pitch set may then be combined to form modes, between which the music can move (see Fig. 17).
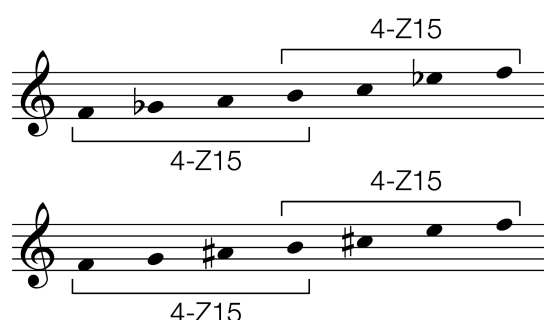

Fig. 17: Modes produced through combinations of 4-Z15

This material does not use microtones and as such is sonically distinct from the material based around D.[84]

E.g. Bars 75-135.

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[84] This is also based upon the practical consideration that microtones are especially difficult to perform in faster material, and are less readily perceived by the listener.

Separation of harmonic functions around pitch classes B and F

The temporal functions associated with B and F respectively are bifurcated over the course of the piece. Serially derived material based around B remains highly unstable, whilst material based around F coagulates into modal constructions. This prolonged use of fixed modal areas results in greater degrees of stability which tend towards repetition and stasis. E.g. bars 432-494.

Interactions between harmonic areas D and B

The harmonic areas on D and B can fuse, for example in Rotation A Cycle 6 (bars 136-170). Here, the overtone series around which D-based material is constructed is distorted to produce inharmonic spectra, predominantly based around bell spectra. This establishes a continuum of harmonic areas which the piece can traverse:

Harmonic series on D ◄─► Inharmonic spectra (D absent) ◄─► 4-Z15 harmony around B

Progression from D towards F

As discussed previously in Section 4.4.2, the two Time Compressions starting at bars 171 and 668 rise up a fourth on each subsequent iteration. The pitch class D, around which the opening of the piece is based, is therefore transposed up a fourth to G for the first Time Compression at bar 171, and up another fourth to C for the second Time Compression at bar 668. A final move up another fourth is made in Rotation E, with the harmony circling around F from bar 794, finally at bars 876-883 reaching a modified repetition of the melody which opens the piece with F as its pitch centre. In arriving at the pitch class F from the stable material centred around D by way of a large-scale linear process, the tension between these pitch centres is dissipated.

Concluding Material on A♭

Over the course of the piece, the pitch classes D, F, and B have each, in their different ways (as just outlined) been made too unstable for the piece to end in any of these harmonic areas. As B and F are each a minor third away from D, a compromise is reached in A♭.[85] The is also made possible by large scale movement through a sequence of ascending fourths from D to F. In order to arrive at A♭, this process of moving up by three fourths is telescoped, with F moving immediately to A♭ without any intervening steps. The interactions between the various harmonic areas under discussion are shown in Fig. 18.
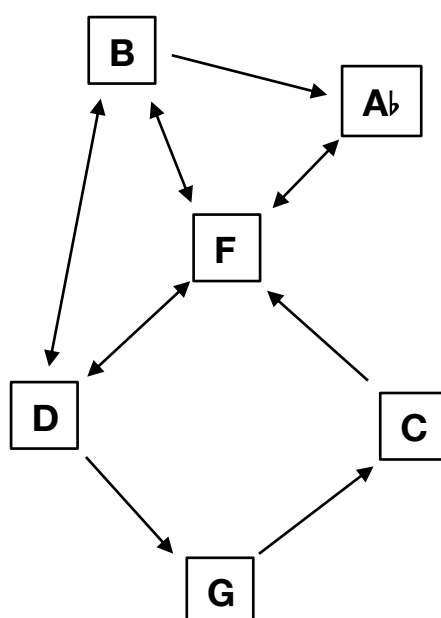
Fig. 18: Main harmonic areas within Antikythera *and their interactions*

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[85] This technique of 'emergent tonality' is taken from the way in which Nielsen arrives at the key of A major at the end of his *Symphony No. 2*, with that key being chosen as a compromise between an array of competing possibilities. This was pointed out to me in one of my first composition lessons as a teenager, and it is significant that I have found myself returning to this strategy, albeit through very different stylistic idiom to Nielsen's example. For a full discussion of the harmonic structure of that piece, see Robert Simpson, *Carl Nielsen: Symphonist*, 38-53.

Correspondingly, the harmony used in upon reaching A♭ at bars 884-913 is also a compromise between the 4-Z15-derived harmony which orbits around B, the modal harmony centred around F, and the spectral harmony based upon D. This is achieved using the spectrum of the bell sample heard at the very end of the piece, the lowest partials of which form 4-Z15 (see Fig. 19).[86]

Fig. 19: Bell chord derived from 4-Z15

Two transpositions of this set separated by a tritone are used, resulting in the mode shown in Fig. 20. All of the music from bar 884 until the end is written using this mode.
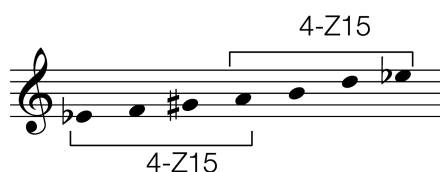
Fig. 20: Final mode derived from combinations of 4-Z15

In this way, spectral, serial, and modal approaches to harmony, which have been juxtaposed throughout the piece, are unified. This large-scale linear process, fundamental to the overall harmonic structure of *Antikythera*, is underpinned by the use of the opposing pitch centres which are associated with the harmonic approaches in question.

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[86] The original sample may be heard on Track 9.

5. *Gruss* [87]

Composed after Antikythera *as a large acousmatic prelude for that piece,* Gruss *is intended to be performed immediately before any performance of* Antikythera *as the audience and performers enter the performance space, before segueing directly into* Antikythera *without a break.[88]* Gruss *was prompted by the sound of a solitary church bell tolling in the Spring of 2021. Hearing a bell being rung for the first time since the start of the Covid-19 pandemic was a joyful occasion. However, this was immediately combined with sorrow due the poignant reminder of the continuing impossibility of group activities such as the change ringing which this lone bell had so hauntingly replaced. Indeed, the bell seemed to encapsulate the necessarily distanced and solitary nature of almost everyone's existence at that time, and to echo the static nature of day-to-day life through periods of lockdown.* Gruss *therefore combines aspects of Static Time and Linear Time, holding time in suspension in preparation for the start of* Antikythera*, through a far more expansive and continuous development than has hitherto been explored in my music. Through this,* Gruss *introduces many of the concepts which feature prominently within* Antikythera*, including space, distance, repetition, transformation, and pulse.*

Although they should ideally be performed together, Gruss *and* Antikythera *may also be performed separately from one another.*

Topics explored: Time Dilation, Static Time, Linear Time, Circular Time

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[87] *Gruss* is an entirely electronic work for which there is no score. In lieu of a score, the Ableton Live session ('Gruss Project', requiring Ableton Live 10 or later) used to produce the final mix is included in the accompanying digital files, together with a Max/MSP patch ('Gruss Player.maxpat', requiring Max 8 or later, with IRCAM's SPAT5 package installed) used for spatialised playback. During playback, audio output from Ableton Live should be routed to Max, with audio from Max outputting to the speakers. Alternatively, audio may be outputted directly from Ableton Live without any spatialisation.

[88] This practice, along with the title, are borrowed from Stockhausen's use of music to greet the audience at performances of operas within the *Licht* cycle.

5.1 Time Dilation in *Gruss*

The large-scale form of *Gruss* is conceived as that of a vastly expanded Cycle within *Antikythera* (see Section 4.1 above). As with the typical shape of Cycles in *Antikythera*, the registral shape of *Gruss* mimics that of a sine wave. This is formed by an initial rise in tessitura (00:00 - 07:41), a subsequent fall (07:41 - 17:18), and a final rise towards the original starting point (17:18 - 20:11). In contrast with the duration of Cycles in *Antikythera*, which typically last less than one minute, *Gruss* traverses its one Cycle over the course of twenty minutes.

Within this broad scheme, the fine degree of control made possible through electronically manipulated sound allows for subtle shifts in timbre to be explored which in turn facilitates the exploration of glacially slow rates of transformation and linear development. This is a new development in my composing, albeit one which follows on from my earlier research which used time dilation to explore the interior of a given sound or structure.[89]

The second half of the piece is characterised by such a gradual transformation, from a dense texture produced by combining several recordings of change ringing,[90] into a large tolling bell.[91] This was achieved through vocoding, whereby the spectrum of one sound is transplanted into the envelope of another.[92] At 13:36 to 15:59, the change ringing texture is transplanted into the envelope of the tolling bell, whilst simultaneously that texture is gradually supplanted by the bell's original spectrum. A partially overlapping process is introduced from 14:53 until the end of *Gruss*, whereby the bell's spectrum is gradually merged with a recording of sea, producing an unpredictable distortion of the bell sound.[93] The degree to which the bell sonority is distorted in this way exhibits a general tendency to increase but is

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[89] Indeed, in *Marangona*, the first piece to be composed as part of this research, a temporal dilation of a bell sound was used to generate the overall structure. See Section 2.1.1 above. However, the temporal dilation which forms *Gruss* is more extreme and as such the musical result of a far slower rate of development than that found in *Marangona* represents a significant new departure in my work. For the possible future consequences of this development, see Section 6.2 below.

[90] An example recording of change ringing is provided on Track 7. In *Gruss*, many such recordings from various sets of bells are sounded simultaneously at 08:51 - 15:59.

[91] The sample used is the same as that which begins Gruss and ends Antikythera, here time-stretched and transposed down by several octaves to sound like a very large bell. The original sample may be heard on Track 9.

[92] This was performed in Max/MSP using IRCAM's supervp.sourcefilter~ object, which allows two sound sources to be merged together by varying degrees, thereby enabling a gradual metamorphosis between the two sources.

[93] The concept of submersion and decay is intentionally suggestive of the Antikythera Mechanism's own history of being lost at sea in around 60 BC and recovered almost 2000 years later in heavily decayed state in a shipwreck. See Jones, *A Portable Cosmos*, 1-15.

varied upon each strike of the bell in a similar manner to Grisey's concept of 'Dynamic-Discontinuous Time'.[94]

5.2 Static and Linear Time in *Gruss*

In contrast with the complex harmonic structure which underpins *Antikythera*, *Gruss* is based entirely upon the pitch class D, with almost all of the samples used in the piece being digitally retuned so as to have D as their fundamental pitch. The near-ubiquitous nature of this pitch class results in an absence of harmonic progression within *Gruss*, producing an underlying temporal suspension which pervades beneath the various linear transformations which occur throughout.[95] The use of Static Time to annihilate any sense of ordinary clock time preceding *Antikythera* is also used as an atmospheric device, providing a temporal context out of which the more complex temporal structures of *Antikythera* can emerge.[96] Furthermore, the almost complete absence of any change in pitch class draws attention towards other parameters of the music, such as rhythm, pulse, timbre, and spatialisation which are of central concern in *Antikythera* alongside harmonic progression.

In the first section of the piece (00:00 - 07:41), the use of numerous field recordings of bells exhibiting complex and characterful timbral contrasts, together with the digital transformations to which they are subjected such as filtering and cross-synthesis, produces the effect of a constantly shifting timbral kaleidoscope which bypasses any overall sense of linear progression. The samples are spatialised such as to surround the listener, with each sample remaining in a fixed location relative to the listener's position, in order to generate the impression of remaining in one place and therefore contributing to the impression of Static Time. In this way, the temporal dimension is replaced by the spatial dimension. Rather than following a temporal trajectory, the listener is able to aurally move around the music's spatially demarcated strata freely, as one might move around a sculpture to perceive it from different angles.

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[94] See Grisey, 'Tempus ex Machina', 252-253. See also Section 1.4 above.

[95] When *Antikythera* is heard following *Gruss*, the stability and stasis associated with the pitch class D in *Antikythera* (see Section 4.5) is emphasised by its strong presence throughout *Gruss*.

[96] This was in part prompted by Wagner's prelude to *Das Rheingold*, which is built entirely upon an E♭ major chord for around five minutes, evoking an elemental quality to set in motion Wagner's vast cycle of music dramas. Despite the stasis generated through the complete absence of harmonic progression, this prelude nonetheless exhibits a strong sense of linearity through its gradual increase in rhythmic activity, textural density, and dynamic.

Linear transformations, such as the metamorphosis of a ticking timer into a chiming bell and back (00:55 - 02:03), typically unfold over relatively short time span and may therefore considered as local events rather than as structural processes. In this way, such linear foreground events contribute to the prolongation of Static Time. Nonetheless, the nature of such linear transformations themselves prefigures the use of more protracted examples later in the piece which do take on a more significant structural role, as discussed in Section 5.1 above. The tension arising from the contradiction between Static Time and Linear Time, and the corresponding ebb and flow between these two tendencies over the course of the piece, is the main driver of form in *Gruss*.

5.3 Circular Time beyond *Gruss*

At the opening of *Gruss*, after an initial cascade the time-stretched bell timbre which predominates the opening section of the piece until 08'20" is made from the same sample which ends *Antikythera*, here transposed down by a tritone to feature a D fundamental rather than A♭.[97] At the opening of the piece, various digital modifications are made to this sample, including time stretching, filtering, envelope manipulation, and reverberation. These modifications are gradually removed until 07'48" - 08'20" where the original sample is revealed. This linear process which underpins the first eight minutes of *Gruss* therefore foreshadows the linear processes which lead towards the ending of *Antikythera*, whereby the same bell sample is gradually revealed.

As discussed in Section 4.5, all of the harmonic resources used in *Antikythera* are drawn together in the spectrum derived from this sample, resulting in a converging and collapsing of time streams into the ending. The use of this timbre at the opening of *Gruss*, coupled with its return at the end of *Antikythera*, forms the largest instance of Circular Time possible here, spanning almost an hour and traversing the entirety of both pieces. Combined with the directed motion towards this spectrum at the end of *Antikythera*, this lends an added finality to the ending of *Antikythera* and emphasises the large-scale harmonic motion from D to A♭ which underpins the structure of *Antikythera* as a whole.

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[97] The original, unedited sample may be heard on Track 9. The same sample is also used later in the piece to produce the large tolling bell from 13:36 (see Section 5.1) and at the end of *Antikythera* (see Section 4.5).

6. Conclusions

6.1 Coming Full Circle: A Return to Linearity

Prior to this research, a crucial ideal in my music was the creation of forward momentum, sustaining the listener's interest by propelling the music forward through time. In *Marangona* and *Thymiaterion*, the manipulation of this forward momentum by juxtaposing many contrasting temporalities aims to create an ultimately more engaging listening experience than a relentless forward drive (see Chapter 2). It is the capacity for music to bridge the gaps between temporalities and to create a dialectic out of their combination which I find the most interesting and creatively productive outcome of this research, as it has provided me with a means of composing music which aims to be colourful, multidimensional, and pluralistic.

Though such a pluralistic idiom is also exhibited in the musical surface of *Bonsho*, there is a mismatch between this and the relative absence of internal temporal diversity as compared with the other works presented here. Nonetheless, the (largely unsuccessful) atomised exploration of individual temporalities (see Chapter 3) served to crystallise the far more crucial realisation that it is the tensions between different temporalities which produce the internal life, fluidity and dynamism that I have always sought in my work. Furthermore, the shortcomings of *Bonsho* were pivotal in the realisation that my tendency towards forward-moving, goal-directed linear time is not an aspect of my practice to be subverted or shied away from. Rather, it is an integral facet of my core musical impulses which can be enriched by embedding it within a more sophisticated network of contrasting temporalities.

Although it was explored in part in *Thymiaterion,* this essential research finding was revealed more fully through the composition of *Antikythera*. In contrast with the Sibelian model of organic growth which had previously been a significant preoccupation in my work, whereby the piece appears expands outwards from an initial germ, *Antikythera* takes an end-oriented approach by seeking a confluence for its disparate materials (see Section 4.5). This forms something of an allegory to my journey through this research, which has allowed me to draw together diverse approaches to temporality and other composition techniques, deploying them strategically within the same piece as a means of generating form.   Although stylistically my work is far removed from that of Robert Simpson, the core act of combining, contrasting, and integrating different kinds of time and motion within a large-scale structure in

order to create a sense of internal "energy" and "life" is a preoccupation shared with much of Simpson's work.[98]

6.2 Future Implications

Composing a work on a vastly expanded time scale in *Antikythera* has already led to unexpected outcomes in *Gruss*, where the course of the music's development is far slower and over a far longer duration than has hitherto been explored in my music. *Antikythera* is a continuous piece, but it is still split into five main Rotations (see section 4.1 above), which could almost be thought of as conjoined movements, with none of these sections lasting longer than ten minutes. *Gruss* is therefore a longer, more protracted development and in this sense is more extreme than *Antikythera*. Although this is a function of it being an electronic piece (see section 5.1 above), this vastly protracted continuous development suggests possible new directions for my future work and could have profound implications for the way I approach composing for acoustic instruments.

Over the course of this research I have been surprised by the extent to which the compositional technique of manipulating and combining musical temporalities has led to new and unexpected creative departures in my work. It must however be emphasised that the music does not exist for the purposes of expressing combined temporalities; rather this technique is a means to enriching my musical ends. Conceiving of music in different temporalities enables the creation of contrasts necessary for my music's multiplicitous aims, while the methods of combining temporalities discussed allow for a multiplicity of approaches to time to be combined within a single musical entity such that they appear part of a unified whole. It is perhaps ironic therefore that my attempts to move away from a Simpson-derived 'symphonic' approach to time have ultimately drawn me closer to it in a more fundamental sense. Pervading these pieces is an overall desire to integrate seemingly disparate temporalities and musical materials into a unified whole. Although my music would appear to have moved very far from the symphonic tradition as enshrined in the works of Sibelius, Nielsen, and Simpson, this preoccupation with the large-scale integration of sharply contrasted materials and temporalities remains essentially, in the most literal sense of the word, symphonic.

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[98] Reflecting on the composition of his *Symphony No. 9*, Simpson stated, "I've always been interested in this question of recovering Classical energy to try to restore it in music to create the feeling that we have muscles [...] and it seems to be important that music reflects it and provides a way of illustrating life." Robert Simpson, 'The Ninth Symphony: RS talks to Gillian White', *Tonic: The Journal of the Robert Simpson Society*, Vol. 3, No. 4 (Spring 1990), 16-20, 17.

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