

Formations – Music from Rocks: New Approaches to Systematic Composition

Matthew Bromley

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This doctorate is dedicated to
my late grandfather, Brian.
Thank you for all you did for me.

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Abstract

Composers have adopted compositional systems in some way or another for many years, such processes involving various approaches. Most important to this project is twelve-tone serial technique, a compositional technique associated with the work of the Second Viennese School, but certainly not limited only to these composers. This project is largely inspired by the compositional techniques of Schoenberg as used in his mature serial output in addition to a range of other approaches adopted by other composers including Messiaen, Boulez, and Satie.

The main goals of this project are to create a compositional system capable of removing almost all creative composer input from the process, and to find new methods of responding to visual imagery in an ultra-literal way. My strategy in this project was to study techniques used by other composers and to combine these with my own systematic compositional techniques in order to achieve these two main goals. In this project, I respond to the macrophotographic imagery of Richard Weston, in particular his investigation of rock and crystal microstructures. All images are taken from Weston's private archives and are used, and reproduced, with permission.

A trial-and-error approach was taken to the project whereby a work might be composed using a newly devised system or idea, after which a reflection was taken on the piece that resulted, and the system tweaked to eliminate any weaknesses and errors in the system-process in order to attempt to create the systems capable of producing the music I wanted to achieve.

Throughout the project, sixteen compositions were completed of which twelve are submitted in the composition portfolio. Extracts of a further two are included as portfolio appendices. The project successfully resulted in new methods of composition in response to imagery, and in the creation of the all-encompassing system which eliminates the necessity for creative composer input. It has also produced systems which can be reapplied to new stimuli to create new and varied compositions.

Composition portfolio: List of works

Nerthus* solo piano	2'30''
Al's Icier Pee* solo piano	2'
Al's Epic Leer* solo piano	2'
Not Just Yet* flute, clarinet in A, piano, violin, cello	4'30''
Jasper's Lament* string quartet	2'30''
Jasper's Regret string quartet	3'30''
Jasper Reborn string quartet	1'
Jasper Rises* flute, oboe, clarinet in A, bassoon, horn in F	2'
Jasper Reigns* string quartet and horn	3'30''
Jasper's Farewell string quartet	13'30''
Holotrix(b.2) flute, oboe, cor anglais, clarinet in A, bassoon, horn in F, trumpet in Bb, trombone, violin, viola, violoncello, double bass	22'
Holotrix 2 flute, oboe, cor anglais, clarinet in A, bassoon, horn in F, trumpet in Bb, trombone, violin, viola, violoncello, double bass	4'30''
Prelude* solo piano	4'50''
Revolutions* cor anglais, clarinet in Bb, bassoon, horn in F, trumpet in C, viola, violoncello	10'

Composition portfolio: Appendices

Jasper's Regret (unedited) string quartet	3'30''
Holotrix (selections) flute, oboe, cor anglais, clarinet in A, bassoon, horn in F, trumpet in Bb, trombone, violin, viola, violoncello, double bass	5'

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Introduction

System versus style

The overall goal for this project is to test the boundaries and limits of systematic processes in musical composition. Through my research, this project combines the creation and development of new methods of systematisation with the application of existing methods. I have attempted a systematic approach to the systematic development project. The systematic processes were to be applied and tested through the writing of a collection of experimental pieces, and then assessed, before making changes I felt necessary to the system. The aim of my approach is to be able to create new musical systems which not only fulfil my own criteria and objective to be systematic composition (discussed below), but also to produce music that is performable and most importantly, varied.

My previous work with systems raised various issues, particularly in respect of rhythm, that I attempted to resolve in the hope of being able to create fully systematic music in which the supporting ‘scaffolding’ of the system would not be easily seen, or heard. I have found there is a danger that heavily systematised compositions, such as total serialist works,¹ can be extremely difficult to play, excessively or inadequately varied, and lacking clearly audible shape or structure. Ironically, such works can even appear almost aleatoric to a listener. Finally, I aimed to take all I had learnt from these various experiments and create and apply an all-encompassing system which, once constructed, could generate a compositional work entirely without human decision. This not only

¹ Works such as Boulez’s *Structures I* and his *Structures II*, and Milton Babbitt’s *Three Compositions for Piano*.

pushes the limits of compositional systematisation, but also has the potential to produce music which I believe would be performable and coherent.

Like many contemporary composers of my generation in the UK, I was first exposed to systematic music whilst still at school during my Music GCSE. During these studies, I first encountered Schoenberg's early works, including *Five Pieces for Orchestra*, Op. 16 (1909), and then discovered serialism, through Webern's *Quartet*, Op. 22 (1930). I recall being more drawn to the Schoenberg than the Webern as its combination of expressionistic character and simpler phrasing and structure appealed to me aesthetically. Since then, I have pondered the limits of systematisation, and the different ways in which a systematic approach could be applied, exploring it through my undergraduate compositions and more extensively through those written for my master's degree.

Ligeti said he wrote twelve-tone music from 1955 to 1956 because it was what was most modern at the time, and though somewhat influenced by Schoenberg, this was mainly limited to the use of rows, rather than any of the more intricate approaches to composition undertaken by him, and so the music he produced was not stylistically similar to Schoenberg, or even of Webern.² Using an approach similar to that of Ligeti, my first foray into using a system to assist in composing a work was using twelve-tone serial rows, applied only to pitch and with a very free approach to the application. Whilst exploring systematic approaches during my undergraduate studies under Dr. Mike Searby, and investigating ideas for new methods of systematisation, I generally found that my ideas were neither unique nor original. I considered exploring the serialisation of other musical parameters, including rhythm, dynamics, and articulation,

² Paul Griffiths, *György Ligeti*, ed. Nicholas Snowman (London: Robson Books Ltd., 1997), p. 14.

discovering and exploring total serialist works by composers such as Boulez. Realising that these ideas and techniques had already been explored by a number of composers in the middle of the twentieth century, I concluded that it was not necessarily an original idea that I needed most, but rather a different approach. This sparked my ideas for a more empirical approach, where I would tweak and modify compositional techniques until they gave me the outcome I desired, not in order to subvert the system, but to create a system that was capable of writing the music I wanted to write.

As part of a composition assignment during my undergraduate degree, I made a plan for a twelve-movement work where each movement would be progressively more systematised. However, some major flaws arose from this attempt at total serialisation of all parameters. The approach to organising rhythm led to an impossibly difficult movement and the systematisation of the structure was fundamentally flawed, in so far as a first movement of just six seconds would result in a twelfth movement of around two and a half hours! As only a single movement was required for my coursework, I chose to create the seventh movement for the work because that is the first point where all aspects of musical material in the hypothetical work would have been systematised. I did not then take the time to adjust the system as the issue was insubstantial to the work on the movement I planned to submit. As a result of these factors, along with some others, I found that the music it produced was unsatisfactory for my personal goals. What resulted was a trundling, inexpressive barrage of pointillistic sound rather than the expressive, and perhaps even audibly structured, outcome I would have preferred. Since then, a significant percentage of all works I have written use

original systems and my approach to systematisation has become to create unique systems for each piece.

The months prior to my applying to do a PhD coincided with a chance meeting with the author, architect, and Cardiff University Professor of Architecture, Richard Weston. We discussed some work he had been doing with macrophotography (extreme close-up photography) of rock and crystal structures.³ After seeing these images, I considered the potential for writing music in response to imagery and how this could tie into my ideas for my doctorate. For this project, I aimed to generate musical material from Weston's imagery of rock and crystal microstructures in a variety of ways. I would experiment with a number of different ways of extracting information from the images, beginning with rather basic approaches, before moving into more complex methods which were able to control more aspects of the music. It was important to me that the material generated would be individual to the image and that if the same approach were to be applied to a different image the material would be different; this was essential in order for me to be able to say that the music was truly responding to the image. My meeting with Weston catalysed the revival of my idea for a twelve-movement work with increasing levels of systematisation, initially envisaged during my undergraduate studies, as well as the potential to create music which is taken directly from, and unique to, a particular image.

Historically, music has been written in response to imagery and landscape in a number of ways, including attempting to produce a likeness to the stimulus such as in Sibelius's *The Oceanides* (1914), through exploitation of synaesthetic tendencies as in Messiaen's *Livre d'orgue* (1952), or in an attempt to evoke an

³ See Richard Weston, *Formations: Images from Rocks* (Dinas Powys: Deukalion Press, 2007).

image of an entire experience, such as in Mussorgsky's *Pictures at an Exhibition* (1874). So whilst the idea of extra-musical stimuli in itself is not new, I hoped to be able to create a system that was able to respond to the physical attributes of an image more literally.

In his book, *Satie the Composer*, Robert Orledge argues that some of Satie's processes use systems and yet what he strove to achieve from using them was in fact very different to what Schoenberg aimed for; in fact, Satie even deliberately left flaws in his systems, in order to prevent imitation.⁴ Indeed, what Orledge calls a system in Satie's work, such as the organisation of chord progressions and the ordering of harmonic materials, as seen in the Rose+Croix music,⁵ some might prefer to refer to as a compositional technique. Whilst Satie's systems were numerous and often individual to the piece they were applied to, the twelve-note serial technique devised by Schoenberg (with input from Berg and Webern) was intended as a system to replace other methods of composition. Schoenberg believed that his serial approach would produce superior music, hence his infamous remark to Josef Rufer: 'I have made a discovery which will ensure the supremacy of German music for the next hundred years.'⁶ His belief was rooted in the fact that the music was so utterly symmetrical and balanced that there could be no weakness and that it was capable of replacing conventional tonality. In his own opinion he had achieved the ultimate in coherence, which was something he had consistently aimed for from his early tonal works, via his expressionist masterpieces, and into his serial period.

⁴ Robert Orledge, *Satie the Composer* (Cambridge: Cambridge University Press, 2008), p. 145.

⁵ *Ibid.*, p. 3.

⁶ Hans Heinz Stuckenschmidt, *Schoenberg: His Life, World and Work*, trans. by Humphrey Searle (Richmond: Oneworld Classics, 2011), p. 277.

Oxford Dictionary of English defines systematic as ‘done or acting according to a fixed plan or system; methodical.’⁷ This would tie in with Satie’s own interpretation of systematic composition. However, there is a danger of the term systematic music being applied too loosely and as a result being applied to a huge amount of notated music to which it is clearly not relevant. It is important that music which has many compositional rules or constraints is not incorrectly defined as systematic music. My own interpretation of the term is music that is written using a method which does not necessarily dictate how the music should be written, but one that may methodically dictate how ideas are applied, how music develops, and most importantly, how musical ideas and motifs are generated. Thus, whilst elements of this project seek to push the boundaries of what can be systemised and to create heavily systemised works which do not deviate from this process, the most important aspect of systemised music composition is that the system is capable of material generation, and that it may be used and exploited to create the music the composer wishes to. Of course, some pieces in this project will take this more cooperative approach between the composer and the system. The principle of using systematic compositional processes to generate material which can then be used in composition is a widely used process by contemporary composers who utilise systems. Oda Tilset, for example, uses computer generated algorithms to produce AI-generated music which she then uses to find inspiration and ‘work on more to make her own’.⁸

⁷ *Oxford Dictionary of English*, ed. Angus Stevenson (Oxford: Oxford University Press, 2010), p.1806.

⁸ Oda Tilset Sees Computer-Generated Music As A Tool, Not A Threat
<<https://www.wshu.org/post/oda-tilset-sees-computer-generated-music-tool-not-threat#stream/0>>
[Accessed 1 September 2020].

In his *Die Reihe* article on Hans Werner Henze, Rudolph Stephan remarked: ‘But nowadays, this view, [that of twelve-tone technique, where one should delay and avoid note repetition for as long as possible] once very prevalent, is already obsolete.’⁹ This project sets out to prove that although this quotation dates from 1959, it was not, and is not, true. Indeed, I intend to demonstrate in this project, that the potential of twelve-tone technique and systematically composed music in general, has only just begun to be realised.

⁹ Rudolph Stephan, ‘Hans Werner Henze’, in *Die Reihe (4) Young Composers*, ed. Herbert Eimert and Karlheinz Stockhausen; trans. Leo Black, (Eng. edn.), (London: Theodore Presser., 1960), p. 34.

Chapter 1

A first attempt at responding to imagery of rock and crystal structures

Amongst the first things I aimed to approach in this project was a response to imagery. Whilst conscious that the intention of the project was to produce pieces that would be heavily systematised, it was impossible to ignore the fact that the majority of pieces composed in the past which respond to external stimuli are not systematic. Instead, they respond in a variety of ways; for example, through the use of text in lyrics or through sound painting. I decided to begin by employing a conceptual and creative response to the concept of rocks and crystals and considered the formation of these structures under the surface of the earth. My work, *Nerthus* is named after the goddess from Germanic paganism, who was referred to by the Roman historian Tacitus in around 100 CE as ‘Terra Mater’, or ‘Mother Earth’.¹⁰ The goddess Nerthus inspires this work through the concepts of fertility and nature and the formation of new life and is symbolic of the generation and creation of something new and the development thereafter.

Though there is nothing systematic about the processes behind the composition here, the material largely stems from the opening cell, which attempts to develop and grow throughout the work, but always returns to the original material. This is symbolic of all life, as well as rocks and crystals, deriving from the earth and returning to the earth. The material attempts to develop but rarely manages to do so beyond a few bars and though it builds in

¹⁰ Norse mythology webpage on Nerthus <<https://norse-mythology.org/gods-and-creatures/the-vanir-gods-and-goddesses/nerthus/>> [Accessed 16 November 2016].

intensity, by the end, the material is still clearly derived from this same opening motif and it becomes even more sparse than the opening bars.

There is regular use of material in the lower registers of the piano, symbolic of the depths of the earth. Even when the music manages to move away from this motif, the two-semiquaver upbeat is often present at the beginning of phrases and highlights a change in direction, each time stepping back slightly from the development that was achieved. The tempo is 72 quaver beats per minute, a slow tempo exaggerated by the continuous introduction of space in the piece. Dynamics were applied freely and generally used to highlight significant moments in the work and to match the arc of the piece. Articulations were similarly applied, freely, to create melodic shape and interest and to define the ends of phrases. The pitch material, too, was freely chosen, though I avoided immediately presenting all twelve tones; indeed, whilst nine pitches are presented in the first four bars, the final three are not seen until bar 16. Whilst the piece that was produced was effective, it was simply an experimental piece intended to show various ways in which one can respond to non-musical concepts.

The genesis of *Holotrix* and *Revolutions*

The major works of this project have their roots in the research I did at the beginning of the project. Whilst conducting my research into Schoenberg's work and the development of his methods, I wrote two short piano works, called *Al's Icier Pee* and *Al's Epic Leer*. Initially written to help strengthen my understanding of Schoenberg's work, their influence continued throughout the project and into the final work, *Revolutions*.

The initial two pieces were written in direct response to the ten features that characterise Schoenberg's late twelve-tone technique, as identified by Ethan Haimo:¹¹

- Hexachordal inversive combinatoriality
- Aggregates
- Linear set presentation
- Partitioning
- Isomorphic partitioning
- Invariants
- Hexachordal levels
- Harmony
- Metre
- Multidimensional set presentations

Some features that Haimo identified have some overlap or are in fact subcategories and continuations of other principles. For this reason, though I discuss all Haimo's features, I categorise them differently. Below, I briefly discuss *Al's Icier Pee* and then discuss *Al's Epic Leer* in more detail.

Al's Icier Pee: a response to Schoenberg's mature style

Possibly the most important element of Schoenberg's mature style, hexachordal inversive combinatoriality (hereafter referred to as HIC) is the pairing of serial rows where the hexachords (a twelve-note set has two hexachords – the first six notes and the final six notes) from each match to produce aggregates (a complete set of all twelve pitch classes, such as a serial row taken from a matrix) with one another. By carefully choosing a secondary inversive set, one can find a matching set in which the first hexachord of the first set would contain the pitches of the second hexachord of the second set. Figs. 1.1 and 1.2 show the opening

¹¹ See Ethan Haimo, *Schoenberg's Serial Odyssey* (Oxford: Clarendon Press, 1990).

linear sets used in both Schoenberg's fourth string quartet, and in *Al's Icier Pee*, respectively, and highlight the HIC relationships in each.

P0	D	C#	A	Bb	F	D#	E	C	Ab	G	F#	B
I5	G	Ab	C	B	E	F#	F	A	C#	D	Eb	Bb

Fig. 1.1: String Quartet No. 4, Op. 37, Arnold Schoenberg, opening set

P1	A	E	Bb	C	B	Ab	Eb	F	D	Gb	Db	G
RI1	Db	G	D	Gb	Eb	F	C	A	Ab	Bb	E	B

Fig. 1.2: *Al's Icier Pee*, bars 1–3, linear set row choices

Of course, many composers have made use of HIC in their compositions, including Milton Babbitt who restricted himself impressively while using HIC within the compositional process. He restricted his works to one hexachordal set, and achieved the maximum variety of orderings.¹² His work *Post Partitions* (1966), which uses the same ordered hexachord as his earlier work *Partitions* (1957), is based on trichordal HIC pairs, which are themselves based on trichordal segments of the prime row. The piece makes use of other Schoenbergian features to be discussed below, including isomorphic partitioning.

Linear set presentation is the simplest method of producing HIC, by presenting the set in an unobstructed, pitch-by-pitch method. It is typical of Schoenberg's work that linear set presentation would be reserved for moments of importance, such as points of structural or musical/dramatic emphasis e.g. beginning and ends of pieces/movements. Occasionally, this would include not

¹² Andrew Mead, *An Introduction to the Music of Milton Babbitt*, ed. Arnold Whittall (Princeton, NJ: Princeton University Press, 1994), p. 23.

only the P0 set, but also any forms and inversions of the primary set.¹³ Some other composers, including Webern, used linear set presentation more freely than Schoenberg.

Various forms of partitioning (when a set is split amongst several voices) are possible when writing serially and using HIC, and these are far more common ways of handling sets in Schoenberg's mature style than linear set presentation. Unlike linear set presentation, polyphonic partitioning can obscure the set, as it can share an aggregate across several voices. It can also often result in secondary set relationships as well as producing lines or chords whose elements may not represent the order positions of the set. Partitioning the set in equal segments was the norm in Schoenberg's early works. By his mature works, however, though he still partitioned in equal segments, he allowed himself use of varied set partitioning. This allowed for a greater freedom from the rigidity of equal partitioning. Partitioning a set across several instruments was often done on the hexachordal level, which could further obscure the set. For example, if set one is shared between a violin and a viola, the violin could start with the first note of the set, when at the second time, the viola could start with the seventh note of the set, i.e. the first note of the second hexachord, further complicating the application of the HIC pairs and any later analysis of the system or work.¹⁴

When two or more set forms are partitioned identically, it is defined as isomorphic partitioning, which creates refined invariant relationships. Schoenberg's earliest serial works used isomorphic partitioning, but this would generally be in isolation. In contrast, in some of the mature works, it is possible to

¹³ Ibid., p. 12.

¹⁴ Ibid., p. 13.

find an isomorphic relationship for virtually every set presentation in the work. The most common form is of two consecutive inversionally related set forms, though it was also used with transpositionally related sets as well as retrograde and retrograde-inversionally related sets.

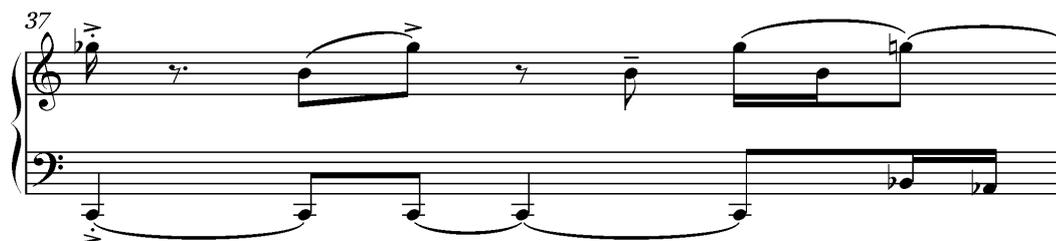
Al's Icier Pee is 44 bars long, beginning with an eight-bar 'prelude' which is a similar approach to Schoenberg's tendency to begin pieces with an opening passage that acts as an introductory prelude. The prelude uses multiple linear set presentations, simultaneously presented in the treble and bass staves. From bar nine to the end, the piece uses polyphonic set presentation, with one set per two bars with six pitch classes in each bar, with three designated to each stave, and HIC-produced through my choosing the order of treble and bass distribution. For the first four bars, the number of individual pitches assigned to each bar was six, but the music slows down harmonically from bar five, where the number of individual pitches assigned to each bar changes to three. Both *Al's Icier Pee* and *Al's Epic Leer* use a row I devised by using alphanumerical representations of people I know.

It is possible to present serial sets in a number of ways, which is described by Haimo as multidimensional set presentation. An aggregate is not only a linearly presented serial set, but any complete set of the twelve chromatic pitch classes. As already discussed, there are numerous methods of set presentation, including linear set presentation, which are classed as primary set presentation. A secondary set may be presented across several voices within an HIC pair of sets. Applying HIC pairs, linearly set, automatically produces primary and secondary aggregates. That is, two linearly placed HIC sets running concurrently will fundamentally produce two linear aggregates, as well as two more as each of the

hexachords is paired with its partner hexachord. With this in mind, the piece in its entirety produces: 1) primary aggregates, linearly set over two bars in the first four bars, and over four bars from 5 to 48; 2) secondary aggregates, polyphonically set, produced from HIC pairs in each bar in the first four bars; and, 3) across each two bars from 5 to 44. Furthermore, I also produced what I named ‘tertiary aggregates’, which are produced through the manual ordering of the distribution of notes from bass and treble lines – each first note of the bass over twelve bars will produce an aggregate, manufactured by choice of sets. Tertiary aggregates are sometimes significant rows, such as P0, and sometimes they are invented aggregates. Four tertiary aggregates are produced throughout the piece, with each note of the aggregate being the first note in each bar in the bass line.

Despite bars 5 to 44 being assigned six pitches instead of the twelve seen in the first four bars, some bars will in fact have more or fewer than this. The reason for this is that there is some allowance for fluidity in the placing of the first sounding of each pitch from a set, e.g. in bar eight, there are four notes in the bass, as opposed to three. Here, it ‘borrows’ the first note from bar nine, which sounds early and is then tied over into bar nine. Pitches are sometimes held over into the following bar in the same manner, such as in the left hand in bars six to seven. Further variance is achieved through the choice of pairs of sets which share a common last and first pitch. The first linear set in the right hand sees six notes in the first bar and five in the second. The final G of the first linear set is combined with the first note of the second linear set in the treble stave, also G. These allowances to lend, borrow, and share pitches were intended to produce a more varied piece, so that the allowance of the introduction of six or three notes per bar per stave would not result in too rigid and unvaried a work. The row is freely

applied to each bar and can move back and forth within that bar, though not outside of it. For example, bar 37 has G \flat , B, and G assigned to the treble staff and the bar begins with a G \flat , before moving to a B, returning to a G \flat and so on, until it settles on the G (Ex. 1.1).



Ex. 1.1: *Al's Icier Pee*, bar 37, handling of pitch material in treble clef

The tempo of *Al's Icier Pee* is 104 crotchet beats per minute, with no deviation and no notated tempo changes, other than fermatas at bars 13 and 30. All rows from bar five to the end were polyphonically set, but the distribution of pitches within each bar, between treble and bass staves was carefully chosen. I had decided that they were to be split evenly across the two staves, with three pitches per bar in the treble staff and three in the bass staff. I decided to exploit the ordering of these pitches to artificially create further aggregates and HIC pairs. This, of course, only applied to polyphonically set bars, from bar five to the end. The primary factor in choosing which rows to use was to create tertiary aggregates as discussed above, however, by carefully choosing the pitch distribution, I succeeded in creating a series of artificial linearly set aggregates in each staff across four bars, from bar five to the end, as well as ensuring that these artificial linear aggregates were also HIC compatible with one another, i.e. the first hexachord of each artificial linear aggregate contained the same pitch

material as the second hexachord of the concurrently occurring artificial linear aggregate.

Ex. 1.2: *Al's Icier Pee*, bar 17

Table 1.1: *Al's Icier Pee*, ordering of pitch row material between staves in bar 17 determined by rolls of a die

Treble	A \flat		A		B \flat	
Bass		D		D \flat		C

I attempted to achieve coherence through similar rhythmic devices when the pitch classes were ordered in the same way as in previous bars. For example, the pitches in both bar 17 and bar 20 are presented treble, bass, treble, bass, treble, bass. As such, both bars use the same rhythms; essentially bar 20 is a transposition of bar 17. I found that this alone was not enough to produce a satisfactory work, and the number of different combinations meant there were too many variations for such a short piece.

Ex. 1.3: *Al's Icier Pee*, bar 20

Al's Icier Pee in relation to Al's Epic Leer

Despite being very popular with the post-war generation of composers, and having a following of composers interested in and inspired by his work, Webern's serial output was relatively small. However, an intricate level of detail was put into his work, even considering the interrelationships of the pitch rows he used. The series he used for the Concerto, Op. 24 (1934), was derived from four tetrachords, the first of which is the basic cell upon which all the others are based. The second is a retrograde inversion of the base cell, the third is a retrograde and the fourth is an inversion. Even more detailed were the interrelationships in the row he used for *Variations for Orchestra*, Op. 30 (1940).¹⁵ Furthermore, he also strove to create rows which gave harmonic results that purposefully avoided triadic chords and whole-tone scales, scalic formations, or cadential potential. However, he was not shy to incorporate more traditional or archaic aspects of music, by using features such as hoquet rhythms, canon, and counterpoint.

Webern's first fully twelve-tone piece was the *Kinderstück* (1924), which at just seventeen bars long managed to encapsulate his style in a figurative nutshell. Applying the method strictly, in an approach similar to my own in *Al's Epic Leer*, all twelve notes were introduced in the piece before any could be repeated, other than when a note was immediately repeated, which produced an early example of 'Morse code' in music, and was a feature of many of Webern's early works, such as the third of *Three Traditional Rhymes*, Op. 17 (1925), where continued passages of repeated notes from the row appear, such as the viola C# in bar 11, which repeats ten times.¹⁶ Webern meticulously ordered his rows – the

¹⁵ Reginald Smith Brindle, *The New Music* (Oxford: Oxford University Press, 1977), p. 9.

¹⁶ Kathryn Bailey, *The Twelve-Note Music of Anton Webern* (Cambridge: Cambridge University Press, 2006), p. 34.

second of *Three Traditional Rhymes*, for example, uses only the original prime row, and is never transposed, repeated 22 times with overlapping of the prime row frequently occurring.¹⁷

In *Al's Epic Leer*, HIC is applied in a fairly similar way to *Al's Icier Pee*. *Al's Epic Leer* is 48 bars long, with a twelve-bar prelude, following the Schoenbergian approach to the opening of the piece, though here linear set presentation is applied to the entirety of the prelude, as opposed to just the first four bars, as it is in *Al's Icier Pee*. I had found that the prelude was not clearly defined enough in *Al's Icier Pee* and the best way to remedy this was to make it as distinct as possible in *Al's Epic Leer*. The prelude in *Al's Epic Leer* has a clear character, not previously achieved, with two distinct and identifiable motifs, in bars 1 to 4 and in bars 5 to 6, then repeated again from bars 7 to 12 with new pitch sets. The distinctiveness of the prelude is further concreted by a tempo change from 92 beats per minute at the beginning to 116 beats per minute at bar 13. *Al's Epic Leer* changes to polyphonic set presentation, one set per two bars, with six tones in each bar, as in *Al's Icier Pee*, and continues in this fashion from bars 13 to 48.

Aggregates are formed in the same way in both pieces, though in *Al's Epic Leer* the point at which the sets change from linear to polyphonic presentation is now in bar 13, in line with the more clearly defined prelude. Thus the first twelve bars see primary polyphonic aggregates in each bar, and in every two bars from bar 13; and the first twelve bars see secondary linear aggregates in every two bars, and in every four bars from bar 13. As in *Al's Icier Pee*, the entire piece has four tertiary aggregates, each across twelve bars, presented through the first note of

¹⁷ Ibid., p. 35.

combining the staccato and legato material which had been previously seen in bars 13 to 36 and developing it further.

The allowance to lend and borrow notes from bar to bar, permitted in *Al's Icier Pee*, I felt, was more flexible than the systematic ideal I am exploring in this project and lent itself to a more linear, almost contrapuntal, writing. Therefore, in *Al's Epic Leer*, the sets are clearly laid out in their bars and do not deviate at all from these partitions. To allow more interest and character in the piece, *Al's Epic Leer* makes use of chordal presentation, such as in bars 5 and 6 in the prelude (Ex. 1.6), as well as continuing to allow repeated notes and moving backwards through the set, though now only once the set has been presented as per the correct ordering. To clarify, each bar properly presents the pitches in the correct order, maintaining treble and bass placement of linear sets which never deviates. However, the lines may move back and forth across the set, though never skipping, and always finishing the bar on the final note for that bar's set ensuring that the initial ordering of the first attack of each note in the bar fully complies with the determined order. This allows more freedom in the piece, whilst still keeping the music within the intended parameters and keeping the harmonic material flowing as it should. There is also more extensive use of metre changes in *Al's Epic Leer*, which aids the attempt to compose a less mechanical piece, with more character.

The image shows a musical score for two staves, treble and bass clef, in 4/4 time. The key signature has one flat (B-flat). The score is divided into two measures, labeled 5 and 6. Measure 5 is marked with a forte (f) dynamic and contains a series of chords. Measure 6 is marked with a pianissimo (pp) dynamic and also contains a series of chords. The chords in both measures appear to be variations of a set, presented in a chordal manner. The notation includes stems, beams, and various accidentals (sharps, flats, naturals) to indicate the specific pitches and their articulation.

Ex. 1.6: *Al's Epic Leer*, bars 5–6, chordal presentation of set

As in *Al's Icier Pee*, I assigned set pitches to treble and bass staves to produce artificial aggregates and continued to use the method of reintroducing rhythmic devices when set was split between the staves in identical ways in different bars; however, in *Al's Epic Leer*, this is restricted. I created rhythmic interest by offsetting the beginning of some treble bars by using rests. I favoured similar melodic shapes, often rising above the first note of the bar, then falling down below it, which gives a cohesive sense of melody. There are also bar-long rhythmic cells repeated throughout the piece, contributing to the overall material coherence of the piece. An example of this is seen in Ex. 1.7, which shows a recurring bass rhythmic motif in bars 13, 15, 16, 28, 34, 36, 40, 41, and 45.

13 ♩ = 118

17

21

27

32

37

41

The musical score consists of eight bass staves, each representing a different bar from the piece. The staves are numbered 13, 17, 21, 27, 32, 37, 41, and 45. Each staff begins with a bass clef and a time signature. The notation includes various rhythmic values, rests, and accidentals. The first staff (bar 13) starts with a tempo marking '♩ = 118'. The staves show a variety of rhythmic patterns, including eighth notes, quarter notes, and rests, often with accents or slurs. The time signatures change throughout the piece, including 3/4, 4/4, 2/4, 3/2, and 3/4.

Ex. 1.7: *Al's Epic Leer*, bars 13–45, bass motif recurring in bars 13, 15, 16, 28, 34, 36, 40, 41, and 45

This smaller number of repeated elements, compared to the number of different elements seen in *Al's Icier Pee*, produces a work which, despite being short, allows elements to be repeated enough times for familiarity to develop for a listener before the piece ends.

A short comparison

All three pieces discussed in this chapter have been approached in different ways. The freedom of the composer in *Nerthus* is almost limitless, as is the case with music written in this more intuitive method, taking a partially self-restricted style which makes use of repeated cells and some developments of these cells and the inclusion of cluster chords to highlight the subject of the piece. In comparison, the 'Al' pieces both employ a more rigid approach to structure, tonality, and, to a lesser extent, rhythm. Whilst the number of newly introduced pitches in a bar is restricted, the allowance of repeated pitches and entirely free rhythm make the potential almost limitless. Of course, in comparison to more totally serial works, even the 'Al' works are relatively free in their composition.

Nerthus is the most free work of this project, and whilst this is not a systematic piece, many other composers have chosen to approach systematisation in their compositional process freely. Berio was exposed to serialism through the music of Dallapiccola; however, Berio did not like all aspects of Dallapiccola's music. He was not interested in the geometries of the row and surrounding music, which Dallapiccola had taken from his studies on Webern's music. Between 1951 and 1954, Berio took on serialism only as much as it suited him and his music. *Chamber Music* (1953) was an example of his serial writing where the row he used was designed to enhance lyricism in the music, rather than to erase tonal elements. The first setting, 'Strings in the Earth and Air' uses a malleable

approach to tone rows, in fact often reordering and using incomplete fragments of the row. He allows skipping over notes too in some areas, particularly when other notes sound which could be thought of as replacing the missing note. Berio approached the concept of integral serialism with a certain caution, yet by 1954 he was already putting the techniques to good use, when he visited Darmstadt, in the work *Nones*, which is based on a very symmetrical thirteen-note series. In fact, it was so symmetrical that the twelve transpositions and retrogrades exhausted all potential, and so he allowed himself to read the rows as fragments, from either end to the centre. Whilst not all compositions in this project have been without freedom, this sort of compositional freedom has never been allowed in the project and generally became more system controlled as the project progressed.

Once I had completed the phase of the project where these early and simple pieces had been completed, it was time to tackle the first major step in the project – response to imagery.

Chapter 2

The Jasper Series

Not Just Yet: a response to calcite

Whilst this chapter predominantly aims to address the Jasper Series, a series of four works written in response to an image of a slide of jasper by Weston, a first response to imagery was made to another of Weston's images, this time of calcite. There is a long history of music responding to visual stimuli and it is still an area of music composition which is explored in a vast number of ways today, particularly in areas of electronic composition¹⁸. There are even examples of artists who have attempted to systematically produce artworks from music, such as Jack Ox, who has created art works based on works by composers including Bruckner. She created a Brucker Colour Wheel, as well as a Consonance-Dissonance Wheel, and contrived algorithmic processes to create her artwork.¹⁹ There are also composers who create artworks or graphic scores before then traditionally notating and orchestrating the music from their graphic score, as Hannah Kendall did in her 2017 work *The Spark Catchers*.²⁰

I initially began my work in this area by considering the various musical factors I aimed to be able to systematise, and how a system could function and respond to the imagery. In the first instance, I made an attempt to respond visually

¹⁸ App development is seeing a move towards algorithmic processes which can derive music from image, such as Bloom, an interactive app developed by Brian Eno and Peter Chilvers, which, on their website *Generative Music* (Bloom Information page <<http://www.generativemusic.com/bloom.html>> [Accessed 6 December 2020]), they describe as 'Part Instrument, part composition and part artwork'.

¹⁹ Jack Ox series of Bruckner's themes from the eighth symphony <<https://intermediaprojects.org/pages/Bruckner.html>> [Accessed 8 December 2020].

²⁰ Catching Sparks: In Conversation with Composer Hannah Kendall <<https://seattlesymphony.org/watch-listen/beyondthestage/hannah-kendall>> [Accessed 8 December 2020].

in a simple way to one of Weston's images of a slide of calcite (Fig. 2.1). From this, I wrote the piece *Not Just Yet*, for flute, clarinet in A, piano, violin, and cello.

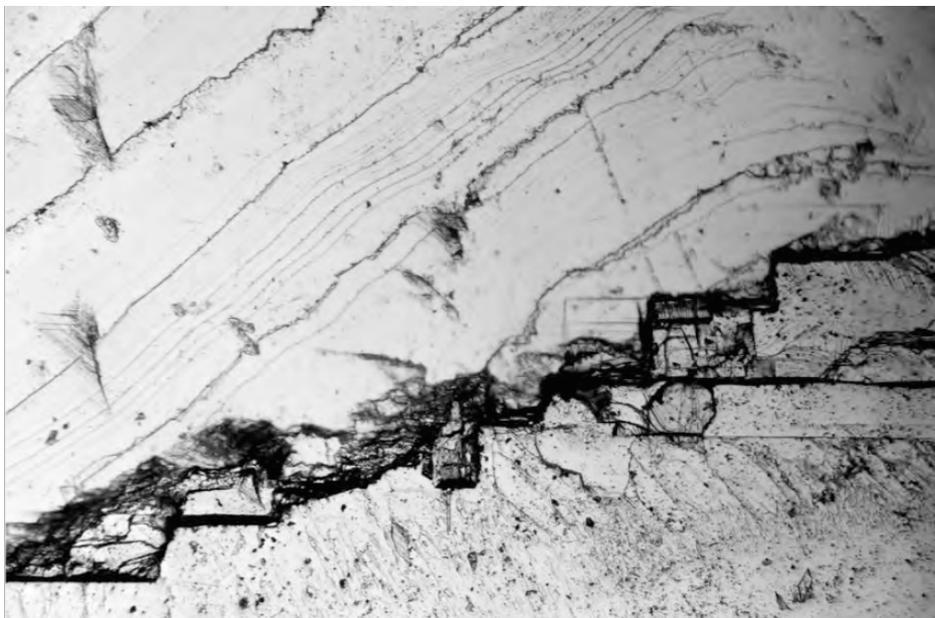


Fig. 2.1: Richard Weston, *Calcite*, reproduced with permission from Richard Weston's private archives. 30x magnification.

To create a simple system from the calcite slide, I superimposed a grid over the image, where horizontal lines tracked pitch and imposed boundaries to the pitch ranges for each instrument, and vertical lines tracked the duration (Fig. 2.2).

The image was split vertically into five main columns, each of which was subdivided into six smaller sections. Each of these five main columns covered the duration of one minute, whilst the six subdivisions covered ten-second subsections. Coloured horizontal lines were imposed on the image, each colour relating to the pitch range of an individual instrument. Using two horizontal coloured lines for each instrument, I assigned an upper and lower boundary for the pitch range of each instrument (Table 2.1).

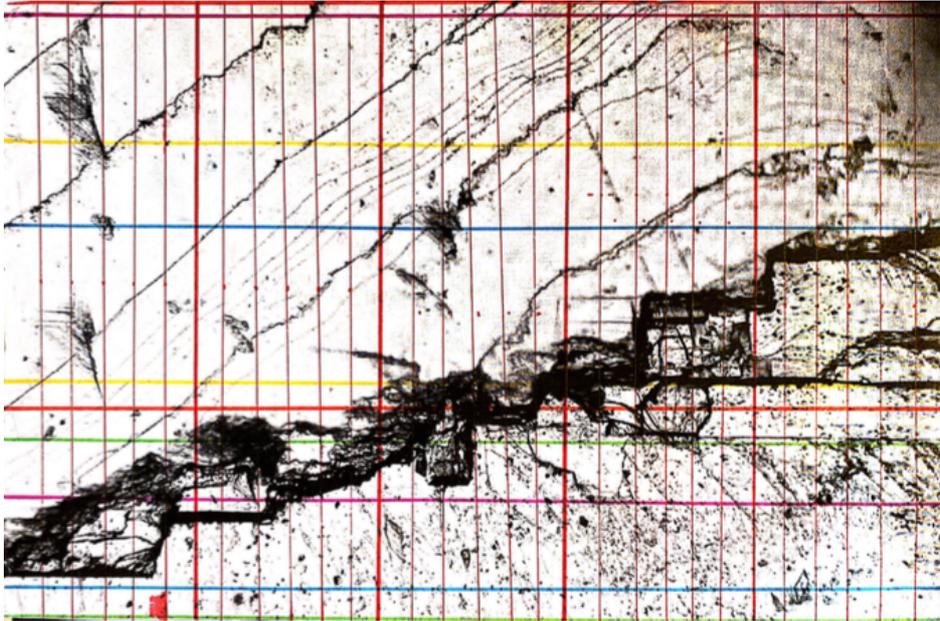


Fig. 2.2: Calcite with coloured duration and pitch boundary lines.

Table 2.1: *Not Just Yet* pitch boundaries for individual instruments and colour code.

Colour	Instrument	Lower Register Limit	Upper Register Limit
Green	Flute	C4	C7
Purple	Clarinet in A	E3	C7
Blue	Piano	A0	C8
Yellow	Violin	G3	E7
Orange	Cello	C2	E6

The boundaries for each instrument were staggered across the image and the lines and shapes of the image contained within these boundaries loosely determined the overall shape of the pitch material. The choice to use this fluid pitch approach was effective in the respect that I was able to make the best use of the full range of each instrument, by selecting lines within the image and applying boundaries

directly to the limits of the lines. However, by doing this, each instrument does not respond to the full height of the image, and furthermore, the uppermost and lowest points of the image are not responded to at all – an issue I avoided in future pitch-mapping attempts. The boundaries were applied to the image to highlight lines in the image which I thought would be effective for the instrument, for example, the piano parameters were placed around the thickest and most varied line in the image because I felt that this would effectively play to the strengths of the piano, such as the substantial pitch and dynamic range, as well as the ability to play chords and clusters. Ex. 2.1 shows the opening of the work, which highlights the thick chord in the lowest register of the piano, which represents the thick, dense, and low line from the original image, from which the piano part is drawn. Throughout the line, the music rises in response to the rising line in the image.

Piano

ffff pp f pp

15b**

Ex. 2.1: *Not Just Yet*, piano, bars 1–5.

This approach is not dissimilar to that of Xenakis in some of his stochastic works, such as *Achorripsis* (1957), in which he created a system whereby the density of events would be dictated. Matrices were created which would dictate density of events in each instruments part in each section.²¹ Elements of this approach were also used in later works, such as *Nomos Alpha* (1965) and *Mikka* (1976), where sound waves were mapped and used to create the music.

²¹ Ronald Squibbs, 'The Composer's Flair: *Achorripsis* As Music', in *Definitive Proceedings of the "International Symposium Iannis Xenakis"*, ed. Makis Solomos, Anastasia Georgaki, Giorgos Zervos, (Athens: Definitive Proceedings, 2006) p. 4.

The primary issue with this approach was the excessively flexible parameters; within the boundaries applied, pitches were relative, yet not clearly defined and controlled, and rhythms were purely instinctive. Textural response was made to the image, e.g. longer lines resulted in more slurred phrases and shorter lines resulted in shorter rhythms and staccato moments. This approach, however, resulted in a piece where more composer decisions were required than I desired, as the system did not generate musical material in the way required to fulfil my criteria as systematic music.

Jasper's Lament: a first response to jasper

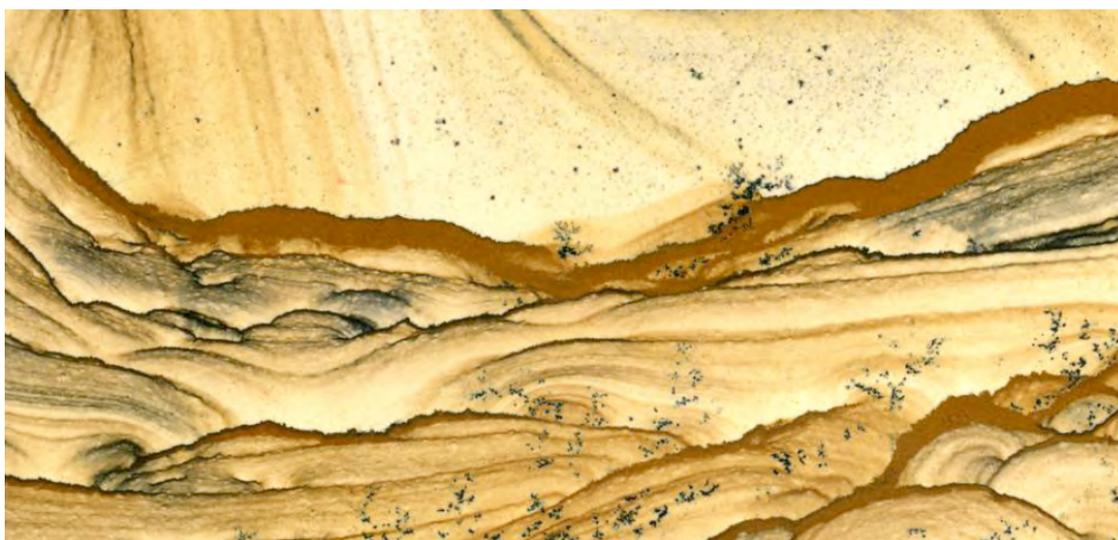


Fig. 2.3: Richard Weston, *Jasper*, reproduced by permission from Richard Weston's private archives. 3x magnification.

When planning *Jasper's Lament*, in order to address the issues I identified with the approach to *Not Just Yet*, I applied the same concept of a grid laid over the image to generate pitches for each of the instruments, but this time more precisely. For the Jasper Series, I respond to an image of a slide of jasper (Fig. 2.3). A grid was created and applied to the image (Fig. 2.4), subdivided and

labelled to create a graph, in a similar way to *Not Just Yet*, but now with smaller subdivisions (Fig. 2.5). This graph comprises 52 columns, each representing one bar, and labelled 1 to 52 along the x-axis (each of these was further subdivided into four smaller columns), and 104 numbered rows representing pitch, each representing the interval of a semitone and labelled 1 to 104 along the y-axis.

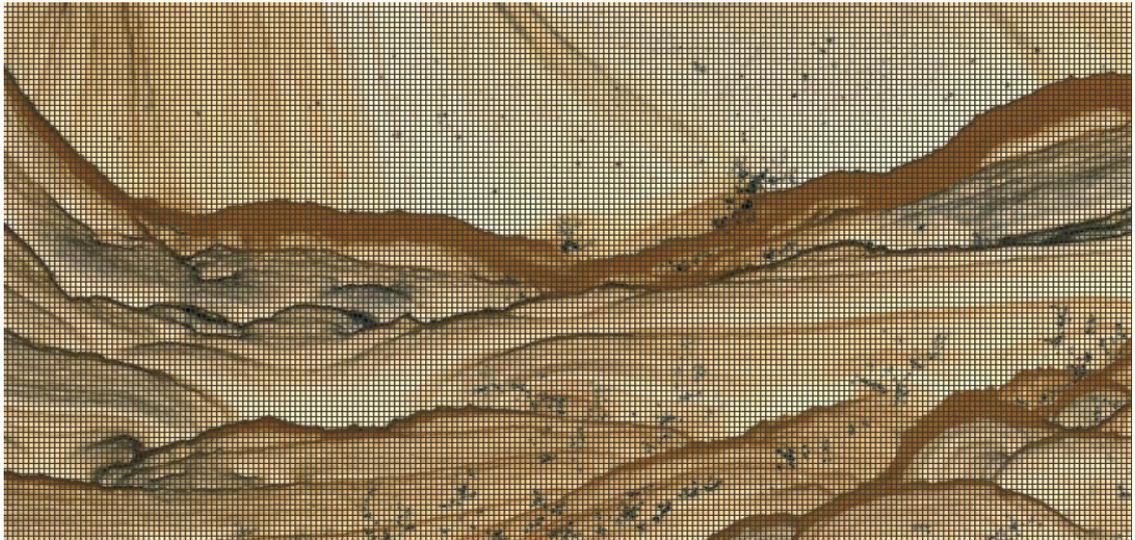


Fig. 2.4: *Jasper* with pitch and duration grid applied.

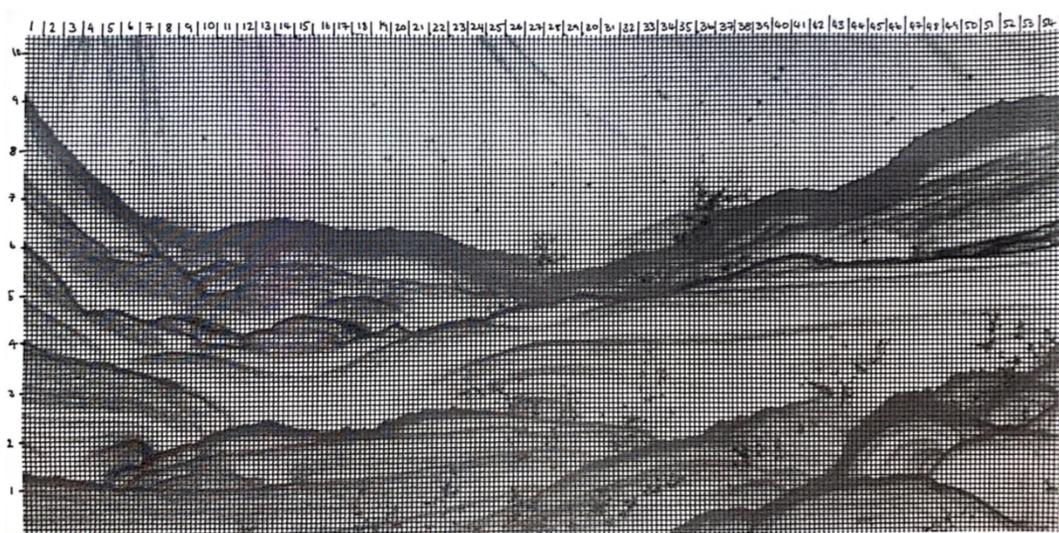


Fig. 2.5: Image of *Jasper* with grid as used for composition showing boundaries used.

Each instrument was given a range of 40 points across the y-axis, which was to formalise the pitch material (Table 2.2), and was assigned a lower and upper pitch boundary according to the range and capabilities of the instrument. This resulted in the y-axis being used as a sliding scale, with values referring to different pitch ranges according to which instrument's pitch material was being extracted. For example, the viola occupied points 30 to 70 up the y-axis, with 30 denoting the pitch C3, up to 70 denoting E6. On the other hand, the cello was assigned points 10 to 50 up the y-axis (10 = C2 to 50 = E5). When being applied to the cello, point 30 indicates G#3, whereas when it is applied to the viola, it indicates C3.

The fluid use of the y-axis allowed for the crossover of pitches within the range, in an attempt to avoid instruments with similar pitch ranges resulting in unison or close to perfect/consonant pitch intervals, as I was hoping to produce music which makes use of a range of harmonic tensions, particularly moving in and out of close harmonies and dissonant intervals. This marked the first point in my research where I was both attempting to find new ways to respond to imagery systematically and trying to find a way to create lines that are capable of being both varied but also having simultaneously similar melodic shapes which can create coherence between the parts.

Table 2.2: Jasper's Lament pitch boundary information.

Instrument	Graph Pitch Range (y-axis)	Pitch boundaries				
Violin 1	60–100	60–G3	70–F4	80–D#5	90–C#6	100–B7
Violin 2	40–80	40–G3	50–F4	60–D#5	70–C#6	80–B7
Viola	30–70	30–C3	40–A#3	50–G#4	60–F#5	70–E6
Cello	10–50	10–C2	20–A#2	30–G#3	40–F#4	50–E5

This technique has similarities to that which Xenakis developed in *Evryali* (1973) where, like in *Mikka*, Xenakis drew shapes into his computer screen before the image was mapped, tracked, and then notated traditionally. Crucially, the image was drawn on graph paper, with one semitone equalling one millimetre.²²

To further systematise the approach and to distance my own choices from the system and music, die rolls were used to determine the number of notes each instrument would play in each bar, using a four-sided die (D4). The D4 was rolled fifty-two times for each instrument, once per bar, to ascertain how many notes each instrument would sound per bar, a sample of which is seen in Table 2.3.

Table 2.3: Number of notes sounding in each instrument in the first 23 bars of *Jasper's Lament*.

Bar Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Violin 1	3	1	3	4	1	3	4	4	3	1	3	1	1	3	1	3	1	3	3	2	2	4	3
Violin 2	1	2	1	2	4	3	1	3	2	1	4	1	1	4	3	2	3	4	2	1	3	1	4
Viola	3	1	4	4	3	2	3	4	2	4	4	4	1	4	4	1	3	4	1	1	2	2	1
Cello	3	1	2	1	4	2	4	2	3	3	4	4	3	3	1	2	2	4	1	4	3	2	1

Further D4 rolls were then used to produce the cell choices for each bar. That is, which of the four subdivisions of each of the fifty-two columns are used. They were used in order of rolling, not from low to high, and repeated numbers were allowed. E.g. violin 1, bar 1, has three notes in it, as seen above. The three die rolls for violin 1, bar 1, were 3,1,1 as seen in Table 2.4, and are used in that order.

²² Iannis Xenakis. *Formalized Music*. (Hillsdale, New York: Pendragon Press. 1992), p. 269.

Table 2.4: Cell choice for each instrument in first 11 bars of *Jasper's Lament*.

Bar Number	1	2	3	4	5	6	7	8	9	10	11
Violin 1	3,1,1	1	3,3,2	4,2,3,1	3	3,2,2	2,3,1,1	1,2,2,4	4,4,2	3	3,4,4
Violin 2	3	4,2	3	1,1	1,1,4,3	1,4,3	4	3,2,1	2,3	4	3,4,3,1
Viola	4,4,1	4	4,1,1,3	2,2,2,4	2,1,1	4,3	3,4,3	3,4,2,2	4,4	2,1,4,4	3,4,2,1
Cello	4,1,4	3	2,3	3	2,1,3,2	3,3	2,1,2,3	1,2	3,4,1	1,3,2	2,1,1,4

The cell choices, as shown in Table 2.4, were written out fully, and then applied to the grid on the image in order to produce the full list of pitches for each instrument, bar by bar. In order to generate the pitches using this data, the content of the image was viewed through the designated cell column for each bar. Where there are features in the image, a pitch was able to be determined by taking note of the cells across the y-axis in which these features occurred. The rhythms were applied intuitively, and I made some other small changes to allow some variation, such as glissandi. Of course, there are some repeated rhythmic cells used to aid coherence in the piece and to create melody lines. There are also moments of punctuated rhythm where the instruments play homorhythmically. This is seen particularly in bars which were similar over a longer period due to static lines in the image or repeated die rolls. Dynamics and articulation were also applied freely. Table 2.5 shows a list of the instruments and their notes in the opening twelve bars, once they were applied to the image and given a related pitch. Ex. 2.2 shows the first four bars of the quartet, displaying the use of the data extracted for Table. 2.5 applied to the pitch material.

Table 2.5: Instrument pitches dictated for first twelve bars of *Jasper's Lament*.

Bar Number	1	2	3	4	5	6	7	8	9	10	11	12
Violin 1	C6, C6, D6	G#5	D5, D5, D#5	A4, B4, A#6, C5	F#4	D#4, (gl.)E4, D#4	C#4, C#4, C#4, C4	C4, C4, C4, B3	A#3, A#3, B3	A#3	A#3, B3, B3	B3
Violin 2	C#5	G#4, B4	E4	D4	F4, F4, F#4, F#4	E4, D#4, (gl), E4	C4	B3, B3, A#3	A3/C4, G#3, C4	C4	A#3, A3, A#3, B3	A3
Viola	A3, A3, A#3	G3	F#3, G3, G3, (gl) F#3	G3, G3, G3, F#3	C#4, (gl) D4, D4	E3, F3	D#3, D3, D#3	D3, C#3, D#3, D#3	C3	B2, C3, A2, A2,	C3, C3, B, 3, A#2	F3, F#3, F, E
Cello	D#2, E2, D#2	D2	D2, C#2	C#2	E2	C#2, C#2	C2, C#2, C2/E2	G#2, A2	A2, A2, G#2	A2, B2, A#2	A3, A3, A3, A#3	C#2, D, D, D

turbulent ♩ = 72

The musical score shows four staves: Violin 1, Violin 2, Viola, and Violoncello. The tempo is marked 'turbulent' with a quarter note equal to 72 beats per minute. The key signature has one sharp (F#). The score includes dynamic markings of piano (p) and forte (f) for each instrument. The Violin 1 part starts with a half note F#6, followed by a half note G#5, and then a half note D#5. The Violin 2 part starts with a half note C#5, followed by a half note G#4, and then a half note E4. The Viola part starts with a half note A3, followed by a half note G3, and then a half note F#3. The Violoncello part starts with a half note D#2, followed by a half note D2, and then a half note C#2.

Ex. 2.2: *Jasper's Lament*, bars 1–4.***Jasper's Regret*: a second response to jasper**

As previously stated, *Jasper's Lament* made use of creative application of rhythm, articulation, and dynamics. When beginning the second of the Jasper Series works, *Jasper's Regret*, I endeavoured to continue to develop the system to

generate more musical potential from the image and began to include systematisation of dynamics, rhythm, and articulation.

Messiaen catalysed development of total serialism with his *Mode de valeurs et d'intensités* (1950), which is a significant early approach towards total serialism. Whilst this is not technically a serial work, Messiaen took an approach that affected the ordering of not only pitch, but also note values, dynamics, and articulation. These musical events were pre-ordered as a mode with three divisions, but there was no serial application. Each pitch was assigned its own dynamic, duration, and register. Though he made much use of the order of the original sequence, there was no strict ordering or regulation of how and when certain values could be used before being reused. Though it is clear this mode-based idea follows on somewhat from the work produced by the Second Viennese School, Messiaen was outspoken in his disapproval of their tendency to exclusively systematise pitch but to adhere to traditional approaches to rhythm and form.²³

Prior to this project, systematisation of rhythm is an aspect of composition that I have regularly found unsatisfactory, often resulting in excessively difficult or mechanical and shapeless music. In my attempt to systematise the rhythm, I looked to the approach Messiaen took in *Mode de valeurs et d'intensités*, and produced twelve different durations, though I chose to apply them to a serial matrix. In order to do this, I wrote out my twelve rhythmic durations and applied numbers 0 to 11 to them, before using a twelve-sided die (D12), to produce a random order of numbers from 1 to 12, following the serial principle of not allowing repeated numbers, then reducing each of these by one to produce a 0 to

²³ Robert Sherlaw Johnson, *Messiaen* (London: Omnibus Press, 2009) p. 106.

11 row. I then used this as a P0 line and created a serial matrix by using inversions, as you would with a pitch-based matrix, though applied to numerical values rather than pitch. Unlike Messiaen, I chose to include rests as well as note values, with the view that this would hopefully result in more satisfactory and interesting music than had my previous attempts, and perhaps even produce music that contains melodic shape. Once the matrix was put together, the rhythms were applied part by part to the pitches which were derived from the image for *Jasper's Lament*. By this, I mean each row of rhythms was applied to each individual instrument, from beginning to end of the piece, one after the other with no variation and with no movement other than through the row in a consistent order, with each instrument working systematically through the whole matrix. This was done on a rolling system across the piece, starting with P lines, followed by I lines, then R lines, and finally RI lines. Once the initial lines were depleted, the cycle began again. Lines were used from 1 to 12 for the P and I lines, and then 12 to 1 for the R and RI lines, beginning with violin 1, then violin 2, then viola then cello (e.g. violin 1 – P1, violin 2 – P2, viola – P3, cello – P4, violin 1 – P5, and so on), and are marked on the score above the point at which each enters (Fig. 2.6).

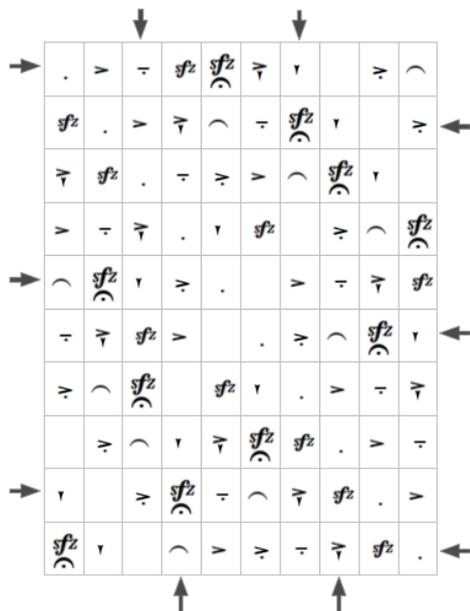


Fig. 2.7b: Violin 1 matrix.

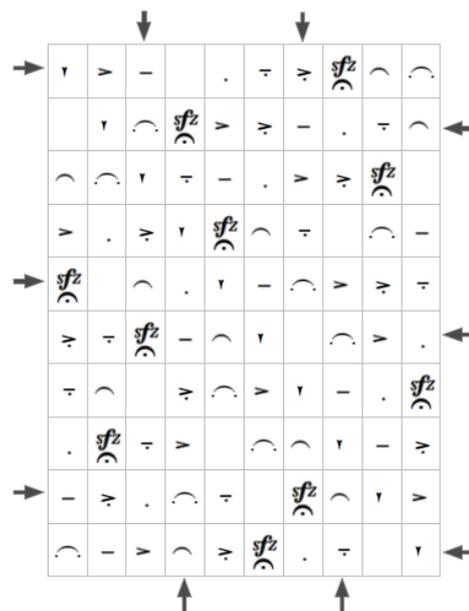


Fig. 2.7c: Violin 2 matrix.

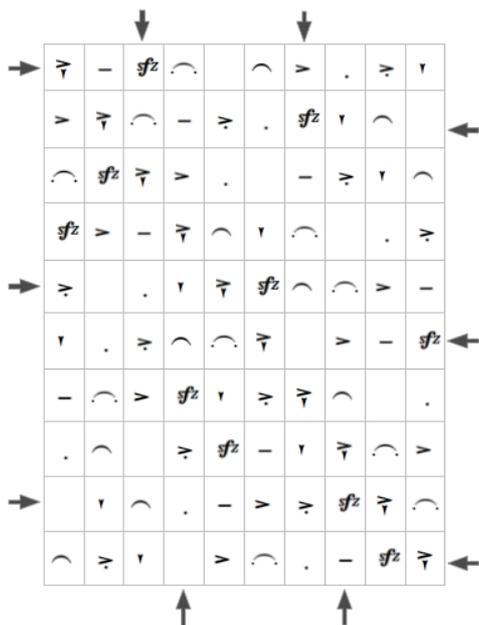


Fig. 2.7d: Viola matrix.

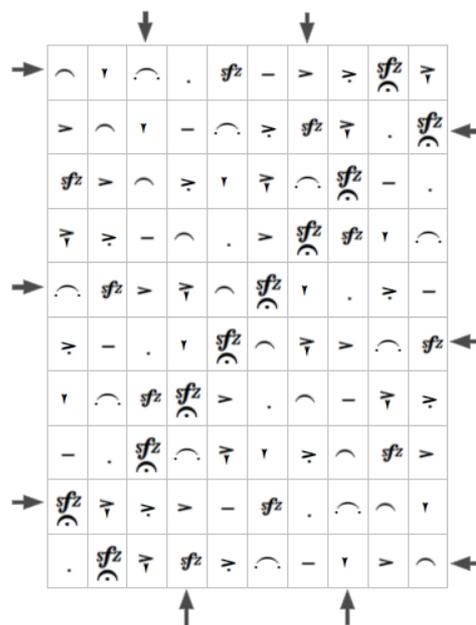


Fig. 2.7e: Cello matrix.

Many other composers have made use of matrices which are not 12x12, such as Boulez who in his composition of *Structures 1a* (1952), where he created a row of ten for articulations, due to the difficulty of finding twelve clearly distinct forms of attack to create 10x10 matrices. Ligeti, not a fan of Boulez's approach to composing *Structures 1a*, said of it, '...and the tables [were] finally used like a

fetish, as a measure for duration qualities [rather than their musical content].²⁵

When composing using Magic Squares, Peter Maxwell Davies did not use 12x12 matrices, instead opting to use Magic Squares ranging in size from 3x3 to 9x9. His 1975 work *Ave Maris Stella* was composed using Magic Square matrices which worked with a modulus 9 approach²⁶, producing a 9x9 matrix from which he drew material in a liberal way.²⁷

Notationally, when a ‘*sfz*’ and ‘*sfz* with fermata’ symbol would arise during a crescendo or diminuendo (dynamics will be discussed below), they were purposefully placed to interrupt them with the intention that they should particularly stand out over the surrounding notes, and then immediately return to the still rising or falling dynamic that was already present in the line. As there are fermatas present in some, but not all, instruments, there is an issue of irregularity within the length of the parts per bar. For this reason, in this piece, the fermata indicates that the note should be extended slightly by beginning the note ahead of where it is written to begin, thus extending the notes without making it too difficult to play as an ensemble. After discussion with performers, I decided that this was not a suitable alternative to clearer notation, and notated it as I intended a performer to play it. The unedited score of *Jasper’s Regret* is included in the appendix.

The approach to systematisation of dynamics in *Jasper’s Regret* was a simple application based on pitch, whereby the lowest registers of each instrument

²⁵ György Ligeti, ‘Pierre Boulez’, in *Die Reihe (4) Young Composers*, ed. Herbert Eimert and Karlheinz Stockhausen; trans. Leo Black, (Eng. edn.), (London: Theodore Presser, 1960), p. 40.

²⁶ David Roberts, ‘Review of Peter Maxwell Davies: Ave Maris Stella, Dark Angels, Five Klee Pictures, Miss Donnithorne’s Maggot, Stedman Doubles, Stevie’s Ferry to Hoy, Stone Litany, Symphony, Vesalii Icones, Westerlings, and Worlde’s Blis’ in *Contact*, ed. Keith Potter, Hilary Bracefield, David Roberts, and John Shepherd, London: Goldsmiths University of London, 1978), p. 28.

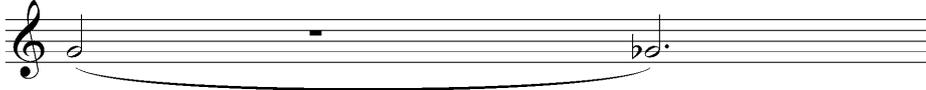
²⁷ His choice of material would sometimes be taken from rows, or fragments of rows, and sometimes following various patterns across the Magic Squares.

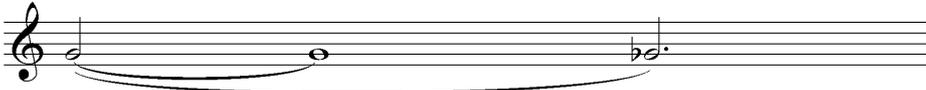
were assigned a *pianissimo* marking, and the highest were assigned *fortissimo*. Pitches in-between were split into sections, with crescendi and diminuendi over lines which dropped or rose in pitch over a period. By handling the dynamics in this way, it allowed the dynamics of each individual instrument to directly respond to the image, without requiring the creation of a new systematised response to the image, as the pitch responds to height of line in the image and so too do the dynamics. The only issue that arose through this was that sometimes the articulations would be difficult to produce on certain instruments with the pitches that were dictated by the system. However, I found this to be an interesting and satisfactory idiosyncrasy of the combination of types of systematisation, and particularly effective when it appears during longer crescendi or diminuendi.

Each musical parameter that was systematised had identical rows chosen, i.e. all parameters begin with the P1 line, but because the articulation matrices for each instrument are individual, the articulation rows extracted were different for each instrument. Articulation lines were chosen in the following order: P1, P5, P9, I3, I7, R10, R6, R2, RI8, RI4, I2 to match the pitch row choices made for violin I (though some fell short of this final line and not all lines were completed) and are marked on the score over the lines where they begin in the above figuration but with an A (articulation matrix set) at the beginning of each row (e.g. AP1). The unedited version of *Jasper's Regret* is included in the appendix and includes row information.

Some issues arose with regards to systematisation of rests due to their inclusion in the durational matrix, where slurs or staccato slurs would often fall over rests. In this case, I let the slurs go from the note before to the note after the

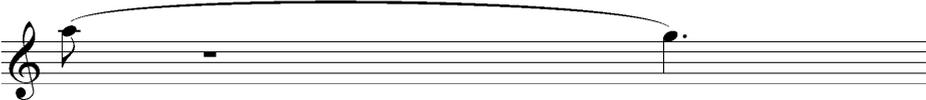
rest, and decided on clarified playing arrangements for when these arise. A note slurred to another note over a rest should be played as though the value of the rest is part of the first note, thereby extending the first note to the full value of the note and rest, then moving on to the second note, allowing further variation of the rhythm rows. The notated appearance and how it should be played are shown in Ex. 2.3 which is taken from the cello part in system 2.

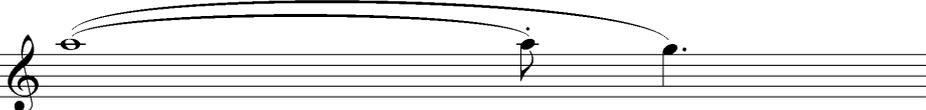
Written: 

Sounding: 

Ex. 2.3: Example of how a notated slur over a rest should be played by the performer.

A slur with staccato over the rest should be approached in the same way, though with a slight pause on the break without removing the bow from the string, and continuing the bow in the same direction, similar to the way a normal staccato slur would be played on a string instrument. This is also laid out in Ex. 2.4, taken from the viola part in system 2.

Written: 

Sounding: 

Ex. 2.4: Example of how a notated staccato slur over a rest should be played by the performer.

The final note of the violin 2 part also caused an issue as it was meant to be a slur. I decided against using this, and instead replaced it with a staccato accent. The reason for this choice was because although slurring onto a rest has been seen in

the past, notably by composers such as Mahler,²⁸ the specific intention for which he used it is not applicable to this composition and so I felt it best to instead provide a sense of closure to the piece.

When writing one of his best-known forays into total serialism, *Structures Ia*, Boulez came across a number of issues, most notably the interaction between the ranges, dynamics, and articulations of instruments, which at times were contradictory. Boulez did intervene – perhaps more actively than I have done – swapping loud dynamics for quiet ones, but always ensuring that he borrowed them back at a later point, so that the balance might be restored. Once Boulez’s various matrices had been created, they were simply laid over one another, and chords occasionally occurred as a coincidence. Ligeti states that this uncontrollability has its roots in traditional twelve-tone composition; however, he defends this approach to composition, stating, ‘The “poor old serialist” is no more a captive than the tonal composer chained to his cadences...’²⁹

The systematisation of new parameters in *Jasper’s Regret* have in some ways led to a more pleasing outcome, yet there are also aspects which would need to be readdressed. The systematisation of rhythms led to a more unstable and flexible rhythmic language, whilst the articulations created further interest within the piece, especially as some lines are rather static. The dynamics, though producing a full range, certainly make possible a more individualistic approach, whilst remaining systematic. All of these previous forms have mixed direct response to imagery, such as pitch and dynamics being based on line shape, with an indirect response, such as the articulation charts reading through the matrices

²⁸ See Gustav Mahler, Eighth Symphony, Part 2: Äußerst langsam, Adagissimo, bar 784 vln. 1, (Universal Edition, 1911).

²⁹ György Ligeti, ‘Pierre Boulez’, in *Die Reihe (4) Young Composers*, ed. Herbert Eimert and Karlheinz Stockhausen, trans. Leo Black, (Eng. edn.), (London: Theodore Presser, 1960), p. 53.

in order once created. Whilst I endeavour to produce variation in the different components of the music, as part of this research I recognised the need to create a system where all musical parameters respond to the image independently, rather than via the systematisation of pitch or any other element of the music, in order to more accurately respond to the image, to push the boundaries of systematisation, and to explore the consequences.

Alongside the unedited score of *Jasper's Regret* (appendix A1), I also produced a fully metred performance score (included in the composition portfolio), though in practice the metre is for ease of reading only and performers would not play with any metric beat emphasis.

Jasper Reborn: a new approach to jasper image response

Of course, many composers have used non-musical stimuli in the past. In Ligeti's *Apparitions* (1959), the composer makes use of the Fibonacci series to systematise the rhythm; however, it was pointed out by Gianmario Borio that Ligeti made so many small changes to the process that what remained was not particularly reminiscent of Fibonacci.³⁰ This is not an approach generally taken in this project, as one of the primary goals of this project is to test the limits of systematisation and to fully explore the raw potential; but in day-to-day application of systematic processes to composition, I have adopted a more flexible approach to systematisation in previous works.

Ligeti was also interested in computer representations of fractals, and these would go on to inspire him in some aspects of his music, such as the fourth movement of his Piano Concerto (1988), which made use of Mandelbrot sets, a

³⁰ Richard Toop, *György Ligeti* (London: Phaidon Press Limited, 1999), p. 67.

type of computer-generated fractal.³¹ Every element of this movement, from the smallest detail to the overarching form, uses the same basic shape, derived from this. This economical approach, whereby one attempts to drain every ounce of potential from the material is a method very much used in this project. I attempt to build on systems, reuse the same tone rows and pitch rows and other such rows for two reasons – to ensure the testing of the system is fair (i.e. a better-quality pitch row might inadvertently lead to a false improvement of the system) and to show the potential of these systems to generate a range of different types of music. This is also the reason that the works of the Jasper Series refer to only one image.

In my initial thoughts about how I might respond to the images, one of the first and most interesting approaches I considered was to find a way of responding to colour. However, it is important to the project that this was done in a literal way and as I do not have synaesthesia, I needed to find a way in which I could extract data directly from the image. I decided a suitable way to do this would be to reduce the resolution to the point where I was left with a small number of very large pixels of colour, and to use this as the basis for my extraction. I managed to do this to the point where I was left with a very convenient six blocks by two, creating a total of twelve pixels (Fig. 2.8). This image of twelve pixels is derived from the entire jasper slide that was used for the previous two jasper pieces.



Fig. 2.8: *Jasper* with reduced resolution to produce twelve pixels.

³¹ Ibid., p. 193.

From this, I was able to use an online HTML code extractor³² to get the RGB value, hex codes, and HSV values of each colour. The RGB code ordinarily indicates the intensity of red, green, and blue in a digital image. The hex code is a way of specifying colour. The HSV value indicates the hue, saturation, and value of a digital image. There can be some gradation within each block due to a slight colour gradient towards the edges of pixels and so I took the first set of information gleaned from the centre of each large pixel. The data extracted is shown in Table 2.6, following the top line of Fig. 2.8 left to right, then bottom line, left to right.

Table 2.6: RGB, hex codes, and HSV values of each pixel from Fig. 2.8.

RGB	216,178,114	233,200,143	239,218,171	234,208,157	227,205,156	217,191,140
Hex code	#d8b272	#e9c88f	#efdaab	#ead09d	#e3cd9c	#d9bf8c
HSV code	37,56%,64%	38,67%,73%	41,68%,80%	39,64%,76%	41,55%,75%	39,50%,70%
RGB	202,171,117	205,174,120	216,180,122	218,179,120	223,188,130	220,190,136
Hex code	#caab75	#cdae78	#d8b47a	#dab378	#dfbc82	#dcbe88
HSV code	38,44%,62%	38,45%,63%	37,54%,66%	36,56%,66%	37,59%,69%	38,54%,69%

This wealth of information left me with a lot of scope for how I might extract musical data. I needed a hinge point for the numbers to be applied to musical parameters and needed to decide how best to handle the approach to taking information for four instruments. I decided that numerical rows would be based on the RGB code, on a per pixel basis and that all instruments would share the same tone row. As I wanted to ensure that all parts were not moving in perfect harmony (dissonant or otherwise), I wanted to discover a way where not only would the numerical information mean something different to each instrument, but that it would also change as the piece went on, further ensuring rich and varying harmonies.

³² Image Color Picker Homepage <<https://imagecolorpicker.com>> [Accessed 16 June 2017].

Rotating base tones were produced for each instrument, based on the hex code, by extracting the letter names in order on an instrument-by-instrument basis. Rather helpfully, all letter names were within the A to F range, and as each code starts with a #, I decided to use this to further the potential of the data by using it as a sharp applied to the following note (e.g. the first part of the first pixel's code is #d, and so this is extracted as a D# for the violin 1). It is worth noting that these base tones are simply the tones from which the numerical rows are counted, and are usually not heard, rather, the only time the actual base tones are seen in the resulting tone rows are at the third pitch of pixel 4, as the numerical row here ended on a one. So, despite the fact that the base tone for violin 1 in the first pixel is D#, the first note is a B. This is because the numerical row for the first pixel starts with a 9 (discussed below), and the ninth degree of the chromatic scale starting on D# is B.

The numerical pitch tones were extracted from the RGB code, but posed an issue. I wanted to produce rows with the capacity to contain all twelve pitches, but if I took the numbers as they came individually, the highest number I could achieve was 9 and choosing groups of notes as they were presented was unlikely to be effective either. To tackle this, I opted to use the digit sum of each set of three numbers separated by a comma and if it was 1 to 12 this would be the number chosen. If it were higher, then 12 would be removed until it was at 12 or fewer. This produced a numerical row which would then be used to produce definite pitches in the next stage.

Table 2.7: Digit sums of RGB values of each pixel from Fig. 2.8.

RGB Digit Sums	216,178,114 9,16(4),6	233,200,143 8,2,8	239,218,171 14(2),11,9	234,208,157 9,10,13(1)	227,205,156 11,7,12	217,191,140 10,11,5
RGB Digit Sums	202,171,117 4,9,9	205,174,120 7,12,3	216,180,122 9,9,5	218,179,120 11,17(5),3	223,188,130 7,17(5),4	220,190,136 4,10,10

These selections swapped systematically from violin 1 to violin 2, viola, then cello, before restarting at the top, apart from a few exceptions:

- In the first pixel, only two letters are present, therefore only violins 1 and 2 play in this first part. They start with different notes because the hex code has dictated that the base tone in pixel 1 for violin 1 is D# and the base tone in this pixel for violin 2 is B. As the RGB code dictates that the first note should be the ninth degree of the twelve-tone scale, the instruments start on B and G respectively.
- In the event of only three pitches in a pixel, the fourth instrument would receive an arrow to indicate continuation of the previous pixel tone, such as pixels 1 to 2 in violin 2.
- Whenever possible, repeated tones would be avoided; therefore, if the regular rotation of the instruments meant that one instrument would have the same base tone for two pixels, then it would be skipped over and revisited, thus ensuring all instruments applied new base tones, as can be seen, for example, in pixels 4 to 5 where violin 1 should receive the first note of the row, but is already on an E#, and so it is skipped to violin 2. Incidentally, the third note of this row which should have been applied to the cello was a D which the cello already had, and so violin 1 took this and the cello took the fourth pitch as it would have originally.

This series of digit sums results in a numerical row which can be applied to each of the four instruments and their respective base tones on a pixel-by-pixel basis.

The rows are shown in Table 2.8 and Table 2.9.

Table 2.8: First half of the numerical row in *Jasper Reborn* producing definite pitch material for instruments.

Numerical Row	9	4	6	8	2	8	2	11	9	9	10	1	11	7	12	10	11	5
Violin 1	B	F#	G#	C	F#	C	D#	C	A#	C#	D	E#	C	G#	C#	C	C#	G
Violin 2	G	D	E	F#	C	F#	F#	D#	C#	F	F#	A	D#	B	E	G#	A	D#
Viola				C	F#	C	A#	G	F	A#	B	D	A#	F#	B	D	D#	A
Cello				G	C#	G	F# C	D# A	C# G	A#	B	D	A#	F#	B	A	A#	E

Table 2.9: Second half of the numerical row in *Jasper Reborn* producing definite pitch material for instruments.

Numerical Row cont.	4	9	9	7	12	3	9	9	5	11	5	3	7	5	4	4	10	10
Violin 1	E	A	A	A#	D#	F#	F	F	C#	C#	G	F	F	D#	D	F#	C	C
Violin 2	C	F	F	G	C	D#	B	B	G	G	C#	B	A	G	F#	D#	A	A
Viola	C	F	F	G#	C#	E	G	G	D#	A	D#	C#	B	A	G#	D	G#	G#
Cello	D	G	G	D#	G#	B	F	F	C#	A	D#	C#	F#	E	D#	G	C#	C#

An anomaly arose in the third pixel (the seventh, eighth, and ninth pitch sets in Table. 2.8) in which there were five letters in the hex code. This surplus pitch was given to the cello as it was the next instrument in the rotation and so produces dyads for the three parts of the tone row it applies to, which are used in the piece as double stop notes, F# and C, then D# and A, and finally C# and G.

The articulation and rhythm tables produced for *Jasper's Regret* were used, but no longer function as rows. Instead, the HSV code percentages were used as coordinates, applied to the articulation and rhythm matrices, e.g. the first

cell has the HSV codes 37, 56, and 64, which become the coordinates 3,7 5,6 and 6,4. These are applied to the matrices with the first number dictating the x-axis, and then the second dictating the y-axis. This purposefully resulted in a piece which is homophonic, avoiding melodic qualities, whilst simultaneously exploiting the production of a different series of articulations for each of the instruments due to the fact the four instruments have individual articulation tables.

Dynamic markings were based on the hex code on a scale of 0 to 9 and extended techniques applied to the extremities, with *col legno battuto* on 0, and Bartók pizzicato at 9. As with rhythm, all instruments share dynamic markings in order to maintain a sense of coherence, primarily because I was satisfied with the outcome of this application in previous Jasper Series works, as well as with the use of the extended techniques. Table 2.10 shows the full breakdown of dynamic register used. The systematisation of dynamics in this manner has been attempted by composers before, notably by Milton Babbitt in *Post Partitions*, where sets are also presented in distinct registers of the piano and distinguished by articulations. Pitches are directly related to dynamics, with a C being *fffff*, a B being *ffff*, etc., which is not dissimilar to the approach seen in *Jasper Reborn*.

Table 2.10: Dynamic markings applied to numbers from the hex code in *Jasper Reborn*.

0	<i>PPP</i> col legno battuto
1	<i>PPP</i>
2	<i>pp</i>
3	<i>p</i>
4	<i>mp</i>
5	<i>mf</i>
6	<i>f</i>
7	<i>ff</i>
8	<i>fff</i>
9	<i>fff</i> 

This approach to using non-musical information as a means of generating material has similarities with the approaches to composition used by James Worlton. In his 2003 work, *Concerto for Organ and Orchestra*, he uses mathematic principles including prime numbers and the golden ratio to systemise elements of the composition, including a formal structure, pitch, and rhythm. Like the rotating base tones I used in the composition of *Jasper Reborn*, he converts the relationships between instruments to different bases, as he found that it created ‘a wealth of material’ for material generation.³³

³³ James Worlton, *Systematic Composition and Intuition in a Concerto for Organ and Orchestra*, Doctor of Musical Arts Thesis, University of North Texas, Denton, TX, 2003.

Jasper Rises and Jasper Reigns: final approaches to jasper image response

Once I had finished composing *Jasper Reborn*, I began work on the fourth work of the Jasper Series, *Jasper Rises*. *Jasper Rises* sets out to combine some of the best aspects of the previous systems and was split into two distinct sections. The first section from bars 1 to 29 acts as a prelude to the work, based mainly on the homophonic approach seen in *Jasper Reborn*, though the section is extended and the inclusion of a horn to the instrumentation means the pitch-based rotations provide new pitches for the notes. The work has also been properly metred in *Jasper Reigns*, in order to aid performance of the work. The second section takes a melodic approach, as seen in *Jasper's Regret*, with staggered melody lines, continuing with the usual approach to application of rows used in the Jasper Series, with no deviation from the row. The issue of ambiguous notations, surrounding staccato and staccatissimo articulations on long notes arose again in this piece.

I had originally intended for performers to approach the ambiguous articulations by assuming that a *staccato* should be reduced to half the value and *staccatissimo* to a quarter. After discussing this with performers, however, I concluded it would be best to simply notate the music in the way I intended a performer to play, rather than true to the system.

Jasper Reigns was to be the last of the Jasper Series, primarily an extension of the methodology behind *Jasper Rises*. This time, the music was split into five sections, alternating between the opening homophonic material and the melodic line approach, both as seen in *Jasper Rises*. The long notes here were notated for the performer, rather than true to the system.

Jasper's Farewell

The final piece to be discussed in this chapter, though not a work I consider to be a part of the Jasper Series, is *Jasper's Farewell*. The approach taken for *Jasper's Farewell* was that I would be able to use *Jasper's Regret*, one of the denser works produced from the Jasper Series, to generate material and to use it as a framework to produce a new piece that directly draws from the systematic work, but at the same time, is not strictly systematic. . The only things that were strictly the same as *Jasper's Regret*, were the pitches and the points of attack. For example, the original score shows a D dotted minim on the second beat of the second bar in the first violin and so if this note is selected to be used in *Jasper's Farewell*, it must be a D and it must strike at that precise moment. Anything else could be changed, be it register, length of note (either shorter or longer), articulation, dynamic or extended technique. Tempo markings did not carry over, nor did time signatures, though the value of all notes, whether used or not, still counted and space could not be diminished, e.g. the above mentioned D in the first violin is originally in 6/4, but if the new piece were to be in 4/4, then it would strike on the second beat of the third bar. A crotchet has the value of a crotchet regardless of the time signature the music was put into in each use.

Jasper's Farewell is a three-movement work, for string quartet, with each movement being based on one entire iteration of *Jasper's Regret*. Choices were made freely and intuitively during the composition, with each movement having a particular function or goal in mind. The approach to *Jasper's Farewell* is a similar approach to my own use of compositional systems in day-to-day composing; systems are used to generate music, potentially give music a direction, but not necessarily to dictate the work in its entirety.

Material was drawn from *Jasper's Regret* to focus on textural elements for the first movement. From the original score, material was chosen based on points of attack that fall close to each other but never together. The focus here was that any clusters of notes that attacked generally within a quaver of another note would be included. What this produced was a number of short figures throughout, as moments of great excitement and pressure building. Longer notes become more common as the movement continues, with hints of melody naturally occurring occasionally through the movement, though always short lived. This piece was also given textural variety, with a number of techniques including pizzicato, Bartok pizzicato, varying vibrato approaches, and scratch tone utilised, as well as extremes of dynamic marking. The movement is underpinned by a moderate tempo of C=88 and an appropriate 'unsettled' character marking, to highlight the constantly changing energy in the moment.

The second movement took material from *Jasper's Regret* based on the vertical harmony within the movement. All note changes were taken from points where more than one instrument would have a note strike at the same time, meaning that in the second movement of *Jasper's Farewell*, almost every pitch change in one instrument is accompanied by simultaneous changes in one or more of the other instruments. At 78 bars, no solo parts were allowed in the first 74 bars and it is marked *molto legato*. Instruments are muted throughout this work to reduce intensity and soften the timbre and they rise in dynamic from bar 70 for first violin and cello, and 72 for second violin and viola from *mp* where they have been since the beginning of the movement to an *ffff* scratch tone, with the cello hanging over into bar 75. The final 4 bars exploit the different lengths of material in *Jasper's Regret*, to end the piece with a whimsical and seemingly out of place

solo in the cello. This was also inspired by my admiration of the music of Francis Poulenc, who would often end pieces with a short statement, a feature which I have borrowed in several of my works.

The third and final movement was based on short linear figures which move around each other, creating at times, a quasi-contrapuntal texture, and occasionally exploiting textural shapes and gestures that I found effective that had occurred in *Jasper's Regret*. There were moments in *Jasper's Regret* which lent themselves perfectly to this exploitation of textural gestures, such as in bar 54, where a single-note figure moves between the four instruments, before falling back down in bars 57-8. This movement, like the first, has an unsettled and this time, pulsating quality to it, with figures constantly rising and falling in terms of dynamics, textures, and density. The uneven ending to *Jasper's Regret* was overcome here by allowing the original solo between the viola and cello to continue to the end, whilst extending the final note of the first violin to the final moment.

My reasoning behind the approach to each of these movements was that my systematic processes have a tendency to be focussed linearly, rather than vertically. By choosing material based entirely on the texture created by points of attack, vertical harmony, and interplay between parts I have been able to compose a piece suitably varied and well structured, whilst still drawing from heavily systemised music.

In this process, *Jasper's Regret* could be thought of as a work which has been used as a large set of possible materials from which I can draw the work I most want to create. If I had wanted to use the approach I took to composing *Jasper's Farewell*, to compose a piece that was serial, or even a consonant piece, I

would have been able to. This approach of using the systemised work as a palate of material is capable of producing extremely satisfying works.

By taking what I had learnt from the creation of the system of the Jasper Series and addressing issues that arose, I looked to move on to creating the all-encompassing Holotrix system. Writing the Jasper Series helped me not only in my creation of new systems, but in my understanding of the task ahead of me – to successfully create a system that removed the need for a composer's creative input. As each of these creative choices became apparent, I looked to tackle and eliminate the need for that choice; indeed this elimination of choice being the most crucial element of Holotrix. These choices will be discussed in chapter 3.

Chapter 3

The Holotrix system

A transformative process took place through the Jasper Series. From a simple graph being overlaid on the image, to significant quantities of data being taken from a pixelated image and applied to various musical elements in a number of ways, the foundation work had been completed. I had found a way to extract a sufficient quantity of information from the image and to convert it into musical material. I now needed to turn this approach to using data and various systematic elements into a large-scale system capable of dictating and systematising almost all creative choices a composer would usually make. The small-scale works which tested the various aspects of systematisation resulted in a set of approaches to different musical components which were then applied as a collective to create the new Holotrix system.

Etymologically, the word ‘Holotrix’ was taken from the Greek cardinal prefix ‘όλο’, meaning ‘whole’, ‘entire’, or ‘all’ and ‘trix’ taken from the word matrix, which stems from Latin. All movements follow the same mixture of origins for their titles, with Greek prefixes taken primarily from the cardinal prefixes. The first movement took the prefix from the Greek multiple proportional quantitative prefix ‘prot’, primarily because the Greek cardinal prefix for ‘one’ can also be ‘holo’, which would mean both the system, the work, and the first movement would all be called Holotrix. A full list of the names of the movements of *Holotrix* and their origins is shown in Table 3.1

Table 3.1 *Holotrix* movement names, prefix origins, and degrees of systematisation in each movement. [FC = Free Choice (a free choice of rows applied within the limitations of the system), DD = Die Dictated, SD = System Dictated].

Movement Number	Movement Name	Movement Prefix Origin	Systematised Musical Aspects
1	Protrix	Greek multiple proportional quantitative prefix	Pitch (FC)
2	Deutrix	Greek ordinal prefix	Pitch (FC), bar count (DD)
3	Tritrix	Greek cardinal prefix	Pitch (FC), bar count (DD), rhythm (FC)
4	Tetratrix	Greek cardinal prefix	Pitch (FC), bar count (DD), rhythm (FC), articulation (FC)
5	Pentatrix	Greek cardinal prefix	Pitch (FC), bar count (DD), rhythm (FC), articulation (FC), dynamics (FC)
6	Hexatrix	Greek cardinal prefix	Pitch (FC), bar count (DD), rhythm (FC), articulation (FC), dynamics (FC), motion (FC)
7	Heptatrix	Greek cardinal prefix	Pitch (SD), bar count (DD), rhythm (FC), articulation (FC), dynamics (FC), motion (FC)
8	Octotrix	Greek cardinal prefix	Pitch (SD), bar count (SD), rhythm (FC), articulation (FC), dynamics (FC), motion (FC)
9	Entrix	Greek cardinal prefix	Pitch (SD), bar count (SD), rhythm (SD), articulation (FC), dynamics (FC), motion (FC)
10	Decatrix	Greek cardinal prefix	Pitch (SD), bar count (SD), rhythm (SD), articulation (SD), dynamics (FC), motion (FC)
11	Hendecatrix	Greek cardinal prefix	Pitch (SD), bar count (SD), rhythm (SD), articulation (SD), Dynamics (SD), motion (FC)
12	Dodecatrix	Greek cardinal prefix	Pitch (SD), bar count (SD), rhythm (SD), articulation (SD), dynamics (SD), motion (SD)

One of the earliest ideas I had wanted to realise in this project was the creation of a twelve-movement work, where in each of the movements, some degree of composer input would be eliminated. I decided that the best way to approach this

was to split the twelve movements into two halves. The first six movements would systematise each of the six musical parameters in turn, leading to a sixth movement in which the composer is able to freely select all musical content but only from options presented by the system. This would be followed by a further six movements, where the composer's freedom of choice over each parameter was gradually eliminated one by one.

I decided to follow the historical precedent of pitch being one of the first parameters to be widely systematised. Every movement of this work is entirely serial with regards to pitch, though in movements where the length is dictated, the rows may not be completed as the bar count was strictly adhered to. Serial techniques, though perhaps not widely used, are still used by many contemporary composers today. Joel Gressel has written compositions, including *Is It Serious?* (2010), inspired by a meeting with Babbitt after a performance of *Philomel* (1964), which utilise a Babbittian approach to composition using serial techniques.³⁴ Other composers, such as Jeffrey Mumford still use rows, such as in his two Elliott Carter tributes, *For Elliott* (1983-4) and *A Celebration of Elliott* (2006). Today, Mumford still uses tone rows in his music, but harmonies them intuitively.³⁵

Beyond the first movement, composer control was ceded over the following parameters in each of the following five movements in turn: length of each movement in bars, rhythm, dynamics, articulation, and motion. By motion, I mean the way that a melody line moves when the pitch row is applied, e.g. if the first two notes in a row are C and D, the composer would need to choose whether

³⁴ Joel Gressel, 'Is It Serious?', in *Perspectives of New Music* (Vol. 49, No. 25), ed. Benjamin Boretz, Robert Morris, and Dorota Czerner (Seattle: Perspectives of New Music and Open Space, 2012), p. 171.

³⁵ Jeffrey Mumford, *Personal Email*, 27 July 2020.

the D would be higher or lower than the C – the system eliminates this choice.

The bar count aspect of Holotrix was eventually replaced with the flux system, which will be discussed below.

The systematic approach used in the Jasper Series continued through the Holotrix works. Attempts were made to ensure the system could run as smoothly as possible and without generating confusing notations. Furthermore, the ongoing goal was always, when confronted with a decision to be made, to find a way to eliminate this need for decision-making by the final movement of the work. This first issue came about with the motion matrix, which sought to eliminate the choice of upwards and downwards movement when following pitch matrices. Through this series of pieces and reworkings of the system, Holotrix became capable, apart from the creation of the matrices and of course the actual system itself, of producing a compositional work. The experimental approach to Holotrix resulted in three works being created – *Holotrix*, *Holotrix(b)*, and *Holotrix(b.2)*. After this, a final composition was made, called *Holotrix 2* – which showed the potential diversity of the system, and had a few final changes made to the system from *Holotrix(b.2)*. Although this final work only had two movements – applying the methods of the first and the twelfth movements from the original systematic approach – these two movements were created as the purpose of this work was not to show the gradual decline of composer input, as I had done in the previous Holotrix works, but to show how different the work, particularly the final movement, could be with different initial material, as much of the first movement is the basis of the entire work. For the benefit of the reader, I will start by fully discussing the original Holotrix system used in *Holotrix*, before then referring to

changes to each of the six areas of musical systematisation across the second, third, and fourth compositions collectively.

Holotrix

As explained above, the first six movements of each of the *Holotrix* works introduce the six areas of systematisation. In the first work, they were introduced in the following order: pitch, bar count, rhythm, articulation, dynamics, and then motion. For movements seven through to twelve, the choice of rows applied from each parameter were systematised one by one, until the twelfth movement, which was the movement in which all areas of musical choice are systematised. The order in which these areas were systematised through movements seven to twelve were in the same order as in the first six movements: pitch, bar count, rhythm, articulation, dynamics, and finally motion.

The choice of material used in certain rows for *Holotrix* was taken from a work that is very important to the history of systematised music, Messiaen's *Mode de valeurs et d'intensités*. The pitch material is taken from his first division, whilst the array of dynamic and articulation choices are drawn from the work but applied differently. In all *Holotrix* system pieces, once a row begins, it cannot be paused, reversed, or in any other way manipulated. The only time that a row may not be fully presented is when the piece runs out of bars before the row is finished, in which case the bar count restriction overrules the pitch row material, and it simply stops – the number of bars cannot be edited to complete a pitch row. Repeated notes may not occur within the row and the only time that repeated notes may occur is if the last pitch of the former row is the same as the first pitch of a new row, which since I had control over the pitch rows, I actively did on a number of occasions, to encourage the impression of melodic lines in the works. Ex. 3.1

shows bars 5 to 7 of ‘Deutrix’ from *Holotrix*. Here, the trumpet pitch row R4 ends with a G and is immediately followed by line RI0 which also begins with a G, forcing a repeated note within the confines of the system’s restrictions. Fig. 3.1 shows the pitch material used in *Holotrix*.

Ex. 3.1: ‘Deutrix’, *Holotrix*, bars 5–7.

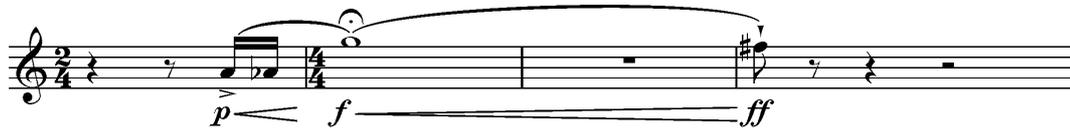
	I ₀	I ₁₁	I ₆	I ₅	I ₄	I ₃	I ₁	I ₁₀	I ₉	I ₇	I ₂	I ₈	
P ₀	E \flat	D	A	A \flat	G	G \flat	E	D \flat	C	B \flat	F	B	R ₀
P ₁	E	E \flat	B \flat	A	A \flat	G	F	D	D \flat	B	G \flat	C	R ₁
P ₆	A	A \flat	E \flat	D	D \flat	C	B \flat	G	G \flat	E	B	F	R ₆
P ₇	B \flat	A	E	E \flat	D	D \flat	B	A \flat	G	F	C	G \flat	R ₇
P ₈	B	B \flat	F	E	E \flat	D	C	A	A \flat	G \flat	D \flat	G	R ₈
P ₉	C	B	G \flat	F	E	E \flat	D \flat	B \flat	A	G	D	A \flat	R ₉
P ₁₁	D	D \flat	A \flat	G	G \flat	F	E \flat	C	B	A	E	B \flat	R ₁₁
P ₂	F	E	B	B \flat	A	A \flat	G \flat	E \flat	D	C	G	D \flat	R ₂
P ₃	G \flat	F	C	B	B \flat	A	G	E	E \flat	D \flat	A \flat	D	R ₃
P ₅	A \flat	G	D	D \flat	C	B	A	G \flat	F	E \flat	B \flat	E	R ₅
P ₁₀	D \flat	C	G	G \flat	F	E	D	B	B \flat	A \flat	E \flat	A	R ₁₀
P ₄	G	G \flat	D \flat	C	B	B \flat	A \flat	F	E	D	A	E \flat	R ₄
	RI ₀	RI ₁₁	RI ₆	RI ₅	RI ₄	RI ₃	RI ₁	RI ₁₀	RI ₉	RI ₇	RI ₂	RI ₈	

Fig. 3.1: Pitch matrix used in *Holotrix*.

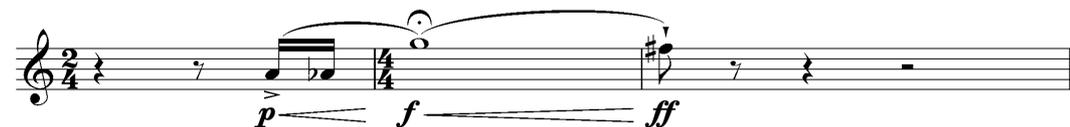
Protrix

Whilst it remained largely the same, some small changes were made to ‘Protrix’ from *Holotrix* to *Holotrix(b)*. The number of bars was decreased from 61 to 50.

This reduction generally came from shortening of longer held notes; for example, in the first few bars a motif is cut short by a semibreve, which does not affect the shape or integrity of the music but helps to resolve a few personal dissatisfactions I had with the original (Ex. 3.2 and Ex. 3.3).



Ex. 3.2: *Holotrix*, Protrix – bars 3–6.



Ex. 3.3: *Holotrix(b)*, Protrix – bars 3–5.

Primary and secondary matrices

Within works composed using the Holotrix system, there are always twelve movements, and these were created using twelve serial-style matrices introduced one by one in each movement. The first six matrices (primary matrices) directly gave the choice rows for each of the areas of systematisation and the final six (secondary matrices) dictated choices from the first six; for example, in movement twelve of *Holotrix*, the seventh matrix dictates the choices taken from the eighth, which in turn dictates the choices taken from the bar count matrix and the tenth matrix and so on.

Movement 6:

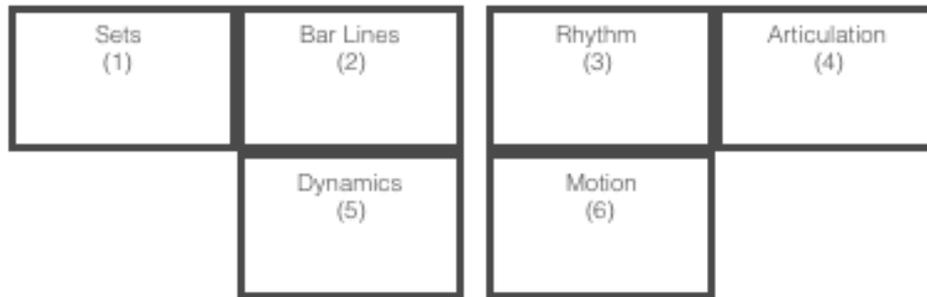


Fig. 3.2: Hexatrix, *Holotrix* – matrix application: at this point, all six areas of systematisation are now in action, but the composer still has the choice of which rows to use from each.

Movement 9:

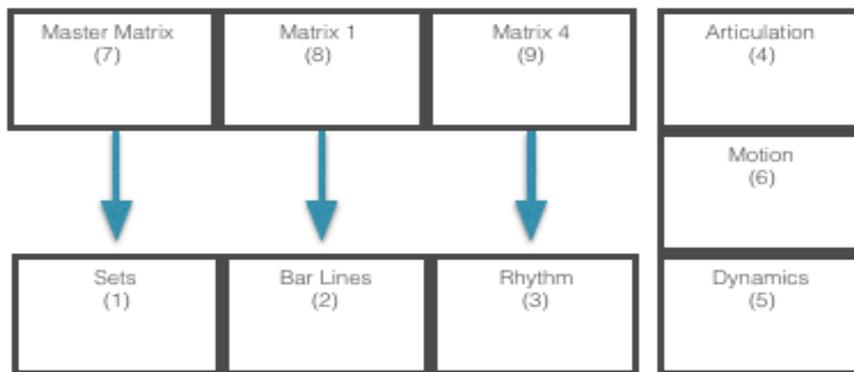


Fig. 3.3: 'Entrix', *Holotrix* – matrix application: pitch sets, the bar count, and the rhythm are dictated by secondary matrices. Articulation, dynamics, and motion are composer choice.

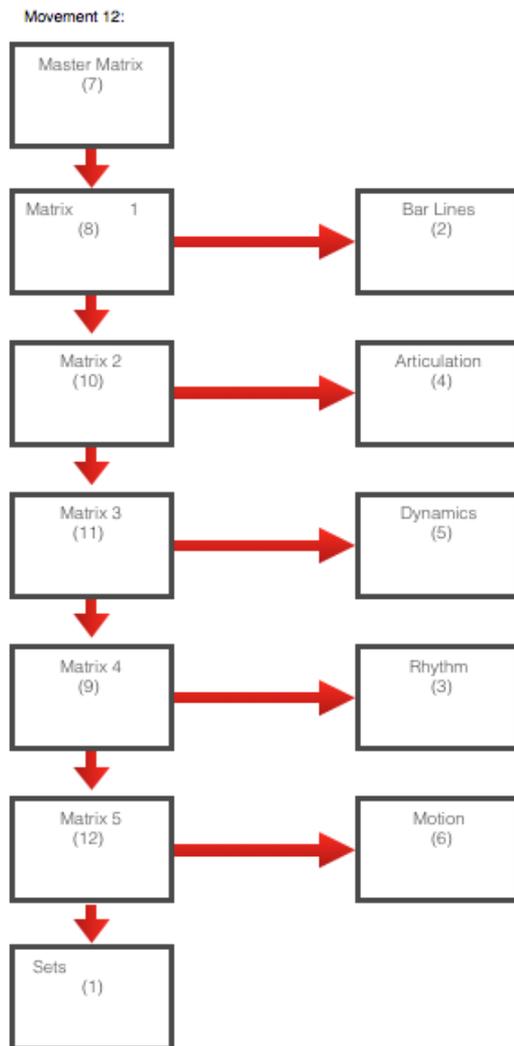


Fig. 3.4: ‘Dodecatrix’, *Holotrix*, – this shows the reorganisation of the secondary matrices for the twelfth movement. The arrows show the matrices that each secondary matrix dictates. N.b. matrix 1, sets, refers to pitch sets.

Throughout the first eleven movements of the works, secondary matrices control the same primary matrices (as can be seen in Figs 3.2 to 3.4). In the twelfth movement, one matrix becomes the ‘master matrix’ which dictates all choices from secondary matrices, and the musical aspect which the newly-appointed master matrix formerly dictated is now doubled up onto another secondary matrix, e.g. in movement nine of *Holotrix*, the seventh matrix dictates the set choice (see Fig.3.3), whereas in movement twelve, the seventh matrix functions as the ‘master matrix’, and the newly applied Matrix 5 (12) dictates both motion and pitch sets

(Fig. 3.4). The reason for this was that I felt that the first secondary matrix to be introduced was significant to the work and would arguably have the most impact, so it made sense for this one to become the master matrix.

As mentioned above, the first six movements introduced each of these parameters one by one with the primary matrices as detailed in the previous paragraphs. The last six movements introduced the automation of each of these with the application of secondary matrices which are used to dictate which rows should be taken from the primary matrices. Secondary matrices were put together and contain rows of various row descriptors, e.g. P0, R11, RI8, etc., each cell dictating another row in the primary matrices. Of course, until the twelfth movement, there is no systematised way of dictating which of these secondary matrix rows should be chosen, and whilst the choice is free in the early movements in the second half, the choice is intended to be eliminated. In order to remedy this, but still leaving the interrelation of secondary matrices until the final movement, I made secondary matrix choices through the use of die rolls. Using a D12, I created coordinates. The first roll would dictate whether I read from the P, I, R, or RI row, and the second would tell me which row to read working clockwise around the matrix. For the P, I, R, RI rows, a 1, 5 or 9 indicted a P row, 2, 6 or 10 would indicate an I row, a 3, 7 or 11 would indicate R and 4, 8 or 12 would indicate an RI row. This means that a roll of an 8 and then a 12 would tell me to take the final row working clockwise from the RI side of the matrix. Doing this meant that rolling two dice dictated twelve full rows from the primary matrix.

In the twelfth movement, when all of the secondary matrices are interrelated, the above rule was applied to the master matrix. If the master matrix dictated a P3, then the top secondary matrix would be read as the third row

working clockwise on the P side, which would in turn dictate which rows to read from the secondary matrix below it, and the bar count matrix, continuing down through the matrices until all aspects have been systematised by two rolls of a die, and essentially, the entire piece is composed, leaving the composer only to extract the data and present it.

Numerical matrices

Most of the matrices dictating both the rows of the various parameters and the choices to be made in the Holotrix system are created using ‘numerical matrices’. By this, I mean a matrix which is composed entirely of numbers and then has other parameters laid over the top. The concept of a numerical matrix is not an original one in this project, and was in fact used by Boulez in *Structures 1a*. The duration series was a twelve-value series, meaning it matched the length of the pitch rows, and rows were generally combined like for like, e.g. pitch row 1 alongside duration row 1, in a similar way to my approach to sets in the Jasper Series. Due to the fact that the rows are numerical ones with the other musical components laid over them, it means that there is no consistent interrelationship between transposed rows, that is to say, a C in one pitch row will not necessarily have the same articulation and dynamic markings as a C in another pitch row.

To generate my numerical matrices, I applied the same principles used in a traditional pitch-based row, but with numbers applied rather than pitch. To begin with, using a random number generator (RNG), or rolls of a twelve sided die, I created a series of numbers from 0 to 11 (or 1 to 12) which works serially, i.e. all twelve numbers must occur once in every row and column, with no repetition or deviation. This row would then be applied across the top of the serial matrix and the matrix would be completed by following the inversion as you would with

pitch; for example, in Fig. 3.5, the first number in the prime row is a 4 followed by an 8, so it has raised by four. In the inversion line, therefore, the next figure is lowered by 4, resulting in a 0, remembering that the only options are 0 to 11, so, for example, 0 to 4 = 8. This process is continued to finish the matrix in the same way one would finish a pitch-based matrix.

4	8	7	0	1	9	10	6	11	3	5	2
0	4	3	8	9	5	6	2	7	11	1	10
1	5	4	9	10	6	7	3	8	0	2	11
8	0	11	4	5	1	2	10	3	7	9	6
7	11	10	3	4	0	1	9	2	6	8	5
11	3	2	7	8	4	5	1	6	10	0	9
10	2	1	6	7	3	4	0	5	9	11	8
2	6	5	10	11	7	8	4	9	1	3	0
9	1	0	5	6	2	3	11	4	8	10	7
5	9	8	1	2	10	11	7	0	4	6	3
3	7	6	1	0	8	9	5	10	2	4	1
6	10	9	2	3	11	0	8	1	5	7	4

Fig. 3.5: *Holotrix* dynamic numerical matrix.

Once this had been done, I went through a process of deciding upon which values I would use, which changed from one *Holotrix* work to the next. An RNG was used to create a row which would then be applied to a sequence of increasing dynamic markings, which were then applied to the numerical matrix. In *Holotrix 2* spaces were added into the lines in order to encourage coherence within the work by limiting the number of changes of articulation, dynamics, and motion. The number of spaces before the sequence was used in order was dictated by the roll of a die. Table 3.2 shows the process of applying the numerical row to the dynamics, and then the tone row dictating the prime dynamic row. Fig. 3.6 shows the completed dynamic matrix.

Table 3.2: *Holotrix 2* dynamic numerical row conversion.

Dynamic marking		pp	p	mp	mf	f	ff					
RNG row	6	10	1	11	7	8	4	5	0	9	2	3
Tone row	4	8	7	0	1	9	10	6	11	3	5	2
Prime row in matrix	ff	f	mf		p		pp		mp			

ff	f	mf		p		pp		mp				
	ff		f					mf	mp	p	pp	
p		ff		pp		mf		f				mp
f		mp	ff		p		pp		mf			
mf	mp	pp		ff		p				f		
mp			mf	f	ff		p		pp			
pp		p		mf		ff				mp	f	
			pp	mp	mf	f	ff		p			
	p						mp	ff	f	pp	mf	
		f	p		pp	mp	mf		ff			
	mf		mp		f			pp		ff	p	
	pp				mp		f	p		mf	ff	

Fig. 3.6: *Holotrix 2* – Completed dynamic matrix.

The six areas of systematisation in *Holotrix*

1 and 2. Bar count and pitch

The approach to the systematisation of bar count in *Holotrix* was very simple, but aimed to create a series of movements with some variety of length. A blank matrix was made and a series of bar counts were applied to it, decided using an

RNG with a high limit of 122 and a low limit of 5, in the hope of creating a piece that would have shorter and longer movements. The choice of bar numbers in the first movement was free and from movements two to eight I chose the rows that suited the number of bars I wanted in each movement. Pitch was approached serially, with no deviation from the row and no repetition allowed.

3. Rhythm

A numerical matrix was made using an RNG for the initial row, and individual rhythmic values were applied to each of the numbers in the same way as with the dynamics, before being applied to the matrix. From the third movement until when the rhythm is fully systematised in the ninth, the rhythm rows were chosen by myself from the matrix to try to find moments which would cause rhythmic unison between the instruments and develop more coherence.

4 and 5. Articulation and dynamics

As explained above, a numerical row was created using an RNG and used to make a numerical matrix. Articulations were applied to these individual numbers and so an articulation matrix was created. From the fourth movement until the tenth movement, when the articulation was fully systematised, I was able to choose the articulation rows I wished to use. Dynamics were applied to the system and composition in the same way as the articulation.

6. Motion

Similarly, with motion, a numerical matrix was made, and six up arrows and six down arrows were applied to each number in the same way as previously

mentioned, resulting in six up arrows and six down arrows in each row. This was applied to the notes generated by the chosen or given row and dictated whether the following note should go up or down from the previous one. This worked rotationally, e.g. if a flute played a middle C and the motion dictated the next note should be lower, then it would move to a high range note.

After having put this system together, I began composing *Holotrix* using the system as detailed above. Some issues occurred early on in the process, which led me to realise that the stage of experimenting and editing the system had not yet finished, and only the first six movements of *Holotrix* were produced. A selection of movements from *Holotrix* is included in the appendix. Below, I will detail the various areas of systematisation, the issues that had arisen, and the changes that were made to the system across these areas.

Holotrix(b)*, *Holotrix(b.2)*, and *Holotrix 2

Structure

It was immediately apparent to me when composing *Holotrix* that introducing the systematisation of rhythm in the third movement was too soon. I have always thought that rhythm is the most important aspect of coherence in music, and whilst this is not necessarily a view held by all, I believe that rhythmic change can have the most impact. For this reason, it did not make sense for me to take away control of rhythmic choice so early on in the piece and instead I decided to leave what I consider to be the most powerful aspect of systematisation to the end. At the same time, leaving the articulation, dynamics, and motion to the end did not make good sense as they arguably have the smallest impact on what the difference between my own decision-making and the system outcome might produce.

It was after this that I concluded that whilst my above thought process was sound for movement twelve, it meant that the mirrored introduction of systematised elements in movements one to six and seven to twelve would mean that there would be no rhythmic systematisation until the sixth movement, which I felt was in fact too late in the work, and due to changes made to the rhythmic material, detailed below, systematisation of rhythm was introduced in movement three as before.

The order of the introduction of systematised aspects in the first half was changed, with the view of attempting to save the most effective matrices for later in the piece. Therefore, the introduction of the articulation matrix was moved from movement four to movement six and the motion matrix was moved from movement six to movement four, with dynamics staying in place at movement five. I deemed the impact of the systematisation of articulation to be greater than that of motion and dynamics in consideration of what I was able to achieve with free choice and it was therefore saved for the final movement of the first half. The second half had similar changes – movement seven still introduced the automation of pitch sets and movement eight saw the introduction of flux, which replaced the bar count matrix. Motion was moved from movement twelve to movement nine, as this was seen to have the smallest impact on the music with the remaining matrices. In the same vein, the rhythm matrix was moved from movement nine to movement twelve. My views of the importance of rhythm within the work indicated that I should have as much control of the rhythmic choices as possible, in order to create the most interest until the final movement, when the most powerful aspect of systematisation would be automated. For the same reasons as in the first half, the dynamic matrix was moved from movement eleven to

movement ten and articulation from movement ten to movement eleven. Fig. 3.7 shows the breakdown of matrix application from movement to movement in *Holotrix(b.2)*. This approach of systemisation through a series of interrelating matrices is not dissimilar to the principles behind Xenakis' when he applied his ST algorithm to his works, where flow charts would be used which contained series of parameters, such as 'attack time, "instrument class", "Instrument", pitch, duration, dynamics, and three parameters for glissandi'.³⁶ This system dictated the order of events and boundaries of possibilities, using matrices to apply these factors to the music. The first work to utilise the ST algorithm was *Achorripsis*, which may be considered to be a prototype, followed by works including *ST/48* (1962), *ST/10* (1962), and *Atrées* (1962).³⁷

³⁶ Damián Keller, and Brian Ferneyhough, 'Analysis by Modeling: Xenakis's *ST/10-1 080262*' in *Journal of New Music Research*, (Vol. 33, No. 2), (London: Routledge, 2004), p. 164.

³⁷ Bálint András Varga, *Conversations with Iannis Xenakis* (London: Faber & Faber, 1996), p.80-81.

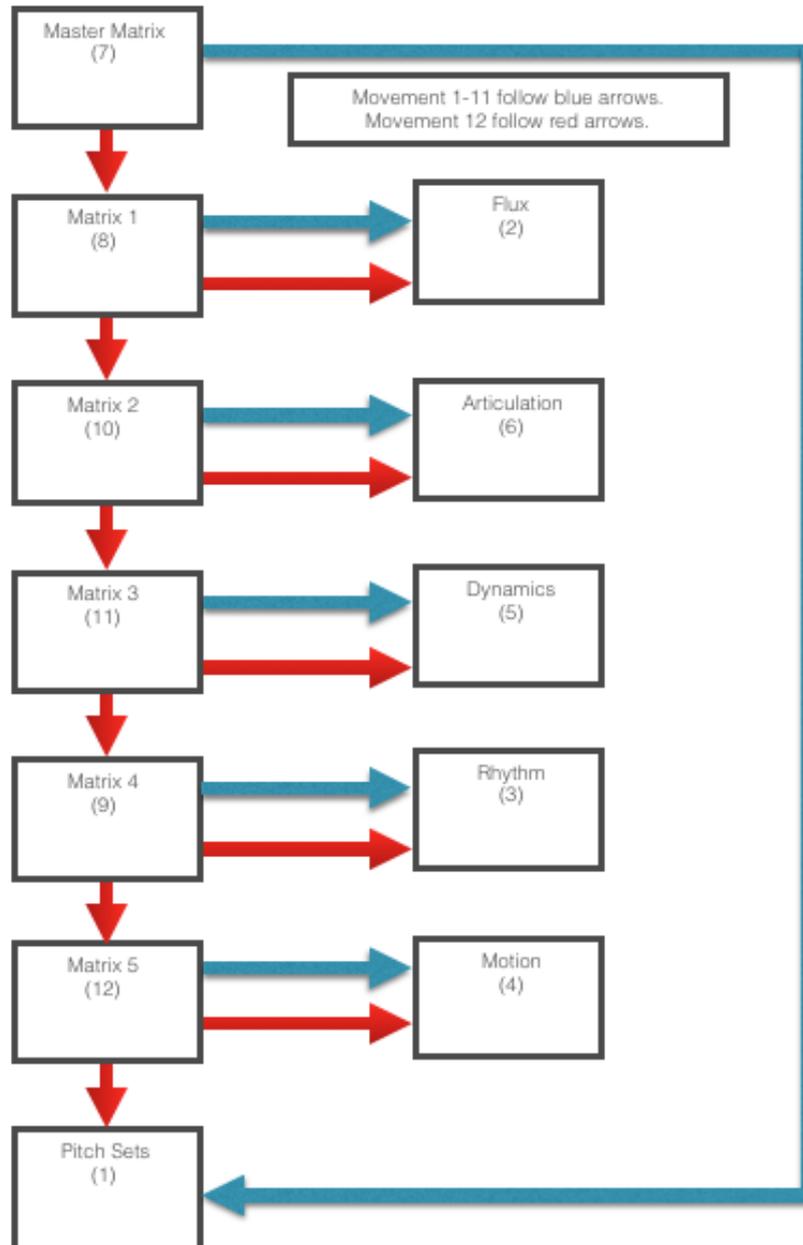


Fig. 3.7: *Holotrix(b)* and *Holotrix(b.2)* – movement matrix application. Numbers in parenthesis show the movement in which each matrix is applied. The blue arrows show the interaction in movements 1 to 11 and the red arrows show interaction in movement 12. Secondary matrices (with 7 to 12 in parentheses) are used to determine the row choices that should be taken from primary matrices (with 1 to 6 in parentheses).

Flux

Although Hans Werner Henze was a composer influenced by, amongst others, the Second Viennese School, his music is ‘wholly un-Schoenbergian’.³⁸ His foray into integral serialism, in his 1952 work *String Quartet No. 2*, used an arithmetical principle to devise the bar and metre changes. Rudolph Stephan believes that these changes do not match metrical reality and that some simple rewriting would make the piece easier for a performer to comprehend and sound no different to a listener. In fact, Stephan claims that Henze’s approach suppressed a large proportion of the composer’s best qualities.³⁹ Within the *Holotrix* works, one could make the same argument about metrical reality as Stephan did of Henze’s; however, the very way in which rhythms are generated in *Holotrix* means that this is not a fair comparison. Unlike Henze’s string quartet, the raw rhythmic material of *Holotrix* does not have any regular metrical reality. Indeed, *Holotrix* is based on individual note values which are applied as a row and therefore varied, and in *Holotrix(b)* and *Holotrix(b.2)*, as discussed below, rhythms are based on rhythmic cells which do not have a consistent metre. In fact, it is the application of metre from flux that gives *Holotrix* works their metrical reality. Fig. 3.8 shows the completed flux matrix used in *Holotrix(b)*.

³⁸ Rudolph Stephan, ‘Hans Werner Henze’, in *Die Reihe (4) Young Composers*, ed. Herbert Eimert and Karlheinz Stockhausen; trans. Leo Black, (Eng. edn.), (London: Theodore Presser, 1960), p. 29.

³⁹ *Ibid.*, p. 35.

57	25	C=42	C=63	C=84	$\frac{6}{4}$	$\frac{8}{4}$	C=96	42	$\frac{3}{4}$	$\frac{5}{4}$	4
22	14	C=112	C=69	C72=	$\frac{5}{4}$	$\frac{6}{4}$	C=192	68	$\frac{8}{4}$	$\frac{3}{4}$	30
$\frac{8}{4}$	$\frac{3}{4}$	17	45	25	C=144	C=120	13	$\frac{6}{4}$	C=126	C=40	$\frac{5}{4}$
$\frac{5}{4}$	$\frac{6}{4}$	8	94	98	C=56	C=160	16	$\frac{3}{4}$	C=58	C=60	$\frac{8}{4}$
$\frac{3}{4}$	$\frac{2}{4}$	55	22	34	C=176	C=54	86	$\frac{8}{4}$	C=66	C=92	$\frac{6}{4}$
C=138	C=88	$\frac{8}{4}$	$\frac{2}{4}$	$\frac{6}{4}$	22	83	$\frac{3}{4}$	C=168	15	30	C=184
C=60	C=152	$\frac{6}{4}$	$\frac{4}{4}$	$\frac{2}{4}$	10	13	$\frac{8}{4}$	C=80	77	67	C=72
$\frac{7}{4}$	$\frac{7}{4}$	38	26	74	C=44	C=88	84	$\frac{2}{4}$	C=120	C=132	$\frac{4}{4}$
65	18	C=52	C=116	C=50	$\frac{7}{4}$	$\frac{4}{4}$	C=92	22	$\frac{2}{4}$	$\frac{7}{4}$	10
C=46	C=76	$\frac{2}{4}$	$\frac{7}{4}$	$\frac{4}{4}$	18	4	$\frac{5}{4}$	C=80	45	29	C=200
C=96	C=108	$\frac{4}{4}$	$\frac{5}{4}$	$\frac{7}{4}$	38	36	$\frac{2}{4}$	C=108	53	49	C=208
10	93	C=112	C=66	C=48	$\frac{4}{4}$	$\frac{3}{4}$	C=100	9	$\frac{5}{4}$	$\frac{7}{4}$	20

Fig. 3.8: *Holotrix(b)* – complete flux matrix (C = crotchet).

After writing *Holotrix*, I found that although the bar count matrix had added some variety between movements, it was not sufficient, nor did it add variety within each individual movement. For this reason, as part of the preparation for *Holotrix(b)* the bar count matrix was replaced with the flux matrix, which was used to add further variety to movements, without my own choice being a factor. The flux matrix was made in the same way as other matrices: a numerical row was made into a numerical matrix and then, using die rolls, one in three were assigned a bar count, one in three of the blocks were assigned a tempo marking, and one in three were assigned a time signature. From *Holotrix(b)* to *Holotrix(b.2)*, however, a few further changes were made. In *Holotrix(b)*, as with the bar count matrix in *Holotrix*, the RNG used was set for possibilities from 5 to 100, but this was too broad and resulted in some movements being disproportionately long or short. For this reason, bar counts of less than 15 and more than 60 were discarded, which removed over half of the potential bar counts

whilst still allowing for a wide enough range for variation. The 8/4 time signature was replaced in *Holotrix(b.2)*, as it made it harder to read and perform and with the rhythmic material used it is just as effective in 4/4. All 8/4 signatures were replaced with time signatures of 2/4, 3/4, or 4/4 and the time signatures of 5/4, 6/4 and 7/4 were left in place. The tempi used were taken from standard metronome markings; however, with the complexity of some of the music produced, some of the faster time signatures were simply too fast and so were replaced with slower tempo markings. All markings over 100 were replaced with slow tempi.

For all flux movements, a decision needed to be made as to how many times each flux attribute should change (e.g. how many time signature changes, if any, would occur in a piece), and whilst the system was able to tell me which rows to use when it needed to, there was no way for me to know how many times each should occur. For this reason, a very simple method was used, using a six-sided die (D6). The D6 would be rolled an initial two times, the first of which would dictate how many tempo changes there would be (or none, if a one were rolled), and the second dictating how many time signature changes there should be. This would be continued until I had enough accurate coordinates to dictate all the musical aspects I needed, including a bar count. For movements eight to twelve, the initial two rolls were thrown in order to decide how many tempi and time signatures would be used, and beyond that, it was controlled by the secondary matrix which dictated flux.

All changes of time signature and tempo were split as evenly as possible within each movement. So if a 20-bar movement had two time signatures, the first one would apply from the beginning of the movement and the second from bar 11. If there was not an even split, then the uneven length should be in the middle of

the movement. So, if this same 20-bar movement had three time signatures, then it would be split into sections of seven bars, six bars, then seven bars. Because the coordinate approach would sometimes produce duplicates, each selection of bar count, time signatures, and tempi was always done as a group, used in the order it was rolled, and non-applicable rolls were ignored. If the same signature appeared twice in a row, it still applied but was of course, not reiterated and so this even balance of features was occasionally obscured.

Pitch and rhythm

Holotrix (b) and *Holotrix(b.2)* used the same pitch material drawn from Messiaen as *Holotrix*, but the pitch material was changed for *Holotrix 2*, where Schoenberg's *Moses und Aron* (1932) provided the tone row,⁴⁰ From *Holotrix* to *Holotrix(b)*, the rhythm matrix stopped using individual note values and rests and instead was created using rhythmic cells which were taken from the first movement which was freely composed using the pitch material from *Moses und Aron*, as discussed above. This was a highly successful change. In *Holotrix*, the rhythms that were produced were extremely complex and lacked coherence. By changing the approach to rhythmic cells it meant that lines would be more coherent as they would respond to the original movement, and lines were more likely to have the impression of phrasing. Ex. 3.4 shows bars 6 to 19 'Protrix', from *Holotrix(b.2)*, and Ex. 3.5 shows the rhythmic cells that were drawn from the music shown in Ex. 3.4.

⁴⁰ Arnold Schoenberg, *Moses und Aron*, study score, Edition Eulenburg no. 8004 (London: Eulenburg, 1984), Preface.

6
Tpt. *p* *p* *f* *ff* *mf* <

13
Tpt. *sfz* *ppp* *mp* *ppp*

Io *RIO* *flz.* *nat.*

Ex. 3.4: *Holotrix(b.2)*, Protrix – bars 6–19.

3 4 5 6 7

Ex. 3.5: *Holotrix(b.2)* – rhythmic cells 3–7 showing from where in Protrix these cells had been taken. Cell 3 comes from bars 6–7, cell 4 comes from bar 8, cell 5 from bars 12–13, cell 6 comes from bars 14–15 and cell 7 comes from bars 16–17. Twelve rhythmic cells were taken from the opening movement, and then applied to a numerical matrix. The numerical matrix then provided inversions, retrogrades, and retrograde inversions of the sets of cells also, thus resulting in differently ordered rows of cells.

Motion

The approach to motion was generally effective and it worked well on the whole. There were still some points where the natural lines of the pitch material were negatively affected. For example, there were some points where for several fast-paced notes, there would be pitches flitting between the top and bottom registers, which is not possible on all instruments. For this reason, for *Holotrix 2*, the ‘motion’ no longer applied to the pitches of individual notes. Instead ‘motion’ was applied to rhythmic cells with each cell applied to octaves (A to A). Deviation was allowed at the extremities of pitch in order to try to avoid the large jumps. Large jumps were permitted at the crossover of motion changes if the top register of an instrument was instructed to go up an octave, or an instrument at the bottom was instructed to go lower. Largely, though, this controlled the register of the lines, which added interest to the work, but without employing a technique which made the music sound too aleatoric or incoherent.

Dynamics

In *Holotrix*, the dynamic rows were applied entirely to the rhythmic values, including rests, meaning that the length of rows matched. However, this caused some issues, the primary issue being that the values of rests were ignored. When composing *Holotrix(b)*, the application of dynamics changed from including all individual notes and rests, to being applied to the rhythmic cells. This was done to limit what I considered to be the overuse of dynamic markings as seen in *Holotrix*. For this same reason, as well as some issues arising with complicated or contradictory dynamic markings, spaces were added into the matrices. Moving on to *Holotrix(b.2)*, I continued the cell-based approach, but whilst previously a blank space in the matrix meant that that note would have no dynamic marking, in *Holotrix(b.2)* they were utilised in a slightly different way – if a blank space occurs between two different dynamic markings, then a crescendo or diminuendo can occur. It is possible for more than one blank space to appear next to another. In movements one to nine, when it is my own choice, it will be at the point I consider most effective, which can also include several blank cells. In movements ten to twelve, when I have no choice, it was to be applied in one of the following ways:

1. If there is a held note of one minim or longer directly before the new cell, then the dynamic marking should be applied there.
2. Failing this, if a lively passage including short rests (semiquaver or quaver only) immediately precedes the new cell it should be applied here.
3. Failing this, particularly during rows with several blanks in a row, it should be applied to the longest note available.

Finally, if the two dynamic markings either side of the blank/s are the same marking, then no crescendo or diminuendo is permitted and a reiteration of the same marking should only be given if it has occurred over such a significantly long period that a cautionary reminder is necessary. In the event of the first dynamic marking from a row for a movement being blank an *mf* was put in as a standard introductory dynamic level.

Articulation

As with the dynamic aspect of the system, and for the same reasons, spaces were added into the articulation matrices for *Holotrix(b)*; however, unlike the dynamic aspect of the system, for *Holotrix(b)*, the application of articulation did not change to the cell-focussed approach, but changed from including all individual notes and rests, to only including the notes, meaning that the rhythm moves independently from the dynamics and articulation. As with dynamics, in *Holotrix(b.2)*, the cell-based approach was taken with articulation, based on rhythmic cells rather than individual notes. This actually allows for more coherence, as phrases of short notes can have staccatos over all of them, which is more effective than the sometimes confused material generated from the original approach. This also allowed the introduction of a new method which addresses a previous issue which arose with tenuto appearing on short notes – when a tenuto appears on a cell with many short notes, it now appears as a slur over the longest uninterrupted phrase in the cell.

One issue that had arisen in *Holotrix* was the application of staccato and staccatissimo markings in the matrix which would then be put over rhythms that led to confusing notation, such as semibreves with staccatos. Originally, I had wanted to leave these unusual markings in place, with the view that the performer

should simply halve the note value if a note has a staccato and quarter the value if the note was assigned a staccatissimo. However, after careful consideration and discussing this with a number of contemporary performers, I decided it was best to notate exactly what I want, despite it obscuring the system somewhat. For this reason, notes of a crotchet or more were differently notated, some by being shortened, and some by being both shortened and having a different articulation attached to them. Fig. 3.9 shows 16 ambiguous articulations that came up in the Holotrix system and how they were presented in final scores from *Holotrix(b)* onwards.

1 	2 	3 	4 
5 	6 	7 	8 
9 	10 	11 	12 
13 	14 	15 	16 

Fig. 3.9: Sixteen problematic note/articulation pairings from the Holotrix system and how they were presented in scores from *Holotrix(b)* onwards.

Chapter 4

A prelude to a revolution

Revolutions

For the final composition in the project, *Revolutions*, I wanted to bring together the approaches taken with the other the works of this project, but use this heavily systematised music as a raw data chart from which the composition would emerge using my creative decision and input. Indeed, this is the antithesis of *Holotrix*, where the opening movement dictates the materials for the following movements. Here, *Prelude*, a heavily systematised piano work, would be used as a framework to create a three-movement work for seven instruments, *Revolutions*.

Berio said of Maderna's work that he could take the harsh music created by 'the machine' and transform and reinvent it, so that what was rigid and stiff is now expressive and with emotion.⁴¹ In *Revolutions* I took a similar approach to that of Maderna, whose tone colour was free and dynamics were employed to best give clarity to the row. Whilst he allowed himself the freedom to do this, as well as still using canon, he never returned to serial consistency again, later referring to it as 'one of the worst diseases'. Of course, as Raymond Fearn said, 'Above all, Maderna desired *freedom*.'⁴²

I chose to combine some areas of Schoenberg's strict approach to systematised composition of pitch and harmonic form and structure, with a Satiean approach of systematically organising form and rhythm, as discussed

⁴¹ Raymond Fearn, *Bruno Maderna* (Chur: Harwood Academic Publishers, 1990), p. 95.

⁴² *Ibid.*, p. 170.

below. This generated the source material for the piece, to which I would apply my creative decisions to produce the final work.

The majority of Satie's approaches to systematisation came in his Rose+Croix period, from 1891–5, during which he worked on systematising chord progressions and the position of harmonic cells. By focussing on these areas of systematisation, Satie's approach did not prevent or limit him from being able to write the music he wished. Indeed, rather than being a restrictive system which limits the potential of the material or ability to make compositional choices, Satie's approach left him free to use the slow metres and chains of block chords to create an illusion of timelessness without goals that was ubiquitous in the works of the Rose+Croix period. Satie also invented what Patrick Gowers named 'punctuation form' which is seen in the first *Prélude du Nazaréen* (1892), where the four main motifs are articulated at irregular intervals by a 'punctuation' phrase at three individual pitches.⁴³ This recurring phrase and two subsequent transpositions of this occur four times in rotation,⁴⁴ thus exposing the strict organisational logic of the work, similar to the extremely strict application of parameters as seen in *Prelude*.

Generally, for Erik Satie, the purpose of his system was less to create far-reaching systems as such, but was more a means of creating or choosing material which would be used in the composition at the will of the composer. The earliest known example of systematisation in Satie's work was found in a sketchbook from 1892.⁴⁵ With the sketches for *Messe des pauvres* (1895) Satie notated a series of thirteen dyads, each of which was classified by whether the melodic line

⁴³ Robert Orledge, *Satie the Composer* (Cambridge: Cambridge University Press, 2008), p. 146.

⁴⁴ *Ibid.*, p. 146.

⁴⁵ *Ibid.*, p. 186.

moved by a second, third, or fifth. These cells were used as a basis for what became his 1892 work *Fête donnée par des chevaliers normands en l'honneur d'une jeune demoiselle*.

To begin work on *Prelude*, a tone row was produced using an altered form of the row used for *Holotrix(b.2)*. At 72 bars, the entire work, like *Al's Icier Pee* and *Al's Epic Leer*, is composed of HIC-compatible pairs, always in two-bar sections, with sets presented linearly and with one hexachord per bar with no deviation from these rules. Each bar always has exactly two crotchets and four quavers and for the sake of the performance of the *Prelude* itself, all crotchets are staccato and all quaver groups are slurred.

My approach to the organisation of the rhythm in the work was inspired by the work of Satie. Each crotchet beat in each bar is a cell where there can be either a crotchet or two quavers and I organised them so that every possible combination was serially applied, which in this instance is six possible combinations. For the first six bars, the rhythms in the treble clef systematically rotate through the options whilst the bass clef is always a rhythmic mirror of the treble at that point, i.e. if a crotchet cell is used in the treble, then a two quaver cell is used in the bass and vice versa. Fig. 4.1 shows the six potential single-bar permutations and highlights the order in which they are first introduced into the treble clef.

1	A	A	B	B
2	A	B	A	B
3	A	B	B	A
4	B	A	A	B
5	B	A	B	A
6	B	B	A	A

Fig. 4.1: *Prelude*, potential permutations of rhythmic cells, A = pair of quavers, B = crotchet.

The six rhythmic cell permutations were then themselves rotated through a full set of twelve cycles. For the first six cycles, the bass clef part continues through the same cycle of 6-5-4-3-2-1 and then to 6-5-3-4-2-1 for the final six figurations. The reason for this is because the order had not been dictated by rhythmic retrograde, but by the shifting of A and B permutation cells in reverse order.

For the first six cycles, the treble clef part has a rotating row (1-2-3-4-5-6, 2-3-4-5-6-1 etc.) until the sixth figuration from bars 30 to 36 where it has reached 6-1-2-3-4-5.

After this point, the treble clef rotates this new order starting 2-4-3-5-6-1 and ends with 1-2-4-3-5-6 which in fact means the final cycle in both hands is a pure rhythmic retrograde of the first. The pitches are approached in the same way – the first half uses only P and I lines, and the second half uses the same lines but the RI and R forms of these lines, meaning that the entire piece is harmonically retrograde. Furthermore, to add to the revolving approach to this, the tone row choices for the first half are made so as to create tertiary aggregates of the first two rows applied to each line, i.e. P0 and I5, which of course is also repeated as a retrograde in the last 24 bars. The entire *Prelude* essentially being a retrograde of itself gives it a highly symmetrical quality, similar to Karel Goeyvaerts' approach

to *Komposition Nr. 5 mit reinen Tönen* (1953,) which, despite being an electronic work, is also an exactly symmetrical work, around the very centre of the work, and with each event occurring in its retrograde.⁴⁶

Of course, symmetry has been an important part of the work of many composers before me. The row used in Luigi Dallapiccola's work *Dialoghi* (1960) has elements of symmetry – the second hexachord is a transposed retrograde inversion of the first – and the use of tempi through the work is also symmetrical.

This highly rational organization of the tempo markings in the piece has occasionally prompted the observation that Dallapiccola was approaching, albeit in small measure, the kind of thoroughgoing serial organization that some of the younger composers such as Boulez and Stockhausen had attempted during the 1950s.⁴⁷

Raymond Fearn claims that the appearance of aspects of total serialism in *Dialoghi* could be a by-product of Dallapiccola's desire for symmetry. Symmetry in systematic music is something that I have explored in the later stages of this project in order to attempt to systematise and organise form and structure.

Revolutions

Once the *Prelude* had been composed, it was used as a framework for the final work, *Revolutions*. The title points to the process behind the composition. Each of the three movements comprises a full iteration of the piano work, which is itself a rotation of pitch and rhythmic cycles (bearing in mind that the *Prelude* ends where it begins), which, in turn, is a rotation of rhythmic cycles of a rotation of rhythmic cells as mentioned previously. It is written for seven instruments: cor anglais, clarinet in Bb, bassoon, horn in F, trumpet in C, viola, and cello.

⁴⁶ Morag Josephine Grant, *Serial Music, Serial Aesthetics* (Cambridge: Cambridge University Press, 2005), pp. 64–5.

⁴⁷ *Ibid.*, p. 214.

Revolutions was entirely written by selecting pitches and points of entry from *Prelude*. After a note had been chosen, the rhythmic position could not be altered, e.g. if a note came in on the third beat as an E, that note, if chosen, must appear on the third beat as an E. The articulation markings, dynamic markings, and tempi in the *Prelude* have no effect on the final movements. Finally, note choice from the source material was entirely free and notes could be extended beyond the crotchet or quaver they appear as in the *Prelude*, so as to allow the production of new harmonies and new metres.

By leaving myself free to pick and choose points of attack, the metrical potential was rich. Indeed, I even considered using the material from *Prelude* to write a *valse* movement in the style of Francis Poulenc, but eventually chose not to complete this as I felt this was not in the character of *Prelude* and *Revolutions*.

The first movement makes use of space in the music, with never more than three instruments sounding simultaneously and frequently fewer, as well as exploiting silence between phrases. The movement combines pointillistic moments with points of greatly extended note values creating harmonies which would not be possible without extending these note values. Though a note had to attack at the point it did in the *Prelude*, there was no limit to how far I could extend the note value; for example, in *Revolutions*, the opening cor anglais D, which sounds for five and a half crotchet beats, appears as a quaver in the *Prelude*.

Morose ♩ = 54
 P0
 mp
 I5
 senza ped. senza rit.

Ex. 4.1: Prelude, bars 1–2

♩ = 54 morose

Cor Anglais

Bassoon

p

p

p

Ex. 4.2: Revolutions, bars 1–2: cor anglais and bassoon material derived from bars 1–2 of Prelude in Ex. 4.1.

Though quite a sparse movement, the intention is that it is mercurial and shifting, which is achieved through the combination of very short or long notes, as well as a frequently changing tempo marking and the fast-paced shifting between dynamic markings and sections which are less prone to change. The movement is in five sections, each with a different approach to the handling of the material.

1. Bars 1 to 13
2. Bars 14 to 27
3. Bars 28 to 37
4. Bars 38 to 43
5. Bars 44 to 73

The first section, from bars 1 to 13, makes use of long-drawn-out notes, with dynamic changes always incorporating the use of crescendi or diminuendi, whether it be for the purpose of a swelling sound to the line, or to build up or die away.

Bar 14 marks a changing of style into the second more intense section by including the first notes which have no crescendo or diminuendo markings attached, which then continues into the section marked with Bartók pizzicato notes in the string parts. The pizzicato playing continues through the second section and are offset by long notes from the cor anglais which rise from *p* and *dal niente*, creating a vivid contrast between the parts. All other instruments are silent through this short section.

The third section runs from bars 28 to 37 and is marked by the trumpet entering to join the cor anglais with a longer passage, whilst the strings continue the character of the second section. This section acts as a bridge into the fourth section.

At bar 38 the cor anglais and bassoon take on roles similar to the strings in previous bars, playing a few mechanical and boorish notes of loud staccatissimo interplay, which is intended to stand out from what has been heard in the previous bars. This is the most built-up part of the movement so far and acts as a segue into the final section, from bars 44 to 73, where the highly restricted parts are now allowed to expand and develop. The first four sections can almost be considered a build-up into this long section. A combination of long and short notes, with melody-like passages and the inclusion of extended techniques mean that the movement rapidly builds to the end and ends at a *fff* dynamic for all sounding instruments. The section peters out quickly with single notes, which derives from a feature I include in much of my compositional work.

The second movement is more textually dense than the first, frequently using most instruments simultaneously and occasionally tutti. This movement has four clearly defined sections.

1. Bars 1 to 16
2. Bars 17 to 32
3. Bars 33 to 48
4. Bars 49 to 58

The second movement immediately returns to the opening style of the first movement, with notes building up from nowhere. All instruments able to have mutes are muted as I feel that muted instruments at a loud dynamic give a quality to the timbre which can exaggerate the intense feeling intended. This build-up of intensity continues through the second section until bar 33 which marks the beginning of the third section, where the character marking indicates it becomes progressively less steady. In fact, this is more a comment on the music itself, rather than the way in which a performer should approach it. Movement throughout this section increases and becomes progressively denser, and, as in the first movement, this transition is marked by a lessening of the use of crescendi and diminuendi and an increase in contrasting dynamics. However, long and short lines here are interspersed with pointillist moments to highlight the more frenetic and unstable energy of the movement. This continues to build through the final section of the movement which accelerates from bar 49 to the end, ending in a *tutti dal niente* crescendo in all instruments, apart from the cor anglais which has taken on a solo role by this point, ending with an extended loud hexachord which would not have been possible without allowing the extension of note values.

Unlike the first two movements, which aim to produce dramatic endings, the lack of one in the third and final movement is specifically intended. I have attempted to recreate something that fully systematised music has, in my experience, often produced for the ending of pieces and movements. I chose not to

use any notes past the fourth beat of the final bar to aid the clarity of the ending. The movement continues from the build-up that was witnessed in the second movement, starting at a fast tempo and marked frenetic, with all instruments playing as evenly as possible with no lines to be performed or understood as solo parts. Despite this, there are elements of solo melody from the cor anglais simply through the number of notes chosen, but the performer should not treat it as a solo and should not project above the other instruments. All parts are marked mezzo-piano and there are no deviations. Though this technically would mean certain instruments would be louder than others, it is explained in the programme note that the intention of this is that all instruments should attempt to balance dynamically, i.e. the strings may play at a forte marking to balance dynamically with the brass. This movement is again a nod to the systematic music behind it; solo lines are purposefully prevented, there is little to no climax, no tempo changes, and a deliberately sudden ending.

The pitch choice in *Revolutions* was entirely free, within the options of *Prelude*, and each movement has an individual approach to the use of pitch. In fact, the first two movements are actually more systematic in their pitch choice than that of the third movement. The first movement is entirely based on polyphonic aggregates of the set. The only lines used are P0 and its HIC pair set, I5 (the first two presented in the *Prelude*) and their inversions, R0 and RI5 respectively. Bars 1 to 14 state the P0 line for pitch material; each time the next note of the P0 line appeared in the *Prelude*, it was placed into the *Revolutions* score in the same place. The choice of instruments to take each voice was free in this movement. This process continues throughout the movement until the final seven bars, where the six notes chosen to sound are derived from the retrograde of

the I5 row, which, being a HIC pair with P0, shares the pitches of the first hexachord of P0. The breakdown of the section is as shown in Table 4.1.

Table 4.1: *Revolutions*, choice of pitch material in movement 1.

Bars	Row
1–14	P0
15–28	I5
29–37	P0
38–43	I5
44–47	R0
48–55	RI5
56–65	R0
66–72	First hexachord of RI5

The choice of pitch material in the second movement was the first step away from a twelve-tone technique in *Revolutions*. The choice of material from *Prelude* was split into four sections. There is an independent cor anglais line which was allowed to flourish, with material that was chosen both for pitch and rhythm reasons at various points in the score. There is an element of twelve-tone technique as in the first movement, which is confined to the bass instruments of the work, the cello and bassoon. As in the ‘Al’ pieces, tertiary aggregates are created throughout the movement and are split between the two instruments creatively rather than systematically. Bars 1 to 24 contain a tertiary aggregate of I5 and bars 25 to 48 contain a tertiary aggregate of the P0 line. Bars 49 to 58 see a rising five-note chromatic scale from A in the cello and the bassoon takes on other roles. Other than this, notes were chosen to contrast dissonance and consonance. Only pairs of notes that sounded within the same crotchet beat in the *Prelude* which were either a perfect interval, a minor second, or a major seventh were chosen. These are generally placed as written and shared between the clarinet,

bassoon, horn, trumpet, and viola. With this, I almost considered the instruments to be caught between the cor anglais line across the top and the bulk of the serially approached material at the bottom in the cello. Between these two different approaches lie the extremities of dyad consonance and dissonance.

The final movement was also split into four sections, a ‘bass’ part which was shared by cello and bassoon again, two mid-voices, and a top cor anglais line. The ‘bass’ part is once again predominantly drawn from aggregates, this time directly taken from the tertiary aggregates written into the *Prelude*. For this reason, the aggregate is laid relatively bare, with a note appearing every two bars on the first beat of the bar. A series of P0 and I5 lines are used until bar 48. From bars 49 to 60, the tertiary aggregate forms an altered chromatic scale, beginning on G, rising a major second before falling a minor second, then continuing to rise an augmented second/minor third and fall a minor second, until it reaches G \flat in bar 60 (Ex. 4.3). The piece ends from bars 60 to 72 where the tertiary aggregate is formed on a rising chromatic scale from G to G. These tertiary aggregates are obscured by the inclusion of other notes occasionally being played by each instrument when they are selected to be part of a harmonic device used elsewhere in the work.



Ex. 4.3: *Revolutions*, tertiary aggregate in bassoon and cello, movement 3, bars 49–60

This overarching approach to the work is one that is intended to be a build-up, though not steady, from linear and at times chordal qualities, to something that is perhaps not dissimilar to something that a system would be capable of producing,

but with more clarity and more shape, particularly aided by my choice of notes and articulations. Ultimately, the rhythm was essentially systematised throughout because, despite my free choice of pitch material, the pitch material directly dictated the point of attack for each note. I did in fact allow a few deviations from the rules in *Revolutions* for creative reasons, such as in the first movement where the row is interrupted in bar 4 by the cello, where the long note should remain as a B \flat and I allowed it to rise, and the cor anglais in bars 4 to 7 (as shown in Ex. 4.4) where the note should remain an F but I raised it to a G. This was done for creative reasons in the music, and of course being entirely free with my choice of pitch was in agreement with the ethos of *Revolutions*.

The musical score for Ex. 4.4 shows three staves: C. A. (Cor Anglais), Bsn. (Bassoon), and Vc. (Cello). The C. A. staff begins in bar 4 with a forte (f) dynamic, followed by a piano (p) dynamic in bar 5. The Bsn. staff has a piano (p) dynamic in bar 6. The Vc. staff has a piano (p) dynamic in bar 4. The score includes various note values, rests, and articulations across the four bars.

Ex. 4.4 – *Revolutions*, bars 4–7.

Of course, this is just one of an incalculable number of possible ways I or anyone else could have approached *Revolutions*. Once the *Prelude* had been written, even within the confines I gave myself the choices are still practically limitless. Henri Pousseur's *Quintette à la mémoire d'Anton Webern* (1955) has elements of symmetry, split into four equal sections of 96 bars, each with its own tempo. In the first and third sections, instruments are combined by register capabilities, and in sections two and four they are paired according to timbre. Further adding to the regularity is the fact that each of the 96-bar-long sections is split into twenty-

four equal four bar sections, though he has attempted to disguise this through the use of various subdivisions within each instrument's part, dissolving the metre. Echoing my own dissatisfactions with some rhythmically systematised music, Koenig states that the music is so varied that it, in fact, sounds stagnant and ineffective: 'The last thing Pousseur wants to make us hear is a constant metre; but this is precisely what he uses as a first and basic ingredient. The whole piece grapples with this contradiction.'⁴⁸ My approach to the *Prelude* was not dissimilar to Pousseur's own in *Quintette à la mémoire d'Anton Webern*, which is symmetrically structured and drew pitches that were generally subdivided into instrument groupings or at least groups each of which had a specific purpose. Just as symmetrical, *Prelude* did not necessarily need to remain so. Indeed, it was a conscious choice; however, one could approach the *Revolutions* method in a number of ways, and certainly could chose to do so in a freer way than I attempted here.

⁴⁸ Gottfried Michael Koenig, 'Henri Pousseur', in *Die Reihe (4) Young Composers*, ed. Herbert Eimert and Karlheinz Stockhausen; trans. Leo Black, (Eng. edn.), (London: Theodore Presser, 1960), p. 18.

Chapter 5

Conclusion

This project had two primary goals: to create new methods of systematisation, and to find a way to apply this system to non-musical stimuli, primarily, imagery. I set out to create systems that could distance the composer as far as possible from decision-making in the creative aspects of composition, indeed, once the composer had created and tested the system, it should be capable of dictating various elements of the music, to a degree that the composer did not need to make creative decisions. It is clear that these two primary goals are easily combined, particularly when considering the ways in which I went about responding to these non-musical stimuli. My goals throughout the project have, of course, changed slightly. Perhaps naively, I had initially expected my systems to work immediately, as many of my systems have in the past. Naturally, with systems as large-scale as *Holotrix*, it is no surprise that the more experimental approach I took was essential to the process.

This experimental approach was a common one throughout the project, starting with early pieces, such as *Al's Icier Pee* and *Al's Epic Leer* which were test pieces to aid my comprehension of the methods. With *Nerthus*, I employed a more traditional approach to external stimuli after considering various ways in which I could respond non-systematically to the imagery.

I initially expected the response to imagery to be a far larger component of the project, yet at the completion of the final work of the Jasper Series, *Jasper Reigns*, and the subsequent composition, *Jasper's Farewell*, it became clear that I had managed to achieve precisely what I hoped to from this part of the project. This process fulfilled my ambition to create systems capable of generating

musical material, perhaps to an even greater degree than I had imagined; the quantity of data extracted from the imagery was capable of yielding even more musical material than it had done in the project. I will return to the process in the future and continue to explore the ways in which this system can be used. Whilst not a primary focus of this project, *Jasper's Farewell* highlights what is, for me at the moment, the most satisfying way of handling the material that any heavily systematic approach produces.

In order to achieve the aim of distancing of the composer, through a range of processes, from active decision-making and creative input into the final music, I aimed to create systems capable of dictating the use of material, as well as generating material. The early pieces I wrote during the process were relatively free in the process and whilst the systematic process of material generation in the Jasper Series works was intense and fruitful, there was little in the way of dictation about how this material should be applied to the music. This marked the beginning of the process towards what was always intended to be the largest work of the project, which I first envisaged around ten years ago, that of not only being able to dictate the material but also the application of it. *Holotrix* achieves all of this and more, from a very raw *Holotrix* to a highly effective *Holotrix 2*, which was created using a completed and fully functioning system. Through my experimental processes of composition and evaluation, I was able to take the system from something that brought about similar issues with total serialism as seen by earlier composers, to something that was capable of producing music with a coherent sense of rhythm and structure, elements of melody and, most importantly, had a style and character which was recognisable throughout the movements. Of course, more could still be done with this system; there is no

reason why one could not produce a work with the Holotrix system without writing an opening movement; rhythmic cells could simply be devised. There is also no reason why it needs to be a twelve-movement work in which the composer input is gradually diminished; whilst this is what I had always wanted to do with it, one could also use the system to create a single-movement work, similar to my application of the system to *Holotrix 2*. Holotrix has proved the capability of near-total systematisation, which also has the potential to be tied in with the data extraction techniques used in the Jasper Series works. Holotrix could also be used in the same way as *Jasper's Regret* and the *Prelude*, whereby the music is used as a systematically created musical framework from which a final, more intuitive, piece can be drawn.

Once my goals had been achieved with the Holotrix system, I felt it was time to strip back the automation of the system and to return to a method of composition which is closer to my use of compositional systems outside of this project. Holotrix achieved the goal of being capable of dictation of the musical material and, of course, was also capable of data generation. What I set out to achieve post-Holotrix was to take what a system produced and making my own decisions based on this to create a final work, similar to the approach taken with composing *Jasper's Farewell*. In some ways, the final two works merge the two approaches very well. The *Prelude* has a highly systematised and rigid format, from which *Revolutions* is drawn creatively. What was produced was a work that is heavily systematised and yet at the same time very free in terms of composer input.

Reflecting upon the works that have been produced in this project, I believe that, at least for the time being, the most effective way of dealing with

systematic composition is not one where the system rules all, rather where the system and the composer can work in harmony, with a potential to produce music that is precisely the kind of music I want to be writing.

There is also an overlap of systematic compositional processes between the way that I use them and algorithmic computer generation. David Cope's two compositional computer programmes, the first named EMMY, and the second named Emily Howell both began as algorithms written out on paper, with a database of pre-existing music input into the system. The programmes were then able to create music, which was essentially a pastiche of the musical database that was put in. The processes that the material went through, followed three stages of deconstruction and analysis, identification of elements that signify the style, and then 'recombinancy', where the elements are recombined into new works.⁴⁹ *From Darkness, Light* (2004), was the first complete work, in six movements, created by the Emily Howell programme. This process is not dissimilar, in fact, to the process behind compositions such as *Jasper's Farewell*, *Holotrix b.2*, and *Revolutions*. The raw data, in my case, systemised music, and in Cope's case, pre-existing music written by Classical composers, and the system runs through a series of algorithms to produce the new music. The main differences are that Cope's output is automated by the programme, rather than needing to be written out like mine; and Cope's programmes produce a pastiche whereas my output can be very different to the original input music. Of course, the *Holotrix* works are closer to Cope's with regards to automation, because *Jasper's Farewell* and *Revolutions* both allow the composer a free choice in the selection of material.

⁴⁹ Experiments in Musical Intelligence <http://artsites.ucsc.edu/faculty/cope/experiments.htm> [Accessed 2 September 2020].

My belief is that whilst the ideas of twelve-tone technique and integral serialism dominated the training and often professional lives of many composers around the world for many years in the middle of the 20th century, the full potential of integral serialism was never realised. Many of the issues that are discussed as having arisen from integral serialism are exactly the issues which I have encountered in my own work, and in many cases managed to successfully overcome. One of the biggest areas where integral serialism has previously failed is rhythmic coherence which, when fully serialised on a note-by-note basis as also seen in the work of composers such as Messiaen and Boulez, does not provide the listener with music which is immediately accessible nor easily playable to a performer. Rhythmic systematisation in composition had long been a cause of dissatisfaction for me in my compositional processes, and I believe that this was perhaps the most important thing I attempted to tackle throughout this project.

The constant use of a serially derived approach in many of the systems did result in some restrictions to the development of the systems used in this project, but the potential of the technique is continuing to be explored by composers other than myself, even still today. In a similar approach to my own, Jesse Jones has combined methodologies and approaches to create his own systematic approach to composition. For example, in his 2012 work, *Threshold*, he combined serial technique with microtonalism, using a 24 pitch half-tone row to produce a serial matrix of 24x24, dubbing the term ‘micro-serialism’.⁵⁰ As in my own work, he has been inspired by Messiaen and created a ‘micromode of limited transposition.’⁵¹ Whilst this project has used a number of serial and post-serial

⁵⁰ Jesse Jones, *Microtonalis: A Systematic Approach to Microtonal Composition* (Saarbrücken: Lambert Academic Publishing, 2014) p. 47.

⁵¹ *Ibid.*, p. 53.

techniques, there are many other approaches to systematic composition that can be taken. The Schillinger Technique, for example, is still a relevant compositional system with composers including Jeremy Arden utilising it, as he did in his 2017 work, *Im Freyghish* for string quartet.⁵² There are also composers who attempt to create new methods of systemisation as I do and have done in this project, such as Jeremy Mayall who devises his own systems to create cross genre hybrid music using Webster's Model of Creative Thinking, such as in *Sketches of an Intergalactic Earworm*.⁵³

In this project, I set out to further my understanding of systematic music as well as the strengths and limitations of these processes. I achieved this, and even managed to eliminate many of these limitations. I aspired to produce systems which were capable of generating material and extracting material from imagery of rocks and crystals. This was achieved to a degree I never had originally thought possible and it was done in a way that could respond to absolutely any image and would produce starkly different outcomes with each image. I planned to create an all-encompassing system which would show a multi-movement work of gradually diminishing composer input. Whilst Holotrix brought about problems that I could never have envisaged within it and there is arguably still more I could do with the system, the system produced exactly what I had hoped it would. From Holotrix came a work that was coherent, logically ordered, and playable.

Whilst this project had originally set out to test the limits of composition and did so through the creation and utilisation of the Jasper and Holotrix systems,

⁵² Jeremy Arden <http://www.composers21.com/compdocs/ardenj.htm> [Accessed 5 December 2020].

⁵³ Jeremy Mayall, *Systematic Composition of Cross-Genre Hybrid Music*, Doctor of Philosophy Thesis, University of Waikato, Hamilton, NZ, 2015.

as I have previously stated, my own real-world approach to systematic composition is not focussed like this. In fact, it is more aimed at systematic processes which can generate material, perhaps occasionally dictating the application of said material, but primarily serving to produce compositional elements which can be used by myself as a composer. The creation of these systems has shown to me the pure potential of a systematic approach to composition. The combination of systematisation of the compositional process followed by the intuitive approaches I took to responding to and using the material generated by these systems produced the most successful and exciting works of the project. *Jasper's Farewell* and *Revolutions* have both shown that these systematic processes are capable of producing extremely interesting music and that the raw data of these processes is able to be exploited in a way that produces music that is varied, performable, and aesthetically most close to what I want my music to be.

I believe that compositionally, these two works may be the most satisfying of this project despite not being pieces which are entirely dictated by the system. A factor that can potentially arise from heavily systemised music is a lack of direction or shape, yet by taking the approach I did in *Jasper's Farewell* and *Revolutions*, one can create systemised, if not systematic, compositions which still has shape, direction, and a logical and human output. The allowance to draw material from these systemised frameworks allows one to choose textures, harmonies, melodies, and rhythms, and to exploit and vary these elements as one sees fit. The various movements from both *Jasper's Farewell* and *Revolutions* were purposefully built upon a different approach to, and journey through, each movement. This gives the work shape and structure that the fully systemised

works perhaps do not yet have, though I believe that my future work with systems will lead to processes that are capable of doing this.

In the future, I will certainly continue to use various aspects of systematisation that I worked with in this project and will return to Holotrix to continue to refine the process; a work that would perhaps merge together all the major ideas of this project. Through this project, I have now managed to produce the Jasper and Holotrix systems which are capable of producing an infinite number of works, and *Jasper's Farewell* and *Revolutions*, the methods behind which are also capable of producing the same. When considering the personal aims of the project, I have managed to produce systems that generate material which offer limitless potential. Whilst many works have been extremely successful, particularly *Jasper's Regret* and *Revolutions*, I could not claim that every work that has been produced in this project has fulfilled my objectives, or has been of a suitable quality for performance – though most certainly are of a suitable quality, and have been performed. In fact, the very nature of the heuristic approach taken to this project would lend itself to this outcome. But whilst not all of the pieces have been as successful as I might have wished, the process that has been undertaken to produce these works, and the insights this process has given me to help realise my larger goals, gives them, to me, a significance which is undeniable. The systems behind them have been extremely successful and have more than met my goals and ambitions for the music. As Schoenberg himself said: 'The real purpose of musical construction is not beauty, but intelligibility.'⁵⁴

⁵⁴ Arnold Schoenberg, *Fundamentals of Musical Composition* (London: Faber and Faber, 1967), p. 25.

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