



University  
of Glasgow

Beattie, Alison Margaret (2019) *Portfolio of compositions*. MMus(R) thesis.

<https://theses.gla.ac.uk/70944/>

Accompanying commentary.

Copyright and moral rights for this work are retained by the author

A copy can be downloaded for personal non-commercial research or study,  
without prior permission or charge

This work cannot be reproduced or quoted extensively from without first  
obtaining permission in writing from the author

The content must not be changed in any way or sold commercially in any  
format or medium without the formal permission of the author

When referring to this work, full bibliographic details including the author,  
title, awarding institution and date of the thesis must be given

Enlighten: Theses

<https://theses.gla.ac.uk/>  
[research-enlighten@glasgow.ac.uk](mailto:research-enlighten@glasgow.ac.uk)

# Portfolio of Compositions

**Alison Margaret Beattie**

**PhD BSc(Hons) MA(Hons)**



**Submitted in fulfilment of the requirements for the degree of  
Master of Music in Composition, by Research**

**Department of Music**

**School of Culture and Creative Arts**

**College of Arts**

**University of Glasgow**

**May 2019**

## Abstract

This portfolio contains two works. The first, arising from equations describing chaotic systems, is a four-movement composition entitled *Bifurcation of Nature*. This is written for six amplified cellos, six amplified horns and field recordings. The second entitled *Angle to the Sun*, in two movements, and written for an acoustic ensemble, Flute, Bb Clarinet, Bass Clarinet, Horn, Cello and soundscape, was developed from genetic concepts. This commentary discusses my compositional strategies in terms of a “Beyond Domain” approach and my investigations into the combination of instrumental forces and recorded media using ideas within the fields of spectralism, spectromorphology and mimetic discourse. Concepts of imagery and political allusion also form part of this discussion.

## MMus Commentary - Table of Contents

List of Accompanying Material	iii
List of Figures	iv
Acknowledgements	v
1. Introduction	1
2. My Aesthetic and Practice	2
3. Beyond Domain - Inspiration, Systems and Rules	4
4. Soundscape Composition - Spectralism, Spectromorphology and Mimetic Discourse	8
5. Bifurcation of Nature	11
5.1 Inspiration and System Development	
5.2 Movement 1 - Swallowtail	
5.3 Movement 2 - Rayleigh Scattering	
5.4 Movement 3 - Butterfly	
5.5 Movement 4 - Smiles and Teardrops	
6. Angle to the Sun	22
6.1 Inspiration and Overarching Theme	
6.2 Angle to the Sun - Acute	
6.3 Angle to the Sun - Oblique	
7. Spatialisation	27
8. Evaluation	29
Bibliography	31
Portfolio of Compositions	35
<i>Bifurcation of Nature</i>	
<i>Angle to the Sun</i>	

## List of Accompanying Materials

### Portfolio of Compositions:

Bifurcation of Nature for 6 horns, 6 cellos and laptop recording.

Movement 1 - Swallowtail

Movement 2 - Rayleigh Scattering

Movement 3 - Butterfly

Movement 4 - Smiles and Teardrops

Angle to the Sun for Flute, Bb Clarinet, Bass Clarinet, Horn, Cello and laptop recording.

Movement 1 - Acute

Movement 2 - Oblique

### Recordings of Backing Tracks:

Bifurcation of Nature

Movement 1 - Swallowtail

Movement 2 - Rayleigh Scattering

Movement 3 - Butterfly

Movement 4 - Smiles and Teardrops

Angle to the Sun

Movement 1 - Acute

Movement 2 - Oblique

## List of Figures

Figure 1 : Mimetic Reference as a Compositional Device

Figure 2 : Swallowtail

Figure 3 : Graph to Pitch Realisation

Figure 4 : Bifurcation Set for the Simplified Machine

Figure 5 : Pitch and Rhythm Derivation

Figure 6 : Model of the Lorenz Attractor

Figure 7 : Motivic Intertwining

Figure 8 : Pitch Class Extraction (Concert Pitch)

Figure 9 : Harmonic Series

## Acknowledgements

I'd like to take this opportunity to thank sincerely my supervisors Dr Drew Hammond and Professor Nick Fells for their support and guidance during the creation of my portfolio. Each brought their own specific strengths, talents and areas of expertise to the mentoring process enabling me to better understand my process and my need to synergise different musical strands; thus empowering me to move further towards the construction of a personal voice. The blend of philosophical contemplations and hard technical intelligence has been invaluable. I'm also grateful for their patience and at times direct honesty when things were going less smoothly and praise and encouragement when going well.

I greatly appreciate the efforts of my friends who gave up their time to rehearse and perform one of my compositions during my showcase concert. These were the talented Karen Clayton on flute, Jan Winder on clarinet, Cameron McCulloch on bass clarinet, Steven Millar on French horn, Jane MacDiarmid on cello and Calum Scott on mixing desk, all ably conducted by Michelle McCabe. Also thanks to Sebastian Lexer, Nick and Calum for derigging and to Steve Reid for set up and additional support towards my understanding of the technical capabilities of a mixing desk. I further mustn't forget contributions to the soundscapes: Steven Millar for his stupendous whale and wolf impersonations on horn and Jane MacDiarmid for her excellent seagull and ship rigging imitations on cello. Gratitude is also expressed to Andrew Walker (Arran) and Rose and Howard (Holy Isle) for allowing me access to their bee hives.

I am grateful to Louise Harris and latterly John Williamson for organising the regular PGR meetings; the organisers of Sound Thought 2017; the members of the Hermes Experiment - workshop curated by Jane Stanley; and Iain Findlay-Walsh, organiser of the Inter performance platform. These people provided me with the opportunity to present my work to a wider audience.

Thanks to my Mum for encouragement and free board and lodgings on Arran whilst collecting the field recordings. Also to my son Callum for making the dinner on colloquium evenings.

Finally, I wish to dedicate this portfolio to my late Father. He passed before I set out on my musical journey. I often wonder what he would think about it all.



## 1. Introduction

Creation of this Portfolio has arisen from exploration of the efficacy of blending several different aspects of instrumental writing with elements of recordings of nature. Investigation of pitch blending between equal tempered tuning, the natural harmonic series and perceived pitches within natural sounds forms one aspect of this study. This process has integrated uncompromised and manipulated sound recordings. Timbral possibilities have been explored by juxtaposing instrumental pitched material with semi-pitched nature recordings such as birdsong at one end of the spectrum, to sound with a high inharmonic/noise content at the other end e.g. wind and water, and expanded by incorporating inharmonic extended techniques of the instruments. The timbral elements of the field recordings have been manipulated to generate new sound-worlds and imagery absent in the original recordings. Pitched material has been derived from field recordings following spectral analysis, and blended with the original sound file. Further refinements to the unifying of the instruments and recordings came from assessment of spatialisation on the aesthetics of the soundscape and images portrayed. In addition, my portfolio demonstrates another facet of my practice, the use of algorithms to inspire, and generate raw musical material from which I sculpt the final product. During this paper, I will position the portfolio's creation within a range of composition methodologies including mathematically derived writing, some recent practices within spectralism and the use of tonal and timbral associations to evoke imagery, as expounded in the writing of Simon Emmerson (Emmerson, 1986). I will explain my thought processes in terms of recent thinking on musical creativity, drawn together by Hargreaves (2012) specifically the chapter by Katz (2012). I will consider how my systematic approach aligns with a few notable composers' methodology and I will contextualise the research aims and musical outcomes by analogy with other practitioners within the fields of acoustic, electroacoustic and spectral composition.

## 2. My Aesthetic and Practice

My compositional practice is heterogeneous borrowing from many different compositional methodologies and aesthetics. I like to work with schemes, devices, games, and metaphor. These facilitate my process of composition. I have used many of the “Beyond Domain” devices (detailed later) used by composers where mathematical concepts have been utilised either as inspiration or directly.

I do this to avoid the danger of falling back upon what I consider to be overworked sonic idioms and allow for the possibility of generating less commonplace sound-worlds. There is a risk that by beginning from prior learning, a knowledge of scales or counterpoint or knowledge of stylistic characteristics to be emulated, the outcome could approach pastiche. In using a mathematical algorithm or set of rules not related to music there is the potential to generate something unexpected and unforeseen; raw material which can be molded into something which couldn't be achieved from prior knowledge. Why then merge or sculpt the material generated with other more intuitive thought processes? I tend to avoid using unmodified material generated entirely by a process. By intervening I am able to shape material to my aesthetic goals. The surprising and satisfying can be separated from the banal and unpleasant or material having characteristics at odds with the desired sound-world. Instead I try to add meaning to the musical material by invoking images or memories. I believe strongly that music should evoke an emotion or generate a thought, image, memory, sense of place and time or anything which is personal to the listener. By sculpting sounds and creating a scenario I also believe that music, by allusion and metaphor, can be a powerful tool for raising awareness of things a composer thinks important, in my case politics and the inequality and injustices that exist.

My combining of instrumental timbre and field recordings, and decisions on manipulation of these blended sound-worlds, has been affected by listening to the music of György Ligeti (b. 1923), Denis Smalley (b. 1946), Jean-Claude Risset (b. 1938) and Anna Clyne (b.1980). Also, some of the principals

developed by spectralists including Murail, Tenney and Haas have driven some of my ideas. Use of natural harmonics and the overtone series is a major component of my writing.

My portfolio consists of two works. *Bifurcation of Nature*, a four-part composition inspired by mathematical equations from the domain of chaos theory and *Angle to the Sun*, a two-part composition inspired by a genetic model and natural harmonic series arising from four different fundamental pitches. Incorporation of field recordings with the systematically generated instrumental materials is underpinned by principles adopted from spectralism and spectromorphology and placed within the mimetic discourse framework expounded by Emmerson (1986).

### 3. Beyond Domain - Inspiration, Systems and Rules

Inspiration for my approach can be rationalized using the ideas of Katz (2012). This study of 24 contemporary composers explores their mindsets during the writing, the factors that inspire them, and the choices that propel the process (p108). Composers are categorized into two types, or a hybrid of the two, designated “Within-Domain” and “Beyond-Domain”

During the Preparation/Incubation stages, the Within-Domain composer concentrates on portions of musical material, using inner ear or instruments, whereas the Beyond-Domain composers develop a “conceptual framework that is rooted in a content domain outside of music” often associated with work, hobbies or a “belief system” (p110). “Worthy framework[s] ... will serve as structures for entire pieces”. (p115). The illumination stage for the Within-Domain composer is coalescence of material into a larger form but for the Beyond-Domain composer definition and use of the conceptual model. The verification stage for the Within-Domain composer is where musical details are refined and notated, for the Beyond-Domain composer where models are fleshed out and connections made to the larger framework (p120).

I can identify my own practice and compositional thought on the spectrum toward the latter type, as it follows the characteristics detailed from Katz’s paper below. Beyond-Domain composers are:

“More conventionally cerebral about the process”(p117); “gravitate toward conceptual frameworks and material outside of the music domain ... which they have been familiar with previously” (p117); “develop a set of guidelines or ‘parameters’ by which they work” (p117); “develop their ideas about the musical matter through formal devices such as metaphors and images (p117); and “test ... ideas that spin-off from the broader conceptual framework...[in order to] translate into music at the note level”. (p120).

This system, or series of rules, derived from a topic not involving the hearing or imagining of sonic components, has been utilized by noted composers, below. This is at least true in the initial stages of the composition process.

A group of such systematic approaches can be called algorithmic composition. The algorithmic process follows a set of mathematical instructions/rules in a fixed order to answer a problem. This can be either deterministic or stochastic. The stochastic approach is more commonly used in composition (Nierhaus, 2009, p2).

Mathematical and scientific processes have been used to generate musical structure/material by direct mapping data onto musical parameters. An early such systematic approach was used by Guido of Arezzo (~991-1031), who mapped pitches and musical phrases onto specific letters, syllables and components of verse (Nierhaus, 2009, p21).

Iannis Xenakis's (b. 1922) use of systematic procedures arising from his knowledge of architecture, is widely documented. In *Metastasis*, written in 1954, Xenakis applied a stochastic process to string glissandi, resulting in a complex web of glissandi moving at different speeds. He describes the result thus: "If glissandi are long and sufficiently interlaced, we obtain sonic spaces of continuous evolution. It is possible to produce ruled surfaces by drawing the glissandi as straight lines". (Xenakis, 1992, p10). This algorithmic process used to generate the music and the drawings which resulted were later used as the basis of the architecture of the Philips Pavilion built in 1958. This is perhaps a unique case of innovation in another field having arisen from music, rather than the reverse.

Xenakis used a stochastic algorithm, the Markov Model, in electroacoustic realms by applying this principle to more fundamental sonorities. He explains *Analogique A* in terms of "ordered clouds of elementary grains" (Xenakis, 1992, p103). This methodology is not limited to acoustic instruments; instead any timbre which can be generated by electronic means can be used to create a sound-world. Position in space is also seen as a possible data set to be acted upon. The resultant works demonstrate a greater focus on the timbral content of sound.

This focus on timbre comes to the fore in the works of Ligeti, specifically *Atmospheres*, 1961. Ligeti is considered by Anderson (2000) as an influential proto-spectralist whose use of micropolyphony to create sound clouds influenced Grisey, thus leading to spectralism.

Attempts by scientists to model natural chaotic systems has resulted in equations explaining the behaviour. The mathematics of chaotic systems have stimulated many composers e.g. Bidlack (1992), due to the unpredicted sound-worlds which can arise from such an approach. I have used four such chaotic systems, as a basis for the four-movement composition, *Bifurcation of Nature* discussed later.

Lorenz's studies on atmospheric flow is a well-known example of the study of chaotic systems. He deduced "three coupled non-linear differential equations" (Nierhaus, 2009, p133). As the solution to the Lorenz equations is approached the visualization traces out the form of a Butterfly (p134). I have used this concept to create the third movement of *Bifurcation of Nature* named *Butterfly*.

Bidlack thought that (1992, p46) "The great attraction of non-linear dynamical systems for compositional use is their natural affinity to the behaviors of phenomena in the real world". Such a biologically founded systems discovered by Lindenmayer known as the L-Systems can be seen in the branching of a tree or in the self-replication within a fern. This approach has been used by contemporary composer Hanspeter Kyburz (b. 1960) (Supper, 2001) in his piece *Cells for Saxophone and Ensemble*, in which he uses motifs selected from "13 generations of L-system rewrites, (Edwards, 2011). Also Drew Hammond (b. 1974) has used a similar methodology. In his composition *Watershed* (2011) an L system was used to generate a string of ordered intervals based on interval classes 1, 4, and 5. That string was used as the skeletal framework for a set of cumulative variations, often as a kind of cantus firmus. (Hammond, 2019).

The use of genetic algorithms in composition (Nierhaus, 2009, p158-9) is perhaps less well known and during my research it became apparent that I had already been utilizing the principals of "crossover," "mutation" and "survival of the fittest" on which this methodology is based. In musical terms crossover could mean that a string of musical material is broken and fragments rearranged and superimposed to create new sounds and textures. Mutation of chromosomes is exemplified by the application of random or stochastic procedures to small musical elements. The survival of the fittest requires a

musical decision to be made regarding fitness and could be many things, e.g. a matter of personal taste, similarity to a genre (in pastiche) or suggestions of specific imagery. Horner and Goldberg (1991) have described the generation of five-voice canon using these genetic principles. Some of these ideas have inspired the pitches and structure of my second piece, *Angle to the Sun* to be discussed in depth later.

#### 4. Soundscape Composition - Spectralism, Spectromorphology and Mimetic Discourse

The dawn of the electronic age caused a paradigm shift in musical styles by enabling the generation of totally new sound-worlds and the analysis and reconstruction of the old. Experimental music was created by initially the exploratory use of audio tape recording and computers in the 50's e.g. *Illiad Suite for String Quartet* by Lejaren Hillier (b. 1924), followed by some music manipulation programmes in the 60s. This was furthered by the development of electronic instruments such as synthesisers in the late 60s and 70s. This new style included the soundscape compositions of Jean Claude Risset (b. 1938) who was one of the first to blend natural sounds with synthesized instrumental sounds using spectral manipulation of both forces (Risset, 2015).

Running in parallel with this was an increased interest in the timbral character of sound. Arnold Schoenberg (b. 1874) was one of the first composers who used timbral modulation in addition to the more traditional harmonic movements within counterpoint. This is exemplified in *Farben*, where the recolouration of the chord is a central mode of progression. (Schnittke, 2002, p113). An important proto-spectralist was György Ligeti (b. 1923) whose use of slowly moving timbral and textural clouds of sound in e.g. *Atmospheres* and *Lontano* propelled many composers in this musical direction. This use of timbre as musical building blocks heralded a style which became known as Spectralism.

Spectralism was spearheaded by Gérard Grisey (b. 1946), Tristan Murail (b. 1947) and Horațiu Rădulescu (b. 1942), and institutions including IRCAM and GRM. This style is characterized by the predominance of timbre over pitch and motivic considerations, and uses “the overtone series as their point of reference” (Rose, 1996). “Spectral composers use the acoustical fingerprints of sounds - their spectra - as basic musical material”. (Hasegawa, 2015). Also, metaphors of electronic processes have been extensively used. Murail used the FM technique to generating the harmonic structures in the first section of *Gondwana* (1980). (Rose, 1996).

However, Murail has stated “one can find examples of spectral music with ‘beautiful sounds’, but spectral music has also bestowed the history of music with some of its most atrocious noises”. He considers for such music



“orchestration...[is] particularly advantageous, and sometimes necessary, for without [this]... it will be either incomprehensible or uninteresting”. The mixing of timbre and harmony has been “liberally exploited in works mixing electronics with acoustic / instrumental sounds (e.g. Grisey’s *Jour, contrejour* and my [Murail] *Les Courants de l’Espace* and *Desintegrations*)”. He also states that there are composers who find “immediate pleasure in sound”, and those whose interest is in “formal craftsmanship”. Murail’s ideal is to “melt them together” (Murail, 2005).

This melting is exemplified in Murail’s later work *L’esprit des dames* (1996) which uses the spectral analysis of instruments and the blending of electronic and instrumental sounds (Anderson, 2001).

Spectralism has spawned a second generation of Spectralists who have taken some of the features described above and combined them with their own personal aesthetic or indeed other musical genres. James Tenney (b. 1934) could be considered within this frame. He was of the view that spectral music had to “invoke Fourier spectral analysis as a conceptual point-of-reference” (Wannamaker, 2008). His guiding principal has been the analysis and orchestration of acoustic and electronic sources by assigning spectral components e.g. partials arising from both these sources to acoustic instruments.

Georg Frederich Haas (b. 1953) is an Austrian composer who moved to North America. Although he makes “frequent use of chords based on the overtone series” (Hasegawa, 2015), as typical of the spectralists, he also combines this with harmonies arising from different traditions. This has included the equal temperament of the Second Viennese school, the systems of microtonality, as explored by Wyschnegradsky, and the extended just intonation of Partch. (Hasegawa, 2015).

Some aspects of sound blending and some of the principles of spectralism pioneered by these composers have aided my thinking and decision making during the writing of this portfolio, to be discussed further in sections 5 and 6.

A major strand of my research was to investigate different ways of blending the instrumental material created using systems, with environmental recordings.

Emmerson (1986) extensively explored how electroacoustic composers have negotiated this challenge and the techniques-used to do so.

Emmerson’s contention is that electroacoustic music in which timbre plays an important part can be split into a matrix of 3 by 3 components as reproduced below at Figure 1 (Emmerson 1986, p24).

Abstract syntax	1	4	7
Combination of abstract and abstracted syntax	2	5	8
Abstracted syntax	3	6	9

I: Aural discourse dominant      II: Combination of aural and mimetic discourse      III: Mimetic discourse dominant

┌─────────── MUSICAL DISCOURSE ─────────┐

Figure 1 : Mimetic Reference as a Compositional Device (Emmerson 1986, p24)

The musical language of category 1 is identified as aural (least likely to evoke images of the real world), and generally instrument based or electronic sounds, often arising from a system (Emmerson 1986, p25). Category 9 at the other extreme is defined as mimetic and abstracted. Here the musical language is predominantly recorded identifiable environmental sounds which are selected, edited and ordered by the composer, with the intention of creating a storyline in the mind of the listener (Emmerson 1986, p39). I found myself attempting to construct a musical narrative from these extreme points on the matrix, pitched instrumental material arising from a system with environmental recordings.

I embarked on this combination of the extremes because I hear “music” in the sounds of nature and wanted to unleash and enhance these perceived elements and combine them with pitched instrumental music in different ways. I also wanted to generate a political narrative by using known sounds, electronic manipulation to create recognized sounds and associations of these with current events. The following sections provide a critical appraisal within the context of each piece in the portfolio.

## 5. Bifurcation of Nature

### 5.1 Inspiration and System development

My tendency to be a “Beyond Domain” composer is seen in *Bifurcation of Nature*. The initial inspiration arose from my disgust and horror at the Brexit vote to leave the EU in the summer of 2016. My reaction to this political situation paralleled that of other composers, including Haas, who composed the piece *In Vain* (2000) due to the “consternation at the formation of a coalition government with the far right in 2000” (Rogl, 2017). He describes the feelings of sorrow, fear and of “being taken somewhere you do not want to go” (Varga, 2011). Krzysztof Penderecki’s (b. 1933) dedication of *Threnody (for the victims of Hiroshima)* also falls into this category. This autobiographical piece arose from his experience of “the great Apocalypse” of Auschwitz and from his “subconscious mind since the war”, an expression of “universal mourning for the victims of war” (Carpenter 2018).

I felt the need to reflect my feelings musically. As a composer, whose practice originates from concepts out with music, and whose background is in science, I turned to Catastrophe theory, a subset of Bifurcation Theory. This body of work initiated by René Thom, can be précised as “small changes in certain parameters of a nonlinear system ... leading to large and sudden changes in the behaviour of the system” (Balas, 2017, p139). The overall plan for this piece crystallised in my mind, resulting in four movements from four different chaotic systems.

The first Movement was derived from a set of equations leading to extreme bifurcation. This set is called Swallowtail, from the shape of the graph generated. The second movement was defined from a graph designated “Bifurcation Set for the Simplified Machine”, the third from the previously mentioned and extensively used “Butterfly” equations. The fourth and final movement is inspired by another chaotic system of two independently moving, but joined pendulums which when configured in a certain way trace out the shape of Smiles and Teardrops. These systems were used in different ways to generate the initial musical material, which was then sculpted using additional methods into the final composition.

An aim in my research was to examine the combination of the spectral properties of chamber instruments with field recordings. Another was to extract and enhance the properties of natural complex sound that may be perceived as “music”, such as pitch rhythm and timbre. Some of the characteristics and methodologies associated with spectralism have been explored in the creation of this composition.

## 5.2 Movement 1 - Swallowtail

For the first movement, I used one of Thom’s set of equations, known as Swallowtail. Initial attempts to correlate numerical solutions of the 3 simultaneous equations, which describe the Swallowtail catastrophe (Weisstein, 2019), with pitch classes gave a harmonic progression. This did not however suggest the catastrophic bifurcation of Brexit that I was aiming to allude to. However, a simple solution to the “unfolding singularity” (Weisstein, 1999) presents graphically as an extreme bifurcation of two lines. I therefore abandoned my initial thoughts and instead used a representation of the equations, which had been immortalized by Dali in a painting entitled *The Swallow’s Tail*, as a template for pitchmapping. (Figure 2)

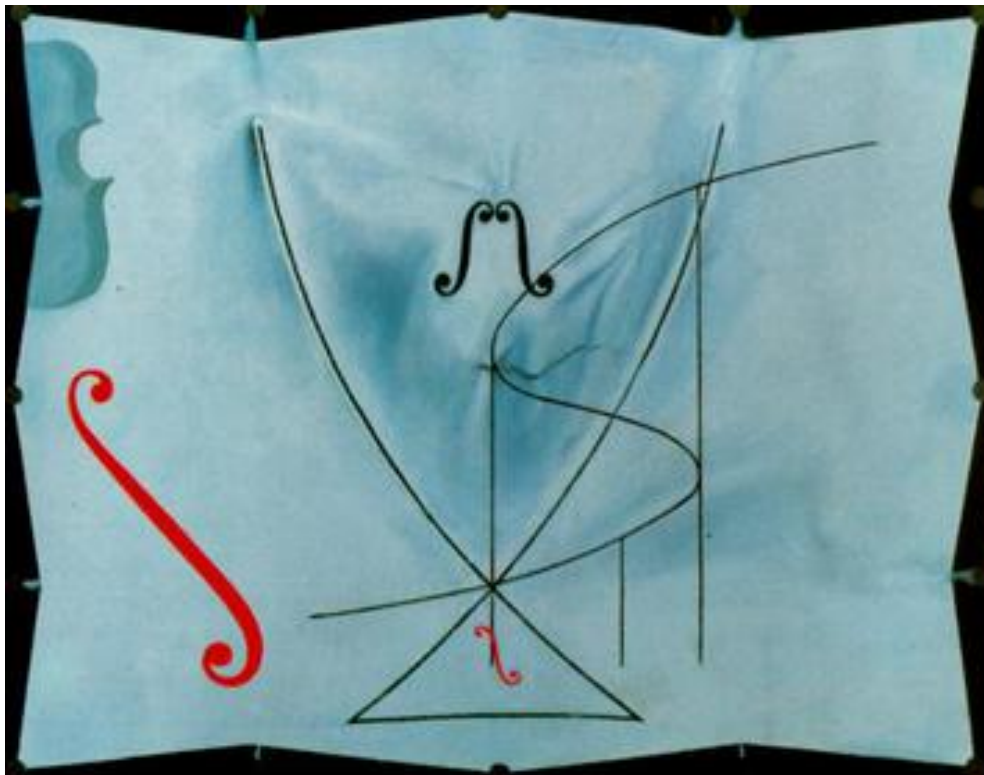


Figure 2 : The Swallow’s Tail - Dali (Spiritual Travel, 2011)

Cellos were selected due to their wide pitch range and easily understood harmonic structure based on the simple divisions of a string. Mapping of 6 cellos onto the 6 lines using the full range of the instrument was carried out. (Figure 3). This resulted in a linear piece of music with very slow, gradually increasing tension as the pitches diverge and move to the extremes of the possible range. Once the initial material had been heard, it became apparent a longer time frame and more interest in the descending and ascending lines were required. Experimentation resulted in staggered multiple entry of each of the lines. Instrument limitations required some parts to be pre-recorded into the soundscape.

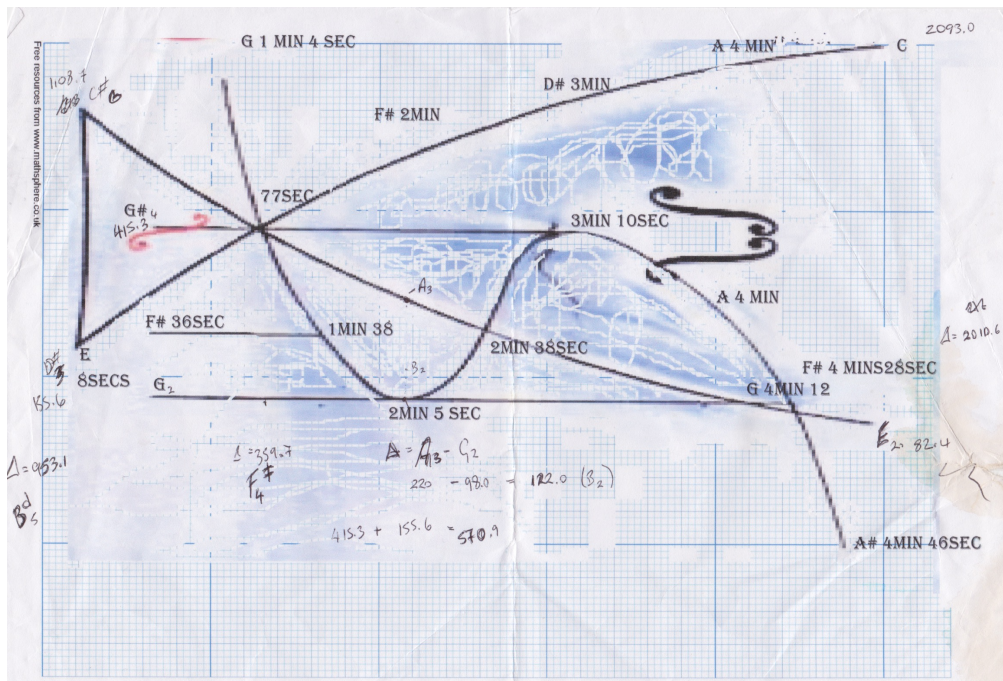


Figure 3 : Graph to Pitch Realisation

Combining the gradually intensifying cello music with a series of hydrophone water recordings strongly evoked, in my mind, images of the Syrian refugee crisis and their attempts to escape by sea. Placement of the field recordings parallels the instrumental music, with evolution from pleasant sounding material to more intense, unsettling harsher sounds.

Pleasant seashore recordings of birdsong and lapping water at the beginning are followed by popping seaweed to give some percussive interest. The tension is then increased by introducing a boat engine sound, and further so using recordings where the hydrophone has been rubbing on the sea bed. Rocks

grinding against each other underwater add an unpleasant element of harshness. Reverse reverb has been used on recordings of water dropping to give an unsettling effect. I then introduced faster running water to increase the tempo and texture. The field recordings are largely untreated except in a few instances to suggest specific imagery or metaphor. Some hydrophone recordings of water splashes were reversed and much reverb added to give the impression of hiding in a sea cave. The only instrumental contribution to the soundscape was contrabass clarinet multiphonics just at the climax. Pitch gradient, layering and use of dynamic panning were used to suggest the circling of the dinghy by gun boats.

### 5.3 Movement 2 - Rayleigh Scattering

The pitched instrumental material used as the starting point was derived from equations named Cusp Catastrophe. This describes the behaviour which occurs when more and more stress is applied leading to a sudden and dramatic breaking point. A graphical representation was found (Robbin 2013) designated “Bifurcation Set for the Simplified Machine”, which can be seen at Figure 4.

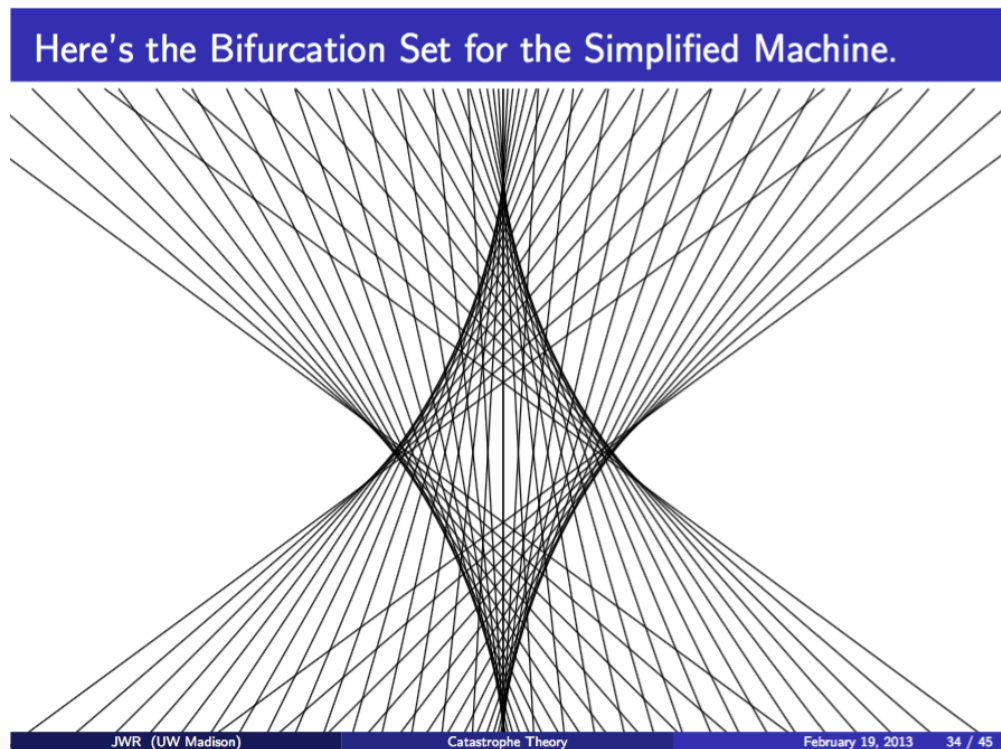


Figure 4 : Bifurcation Set for the Simplified Machine (Robbin, 3013)

This was used to prompt the pitches and rhythm of the initial cello material. A line through the plane of reflection was designated as the highest pitch and the x axis the lowest. The graph was split equally for the 6 cellos. Lines were drawn horizontally at these chosen positions on the graph, and the points of intersection projected onto the x axis. This gave the temporal placement of the cello notes. Pitches chosen for the cellos were the 4<sup>th</sup> to 9<sup>th</sup> harmonic arising from G0 and were rounded to the nearest quartertone (Figure 5). The rhythmic mechanical musical material arising gave the framework and starting point of this movement.

After hearing Anna Meredith's (b. 1978) *Anno*, a string and mixed media reworking of Vivaldi's *Four Seasons* and her use, during one particularly attention grabbing section, of juxtaposed totally unrelated material I decided to explore this possibility.

I had the good fortune to witness a duck fight whilst recording in the field, and I used slowed down versions of this aggressive, percussive material to contrast the regular rhythms of the cellos. The result was a comparatively smooth surface texture with a darker, more aggressive undercurrent.

Simultaneous research into the phenomena of "Bifurcation" led me to the writings of Alfred North Whitehead (1861-1847) on the "Bifurcation of Nature". The following quotation summarises his main philosophical argument:

*"We may not pick and choose. For us the red glow of the sunset should be as much part of nature as are the molecules and electric waves by which men of science would explain the phenomenon". (Whitehead 1920)*

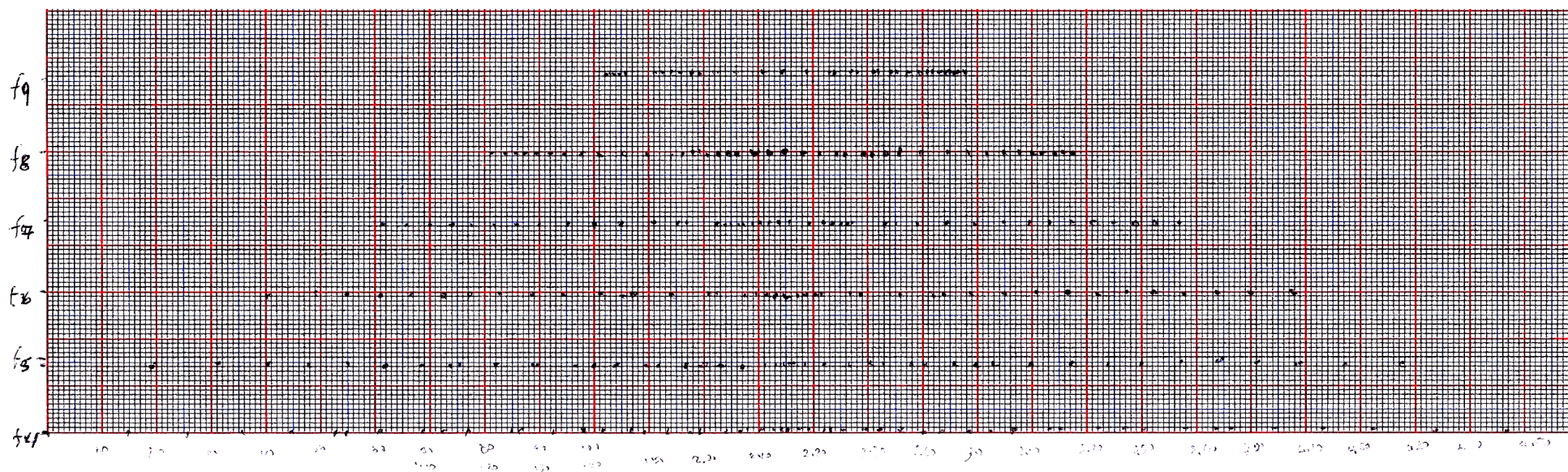
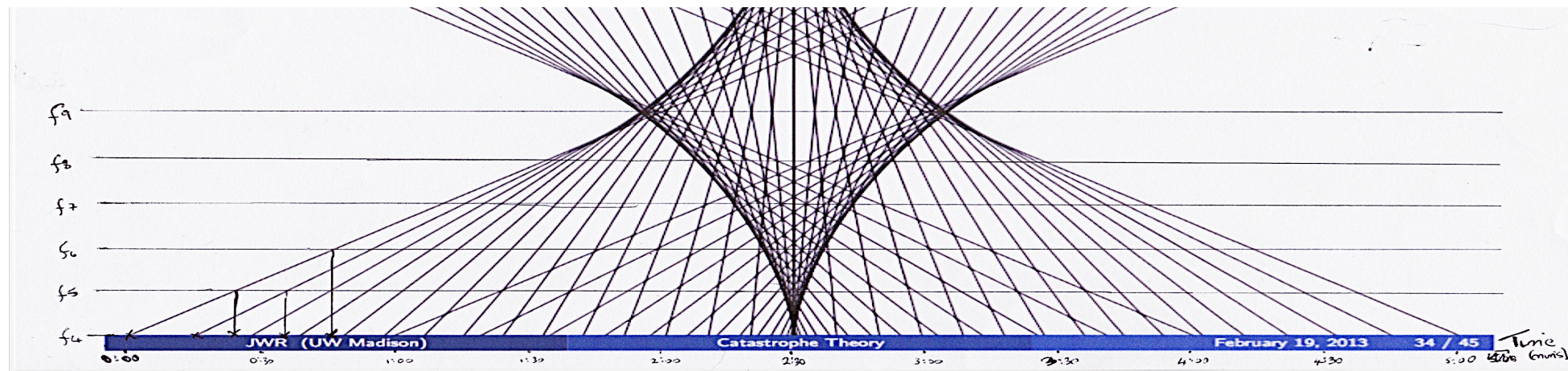


Figure 5 : Pitch and Rhythm Derivation



This touched on my own feelings of conflict between science and the creative arts and my personal journey to allow these facets to work together.

As the movement progresses, the imagery of a calm sea under a sunset is evoked through 6 horns playing the same pitches as the cellos, but in a much attenuated, slowly undulating time scale. The mechanical vibrations which give rise to the colours of a sunset are represented by the rhythmic cellos, and undercurrents by the accompanying soundscape including duck fight and buzzing bees. The undercurrents finally erupt with the introduction of fireworks and transposition of the string pitches. Irregularity is also introduced into the cello writing at this section.

Each amplified cello has a designated unique speaker, the lowest pitch coming from the sub. I introduced a visual dimension to the performance by positioning the cellos in a straight line at an approximate 45-degree angle to the front of the stage so each cellist's arm is visible. The direction of the bowing is carefully stipulated to portray a machine, the movement of one bow choreographed with that of the others and synchronized with the sound emanating from that specific cello. A brown sleeve is worn on the player's right arm to further suggest the levers in a large interconnected mechanical device. After the fireworks, this disintegrates into random unsynchronized bowing.

This movement is called *Rayleigh Scattering* after the phenomenon whereby light is scattered by atmospheric particles leading to the sky's blue colour, and the colours of a sunset. *Bifurcation of Nature* became the overall title for this composition.

#### 5.4 Movement 3 - Butterfly

The third movement required a lot of trial and error and abandoning initial strategies in order to reach a satisfactory outcome. The original concept was to use a bifurcation equation namely butterfly, developed by Lorenz to explain chaotic weather systems, the well-known "butterfly effect", in which

*“One flap of the wings of a butterfly causes a minimal turbulence which, however, in the course of the deterministic chaotic development of the system, may lead to completely unforeseeable meteorological consequences also in very distant places” (Nierhaus, 2009 p133).*

The equations have a dynamic fractal type solution based on 3 attractors which trace out the shape of a butterfly. Figure 6. The animation can be seen on YouTube (HumanicS, 2010).

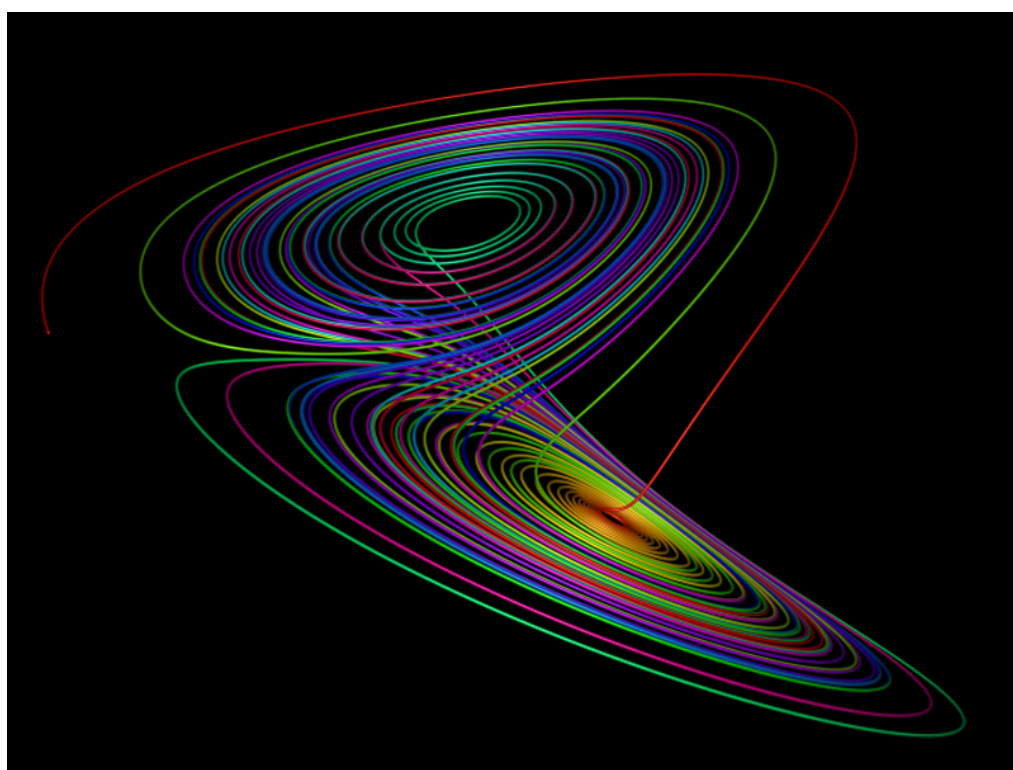


Figure 6 : Model of the Lorenz Attractor (HumanicS, 2010)

I had been recording seabirds on the Isle of Arran, and I wanted to make use of the spectral properties of these recordings to generate material. I began to explore the use of SPEAR (Sinusoidal Partial Editing Analysis and Resynthesis) to generate more abstract sounds. This software allowed the selective removal of partials by frequency and duration, amongst other things. It also allowed the arbitrary willful removal of portions from the spectrogram. Audio files which made it to the final cut were created by drawing and removing different shaped objects from the sound file. The resulting watery, bubbly sounds enter at 36 seconds and can be heard in different layers throughout.

An idea, which was eventually discarded, was to analyse the sound recording using an FFT method and to use the most frequently occurring 4 pitches as scordatura tuning for a solo cello. Double stopped cycling up and down through the natural harmonics was then to be performed to suggest the cycling behaviour of the butterfly attractors seen in the animation. The result was banal and didn't blend with the sound files, so eventually the method was discarded. The idea of cycling was later reintroduced in an alternate way, described below.

I instead took a more reflective, philosophical approach, using the “Butterfly Effect” as a metaphor for the unexpected and uncontrollable trajectory of life's journey, and the small occurrences which can lead to major changes in direction. Thinking laterally, I also used the Japanese In and Yo scales, as well as the start of the famous *Madame Butterfly* aria, “Un Bel di Vedremo”, to generate material. I wanted to make use of natural harmonics in conjunction with Japanese harmony, a modification of one of Haas's tenets of spectralism, his combination of different systems, as found in both *Blumenstück* and *In Vain* (Hasegawa, 2015). I decided to exploit the pitch fluctuation between harmonics generated from the F and Bb fundamentals of the horn, which then necessitated lowering 2 strings on the solo cello from C and G to Bb and F respectively. The resulting occasional clashes with the equal temperament writing gives a sad plaintive tonality in keeping with the theme.

The overall trajectory of this movement depicts a journey starting from recorded sounds which were both a metaphor for the flapping of the butterfly's wings and suggestive of the flapping of sails in the plot of *Madame Butterfly*. Changing the playback speeds of these recordings resulted in sounds suggesting a wide array of things, from wild dogs to whale song. When lowering sounds by one octave, the formants, or “concentrations of acoustic energy or spectral strength within a particular invariant frequency range” (Hugill, 2008), are also lowered by an octave, and the frame of frequency perception is also changed. This can result in interesting and unusual associations. When birdsong is slowed down to half speed, there was a strong suggestion of wild dogs barking. This was enhanced by additional lupine effects from the horns. Whale song is signified in the extremely slow playback speeds with further emphasis by the horns. The butterfly wing metaphor ends with a violent storm.

At the same time, the solo cello and two horns develop motives that become more elaborate from section to section (Figure 7). These three lines, as well as an underpinning cycling of wind recordings, which are panned around the 5.1 array in diminishing circles, allude to the cycling of the Lorenz attractor. The start of the most dense, intertwined section at the golden ratio is heralded by a thunder clap (sampled from BBC, 2018). The movement ends with a retrograde version of the initial plaintive slow natural horn melody.

Section 4 15

The musical score for Section 4 consists of two systems of three staves each. The first system (measures 223-228) features a horn line with a triplet of eighth notes, a cello line with a triplet of eighth notes, and a bass line with a triplet of eighth notes. The second system (measures 229-234) features a horn line with a quintuplet of eighth notes, a cello line with a quintuplet of eighth notes, and a bass line with a quintuplet of eighth notes. A double bar line with a repeat sign is placed between the two systems.

Figure 7 : Motivic Intertwining

#### 5.5 Movement 4 - Smiles and Teardrops

This movement explores Tenney’s assertion that spectral music invokes Fourier spectral analysis as a “conceptual point-of-reference” (Wannamaker, 2008). I used the Sigmund object, involving a Fast Fourier Transform process, in Max/MSP on the spectral frequencies of bee recordings to generate the cello and horn material. Initial results sounded very random but some judicious fragmenting and rearranging of the musical material formed the basis of this movement. This material was split between the solo horn and solo cello by

playability and a dialogue constructed. A light-hearted jaunty melody resulted reminiscent of bees flitting between flowers.

I wanted to tie this in with my systematic oeuvre and the chaotic systems model I had used for the subsequent movements, and a search of possible models led me to the Swinging Atwood's Machine. A simulation can be viewed (Swinging Atwood Machine, 2017). It is constructed from two pendulums joined together via two frictionless pulleys. The small mass can move freely whereas the larger mass can only move up and down. When two specific masses are selected, the trajectory traces out a shape that has been described as "Smiles and Teardrops". The free random buzzing of the bees and the transcribed material reminded me of the small masses motion. I thought therefore it would be an idea to simulate the up and down motion of the larger pendulum in the accompanying cellos. The same pitch classes present in small phrases in the solo lines were selected and notated within the corresponding accompanying voices (Cellos 2 - 6) (Figure 8).

The image displays a musical score for Figure 8, illustrating pitch class extraction. The score is divided into two systems. The first system, starting at measure 141, features a Horn 1 (Hn.1) part with a melodic line. Above the staff, there are two musical motifs: a quarter note followed by a dotted quarter note, and a quarter note followed by a dotted quarter note. The Hn.1 part includes dynamic markings: *mp*, *f*, *mp*, *f*, and *p*. A note with a glissando line is marked with a '5'. The second system, starting at measure 65, shows the Cello parts (Vc.1 to Vc.6). Vc.1 has a long glissando line with a '5' and dynamic markings *mp*, *f*, and *p*. Vc.2 through Vc.6 have rhythmic patterns with dynamic markings *f* and *p*. A note with a glissando line is marked with a '5'. The score is numbered 141 and 65 at the beginning and end of the systems respectively.

Figure 8 : Pitch Class Extraction (Transposing Pitch)

The motion from extreme stretch of the pendulum to reduced periodicity was reflected in the pitches selected for the cellos. This reduction in the extremes of the pitches within each bar led to an interesting phenomenon whereby the ear does not follow the actual rhythm but instead the line of the ascending or descending pitches. This gives a slightly off kilter feel in keeping with the jaunty melody.

## 6. Angle to the Sun

### 6.1 Inspiration and Overarching Theme

Both the thought of using a genetic model discussed previously at section 3 and my background in Chemistry led me to investigate the use of 4 pitch classes as an analogy for the 4 chemical bases in DNA. Four pitches were selected from a double harmonic scale at the most characteristic point of the augmented 2<sup>nd</sup>. Flute, Bb Clarinet, Bass Clarinet, Horn, Cello and field recordings were chosen.

Material was constructed using these two sets of 2 notes for the beginning of the piece. Some small musical fragments, 10 notes long, were then created analogous to chromosomes.

I had recorded bees in a hive, on the Holy Isle and wanted to use these to evoke the feeling of heat. The pitches selected from the double harmonic scale were very close to an Ethiopian scale, the Half Tizita. Movement from one to the other was to represent a genetic “mutation”. This pentatonic scale had one too many pitches for my genetic model but I decided to use one as a drone.

Furthering the genetic concept replication was evoked by next using 8 pitch classes, then 16 (used for another acoustic piece, not included in this portfolio), and then 32. Selection of the pitches for each instrumental line in the 32 note sections was made from the natural harmonic series arising from the starting points of F0 for Bass Clarinet, G1 for Horn, Ab1 for clarinet and Db2 for Flute. Two movements were created using these rules and ideas, one fast the other very slow. A proportion of the same musical material was used differently in both.

Bee recordings feature heavily in both pieces. Research into the behavior of bees gave a fascinating insight into the phenomenon known as the “waggle dance”, a figure of 8 motion carried out by the honey bee to indicate to the hive the quantity, direction (using the sun as reference) and distance to the source of nectar (von Frisch, K 1967). This behavior led to the naming of this composition *Angle to the Sun*, the faster movement called *Acute* and the slower, *Oblique*. It also inspired the dynamic panning and spatialisation used in the soundscape.

## 6.2 Angle to the Sun - Acute

The start is, to me, highly evocative of a middle eastern setting and the pace processional in nature. This has been underscored with field recordings of cobbles, birdsong and crickets. Flute motives were added to compliment and mimic the birdsong. A GRM plug-in was used to isolate some of the frequencies and associated overtones present in a sea recording, giving an aeolian harp effect. Tertiary modulation and addition of horn crescendos then increases the tension. Bee recordings are then added, having been modified using the GRM Space Grain plug-in which distributes grains randomly around the speaker array. Two such files are overlapped to increase the activity and anger and suggest overhead aircraft. Genetic replication is indicated by the doubling of 4 main pitch classes to 8 pitch classes. The third part consists of alternating sections of 7/8 and 5/4 to insinuate 2 opposing forces. The block rhythms suggest the war machine and the gradual blending of the material the ensuing battle. Bee recordings have been modified by introducing a pitch gradient from the 4 principal pitches to the next 4 of the 8. These are placed to coincide with the block chord sections. Out of sync cricket sounds are placed with the manic, fluid 7/8 bars. Slowed down recordings of flapping flags are also added here. The lowering of the centroid pitch with associated formants and the stretching of the sound envelope are extremely evocative of distant rocket fire. This section crescendos then stops with only the crickets remaining.

## 6.3 Angle to the sun - Oblique

The overall shape of this movement is from low to high pitch as more notes along the harmonic series are introduced. Pitches have been approximated to quartertones for all but the horn which makes use of natural harmonics.

Tenney's guiding principles have been examined. He has made extensive use of the analysis and orchestration of electronic sources by assigning spectral components e.g. partials, to acoustic instruments (Tenney, 1993). I have done the reverse and tuned the pitches present in the bee recordings to my tonal system by playback speed alteration. Where Tenney used strict intonation (Wannamaker, 2008) I have restricted myself to quartertone writing for the instruments for practical purposes, however the field recordings have been

manipulated to give a wide spectrum of microtonal output using gradient treatments.

Haas, as typical of the spectralists, makes “frequent use of chords based on the overtone series” (Hasegawa, 2015), he also combines this with harmonies arising from different traditions. (Hasegawa, 2015). This use of chords from the harmonic series and a hybrid approach can be seen in the latter sections of *Angle to the Sun - Oblique* where I move progressively to higher harmonics, ending on the 32<sup>nd</sup>, using chords arising from the four simultaneous, differently rooted series. The choice of pitches was aided by the graph at Figure 9.

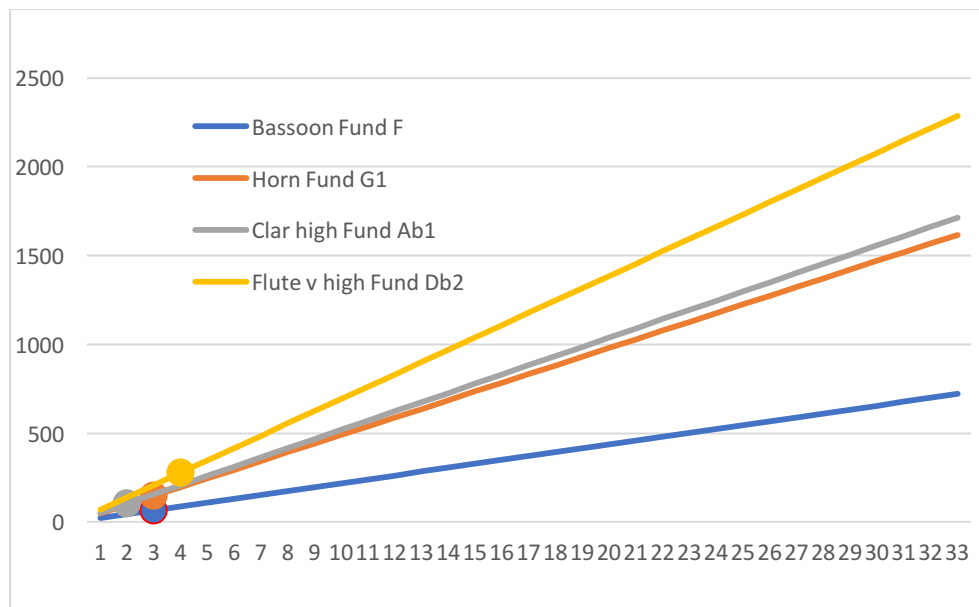


Figure 9 : Harmonic Series

In *Oblique* the use of the field recordings has been threefold, firstly as orchestration to harmonise with the instruments, increase the texture and extend the timbral quality; secondly to add some percussive elements to the ensemble; and thirdly to connote a different meaning from the original by transformation of the sounds. Examples of “transcontextuality” (Smalley 1993), “the potential of sounds to suggest identities which relate to a background that is external to the musical discourse” (Martins 1997) can be heard throughout.



In addition to pitch related timbral differences due to formant transformations as described for *Butterfly*, some sound objects present in *Angle to the Sun* have been manipulated to produce allusion in a different way. The inharmonic sounds of flapping flags and walking on cobbles have been slowed down. In these instances, the pitch transformations are less important, although some sense of lowering of the centroid is present. Instead the extending of time duration of the envelope of attack, continuant and decay and how the spectral content can be heard to change with time is what allows the ear to infer meaning and create images in the mind. My perception of these new sounds is of distant gunfire and the movement of vehicles on rocky terrain, consistent with a war scenario.

The main elements which characterise *Oblique* are the low slow bass clarinet and horn progressions lending a dark threatening feel. The slowed down field recordings of ducks and seagulls result in what, to my mind, sounds like owls and nocturnal resonances.

The second section (6'08") is formed from the 10 note fragments (analogous to the chromosomes present in DNA) and the relative placement of these by ear, the survival of the fittest. This melancholy material continues until addition of bee recordings and slowed down water adds menace.

Up until now in *Oblique* the balance between the instruments and the field recordings has been slightly weighted towards the acoustic side. From this point (10'44") the electroacoustic soundscape dominates. The bee recordings have been manipulated in several different ways. These were tuned firstly to the 4 pitches which started each of the 4 harmonic series, as mentioned in 6.1. A low C drone was also created. Pitch gradients over two-octaves were generated and much experimental blending of these sound files performed. Portions were used in *Acute* but for *Oblique* continuous evolution of timbre was done using the GRM Evol plug-in. The GRM Space Grain plug-in was also used to explore and fragment the diffusion space of the bees and produce granulation effects.

Instrumental chords, selected from several of the odd numbered harmonics, were added in to the mix using the graph (Figure 9). These increased the pitch classes gradually from 4 until all 24 possible quartertone pitches had been

played. The treated bee files supplied the remaining 32 for the genetic model plus an infinite number of intermediate pitches. Final progression is towards the upper playable range of all instruments alluding to a journey towards the sun.

## 7. Spatialisation

Different aspects of spacialisation have been explored to assess whether the arrangement of the materials within the space has aided the blending of the instrumental writing with the field recordings. There has also been an attempt to immerse the listener within the scene/scenario that I hope the sounds and their placements suggest. These aspects are expanded below.

### 7.1 Spatialisation in *Angle to the Sun*

This has been written for acoustic/unamplified instruments. In this piece the contrast between the categories in terms of Emmerson's model is most stark. In *Acute* the blending has been executed in accordance with Smalley's idea of zoning (2007). The instruments form one zone, centre stage, surrounded in 5.1 by nature sounds as a backdrop. The percussive sounds of walking on cobbles and crickets chirping have been placed in the front centre speaker as part of the instrumental force to add an intermediate zone and mediate spatially between the two contrasting materials. In *Oblique* a similar arrangement starts the piece but the field recordings have been given a more reverberant quality to bring them closer to the listener, more oppressive and darker, giving the suggestion of a night scene.

### 7.2 Spatialisation in *Bifurcation of Nature*

By contrast *Bifurcation of Nature* has been written for amplified instruments. This allows the specific placing and movement of each instrument within the soundscape. Fewer extended techniques have been used than in *Angle to the Sun*. The blending of the essentially disparate material has been aided by its positioning in space alongside the field recordings in different ways.

Throughout *Swallowtail* all Cello sounds are to be routed through the front left, right and centre speakers. The more ambient sounds of birds and sea have been placed equally in the front left and right and rear left and right speakers. Some of the more disturbing sounds have been placed in zones closer to the audience. Dynamic panning of the processed contrabass clarinet at the end is

utilized to make the audience feel surrounded by a circling oppressive presence, in my mind to suggest a gun boat.

In *Rayleigh Scattering*, each Cello has been allocated their own individual speaker with the lowest harmonic emanating from the sub, the next 2 higher harmonics from the rear, then the centre speaker, then the front speakers. This adds to the theatrics of the bowing direction by correlating the parts of the machine with the direction of the individual sounds. The coll legno section at the end of the movement, representing chaos, is placed equally from all directions. The 6 horns are placed as a wash from the front and centre speakers. Birds and bees are placed in different zones of the soundscape throughout and the fireworks have been placed to surround the audience, with dynamic panning introduced to simulate movement across the heads of the audience. Without overhead speakers, it is only source bonding which allows this illusion to be successful.

*Butterfly* is the most spatially complex of the movements because the lead trio of 2 horns and cello become part of the dynamic soundscape. During the initial two thirds of the piece, the instruments are placed front and centre in the mix with the ambient ship and watery sounds surrounding. An illusion of passing by zones of birds then dogs and wolves is created by placing those recordings in specific areas on the right which gravitate towards the back of the room as the movement progresses, to be replaced by whale sounds on the left suggesting movement from land to open sea. In the latter third of the movement the concept of cycling of the three exponents of the mathematical model, is expanded into the spatialisation in both the fixed media components and the trio of lead instruments. Panning of the stormy sea and wind recordings around the space in an interweaving pattern is compounded by the dynamic panning of the horns.

Spatialisation in *Smiles and Teardrops* has concentrated on placing the duet between the horn and cello in the front left and right speakers respectively, emphasizing the interplay between these instrumental lines. The chorus instruments are placed equally in the front left, right and centre and the soundscape created from the bird, bee and firework recordings surround the audience equally from all speakers.

## 8. Evaluation

One means of synergy I have deployed has been to generate instrumental parts by the spectral analysis of field recordings. There has been doubt cast on this type of analysis as a method of mimicry as its use in noise samples such as water result in music which in no way resembles the field recording.

(O'Callachan, 2013). In the development of *Smiles and Teardrops* bee recordings were analysed using the Max/MSP object Sigmund and the most intense frequencies, above a threshold, notated in the rhythm present. Why I think this succeeds is that the loudest parts of the rhythm have been replicated accurately and the handstopped horn has a timbral quality very reminiscent of the sound of bees. Also, the presence of the bee recordings is in close proximity to the pitched instrumental parts generated. The instance which didn't work was in the first draft of *Butterfly* where the bird song was similarly analysed and the four most prevalent pitches selected for the cello scordatura tuning and double stopped cycling through the harmonics. Although all the possible harmonics generated by the cello would have been present within the field recording I suspect this failed because they were out of context due to the absence of any rhythmic imitation and only the very highest parts of the cycle would have been in the correct range.

Overlapping of different materials has been used to orchestrate, add texture and to move from one section into the next. Modification of a field recording by comb filtering to create abstracted pitched material was used to allow smooth passage from one segment to the next in

*Angle to the Sun - Acute*. These types of synthesis techniques have been explored in the past by Stanford and IRCAM (Emmerson, 1986, p32). In *Butterfly* use of SPEAR, another abstraction method, on recordings of ducks, resulted in the creation of interesting and unpredicted soundscapes which had a nautical character. These in juxtaposition with the tonal ethnic scale added texture and enhanced the desired imagery.

A different type of combination, that of two different tonal systems can also be found in *Butterfly*. The principal of using the natural harmonic spectrum inherent in the two sides of the horn, the F and Bb side, and juxtaposing this with some tonal four-part choral writing in equal temperament has led to some

beautiful alternating moments of angst and resolution which furthers the emotions associated with the *Madame Butterfly* plot.

It is difficult to assess whether manipulation of sound files to evoke political imagery has been effective as any inference is down to the listener. For me it was slowing down the flag pole recordings, that suggested distant gun fire and a war scenario. This propelled the development of *Angle to the Sun* in that direction

I believe the use of 5.1 surround sound and zoning within the soundscape has added to the intended imagery in both compositions. I also feel that judicious positioning of the instrumental materials derived from the recordings against an immersive backdrop of the said source recordings, as in *Smiles and Teardrops* has enhanced the spectral blending.

## Bibliography

Anderson, J. (2000) A provisional history of spectral music, *Contemporary Music Review*, Volume 19, Issue 2, p 7 - 22

Anderson, J. (2001). Murail, Tristan. *Grove Music Online*. Retrieved 12 Jun. 2018,

<http://www.oxfordmusiconline.com/grovemusic/view/10.1093/gmo/9781561592630.001.0001/omo-9781561592630-e-0000044940>.

Attwood (2017) -

[https://en.wikipedia.org/wiki/Swinging\\_Atwood%27s\\_machine](https://en.wikipedia.org/wiki/Swinging_Atwood%27s_machine)

accessed April 2017

Balas, V.E. Jain, L.C. Zhao, X. & Shi, F. (2017) *Information Technology and Intelligence*, IOS Press, Amsterdam.

BBC Sound Effects downloaded June 2018

<http://bbcsfx.acropolis.org.uk/assets/07070202.wav>

Bidlack R (1992), Chaotic systems as simple (but complex) compositional algorithms. *Computer Music Journal*, Volume 16, Issue 3, p 33 - 47

Carpenter, A (2018) <https://www.allmusic.com/composition/threnody-for-the-victims-of-hiroshima-for-52-strings-mc0002378039> accessed June 2018

Edwards, M (2011) *Communications of the ACM*, Volume. 54, No. 7, p 58 - 67

Emmerson, S. (1986), *The Language of Electroacoustic Music*. The Macmillan Press Ltd, London.

Encyclopedia Britannica - Generative Grammar - accessed online June 2017.

von Frisch, K. (1967). *The Dance Language and Orientation of Bees*. Cambridge, MA: Harvard University Press.

Grisey, G. & Fineberg, J. (2000), *Did you say spectral?* *Contemporary Music Review*, Volume 19, Issue 3, p 1 - 3

Hammond, D. A. (accessed 2017),

<http://www.drewhammondmusic.com/scores-and-samples>

Hammond, D. A (2019). Personal correspondence.

Hargreaves, D., Miell, D., & MacDonald, R. (Eds.), (2012), *Musical Imaginations: Multidisciplinary perspectives on creativity, performance and perception*. Oxford University Press. Hasegawa, R. Gerard Grisey and the 'Nature' of Harmony,

Hasegawa, R (2015), *Clashing Harmonic Systems in Haas's Blumenstück and In Vain*, *Music Theory Spectrum*, Volume 37, Issue 2, p 204 -223

Horner, A. Goldberg, D.E. (1991), *Genetic algorithms and computer-assisted music composition*. In: *Proceedings of the 1991 International Computer Music Conference*. International Computer Music Association, San Francisco

Hugill, A. (2008), *The Digital Musician*, Routledge, Oxon.

HumanicS (2010), *Simple Model of the Lorenz Attractor* [online video] available at: <https://www.youtube.com/watch?v=FYE4JKAXSfY> [Accessed May 2018]

Katz, S. L., & Gardner, H. (2012), *Musical materials or metaphorical models? A psychological investigation of what inspires composers*. In D. Hargreaves, D. Miell, & R. MacDonald (Eds.), *Musical imaginations: Multidisciplinary perspectives on creativity, performance, and perception* (p. 107 - 123). Oxford, UK: Oxford University Press.

Martins, G. & Ferreira, S. (1997), *A perceptual approach to the analysis of J. C. Risset's Sud: sound, structure and symbol*, *Organised Sound* Volume 2, Issue 2, Cambridge University Press.

Murail, T. (2005) *Target Practice*, *Contemporary Music Review*, Volume 24, p 149 - 171.

Murail T (2018) <http://www.tristanmurail.com/en/oeuvre-fiche.php?cotage=27533> accessed June 2018

Nierhaus, G. (2009), *Algorithmic Composition, Paradigms of Automated Music Generation*, Springer Wein New York.

O'Callaghan, J. (2013), *Orchestration of Ecology, as Ecology*, Paper presented in the symposium *Music and ecologies of sound. Theoretical and practical projects for a listening of the world*, University Paris 8, May 2013



- Partch, H. (1974 [1949]), *Genesis of a music* (2nd edn). New York: Da Capo Press.
- Risset, J. (2015). *Recollections and Reflections on Organised Sound*. *Organised Sound*, Volume 20, Issue 1, p 15 - 22.
- Robbin, J.W. (2013),  
[https://www.math.wisc.edu/~robbin/catastrophe/catastrophe\\_talk.pdf](https://www.math.wisc.edu/~robbin/catastrophe/catastrophe_talk.pdf)
- Rogel, H. *On the magic of “pure” intervals* - Interview with Georg Friedrich Haas  
<http://musiksalon.universaledition.com/en/article/on-the-magic-of-pure-intervals> (accessed June 2017)
- Rose, F. (1996), *Introduction to the Pitch Organization of French Spectral Music*. *Perspectives of New Music*, Volume 34 Issue 2, p 6 - 39.
- Schnittke, A. (2002), *A Schnittke Reader*, Indiana University Press
- Smalley, D. (1993), *Defining Transformations*. *Interface* 22, p 279 - 300.
- Smalley, D (2007), *Space-form and the Acousmatic Image*, *Organised Sound*, Volume 12, Issue 1, p 35 - 58
- Spiritual Travel (2011) <https://www.slideshare.net/mafreiromil/salvador-dal-and-pop-art-8693012>
- Supper, M (2001), *A few remarks on algorithmic composition*. *Computer Music Journal*, Volume 25, Issue 1, p 48 - 53
- Swinging Atwood Machine. 2006. *Swinging Atwood Machine*. [Online]. [2016]. Available from: [https://en.wikipedia.org/wiki/Swinging\\_Atwood%27s\\_machine](https://en.wikipedia.org/wiki/Swinging_Atwood%27s_machine)
- Tenney J (1993, [1983]), *John Cage and the theory of harmony*. In R. Kostelanetz (Ed.), *Writings about John Cage* (p. 136 - 161). Ann Arbor, MI: University of Michigan Press. Available online at:  
<http://www.plainsound.org/JTwork.html>
- Varga, B. A. (2011), *Three Questions for Sixty-Five Composers*. University of Rochester Press, NY

Wannamaker, R. A. (2008), *The Spectral Music of James Tenney*, Contemporary Music Review, Volume 27, Issue 1, p 91-130.

Whitehead, A.N. (1920), *Theories of the Bifurcation of Nature*. Chapter 2 : *The Concept of Nature*. Cambridge: Cambridge University Press.

Weisstein, E. W. (1999) "Swallowtail Catastrophe." From *MathWorld*--A Wolfram Web Resource. <http://mathworld.wolfram.com/SwallowtailCatastrophe.html> accessed 2019.

Xenakis I (1992), *Formalized music. Thought and mathematics in music*, revised edition. Pendragon, Stuyvesant, NY.

# **Bifurcation of Nature**

**Alison Beattie**



# Bifurcation of Nature

Duration 32'59"

Movement 1 – Swallowtail 10'13"

Movement 2 – Rayleigh Scattering 4'25"

Movement 3 – Butterfly 11'43"

Movement 4 – Smiles and Teardrops 6'38"

Amplified Instruments Violoncellos x 6  
French Horns x 6  
Laptop & Mixing desk operator

Conductor Click track

Score Transposing Pitch

## Programme Note

*Bifurcation of Nature* has been inspired by four mathematical equations describing different Chaotic Systems. An instrumental force of six amplified cellos, 6 amplified horns and field recordings including birds, insects, wind and water made on the Holy Isle - off Arran, have been manipulated and combined in a range of different ways to create novel textures and timbres. This four-movement composition is presented as a 5.1 soundscape.

## Performance Directions

The sound desk must have a minimum of 19 input channels and 7 output channels. Each input must be routable to 3 stereo pairs of output channels controllable via a pan pot and routing switches. One of the inputs must be routable to a 7<sup>th</sup> channel for click track to headphones. Each instrument will have a dedicated microphone assigned to its own channel throughout. The laptop will be connected via a sound card having 8 inputs and 8 outputs. The initial set up will be as follows.

Violoncellos 1-6 connected to input channels 1-6 respectively routed to all outputs 1-6

French Horns 1-6 connected to input channels 7-12 respectively routed to all outputs 1-6

Sound card connected to input channels 13-19 routed to outputs 1, 2, 3, 4, 5, 6 & 7 respectively.

Mixing desk outputs must be routed to speakers as follows:

1 = Front Left      2 = Front Right      3 = Centre

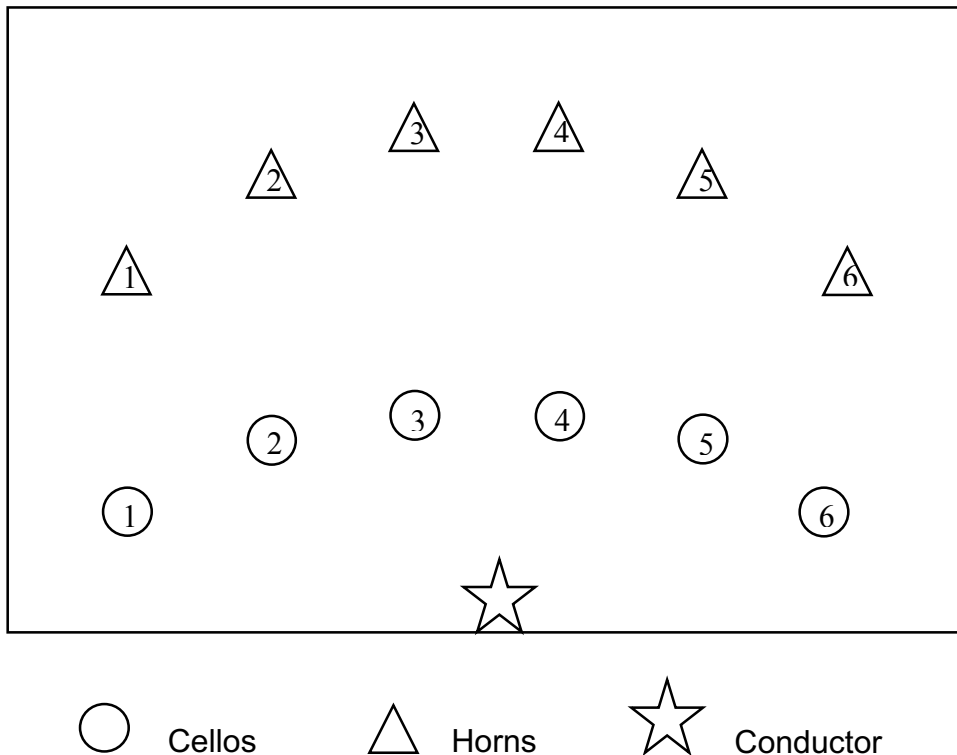
4 = Subwoofer      5 = Rear Left      6 = Rear Right

7 = Conductor – Click track/Headphones

## Stage Directions

The players will be positioned on stage as per the following diagrams.

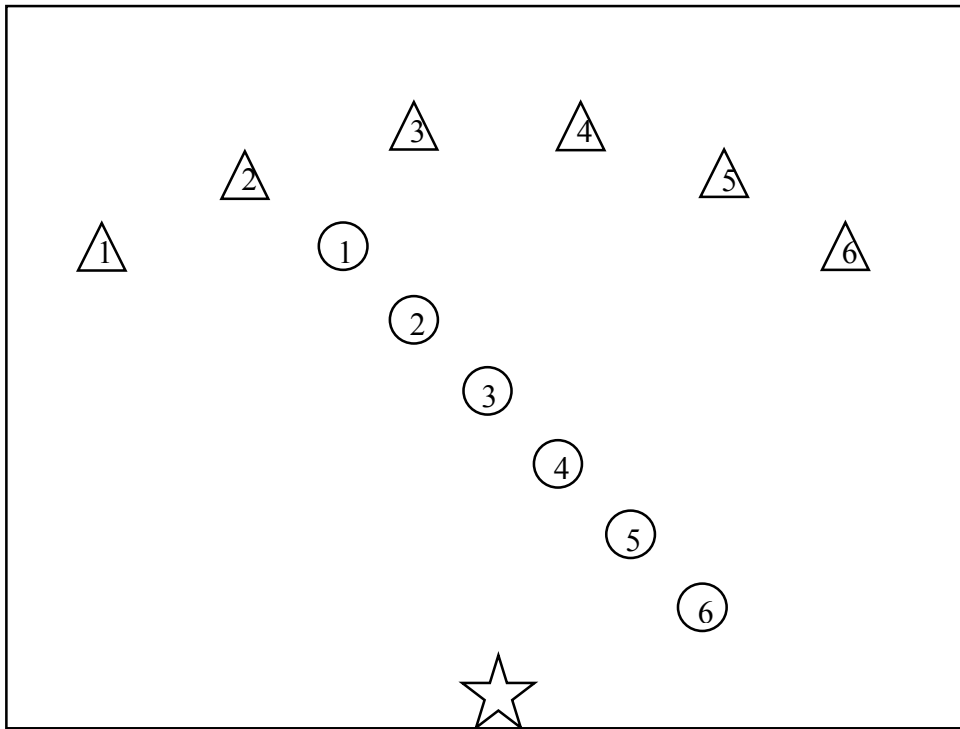
### Movement 1 - Swallowtail



### Movement 2 – Rayleigh Scattering.

Violoncellos 1-6

Cellos will move into their respective positions for movement 2 as indicated below, taking their microphone with them. Enough slack in cable should be factored into the set up. A brown sleeve will be worn on the right arm from mid hand to elbow to simulate a wooden lever. The bowing direction indicated in the score must be followed precisely and in an exaggerated fashion. The arm and bow movements are choreographed to illustrate the inner workings of a mechanical device.



### **Movement 3 – Butterfly**

All cellos move back to original positions.

Violoncello 1 – Scordatura tuning – Bb F D A.

### **Movement 4 – Smiles and Teardrops**

Remain in position

Violoncello 1 – Back to standard tuning.

Horn 1 – Stopping mute would be useful.

## Sound Key for Laptop Backing Track



Bee sounds



Swarm of bees



Duck quacks



Ducks percussive thumping



Ambient seaside



High chime like partials



High tinkly partials



Storm at sea



Thunder

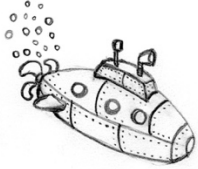


Whale song



Wolves howling





Sonar type bloops



Wild dogs barking



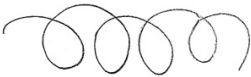
Large flock of birds



Fireworks



Metallic clangs



Metallic swirl



Pops and squelches



Explosive pop



Water drops/splashes



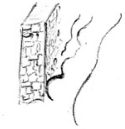
Reversed water drops



Fast running water



Grinding rocks



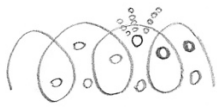
Lapping water



Flapping flag/sails



Contrabass Clarinet multiphonics



Spacey/bloopy



Space type sound



Low ambient drone

# Movement 1 - Swallowtail

Alison Beattie

♩ = 60

A

Score for Horns and Violoncellos. The score consists of 19 staves. The top six staves are for Horns in F (Horn in F 1-6). The next six staves are for Violoncello 1-6. The next four staves are for Violoncello rec (Violoncello recording). The bottom three staves are for Violoncello drone rec (Violoncello drone recording). The key signature is one sharp (F#) and the time signature is 3/4. The tempo is marked as ♩ = 60. A rehearsal mark 'A' is placed above the first staff at the beginning of the piece. The score is mostly blank, with some notes and dynamics appearing in the lower staves starting at 0:27.

Smoothly as Possible  
Sul D  
*p*  
Smoothly as Possible  
Sul D  
*p*  
Smoothly as Possible  
Sul D  
*mp*



Click track commences and continues throughout

0:27

♩ = 60

Input channels Routing to Output channels

A

Sound Desk  
Cellos 1-6  
Sound Desk  
Horns 1-6

1-6 3/4 1/2 pan C, 3/4 pan C, 5/6 off  
7-12 3/4 1/2 off, 3/4 off, 5/6 off

13

**B**

Vc.3

Vc.4

Vc.5

Vc.6

Vc.rec

Vc.rec

Vc.rec

Vc.rec

Smoothly as Possible  
Sul D  
*mp*

Smoothly as Possible  
Sul D  
*p*

Smoothly as Possible  
Sul D  
*p*

Smoothly as Possible  
Sul D  
*mp*

Smoothly as Possible  
Sul D  
*mp*



L. Top

0:39

1:00

**B**

S Desk  
Vc 1-6

S Desk  
Hn 1-6

Vc.1

Vc.2

Vc.3 *mp*

Vc.4 *mp*

Vc.5 Sul A *p*

Vc.6 Sul A *p*

Vc.rec *mp*

Vc.rec *mp*

Vc.rec Sul A *p*

Vc.rec Sul A *p*

Vc.drone Sul A

Vc.drone Sul D

Vc.drone Sul G

L. Top ||

1:30

S Desk  
Vc 1-6

S Desk  
Hn 1-6

Detailed description of the musical score: The score is for a string ensemble. It features six Violin parts (Vc.1-Vc.6), two Violoncello parts (Vc.rec), and three Drone parts (Vc.drone). The Violin parts (Vc.3-Vc.6) and Violoncello parts (Vc.rec) contain melodic lines with various dynamics and articulations. The Drone parts provide a harmonic background with specific techniques: Sul A (Sul ponticello), Sul D, and Sul G. The score is marked with a rehearsal sign at 1:30. The bottom of the page shows empty staves for S Desk Vc 1-6 and S Desk Hn 1-6.



Free uneven rhythm at will

(o)

(o)

(o)

(o)

(o)

Vc.1

Free uneven rhythm at will

(o)

(o)

(o)

(o)

(o)

Sul D

Vc.2

Vc.3

Vc.4

gliss.

Sul D

mp

Vc.5

Vc.6

Vc.rec

Vc.rec

Vc.rec

Vc.rec

Vc.drone

Vc.drone

Vc.drone



L. Top

S Desk  
Vc 1-6.

S Desk  
Hn 1-6

51 (o) (o) (o) (o)

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

Vc.6

Vc.rec

Vc.rec

Vc.rec

Vc.rec

Vc.drone

Vc.drone

Vc.drone

L. Top

2:30

S Desk  
Vc 1-6.

S Desk  
Hn 1-6

*gliss.* Sul G

*gliss.* Sul D

*mp*

*gliss.* Sul D

*mp*



55 ( )

Vc.1 Sul D

Vc.2 Dolce

Vc.3 Sul A *gliss.* *mf*

Vc.4 Sul A *gliss.* *mf*

Vc.5

Vc.6

Vc.rec Sul A *gliss.* *mf*

Vc.rec *gliss.*

Vc.rec

Vc.rec Sul D *gliss.* *mp*

Vc.drone


Vc.drone

Vc.drone

L. Top || 3:00

S Desk Vc 1-6

S Desk Hn 1-6



63 Dolce

**D**

Score for Violins 1-6, Viola, and Cello/Double Bass. The score includes various performance instructions such as *mp*, *mf*, *f*, *Sul G*, *Sul A*, and *gliss.* The notation features complex phrasing with many slurs and ties across the measures.



L. Top **H** 3:18 3:30

**D**

Ch 3 audible and balanced

S Desk Vc 1-6 Ch 4

S Desk Hn 1-6



Vc.1

Vc.2 *triss.* Sul C

Vc.3

Vc.4

Vc.5

Vc.6

Vc.rec

Vc.rec



Vc.rec

Vc.rec

Vc.drone

Vc.drone

Vc.drone

L. Top    
 || *fff* 4:30

S Desk  
Vc 1-6

S Desk  
Hn 1-6

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5 *gliss.* *f* *Sul C*

Vc.6 *gliss.* *f* *Sul C*

Vc.rec

Vc.rec



Vc.rec *gliss.* *f* *Sul C*

Vc.rec *gliss.* *f* *Sul C*

Vc.drone

Vc.drone

Vc.drone

L. Top  *getting more frequent*  5:00

S Desk  
Vc 1-6.

S Desk  
Hn 1-6

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

Vc.6

Vc.rec

Vc.rec

Vc.rec


Vc.rec

Vc.drone

Vc.drone

Vc.drone

L. Top



5:12

getting more frequent to 6:04

S Desk  
Vc 1-6

S Desk  
Hn 1-6

110

The musical score consists of 13 staves for string instruments and a table for mixing desk channels. The staves are labeled as follows:

- Vc.1: Bass clef, starting with a glissando and Sul D.
- Vc.2: Bass clef.
- Vc.3: Treble clef, starting with a glissando, Sul D, and *ff*.
- Vc.4: Treble clef, with glissando and Sul D markings.
- Vc.5: Bass clef.
- Vc.6: Bass clef.
- Vc.rec (1): Treble clef, with Sul D and *ff*.
- Vc.rec (2): Bass clef, with glissando and Sul D.
- Vc.rec (3): Bass clef.
- Vc.rec (4): Bass clef.
- Vc.drone (1): Treble clef.
- Vc.drone (2): Bass clef, mostly empty.
- Vc.drone (3): Bass clef.
- L. Top: Empty staff.

The table at the bottom is for mixing desk channels:

S Desk	Ch 3	audible and balanced		5:30
Vc 1-6	Ch 4			
S Desk				
Hn 1-6				

**G**

120

Score for Violins 1-6, Recordings, and Drone parts. The score includes the following staves:

- Vc.1: Bass clef, includes gliss. and Sul A markings.
- Vc.2: Bass clef, includes gliss. and Sul G markings.
- Vc.3: Treble clef, contains a continuous melodic line.
- Vc.4: Treble clef, contains a continuous melodic line.
- Vc.5: Bass clef, contains a continuous melodic line.
- Vc.6: Bass clef, contains a continuous melodic line.
- Vc.rec (Violin Recording): Treble clef, contains a continuous melodic line.
- Vc.rec (Violin Recording): Treble clef, contains a continuous melodic line.
- Vc.rec (Violin Recording): Bass clef, contains a continuous melodic line.
- Vc.rec (Violin Recording): Bass clef, contains a continuous melodic line.
- Vc.drone (Violin Drone): Treble clef, contains a continuous melodic line.
- Vc.drone (Violin Drone): Bass clef, contains a continuous melodic line.
- Vc.drone (Violin Drone): Bass clef, contains a continuous melodic line.



L. Top

6:00

**G**

S Desk  
Vc 1-6.

S Desk  
Hn 1-6



Vc.1 *mf*

Vc.2 Sul D *mf* Sul A

Vc.3

Vc.4

Vc.5

Vc.6

Vc.rec

Vc.rec

Vc.rec

Vc.rec

Vc.drone

Vc.drone

Vc.drone

L. Top 6:30 6:51 7:00

S Desk Vc 1-6

S Desk Hn 1-6



142

Vc.1 *mp*

Vc.2 *mp*

Vc.3

Vc.4

Vc.5

Vc.6

Vc.rec

Vc.rec

Vc.rec

Vc.rec

Vc.drone

Vc.drone

Vc.drone



L. Top **||**

7:15

*fff*

7:30

S Desk  
Vc 1-6

S Desk  
Hn 1-6



163 *gliss.* *Sul G* **I**

Vc.1

Vc.2 *gliss.* *Sul G*

Vc.3

Vc.4

Vc.5

Vc.6

Vc.rec *gliss Sul A* *fff*

Vc.rec *gliss Sul A* *gliss.* *fff*

Vc.rec

Vc.rec

Vc.drone

Vc.drone

Vc.drone

L. Top **I**

*increasing density* 8:30

S Desk **I**

Vc 1-6

S Desk

Hn 1-6

174 Sul D

Vc.1 *p*

Vc.2 *p* miss

Vc.3

Vc.4

Vc.5

Vc.6

Vc.rec

Vc.rec

Vc.rec

Vc.rec

Vc.drone

Vc.drone

Vc.drone

L. Top

9:00

S Desk Vc 1-6

S Desk Hn 1-6

J

186

Sul G

Score for Violins 1-6, Violoncellos, and Drone parts. The score consists of 14 staves:

- Vc.1: Violin 1, Bass clef, melodic line with slurs and a "Sul G" instruction.
- Vc.2: Violin 2, Bass clef, melodic line with slurs.
- Vc.3: Violin 3, Treble clef, melodic line with slurs.
- Vc.4: Violin 4, Treble clef, melodic line with slurs.
- Vc.5: Violin 5, Bass clef, melodic line with slurs.
- Vc.6: Violin 6, Bass clef, melodic line with slurs.
- Vc.rec: Violoncello 1, Treble clef, melodic line with slurs.
- Vc.rec: Violoncello 2, Treble clef, melodic line with slurs.
- Vc.rec: Violoncello 3, Bass clef, melodic line with slurs.
- Vc.rec: Violoncello 4, Bass clef, melodic line with slurs.
- Vc.drone: Violoncello drone 1, Treble clef, empty staff.
- Vc.drone: Violoncello drone 2, Bass clef, empty staff.
- Vc.drone: Violoncello drone 3, Bass clef, empty staff.

*Handwritten musical notation and scribbles across the bottom of the page.*



Conductor's desk and stage desk information:

- L. Top: 9:15, J, 9:30
- S Desk: Vc 1-6
- S Desk: Hn 1-6

Vc.1  
 Vc.2  
 Vc.3  
 Vc.4  
 Vc.5  
 Vc.6  
 Vc.rec  
 Vc.rec  
 Vc.rec  
 Vc.rec  
 Vc.drone  
 Vc.drone  
 Vc.drone

*al niente*

*al niente*

*al niente*

*al niente*



L. Top

10:00

10:09

S Desk  
Vc 1-6.

S Desk  
Hn 1-6

# Movement 2 - Rayleigh Scattering.

Transposing Score

Alison Beattie

**♩=120**

Horn in F 1  
Horn in F 2  
Horn in F 3  
Horn in F 4  
Horn in F 5  
Horn in F 6

Bowing direction to be followed precisely with exaggerated thrusting gestures. When not playing keep elbow at side. In strict rhythm throughout.

Violoncello 1  
Violoncello 2  
Violoncello 3  
Violoncello 4  
Violoncello 5  
Violoncello 6

Click track continues throughout

Laptop

0:04

Input channels	Routing
1	1/2 pan L, 3/4 off, 5/6 off
2	1/2 pan R, 3/4 off, 5/6 off
3	1/2 off, 3/4 pan L, 5/6 off
4	1/2 off, 3/4 off, 5/6 pan L
5	1/2 off, 3/4 off, 5/6 pan R
6	1/2 off, 3/4 pan R, 5/6 off

Sound desk  
Cellos 1-6

Input Channels	Routing
7-12	all - 1/2 pan C, 3/4 pan C, 5/6 off

Sound desk  
Horns 1-6



11

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

Vc.6

L.top

S. Desk  
Vc. 1-6

S desk  
Horns 1-6

*f*

*f*

*< < < <*

0:30

17

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

Vc.6

L.top

S. Desk  
Vc. 1-6

S desk  
Horns 1-6

23

Vc. 1  
Vc. 2  
Vc. 3  
Vc. 4  
Vc. 5  
Vc. 6  
L.top  
S. Desk Vc. 1-6  
S desk Horns 1-6



29

**A**

Vc. 1  
Vc. 2  
Vc. 3  
Vc. 4  
Vc. 5  
Vc. 6  
L.top  
S. Desk Vc. 1-6  
S desk Horns 1-6

35

Vc.1 *fff*

Vc.2 *fff*

Vc.3 *fff*

Vc.4

Vc.5

Vc.6 *fff*



L.top

||

S. Desk  
Vc. 1-6


S desk  
Horns 1-6

||

**B**

42

Hn.1  
Hn.2  
Hn.3  
Hn.4  
Hn.5  
Hn.6

Like sunlight caressing the surface of a perfectly still ocean

*p*

Vc.1  
Vc.2  
Vc.3  
Vc.4  
Vc.5  
Vc.6



L.top

1:24 1:30

**B**

S. Desk  
Vc. 1-6

S desk  
Horns 1-6

49

Hn.1

Hn.2

Hn.3

Hn.4

Hn.5

Hn.6

Like sunlight caressing the surface of a perfectly still ocean  
Natural horn harmonics uncorrected (F:0 - 7th harmonic)

*p*

*mf*

*mf*

*p*

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

Vc.6

*f*

*f*

*V*

*V*

*V*

*V*

*V*



L.top

1:48

S. Desk  
Vc. 1-6

S desk  
Horns 1-6

58

Hn.1

Hn.2

Hn.3

Hn.4

Hn.5

Hn.6

Like sunlight caressing the surface of a perfectly still ocean

*p* *mf* *p*

*p* *mf* *p* *ff* *p*

*p*

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

Vc.6

*f*

*f*

*f*

L.top

2:00

S. Desk  
Vc. 1-6

S desk  
Horns 1-6

65

Hn.1  
Hn.2  
Hn.3  
Hn.4  
Hn.5  
Hn.6

*mf* *p*  
*mf* *p*  
*mf* *mp* *f* *p*

Vc.1  
Vc.2  
Vc.3  
Vc.4  
Vc.5  
Vc.6

*f*

L.top

*2:20*

S. Desk  
Vc. 1-6

S desk  
Horns 1-6

71

Hn.1

Hn.2

Hn.3

Hn.4

Hn.5

Hn.6

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

Vc.6

L.top

S. Desk  
Vc. 1-6

S desk  
Horns 1-6

Like sunlight caressing the surface of a perfectly still ocean

*mf* *p* *mf* *p*

*mf* *p*

*mf* *p*

*mf* *p*

*mf* *p*

*f*

2:30



77

Hn.1

Hn.2

Hn.3

Hn.4

Hn.5

Hn.6

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

Vc.6

L.top

S. Desk  
Vc. 1-6

S desk  
Horns 1-6

*mf* *p*

*mf* *p* *ff* *p*

*mf* *p* *mf* *p*

*mf* *p* *ff* *p*

*f*



Like sunlight caressing the surface of a perfectly still ocean

Hn.1  
Hn.2  
Hn.3  
Hn.4  
Hn.5  
Hn.6

Vc.1  
Vc.2  
Vc.3  
Vc.4  
Vc.5  
Vc.6

L.top

S. Desk  
Vc. 1-6

89

Hn.1

Hn.2 *ff p ff p ff p*

Hn.3 *mf p mf p*

Hn.4 *mf p mf p*

Hn.5 *mf p*

Hn.6 *mf p*

Vc.1

Vc.2 *fff*

Vc.3

Vc.4

Vc.5 *fff*

Vc.6 *fff*

L.top

3:00

S. Desk Vc. 1-6

S desk Horns 1-6

C

95

Hn.1

Hn.2

Hn.3

Hn.4

Hn.5

Hn.6

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

Vc.6

L.top

S. Desk  
Vc. 1-6

S desk  
Horns 1-6

*mf* *p* *mf* *p* *mf* *p* *mf* *mp* *f* *mf*

3:10 3:16

C

Detailed description: This is a page of a musical score for a concert band, page 34. It features six horn parts (Hn.1-6) and six violin parts (Vc.1-6). The horn parts are written in treble clef, while the violin parts are in bass clef. The score includes dynamic markings such as *mf* (mezzo-forte), *p* (piano), *mp* (mezzo-piano), and *f* (forte). There are also performance instructions like *mf <* and *f <*. The conductor's part (L.top) shows a baton and two time points, 3:10 and 3:16, with a bird illustration at 3:10 and a fireworks illustration at 3:16. At the bottom, there are staves for the Section Leader (S. Desk) for Violins 1-6 and the Section Leader (S desk) for Horns 1-6. A section marker 'C' is present at the top right and bottom right of the page.

Like sunlight caressing the surface of a perfectly still ocean  
Natural horn harmonics uncorrected (F:0 - 11th harmonic)

101

Hn.1

Hn.2

Hn.3

Hn.4

Hn.5

Hn.6

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

Vc.6

L.top

S. Desk  
Vc. 1-6

S desk  
Horns 1-6

*p*

*mf* *p*

*mf* *p*

*mf* *p*

*mf* *p*

*mf* *p*

*ff* *p*

*f*

*f*

*f*

3:24

3:30

**D**

E=F:1 - 11th harmonic uncorrected

108

Hn.1  
Hn.2  
Hn.3  
Hn.4  
Hn.5  
Hn.6

*mf p mf ff p*  
*mf p mf ff p*  
*mf p*  
*mf p*  
*mf p ff p*  
*f p mf p*

Chaotic with flailing of the bow.  
Direction and distance at will.

col legno battuto to end

Vc.1  
Vc.2  
Vc.3  
Vc.4  
Vc.5  
Vc.6

*ff*  
*ff*  
*ff*  
*ff*  
*ff*  
*ff*

Chaotic with flailing of the bow.  
Direction and distance at will.

col legno battuto to end

Chaotic with flailing of the bow.  
Direction and distance at will.

col legno battuto to end

Chaotic with flailing of the bow.  
Direction and distance at will.

col legno battuto to end

Chaotic with flailing of the bow.  
Direction and distance at will.

col legno battuto to end

Chaotic with flailing of the bow.  
Direction and distance at will.

col legno battuto to end

L.top

3:34

**D**

S. Desk  
Vc. 1-6

Input	Routing
1-6	1/2, 3/4, 5/6 - Pan C all cellos

S desk  
Horns 1-6

113

This musical score page contains the following parts and dynamics:

- Horn 1 (Hn.1):** Dynamics include *mf* and *p*.
- Horn 2 (Hn.2):** Dynamics include *ff*, *p*, *ff*, *p*, *f* (with triplets), and *mp*.
- Horn 3 (Hn.3):** Dynamics include *mf*, *p*, *ff*, *p*, and *f*.
- Horn 4 (Hn.4):** Dynamics include *mf*.
- Horn 5 (Hn.5):** Dynamics include *mf* and *p*.
- Horn 6 (Hn.6):** Dynamics include *mf*, *p*, *ff*, and *p*.
- Violin 1 (Vc.1):** Treble clef, rhythmic accompaniment.
- Violin 2 (Vc.2):** Bass clef, rhythmic accompaniment.
- Violin 3 (Vc.3):** Bass clef, rhythmic accompaniment.
- Violin 4 (Vc.4):** Bass clef, rhythmic accompaniment.
- Violin 5 (Vc.5):** Bass clef, rhythmic accompaniment.
- Violin 6 (Vc.6):** Bass clef, rhythmic accompaniment.
- L.top:** Percussion part with a double bar line.
- S. Desk Vc. 1-6:** Empty staves for string desks.
- S desk Horns 1-6:** Empty staves for horn desks.

118

Hn.1 *mf* *pp*

Hn.2 *p* *ff* *p* *ff* *p* *mf*

Hn.3 *p* *ff* *p* *f* *3* *3* *3* *3*

Hn.4 *p* *f* *p* *ff*

Hn.5 *mf* *p* *mf* *p*

Hn.6 *mf* *p* *ff* *p*

Vc.1

Vc.2

Vc.3 *jete*

Vc.4 *jete*

Vc.5

Vc.6 *jete on tail piece*

L.top **||** 4:00

S. Desk  
Vc. 1-6

S desk  
Horns 1-6



124

Hn.1

Hn.2 *p* *mf*

Hn.3 *p* *ff* *p* *ff*

Hn.4 *p* *ff* *p*

Hn.5 *mf* *p* *ff* *p*

Hn.6 *mf* *p* *mf*

Vc.1

Vc.2

Vc.3 *jete on tail piece* *jete*

Vc.4 *jete*

Vc.5 *jete on tail piece*

Vc.6 *jete on tail piece*

L.top

S. Desk  
Vc. 1-6

Hn.1

Hn.2 *pp*

Hn.3 *pp*

Hn.4 *mf* *pp*

Hn.5 *ff* *pp*

Hn.6 *ff* *pp*

A = F:2 - 7th harmonic uncorrected

7

3 3 3 3

2

Vc.1 *fff* trem using wood

Vc.2 *fff* trem using wood

Vc.3 *fff* trem using wood

Vc.4 *fff* trem using wood

Vc.5

Vc.6

L.top

4:22 4:24

S. Desk  
Vc. 1-6



# Movement 3 - Butterfly

Transposing Score

Alison Beattie

♩=120

Horn 1 in F

Horn 2 in F

Violoncello 1  
Scordatura Bb F D A  
Sounding

Violoncello 2

Violoncello 3

Violoncello 4

Violoncello 5

*pp*

*pp*

*pp*



*pp*

Laptop

continues until 3:40

Click track continues throughout

0:20

♩=120

Input channels	Routing						
1	1/2 pan C, 3/4 pan C, 5/6 off						
2	1/2 pan C, 3/4 pan C, 5/6 off						
3	1/2 pan C, 3/4 pan C, 5/6 off						
4	1/2 pan C, 3/4 pan C, 5/6 off						
5	1/2 pan C, 3/4 pan C, 5/6 off						
6	1/2 off, 3/4 off, 5/6 off						
7	1/2 pan C, 3/4 pan C, 5/6 off						
8	1/2 pan C, 3/4 pan C, 5/6 off						
9	1/2 off, 3/4 off, 5/6 off						
10	1/2 off, 3/4 off, 5/6 off						
11	1/2 off, 3/4 off, 5/6 off						
12	1/2 off, 3/4 off, 5/6 off						

Sound desk Cellos 1-6

Sound desk Horns 1-6

20

Vc.2

Vc.3

Vc.4

Vc.5

L.Top



27

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

L.Top

*pp*

1:00

**A**

35

Hn.1

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

L.Top

*pp* *mf* *pp* *mf* *pp*

T3

7

1:10



43

Hn.1

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

L.Top

*mf* *pp* *mf* *pp*

T3

7

1:20

Hn.1 47 7 11 7 11 7 7 7

T23 T0 T23 T0 T123 13 T123

*mf* *pp* *mf* *pp* *mf* *pp* *mf* (2)

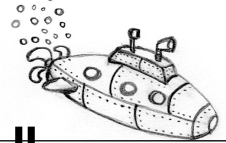
Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

L.Top  continues until 2:15

1:30

1:40



Hn.1 55 7 7 7

T123 T0 T12 T1 T3

*pp* *mf* *pp* *f* *pp* *mf* *pp*

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5



L.Top

1:50

62

Hn.1

7

7 11

T3

T23 T0

*mf* *pp* *mf* *pp* *mf*

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

L.Top

2:00



67

Hn.1

7 11 7

T23 T0 T123 (2)

*pp* *mf* *pp*

Vc.2

Vc.3

Vc.4

Vc.5

L.Top

2:10

Musical score for measures 71-80. The score includes parts for Horn 1 (Hn.1), Horn 2 (Hn.2), Violin 1 (Vc.1), Violin 2 (Vc.2), and a double bass line (L.Top).  
- Hn.1: Measures 71-72 feature a triplet of eighth notes (T23) with a *mf* dynamic. Measures 73-74 have a *pp* dynamic, followed by a *mf* dynamic in measure 75. Measure 76 has a triplet of eighth notes (T0) with a *pp* dynamic. Measure 77 has a *mf* dynamic. Measure 78 has a triplet of eighth notes (T12) with a *pp* dynamic. Measure 79 has a *mf* dynamic. Measure 80 has a *pp* dynamic.  
- Hn.2: Measures 71-72 are silent. Measures 73-74 feature a triplet of eighth notes (T23) with a *pp* dynamic. Measures 75-76 have a *mf* dynamic. Measures 77-78 are silent. Measures 79-80 feature a triplet of eighth notes with a *pp* dynamic.  
- Vc.1: Features a melodic line with slurs and accents, ending with a double bar line and a repeat sign.  
- Vc.2: Features a melodic line with slurs and accents, ending with a double bar line and a repeat sign.  
- L.Top: A double bass line with a series of slurs and accents, with time markers at 2:20 and 2:30.



Musical score for measures 81-90. The score includes parts for Horn 1 (Hn.1), Horn 2 (Hn.2), Violin 1 (Vc.1), Violin 2 (Vc.2), and a double bass line (L.Top).  
- Hn.1: Measures 81-82 have a *mf* dynamic. Measures 83-84 have a *pp* dynamic, followed by a *mf* dynamic in measure 85. Measures 86-87 have a *pp* dynamic, followed by a *mf* dynamic in measure 88. Measure 89 has a *pp* dynamic. Measure 90 has a *pp* dynamic.  
- Hn.2: Measures 81-82 have a *pp* dynamic. Measures 83-84 have a *mf* dynamic. Measures 85-86 have a *pp* dynamic, followed by a *mf* dynamic in measure 87. Measures 88-89 have a *pp* dynamic, followed by a *mf* dynamic in measure 90. Measure 90 has a *pp* dynamic.  
- Vc.1: Features a melodic line with slurs and accents, ending with a double bar line and a repeat sign.  
- Vc.2: Features a melodic line with slurs and accents, ending with a double bar line and a repeat sign.  
- L.Top: A double bass line with a series of slurs and accents, with a time marker at 2:40.



Musical score for measures 87-93. The score includes parts for Hn.1, Hn.2, Vc.1, and L.Top. Hn.1 has fingerings 7, 11, 7, 7 and dynamic markings *mf*, *pp*, *mf*, *pp*, *mf*, *pp*. Hn.2 has dynamic markings *f*, *pp*, *mf*, *pp*, *mf*, *pp*. Vc.1 has a double bar line at the start of the system. L.Top has a double bar line at the start of the system. Time markers 2:50 and 3:00 are present below the L.Top staff.



Musical score for measures 94-99. The score includes parts for Hn.1, Hn.2, Vc.1, and L.Top. Hn.1 has fingerings 7, 7 and dynamic markings *mf*, *pp*, *mf*. Hn.2 has dynamic markings *mf*, *pp*. Vc.1 has a double bar line at the start of the system. L.Top has a double bar line at the start of the system.

96

Hn.1

Hn.2

Vc.1

L.Top

*pp* *f* *pp* *mf* *pp* *mf* *pp* *mf*

*mf* *pp* *mf* *pp* *mf* *pp* *mf*

*gliss.* *gliss.* *gliss.* *gliss.*

3:10 3:20



104

Hn.1

Hn.2

L.Top

*mf* *pp* *mf* *pp*

*mf* *pp* *mf* *pp*

7 11 7

T23 T0 T123

3

3:30

Hn.1

Hn.2

L.Top



Create wolf sounds by playing on the Bb side of the horn.

**B**

Half depress the valves in different combinations and half depress the Bb valve

Play in free time and rhythm. A suitable range may be G4 to A5. Continue until conductor's cue to stop at C

Hn.1

Hn.2

L.Top

3:50



Conductor's cue to stop

**C**



158

7



166

**D**

5

L.Top

5:10

5:24

**E**

171

Hn.1 *pp* *mf* *pp* *mf*

Vc.1 arco *p*

Vc.2 arco *p*

Vc.3 arco *p*

Vc.4 arco *p*

Vc.5 arco *p*



L.Top

5:36



178

Hn.1 *pp* *mf*

Hn.2 5

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5 arco

L.Top

6:00

184

Hn.1

Hn.2

Vc.1

Vc.5

L.Top



187

Hn.1

Hn.2

Vc.1

L.Top



Create whale sounds by playing on the Bb side of the horn.

Conductors cue to stop

**F**

Half depress the valves in different combinations and half depress the Bb valve

Play in free time and rhythm. A suitable range may be A4 to A5. Continue until conductor's cue to stop at F

196

Hn.1

Hn.2

L.Top



**G**

215

Hn.1

Hn.2

L.Top

7:04

This system contains measures 215-220. Horn 1 and 2 are in 4/4 time. Horn 1 starts with a *mf* dynamic and a slur over measures 215-216. Horn 2 has a *mf* dynamic starting at measure 217. A small illustration of a tree is located between the Horn 2 and L. Top staves. The L. Top staff shows a time signature of 4/4 and a time stamp of 7:04.

220

Hn.1

Hn.2

Vc.1

L.Top

7:20

This system contains measures 220-225. Horn 1 has a *pp* dynamic starting at measure 224. Horn 2 and Violin 1 have *mf* dynamics. The L. Top staff shows a time stamp of 7:20.

225

Hn.1

Hn.2

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

L.Top

7:30

This system contains measures 225-230. Horn 1 and 2 have *mf* dynamics. Violin 1 has a *p* dynamic. The L. Top staff shows a time stamp of 7:30.

231

Hn.1

Hn.2

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

L.Top

*ppp*

*ppp*

*ppp*

*ppp*



234

Hn.1

Hn.2

Vc.1

L.Top

*mf*

*mf*

*mf*

7.48

**H**

Input channels	Current Routing	Change to
1	1/2 pan C, 3/4 pan C, 5/6 off	1/2 off
2	1/2 pan C, 3/4 pan C, 5/6 off	1/2 pan R, 3/4 off 5/6 on pan R
3	1/2 pan C, 3/4 pan C, 5/6 off	1/2 pan R, 3/4 off 5/6 on pan R
4	1/2 pan C, 3/4 pan C, 5/6 off	1/2 pan R, 3/4 off 5/6 on pan R
5	1/2 pan C, 3/4 pan C, 5/6 off	1/2 pan R, 3/4 off 5/6 on pan R
6	1/2 off, 3/4 off, 5/6 off	
pan gradually from hard left to hard right over 4 bars		
7	1/2 pan C, 3/4 pan C, 5/6 off	1/2 pan L, 3/4 off, 5/6 off
pan gradually from hard right to hard left over 4 bars		
8	1/2 pan C, 3/4 pan C, 5/6 off	1/2 off, 3/4 off, 5/6 pan R

S Desk Vc 1-6.

S Desk Hn 1-2

241

Hn.1

Hn.2

Vc.1

L.Top

S Desk

Hn 1-2

8:00

pan gradually from hard right to hard left over 4 bars

pan gradually from hard left to hard right over 4 bars



245

Hn.1

Hn.2

Vc.1

L.Top

S Desk

Hn 1-2

sim

sim



249

Hn.1

Hn.2

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

L.Top

S Desk

Hn 1-2

253

Hn.1 *f* *ff* *mf* *ff*

Hn.2

Vc.1 *fff*

Vc.2

Vc.3

Vc.4

Vc.5

L.Top

S Desk  
Hn 1-2

continues to 9:48

256

Hn.1 *mf*

Hn.2 *f* 5 12 *ff* 13 *mf*

Vc.1 *vcl*

Vc.2

Vc.3

Vc.4

Vc.5

L.Top 8:30

S Desk Hn 1-2

2 1

5 6

Detailed description: This page of a musical score, numbered 57, contains staves for Horns 1 and 2, Violins 1 through 5, and a section labeled L.Top. The Horn 1 part (Hn.1) begins at measure 256 with a mezzo-forte (*mf*) dynamic, featuring a quintuplet of eighth notes, a triplet of eighth notes, and a final quintuplet. The Horn 2 part (Hn.2) starts with a forte (*f*) dynamic, includes a quintuplet of eighth notes (labeled '5' and '12'), a fortissimo (*ff*) section with another quintuplet (labeled '5' and '13'), and ends with a mezzo-forte (*mf*) dynamic. The Violin parts (Vc.1-Vc.5) are in bass clef. Vc.1 has a *vcl* marking. Vc.2 and Vc.4 have melodic lines with slurs and ties. Vc.3 and Vc.5 have simpler melodic fragments. The L.Top section shows a time signature of 8:30. At the bottom, the S Desk Hn 1-2 section includes two horizontal lines with arrows and numbers: the top line has arrows pointing to '2' and '1', and the bottom line has arrows pointing to '5' and '6'.

I

261

Hn.1 *mf*

Hn.2

Vc.1 *mf*

Vc.3 *f* 7 *col legno battuto*

L.Top

S Desk 1 → 2

Hn 1-2 6 → 5



265

Hn.1

Hn.2

Vc.2 *f*

Vc.3 7 5 5 5 *col legno battuto*

Vc.4 *f* 6 *col legno battuto*

Vc.5 *f*

L.Top

S Desk 2 → 1

Hn 1-2 5 → 6

269

Hn.1

Hn.2

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

L.Top

S Desk

Hn 1-2

5

3

3

1

2

6

5

273

Hn.1

Hn.2

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

L.Top

S Desk

Hn 1-2

*mf*

*mf*

5

3

9:00

2

1

5

6

277

Hn.1

Hn.2

Vc.1

L.Top

S Desk

Hn 1-2

1 → 2

6 → 5



281

Hn.1

Hn.2

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

L.Top

S Desk

Hn 1-2

2 → 1

5 → 6

284

Hn.1

> *ppp*

Play motifs in random order in free placement within the 14 bar time frame beaten by the conductor.  
Don't synchronise with other cellos.

col legno battuto

Stop on conductors cue.

Vc.2

Play motifs in random order in free placement within the 14 bar time frame beaten by the conductor.  
Don't synchronise with other cellos.

col legno battuto

Stop on conductors cue.

Vc.3

Play motifs in random order in free placement within the 14 bar time frame beaten by the conductor.  
Don't synchronise with other cellos.

col legno battuto

Stop on conductors cue.

Vc.4

Play motifs in random order in free placement within the 14 bar time frame beaten by the conductor.  
Don't synchronise with other cellos.

col legno battuto

Stop on conductors cue.

Vc.5

Conductor continue beating for 14 bars and cue Cellos to stop at J

14

L.Top

9:22

Input channels

Current Routing

Change settings as quickly as practicable

S Desk Vc 1-6.	1	1/2 off 3/4 pan C 5/6 off	1/2 on pan C, 3/4 remain pan C 5/6 remain off
	2	1/2 pan R, 3/4 off 5/6 on pan R	1/2 pan C, 3/4 on pan C 5/6 pan C
	3	1/2 pan R, 3/4 off 5/6 on pan R	1/2 pan C, 3/4 on pan C 5/6 pan C
	4	1/2 pan R, 3/4 off 5/6 on pan R	1/2 pan C, 3/4 on pan C 5/6 pan C
	5	1/2 pan R, 3/4 off 5/6 on pan R	1/2 pan C, 3/4 on pan C 5/6 pan C
	6	1/2 off, 3/4 off, 5/6 off	1/2 off, 3/4 off, 5/6 off
S Desk Hn 1-2	7	1/2 pan L 3/4 off, 5/6 off	1/2 pan C, 3/4 on pan C, 5/6 off
	8	1/2 off, 3/4 off, 5/6 pan R	1/2 on pan C, 3/4 on pan C 5/6 off

284 **K**

Hn.1 *mf* *pp* *mf* *pp*

Hn.2 *mf* *pp* *mf*

Vc.1 *mp* arco

Vc.2 *mp* arco

Vc.3 *mp* arco

Vc.4 *mp* arco

Vc.5 *mp* arco



continues to end

L.Top

9:50

10:00



291

Hn.1

*mp* *T1* *pp* *mf*

11 7 11 7

2 *T0 T23*

Hn.2

*pp* *mf* *pp* *mf* *pp* *mf*

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

L.Top

||

Detailed description: This page of a musical score, numbered 291, features five staves. The top two staves are for Horns 1 and 2, both in treble clef. Horn 1 has a melodic line with dynamic markings *mp*, *pp*, and *mf*, and includes fingering numbers 11, 7, 11, 7, and 2. Horn 2 has a more rhythmic line with dynamics *pp*, *mf*, and *pp*. The next three staves are for Violins 1, 2, 3, 4, and 5, all in bass clef. Violin 1 has a sustained note with a flat. Violin 2 has a melodic line with dynamics *mf* and *pp*. Violin 3 has a melodic line with dynamics *mf* and *pp*. Violin 4 has a melodic line with dynamics *mf* and *pp*. Violin 5 has a sustained note with a flat. The bottom staff, labeled 'L.Top', contains a double bar line.

296

Hn.1

Hn.2

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

L.Top

*pp*

*pp* *mf* *mp* *mf* *pp* *mf*

3

||

302

Hn.1

Hn.2

*mf* > *pp* *mf* *pp* *mf* *pp* *mf* *pp* *mf*

5 4 5 13 2 13 7 7 7 13

T2 2

*pp* *mf* *pp* *mf*

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

308

The musical score consists of six staves. The first two staves are for Horns 1 and 2 (Hn.1 and Hn.2), both in treble clef. The next five staves are for Violins 1 through 5 (Vc.1 to Vc.5), all in bass clef. The bottom staff is labeled 'L.Top' and contains a double bar line. The score is divided into six measures. Horn 1 has dynamics *pp*, *mf*, *pp*, *mf*, and *pp* across the measures, with a *mf* dynamic and a 'T' fingering (T123, T0, T23) in the final measure. Horn 2 has dynamics *pp*, *mf*, *pp*, *mf*, *pp*, and *mf*. Violin 1 is mostly silent. Violin 2 has a melodic line starting in the second measure with a *b* and a fermata. Violin 3 has a melodic line starting in the second measure. Violin 4 has a melodic line starting in the second measure. Violin 5 has a melodic line starting in the second measure. The 'L.Top' staff has a double bar line at the beginning.

Hn.1

Hn.2

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

L.Top

*pp* *mf* *pp* *mf* *pp* *mf*

T123 T0 T23

314

Hn.1

Hn.2

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

3

7

7

*pp* *mf* *pp* *mf* *pp* *mf* *pp*

*pp* *mf* *pp* *mf* *pp* *mf* *pp* *mf*

*mp*

*mp*

322

Hn.1

Hn.2

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

L.Top

mf pp mf pp

pp mf

11 3

T0

7 3

T23

mf

327

Hn.1

Hn.2

Vc.1

L.Top

7 7

T23 3 T3

mf pp mf pp

pp

L

# Movement 4 - Smiles and Teardrops

Transposing score

Alison Beattie

$\text{♩} = 135$

Horn 1

Violoncello 1

Violoncello 2

Violoncello 3

Violoncello 4

Violoncello 5

Violoncello 6

Laptop

0:18

0:28

$\text{♩} = 135$

Input Channel	Routing													
1	1/2 pan R, 3/4 off, 5/6 off													
2	1/2 off, 3/4 off, 5/6 pan C													
3	1/2 off, 3/4 off, 5/6 pan C													
4	1/2 off, 3/4 off, 5/6 pan C													
5	1/2 off, 3/4 off, 5/6 pan C													
6	1/2 off, 3/4 off, 5/6 pan C													
7	1/2 pan L, 3/4 off, 5/6 off													
8	1/2 off, 3/4 off, 5/6 off													
9	1/2 off, 3/4 off, 5/6 off													
10	1/2 off, 3/4 off, 5/6 off													
11	1/2 off, 3/4 off, 5/6 off													
12	1/2 off, 3/4 off, 5/6 off													

12

Hn.1

Vc.1

Vc.2

Vc.3

Laptop

0:38



22

Hn.1

Vc.1

Vc.2

Vc.3

Laptop

0:58



A

34

Hn.1 *f* *mp* *ff* *mp* *ff* *mp* *ff* *sub p* *ff*

Vc.1 *mf* *p* *f* *mp* *f* *p* *f* *mp*

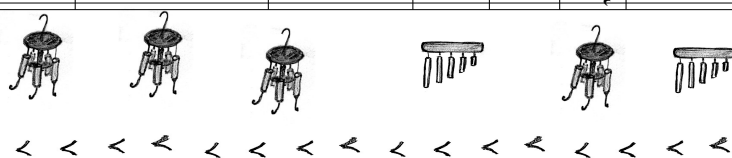
Vc.2 arco pizz

Vc.3 arco pizz

Vc.4 pizz

Vc.5 pizz

Vc.6



Laptop

1:08

46

Hn.1 *mf*

Vc.1 *mp* *f* *sub mp* *mf* *gliss.* *gliss.* *gliss.*

Vc.2

Vc.3

Vc.4

Vc.5

Vc.6



Laptop

1:18

Hn.1 *ff mp f mp mf ff*

Vc.1 *p f mp ff mf ff* *gliss.* *gliss.* *gliss.* *gliss.*

Vc.2

Vc.3

Vc.4

Vc.5

Vc.6

Laptop

1:38



Hn.1 *mf p f* *tr*

Vc.1 *f mp ff mp* *gliss.* *gliss.*

Vc.2

Vc.3

Vc.4

Vc.5

Vc.6

Laptop

1:48

1:58

Hn.1 *mp* *f* *p* *f* *mp* *p* *ff*

Vc.1 *ff* *mp* *ff sub p* *ff* *gliss.* *gliss.*

Vc.2 arco *pp*

Vc.3 arco *pp*

Vc.4 arco *pp*

Vc.5 arco *pp*

Vc.6

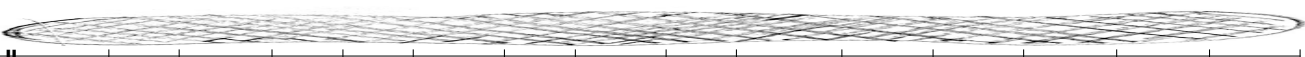
Laptop




Hn.1 *p* *sfz p* *mf* *ff* *sfz mf* *p* *f* *mf*

Vc.1 *p* *ff* *p* *p* *mf* *ff* *gliss.*

Laptop



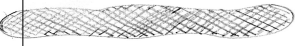
2:18



Hn.1 *p* *mp* *p* *mf* *mp*

Vc.1 *sfz mf* *p* *mf* *p* *mp*

Laptop



2:38



♩=90

Handstop or mute until bar 187

120

Musical score for measures 120-187. The score includes parts for Horn 1 (Hn.1), Violins 1-6 (Vc.1-6), and Laptop. The Horn 1 part features dynamics of *f*, *mf*, and *f*. The Violin 1 part includes dynamics of *p*, *mf*, *mp*, *f*, *mf*, *ff*, and *p*, along with *pizz* (pizzicato) markings. The Laptop part shows a rhythmic pattern with a time signature of 2:58 and a duration of 3:14.



136

Musical score for measures 136-187. The score includes parts for Horn 1 (Hn.1), Violins 1-6 (Vc.1-6), and Laptop. The Horn 1 part features dynamics of *mf* and *mp*. The Violin 1 part includes dynamics of *mp*, *f*, *p*, and *mp*, along with a *gliss.* (glissando) marking. A text instruction reads: "Glissando in rhythm indicated approximately between indicated pitches". The Laptop part shows a wavy line representing a sound effect, with a time signature of 3:24.

141

Hn.1 *random order* *molto accel* *decel* *molto accel* *decel*

*mp* *f* *mp* *f* *p*

Glissando between pitches in rhythm indicated

Vc.1 *mp* *f* *p*

Vc.2

Vc.3

Vc.4

Vc.5

Vc.6

Laptop

144

Hn.1 *random order* *accel to as fast as possible*

*f* *mp*

Vc.1 *f* *mp* *f* *p*

Vc.2

Vc.3

Vc.4

Vc.5

Vc.6

Laptop

Hn.1 

Vc.1 

Vc.2 

Vc.3 

Vc.4 

Vc.5 

Vc.6 

Laptop 

3:44



Hn.1 

Vc.1 

Vc.2 

Vc.3 

Vc.4 

Vc.5 

Vc.6 

Laptop 

3:54

(♩ ♪) molto accel decel

160

Hn.1 *mf* *mp* *mp* *f* *mp*

Vc.1 *mp* *f* *p* *mp*

Vc.2

Vc.3

Vc.4

Vc.5

Vc.6

Laptop

4:04

Glissando between pitches in rhythm indicated



164

Hn.1 *f* *p* *f*

Vc.1

Vc.2

Vc.3

Vc.4

Vc.5

Vc.6

Laptop

4:14

gliss between approximate pitches in approximate rhythm indicated within bracket

accel

decel

random order

accel to as fast as possible

167 *decel to quaver* *random order accel to as fast as possible*

Hn.1 *mp* *f* *mp*

Vc.1 *f* *p* *f* *mp* *f*

Vc.2


Vc.3

Vc.4

Vc.5

Vc.6

Laptop



4:24

172

Hn.1 *mf*

Vc.1 *p* *mp* *mf* *gliss sim*

Vc.2

Vc.3

Vc.4

Vc.5

Vc.6

Laptop



4:34



Discontinue hands

178

Hn.1 *mp* *mf* *pp*

Vc.1 *mp* *pp*

Vc.2

Vc.3 arco *p*

Vc.4 arco *p*

Vc.5 arco *p*

Vc.6 arco *p*

Laptop

4:44 4:56

185 **D** = 135

Hn.1 *mf*

Vc.1 *mp* *f* *sub mp*

Vc.2 pizz *mp*

Vc.3 pizz *mp*

Vc.4 pizz *mp*

Vc.5 pizz *mp*

Vc.6 pizz *mp*

Laptop

5:00

194

Musical score for measures 194-202. The score includes parts for Horn 1 (Hn.1), Violin 1 (Vc.1), Violin 2 (Vc.2), Violin 3 (Vc.3), Violin 4 (Vc.4), Violin 5 (Vc.5), Violin 6 (Vc.6), and Laptop. The key signature has one sharp (F#) and the time signature is 4/4. Dynamics include *ff*, *sub mp*, *f*, *mp*, *mf*, and *p*. Performance techniques include *gliss.* (glissando) and *al niente*. A double bar line is present at the end of the section.



203

Musical score for measures 203-211. The score includes parts for Horn 1 (Hn.1), Violin 1 (Vc.1), Violin 2 (Vc.2), Violin 3 (Vc.3), Violin 4 (Vc.4), Violin 5 (Vc.5), Violin 6 (Vc.6), and Laptop. The key signature has one sharp (F#) and the time signature is 4/4. Dynamics include *mf*, *ff*, *al niente*, and *mp*. Performance techniques include *gliss.* (glissando) and *al niente*. A double bar line is present at the end of the section.

214

Musical score for measures 214-221. Instruments: Hn.1, Vc.1-6, Laptop. Dynamics: *f*, *sub mp*, *mf*. Includes glissando markings and a laptop graphic.

5:40



222

Musical score for measures 222-229. Instruments: Hn.1, Vc.1-6, Laptop. Dynamics: *ff*, *sub mp*, *f*, *mp*, *mf*. Includes glissando markings and a laptop graphic.

5:50

229

Hn.1 *mf* *ff*

Vc.1 *ff* *al niente*

Vc.2 *arco* *al niente*

Vc.3 *arco* *al niente*

Vc.4 *arco* *al niente*

Vc.5 *arco* *al niente*

Vc.6 *arco* *al niente*

Laptop

# Angle to the Sun

**Alison Beattie**



# Angle to the sun – Acute & Oblique

Duration	5'54" & 17'15"
Instruments	Flute Bb Clarinet Bass Clarinet Horn Cello
Laptop & Mixing desk operator	Mixing desk outputs must be routed to speakers as follows: 1 = Front Left      2 = Front Right      3 = Centre 4 = Subwoofer      5 = Rear Left      6 = Rear Right 7 = Conductor – Click track/Headphones
Conductor	Click track
Score	Transposing Pitch

## Programme Note

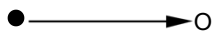
*Angle to the Sun* has been derived from the principals of genetics for the structural development of the musical material. Selection, mutation and survival of the fittest are some of the characteristics used. The pitches have been derived from the natural harmonic series arising from four notes symbolizing the chemical bases of DNA. Field recordings including bees, birdsong and waves made on the Holy Isle - off Arran, have been manipulated in such a way as to “tune” the perceived pitch contents to align with the instrumental material, thus creating novel textures and timbres. The “Waggle Dance” of the bees is alluded to in the spatial presentation of the soundscape.

# Notation

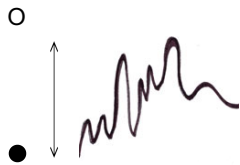
## Flute



Lip glissando – following approximately the pitch contour indicated.

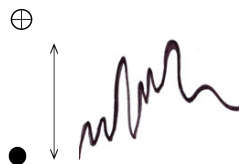


Progress from pitched tone to breath tone.



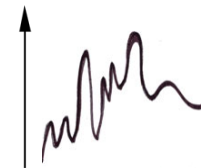
Move between pitch and breath as per contour

## Horn



Move between open horn and fully handstopped as per contour

Flow



Wind pressure through reversed horn mouthpiece as per contour



Contour for speed of trill



Contour for dynamic



Insert straight mute then loosen mute in the rhythm indicated.

## Cello

SP

sul ponticello

mSP

multo sul ponticello (directly on the bridge)

ST

sul tasto

N

normal



Add bow pressure to produce a scratching sound, pitch to noise to pitch.

# Angle to the Sun - Acute

Transposing Score

Alison Beattie

♩=135

Flute

Clarinet in B $\flat$

Bass Clarinet in B $\flat$

Horn in F

Violoncello

Laptop

Click

8

Fl.

Cl.

B. Cl.

Hn.

Vc.

L Top

smooth bow



**A**

2 14

Fl. *mp* *mf* *mp* *mf* *mp*

Cl.

B. Cl.

Hn.

Vc. *f* *mp* *mp* trem accel ST (flutando) rall mSP

L Top

19

Fl. *f* *ff* *b* accel decel tr

Cl. *f* *ff*

B. Cl. *mf* *mp* *f*

Hn. *f*

Vc. *mf* *p* *mf* *f* *mf* smooth bow tr

L Top

25

Fl. *f*

Cl.

B. Cl.

Hn. *mf* *f* *f* *mp*

Vc. *ff* *mf* *f* smooth bow tr ST flutando

L Top

31 **B**

Fl. *mp* *mf* *p*

Cl. *mf* *mp*

B. Cl. *mf* *mp* *p* *mf* *p*

Hn. *fp* *mf* *p* *flz*

Vc. *mf* *p* *mp*

L Top

38

Fl. *f*

Cl. *p* *mp* *p* *mp* *p* *mp* *p*

B. Cl. *mp* *f* *mf* *tr*

Hn. *mp* *mf* *p* *mf* *mp* *flz*

Vc. *mf* *p* *mf* *f*

L Top

4

44

Fl. *f* 3

Cl. *mp* *p* *mp* *p* *mp* *p*

B. Cl. *p* *mf* *mp* *p*

Hn. *mf* *p*

smooth bow  
trill between note indicated and harmonic

Vc. *mp* *f* *f* *mp* *p* *mp* *pp*

L Top

1'27"

**C**

49

$\text{♩} = 135$

Fl.

Cl.

B. Cl.

Hn.

Vc.

L Top

2'03"

52 **D**

Fl. *f*

Cl. *gliss*

B. Cl. *mp* *p* *mf* *p* *mp*

Hn. *p* *f* *p*

Vc. *p* *f* *p* *p*

L Top

59

Fl. *f*

Cl. *flz*

B. Cl. *mf*

Hn. *sfz p < ff*

Vc. *f* *mf* *p*

L Top

65 **E**

Fl. *lip gliss*

Cl. *f*

B. Cl. *p* *mf* *f*

Hn. *mf* *ff* *mf* *sfz p < ff* *sfz p < ff*

Vc. *smooth bow* *tr* *mp* *ff* *mp* *mf* *p* *mf* *f*

L Top

72

Fl. *f* *mf* *ff* *mf* *ff* *mf* *ff* *mf* *ff* *f*

Cl. *mf*

B. Cl. *mf*

Hn.

Vc. *mf* *f*

L Top

76

Fl. *p*

Cl. *mp*

B. Cl. *mp*

Hn. *f* *mf* *f* *p* *sfz* *p* *ff*

Vc. *mf* *f* *mp* *p* *mf*

L Top

**F**

82

Fl. *mf*

Cl. *gliss.* *mf*

B. Cl. *p* *mf* *p*

Hn. *mp* *mf* *p* *mp*

Vc. *mp*

L Top

*flz accel rall*

*tr*

*N → mSP → N → mSP → N*

88

Fl. *f* 3

Cl. *f* *mf*

B. Cl. *p* *mf* *p* *f* *mp*

Hn. flz *mf* *p* *mf* *tr* 4 5 7 harmonics randomly at will  
T0, 1, 13  
T23

Vc. *mf* *p* *mf* *f*

L Top

93

Fl. *f* 3 *mp* > *pp*

Cl. *mf* *mp* > *pp*

B. Cl. *p*

Hn. *f* *mf* *mp* *p*

Vc. *mf* *pp*

L Top

98 **G** **H**  $\text{♩} = 135$

Fl.  $ff$

Cl.  $ff$

B. Cl.  $ff$

Hn.  $ff$   
arco

Vc.  $ff$

L Top 3'33" 3'46"

104

Fl.

Cl.

B. Cl.

Hn.

Vc.

L Top

109 **I**

Fl.

Cl.  $mp < ff$   $mp < ff$   $mp < ff$   $mp$

B. Cl.  $mp$   $ff$   $mp < f$   $mp < f$   $mp$

Hn.  $sfz$   $mp$   $ff$

Vc.  $ff$

L Top

114

Fl. *ff*

Cl. *f sfz mp f sfz mp f*

B. Cl. *ff*

Hn. *ff*

Vc.

L Top

Detailed description: This system covers measures 114 to 118. The Flute part features a rhythmic pattern of eighth notes with accents, starting with a fortissimo (ff) dynamic. The Clarinet and Bass Clarinet parts have a similar rhythmic pattern, with dynamics ranging from forte (f) to mezzo-forte (mp). The Horn part has a steady eighth-note accompaniment, also marked ff. The Violoncello part has a rhythmic accompaniment with accents. The Lyric Tenor part is mostly rests.

119

Fl. *mp f mp f mp*

Cl. *sfz mp mp f mp f mp f*

B. Cl. *mp f mp f mp f*

Hn. *f sfz mp f sfz mp*

Vc.

L Top

**J**

Detailed description: This system covers measures 119 to 123. A section marker 'J' is placed above measure 119. The Flute part has a melodic line with dynamics from mezzo-piano (mp) to forte (f). The Clarinet and Bass Clarinet parts have a similar melodic line with dynamics from sfz to mp. The Horn part has a rhythmic accompaniment with dynamics from f to sfz. The Violoncello part has a rhythmic accompaniment with accents. The Lyric Tenor part is mostly rests.

124

Fl. *tr. (#) ff mp ff mp mf*

Cl. *mp f ff f mp f mp f mp*

B. Cl. *mp f mp f mp f mp*

Hn. *f sfz mp*

Vc.

L Top

Detailed description: This system covers measures 124 to 128. The Flute part features a trill marked with a sharp sign (tr. (#)) and dynamics from ff to mf. The Clarinet and Bass Clarinet parts have a melodic line with dynamics from mp to ff. The Horn part has a rhythmic accompaniment with dynamics from f to mp. The Violoncello part has a rhythmic accompaniment with accents. The Lyric Tenor part is mostly rests.



128

Fl. *f* *mp* *ff* *mp* *f*

Cl. *f* *mp < f* *mp < f* *mp < f*

B. Cl. *f* *mp* *< f* *mp* *f*

Hn. *f* *mp* *sfz* *mp* *f* *mp* *sfz* *mp*

Vc. *f* *mp* *ff* *mp* *f*

L Top  $\frac{5}{4}$   $\frac{7}{8}$   $\frac{5}{4}$   $\frac{7}{8}$

132

**K**

Fl. *ff* *mp* *ff*

Cl. *mp* *sfz* *mp* *f*

B. Cl. *ff* *mp* *ff*

Hn. *f* *ff*

Vc. *f* *mp* *ff* *mp* *f*

L Top  $\frac{7}{8}$   $\frac{5}{4}$   $\frac{7}{8}$   $\frac{5}{4}$

137

**L**

Fl. *sfz* *mp* *mp* *sfz* *mp* *f* *mf*

Cl. *sfz* *mp* *mp* *sfz* *mp* *f* *mf*

B. Cl. *sfz* *mp* *mp* *sfz* *mp* *f* *mf*

Hn. *sfz* *mp*

Vc. *f* *mp* *ff* *mp* *f*

L Top  $\frac{7}{8}$   $\frac{5}{4}$   $\frac{7}{8}$   $\frac{5}{4}$

M

142

Fl. *mp* *sfz* *mp* *ff*

Cl. *mp* *sfz* *mp* *mp* *sfz* *mp*

B. Cl. *tr* *mp*

Hn. *mp* *sfz* *mp* *ff*

Vc. *ff*

L Top

147

Fl. *sfz* *mp* *mp* *sfz* *mp* *mp* *sfz* *mp*

Cl. *sfz* *mp* *mp* *sfz* *mp* *mp* *sfz* *mp*

B. Cl.

Hn.

Vc.

L Top

N

152

Fl. *mf* *ff* *mp* *f* *ff* *tr (#)* *mp*

Cl. *mf* *ff* *mp* *f* *ff* *tr (#)*

B. Cl. *mf* *ff* *mp* *f* *mp*

Hn. *mp* *sfz* *mp* *mp* *sfz* *mp*

Vc.

L Top

157

Fl. *mp* *ff* *mp* *f* *ff* *mf*

Cl. *f* *mp* *mf*

B. Cl. *mp* *ff* *mp* *f* *ff*

Hn. *mp* *sfz* *mp* *f* *mp*

Vc. *ff*

L Top  $\frac{7}{8}$   $\frac{5}{4}$   $\frac{7}{8}$   $\frac{5}{4}$

161

Fl. *mf* *fff* *mf* *fff*

Cl. *mf* *fff* *mf* *fff*

B. Cl. *mf* *fff* *mf* *fff*

Hn. *sfz* *mp* *f* *mp* *sfz* *mp* *mf* *fff*

Vc. *mf*

L Top  $\frac{7}{8}$   $\frac{5}{4}$   $\frac{7}{8}$   $\frac{4}{4}$



12

Fl.

Cl.

B. Cl.

Hn.

Vc.

L. Top

*f* *sub p* *mp* *p* *mp* *p*

*fp* *p* *mp* *p* *mp* *p* *mp* *p* *mp* *p* *mp* *p* *mp* *p*

accel

rall

tr

18

Fl.

Cl.

B. Cl.

Hn.

Vc.

L. Top

**A**

flz - windy

*mf* *f* *mf*

*f*

*f*

flz

tr

tr

2 2

0 T13 randomly at will

*sfz p* *ff*

24

lip gliss

Fl. *mp*

Cl. *f*

B. Cl. *mf* *f* *mf* *f* *mf*


Hn. *sfz p* *ff*

Vc.

L. Top

Flow

reverse mouthpiece and blow unpitched air



31

lip gliss

Fl. *f*

Cl. *f*

B. Cl. *f* *mf* *f*

Hn. *f* *mf* *f* *mf* *f* *mf* *f* *mf* *f* *mf* *f*

Vc.

L. Top



35

Fl.

Cl.

B. Cl.

Hn.

Vc.

L. Top

accel rall  
tr

mf f mp

mf f mf f mf f mf f mf f mf

41

**B**

Fl.

Cl.

B. Cl.

Hn.

Vc.

L. Top

lip gliss

mp

accel rall  
tr

f

f

mf

mf

sfz p ff mf





57 C

Fl. *f* *mf* *f* *mf* *f* *fz* *mf* *f* *mf*

Cl. *mf* *f* *mf* *fz*

B. Cl. *mf* *f* *mf* *f* *mp* *accel* *rall* *fz*

Hn. *mf* *f* *mf* *f* *sfz p* *ff* *fz*

Vc. *f* *mf* *f* *mf* *SP* *N* *SP* *N* *fz*

L. Top

64

Fl.

Cl.

B. Cl. *f* *mf* *accel* *rall*

Hn. *mf* *f* *tr* *irregular as per contour* *T12 13* *f*

Vc.

L. Top

Fl.

Cl.

B. Cl.

Hn.

Vc.

L. Top

*f* *mf* *f* *mp* *f* *mf*

*flz* *tr* *accel* *rall* *tr* *accel* *rall*

irregular as per contour

3 3

0 T13

*mf* *f* > *mf* > *mp* *f*

dynamic fluctuations within *mp* and *f*

**D**

Fl.

Cl.

B. Cl.

Hn.

Vc.

L. Top

*f* *mf* *mp* *f*

*mp* *mf* *mp* *f*

*f* *mf* *f* *mf*

Gliss as per contour

7 3

5

N SP N SP N

82 **E**

Fl. *f*

Cl. *mf* *f* 5

B. Cl. *mf*

Hn. *mf* *f* *mf* flz N *f*

Vc. SP N SP N *f* *mf* *f* *mf* *f* 3 3 *mf* *f* 5

L. Top

88

Fl.

Cl. 3 *mf*

B. Cl. *mf*

Hn. 3 *mf*

Vc. 3 *mf*

L. Top

91 **F**

Fl. **f** **mf** **p**

Cl. **f** **mf** **p**

B. Cl. **f** **mf** **p**

Hn. *tr* 2 3 **f** **mf** **p** *stopping mute*

Vc. **f** **mf** **p**

L. Top 5'33" 5'58"

*T12 13*

*alternating pitch slowly at will ending on C*  
*dynamic alternating slowly at will between p and niente.*

♩=50 **G**

Fl. **mf** **f** **mf** *lip gliss*

Cl. *flz* **mp** **f** **mp** **f**

B. Cl. *tr* **mf** **mp** **mf** *flz* **f** **mp**

Hn. **mp** **mf** **mp** **mf** **mp**

Vc. N mSP N mSP N mSP N

L. Top **mp** **mf** **mp** **f** **mp**

109 lip gliss N flz

**H**

Fl. *f*

Cl. *mf f mp f mp mf*

B. Cl. *mf mp*

Hn. *mf mp mf*

Vc. *mf f mp mf*

L. Top

117 Breath tone lip gliss

**I**

Fl. *f mf*

Cl. *f mf f mf*

B. Cl. *mp f mp ff mp*

Hn. *f mf mp f mp*

Vc. *N mSP p ff p f*

L. Top

126 → ° lip gliss J

Fl.

Cl.

B. Cl.

Hn.

Vc.

L. Top

*f* *rall* *p* *mf* *gliss.* *p* *ff* *p*

T2

132

o n

Fl.

Cl.

B. Cl.


Hn.

Vc.

L. Top

*f* *mp* *mf*

T23 1 23 123 any random order

137  **K** lip gliss

Fl. *f* *mf* *f*

Cl. *mp* *f* *mp* *mf* flz

B. Cl. flz *f* *mp* *f* *mp* *f* *mp*

Hn. SM

Vc. N mSP N *ff* *mp*

L. Top

148 **L** ♩=50

Fl. *ff* *p*

Cl. *f* *mp* *ff* *p*

B. Cl. *f*

Hn. 3 *f* *p*

Vc. *ff* *p*

L. Top *ff* *p*

10'39" 12'35"

**M** 159  $\text{♩} = 50$

Fl. *mp poco a poco cresc*

Cl. *mp poco a poco cresc*

B. Cl. *mp poco a poco cresc*

Hn. *mp poco a poco cresc*

trem speed  $\text{♩}$  accel  $\text{♩}$  rall  $\text{♩}$  (sim)  $\text{♩}$   
 position ST  $\text{♩}$  SP  $\text{♩}$  ST  $\text{♩}$  SP  $\text{♩}$

Vc. *p poco a poco cresc*

L. Top  $\text{||} \frac{3}{4}$

**N** 169

Fl. *mf poco a poco cresc*

Cl. *mf poco a poco cresc*

B. Cl. *mf poco a poco cresc*

Hn. *mf poco a poco cresc*

ST ST SP ST

Vc. *mp poco a poco cresc*

L. Top  $\text{||} \frac{3}{4}$





195

Fl. *f poco a poco cresc* *ff > pp*

Cl. *f poco a poco cresc* *ff > pp*

B. Cl. *f poco a poco cresc* *ff > pp*

Hn. *f poco a poco cresc* *ff > pp*

Vc. *f* *ff > pp* harmonic gliss

L. Top