Stretching the String:

Embedding Pedagogical Strategies in Extended Techniques Compositions for Strings

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by

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Abstract

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The central focus of this research project is the question of how pedagogic strategies concerning the teaching of extended techniques for string instruments can be embedded into original compositions. I show how practical studio-based experimentation, exploration and development of these extended techniques can generate written concert pieces, the study of which will help instrumentalists to acquire the technical and musical resources they need in order to be able to deliver convincing and creative interpretations of contemporary works which include the said techniques.

After giving a brief review of the historical and musical context, these pieces are explained in detail. How and why they were written with the double function of concert pieces and learning paths for the player with explicit pedagogical content is discussed in four essays, which raise some fundamental issues involved in playing, writing and teaching music. Through these essays, I explain my strategy of empowering and equipping the player with the technical and aesthetic means of contributing to the creative interpretation of each piece, emphasizing the collaborative aspect of musical creation.

Videos of complete performances of all the pieces are included in the thesis, as well as some explanatory videos.

Acknowledgements

This thesis and the works I wrote for it are in many ways the result of my many different musical experiences with friends, colleagues and students. They are far too numerous to name here, but I am indebted to all of them, for I rarely made music with someone without learning something from the experience.

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A special mention must go to Diamanda la Berge Dramm, the violinist to whom the *Violin Spaces* are dedicated. Her talent, her enthusiasm, her feedback and her suggestions were invaluably inspiring, and she brings to her performances exactly the type of life and energy which I was trying to capture in writing these pieces. The *Violin Spaces* are in many ways, her *Spaces*.

My wife Valentina has been a constant support, and even while leading a very demanding professional life of her own, she was ever ready to lend a patient and intelligent ear for my many doubts about how to proceed.

I must thank Schott Music for kindly granting me the permission to use extracts from the *Violin Spaces* in this thesis. Schott Music published these pieces in 2018. Schott Music holds the publishing copyright on the *Violin Spaces*, and all extracts from them.

For the videos, I am indebted to Carnegie Hall and the Kronos Quartet for giving me the three videos concerning *Satellites*. Many thanks to the Ligeti Quartet, the Friction Quartet and the Argus Quartet for their magnificent playing on these. All the videos of the *Violin Spaces* were made by Diamanda Dramm herself. All concerned have generously given me full permission to use these videos in this thesis, and a full list of credits can be found embedded in each video.

Table of contents

Chapter 1 – Introduction 5
Chapter 2 – Background 14
Chapter 3 – Inside the Note 19
Violin Spaces n° 1: Up above our heads 22
Violin Spaces n° 2: Skating 28
Satellites movement n° 2: Spectral Sunrise 34
Chapter 4 – The Sounds Formerly Referred to as Noise 38
Violin Spaces n° 3: No pitch, no problem 43
Violin Spaces n° 4: The Raven 46
Chapter 5 – Strings are not Keyboards 52
Violin Spaces n° 5: Sliding 56
Violin Spaces n° 6: Microtonal Blues 60
Chapter 6 – With or Without the Bow 68
Violin Spaces n° 7: Ten fingers 70
Satellites movement n° 1: Geostationary 70
Violin Spaces n° 8: Rick O'Shea 78
Satellites movement n° 3: Dimensions 78
Chapter 7 – Conclusion 85
Glossary 88
Bibliography 91
Listening suggestions 93
List of videos and figures 94

Chapter 1

Introduction

The central focus of this research project is the question of how pedagogic strategies concerning the teaching of extended techniques for string instruments can be embedded into original compositions. I show how practical studio-based experimentation, exploration and development of extended techniques for strings can generate source material and serve as inspiration for the composition of original concert pieces. The pieces presented here arise from and embody this research, containing as they do both my original questions and some of the possible solutions. They comprise a set of eight violin studies entitled *Violin Spaces*:

1. ***Up above our heads***: a study in natural and artificial harmonics
2. ***Skating***: a study in *ponticello*
3. ***No pitch, no problem*****:** a study in noise
4. ***The Raven*****:** a study in white noise and breath.
5. ***Sliding***: a study in *glissando*
6. ***Microtonal Blues***: a study in microtones
7. ***Ten fingers***: a study in *pizzicato*, playing without the bow
8. ***Rick O'Shea***: a study in bow virtuosity

and a string quartet in three movements, *Satellites*.

1. ***Geostationary***
2. ***Spectral sunrise***
3. ***Dimensions***

These works are autonomous pieces of concert music, which can be listened to and enjoyed without any need of prior knowledge. They are also conceived as learning paths for the player, with explicit pedagogical content. This pedagogical aspect does not in any way compromise the artistic level of these

pieces, on the contrary it serves as the inspiration for them. The sonic elements generated by analysis and development of extended techniques constitutes their central musical content. The pedagogical imperatives of clarity and logical progression give strength and purpose to the musical form. These pieces represent my response to what I see as an urgent need for performer-informed compositions which use extended techniques as their basic language, not merely as appendages or ornamentation, as I explain below. As soon as I began their composition, I discovered another even more pressing urgency – my own need to create these pieces.

My immersive research as interpreter, composer, teacher and diffuser has given me experience, knowledge and a comprehensive expert overview of many aspects of artistic creation, performance and transmission. Extensive performing experiences as a member both of the Arditti String Quartet[1], and the Ensemble InterContemporain[2], two of the world's leading contemporary music groups, have brought me into close personal contact with the world's preeminent composers and their music.[3] In many cases, I have worked with these composers at the point of creative decision-making, gaining rare access, through rehearsals, discussions, collaborations and post-performance re-evaluations, to the methods and decisions that inform and direct their compositional processes.

My own composing experiences have been greatly stimulated by this interaction, and also by intensive exchanges with my fellow interpreters. Teaching experiences as professor of viola in Freiburg (Hochschule), San Sebastian (Musikene), Boston (New England Conservatory), London (Royal Academy of Music) and Manchester (Royal Northern College of Music) have allowed me to work with young musicians who are following a classical training at most of the

[1] The Arditti String Quartet was founded in 1976 by Irvine Arditti. One of the first string quartets to dedicate itself entirely to contemporary music, it soon became the leading quartet in this field, working closely with and premiering works by most of the leading composers of the time – Berio, Boulez, Xenakis, Lachenmann, Ligeti, Kurtag, Stockhausen, Sciarrino, Saariaho, Haas and many others.

[2] The Ensemble InterContemporain was founded in Paris by Pierre Boulez in 1976 with the full backing of the French government. With its set-up of 31 soloists capable of forming multiple combinations of instrumentation, its aim was to commission and perform contemporary works to the highest standards, and to serve as the concert mouthpiece for material produced by its sister organization Ircam (Institut de Recherche et Coordination Acoustique/Musique), founded at the same time.

[3] Of these, the composers who influenced me most were Ligeti, Sciarrino and Cage.

leading conservatoires in Europe and several major American music schools. My career as an artist working at the cutting edge of compositional and performance practice has given me the opportunity to play in all types of space and context, providing first-hand experiences which have led to invaluable insights into the forces at work during live performance events and how these forces can be channelled effectively.

All of these activities in their different ways awakened my interest in the analysis, development and transmission of contemporary string techniques. It quickly became obvious to me that there was a fundamental problem in this field: these techniques were in general not being taught in traditional music conservatoires (except for some rare and praiseworthy exceptions) and were not being assimilated into standard instrumental technique. This is in part due to an ingrained resistance to contemporary music in the conservatoires, and a tendency to regard it as complex and inaccessible. But it also due to wider ranging conceptions about what music is and how it is taught.

Our present musical system, as represented in our music schools, is in many ways a product of the rationalisation of music at the time of the Enlightenment. The drive to measure, quantify and classify scientifically everything which could be so treated, led to the establishment of the tempered tuning system (see chapter 5), the exactitude of notation and an inevitable standardisation of scale systems, tuning, rhythms, sound colours etc. The undeniable strengths of this rationalisation gave rise to a fabulously sophisticated and flexible harmonic system, which permitted musical giants such as Bach, Mozart and Beethoven to compose their masterpieces. But although the gains were huge, there were inevitable losses: natural tuning systems, different divisions of the octave allowing alternative scales and especially all the colourful and chaotic sounds, rhythms and noises which fell outside the academic norms of conception and notation. There has been a renewal of interest in these elements in recent years, and this is the territory I have the ambition to reoccupy in my pieces. While purposely choosing to sail as close as possible to the mainstream Conservatoire-based norms as regards harmony, rhythm and style, my 'Trojan horses' what are known as 'extended' techniques. Although these techniques are based on techniques already acknowledged by even the most traditional teachers,

their development and extension lead us firmly away from the narrow paths of academic conservatism into new sound worlds.

Outside the professional contemporary music circuit, these extended techniques are not widely used or appreciated. Conservatoires have long been focused on the techniques and repertoires of the Common Practice Period (CPP; usually defined as being circa 1650 to 1900, corresponding to the era between the formation and the dissolution of the tonal system). For example, this year's (2018) ABRSM grade eight piano exam lists 32 pieces that students can choose from: only five of these were written after 1950.

Consequently, players leaving the Conservatoire who come across pieces containing these techniques often have to find their own ways of tackling them, and the knowledge thus gained is not always transmitted to others. Worse still, due to a lack of experience with these techniques, many players lack the aesthetic judgment necessary for manipulating the sounds produced by these techniques, resulting in musically unsatisfactory performances of new pieces, which are then usually blamed on the deficiencies of the composer. While it is true that something like a corpus of aural tradition of these techniques does exist, available by direct contact with the composers themselves, only a few specialised players like myself have access to this.

I identified an urgent need for new pieces that directly address this issue: technical handbooks are useful but only by actually playing pieces which use these techniques as a language will musicians become fluent in their use. I decided to write concert pieces inspired directly by the sounds and possibilities that these new ways of playing open up. I also wanted to emphasise the poetic, playful and emotive sides of these new sounds giving rise to pieces that any audience could relate to. This is my direct reply to the accusations of complexity and inaccessibility in contemporary music mentioned above. It was important to me that the pieces should have a pedagogical aspect, so they could also be used by player and listener as initiatory paths into these sound universes, paths created by and embedded with as much as possible of the subjective tacit knowledge which I gained in a lifetime career devoted to new ways of thinking about string sound. The idea of learning by doing is a fundamental part of my approach, and the techniques involved in these studies can only be learned by travelling down a

path of knowledge, as in traditional wayfaring. As the anthropologist Tim Ingold says:

> a way of knowing is itself a path of movement through the world: the wayfarer literally 'knows as he goes' (Ingold 2000: 229-30) along a line of travel (Ingold 2007:89).

These pieces were above all my personal research space where I furthered my knowledge of these sounds and techniques. I firmly believe that these sounds are of interest and benefit to all, and that to leave them in the reserved domain of the initiated few of the contemporary music circuit would be a sad waste of their potential.

A number of artistic principles that I have developed over the years were important to me while working on these studies. Firstly, I believe it is time to revalorise the idea of thinking with the fingers as an equal partner to writing with the brain. Historically, the more intellectual *epistemé* has been accepted as the preferred approach to research, the more physical *techne* being considered a less noble path. In my field of research, the importance of tact cannot be underestimated, and my best results are produced by combining both approaches. Secondly, I fully recognise the importance of the players' contribution to the piece. This means sharing artistic responsibility with them instead of considering them as simple executants of the works, and trusting them to make their own aesthetic judgments. It also means accepting a degree of joint ownership/authorship of the performances. Thirdly, I make a conscious attempt to be aware of the dangers of allowing conventional notation to act as a sound filter, which stops us hearing or imagining things that do not correspond to its criteria. Fourthly, it is very important to me to maintain a freedom of musical styles without taboos, only preferences. The essential core of my music is the sounds themselves, and these can be used in any number of different styles, rhythms, harmonies and contexts, the choice depending entirely on how best to present each sound. And finally, I believe that developing a new perception of sound is as important as developing new sounds. The idea of creating something new by revealing what is already present is summed up by Paul Klee in his Creative Credo of 1920: 'Art does not reproduce the visible but makes visible' (Klee 1961: 76).

Methodology

Although my approach to each of these pieces was quite different, and entirely dependent on the nature of the musical material involved, I can nonetheless give a description of my general methodology, at least in regard to the *Violin Spaces* by listing the following steps:

1: Firstly, a specific sound or technique that is already present in the string repertoire of the Common Practice Period (for example *pizzicato*) but which shows rich potential for exploration, extension and development is identified. As well as being based on my subjective evaluation of the inherent aesthetic interest of the sound and my estimation of the technical possibilities of extending its use, this choice is also guided by the wish to present a coherent collection of studies that cover what I consider to be the basic foundations of contemporary string technique.

2: The chosen sound or technique is studied without manipulation in long and intensive listening sessions. This is an important stage in the research, where the artistic imagination is allowed to imagine many possible contexts, developments, associations or relationships of the sounds. Initially, the sounds are considered in as abstract a form as possible, pure sound worlds, then creative hypotheses of how the sounds could be put together are allowed to form progressively.

3: The limits and the possible directions for the extension of this sound or technique are explored: musically, physically, and technically. For technical analysis of the sound, a spectrograph proved extremely useful. A visual image of the sound helps the ear to detect the overtones and shows what influence this has on timbre. The spectrograph becomes a visual map by which we can trace and develop a timbral path.

4: Improvisation sessions with this sound material took place, either alone in private, or with colleagues or in public performances. These different contexts allowed a wide range of styles, intentions and constructions to be experimented with.

5: The process of capturing on paper the most promising sound elements of these improvisations begins, with special thought given to the notation employed in order to gain maximum clarity and comprehension. What I call

strategic notation plays a fundamental part in my pedagogic thinking, and this concept will be explained in detail throughout chapters 3-6.

6: Public presentations of these research ideas, innovations and first sketches of the pieces were organised for specially scheduled workshops and masterclasses with student performers at the Royal Northern College of Music, Manchester, the Royal Academy of Music, London, MDX in Hendon, and the Royal Conservatory in The Hague, Holland. These sessions included improvisations and discussions with the student musicians. The clarity required for pedagogic explanation of the research helped to articulate the project, and encouraged clarity in the composition.

7: More advanced sketches for each study were made, nourished by the experience of the public demonstrations, and these were tested again with colleagues and students from the aforementioned music schools. This experience encouraged reflection on tacit knowledge and to what extent it can be transmitted by musical compositions.

8: Composition of complete versions of the pieces.

9: Following public performances of the pieces by Diamanda Dramm, the dedicatee of the *Violin Spaces,* and many discussions and exchanges with her, substantial revisions and improvements were made, resulting in the final versions of these studies.

General outline

Following an overview in chapter 2 of the historical background and context of extended techniques and the composer-performer, part II presents the composed pieces themselves in a series of four essays, each one focusing on what seems to me to be a fundamental aspect of contemporary string technique. This grouping, my thinking and strategies on the issues in question as well as the deeper thoughts which lie behind these pieces, and how I set about their composition is explained in detail in these essays.

In chapter 3, *The Difference between Notes and Sounds,* I examine a key element in the understanding of timbre, namely the harmonic partials. Timbre has become one of the central elements of today's music and a firm grasp of the fundamental principles of the harmonic partials, both as isolated harmonics and

as composant overtones of a fundamental is an important tool for players when learning the control of their timbral nuances. The extended techniques covered in this chapter are harmonics and *sul ponticello*.

Chapter 4, *The Sounds formerly known as Noise,* reflects on how to assimilate into string technique the fundamental aesthetic shift during the 20th century which allowed some sounds which had been hitherto considered as noise to be considered as music. Two noise-based concert studies are presented; one which takes a more abstract approach, comparing sounds between themselves and the other which uses sounds which contain noise elements as a means of evoking an emotional atmosphere. The technique of *sul tasto* is used as a way of entering the world of noise.

Chapter 5, *Strings are not Keyboards,* focusses on two very natural string techniques, which were largely marginalised during the CPP; sliding and microtones. The dominance of keyboards, and in particular the piano, during this period had a strong influence on notation, composition and musical thought and consequently the free development of natural string techniques such as sliding or using different tunings tended to be ignored or even repressed. String instruments are continuous pitch instruments, and using their natural disposition in these techniques of *glissando* and microtones allows a fuller understanding of their true nature and possibilities.

And finally, in chapter 6, *With and Without the Bow*, the two seemingly inseparable components of violin playing, the violin and bow, are nonetheless separated to show their different origins, backgrounds and capabilities. I explain the musical and physical possibilities that open up when not using the bow, notably in extensions of plucking techniques (*pizzicato*). I then consider the bow and some of its less-exploited possibilities, explaining in the process how I constructed a piece around these ideas.

In chapter 7 the conclusions of my research are presented, and their diffusion discussed.

Performances of all eight *Violin Spaces* and *Satellites* for string quartet can be heard and seen in the attached videos. There are also videos where I explain in detail the techniques that I use. With each of the musical references in the text, I have included a video link where the passage in question can be heard and seen.

The choice of the violin as instrument, even though my own instrument is the viola, comes from a desire to build on my initial research begun in my *Viola Spaces* for viola (Schott 2009), with the aim of extending my field of reflection to the entire string family. I was given the opportunity to put this into practice during my collaboration with the Kronos Quartet, who commissioned my string quartet *Satellites* in 2015[4] (see video). I had originally begun this research project with the intention of concentrating solely on the Violin Spaces, but when the opportunity to write a string quartet came, I quickly realized that this could be a perfect extension of my original project, widening the interest to include three members of the string family, and allowing me to experiment with extended techniques as part of a global texture. I have not yet written any music for double bass, but this will be a logical next step in my explorations. Writing for instruments other than the viola, and knowing that I myself will not be the performer of these pieces means having to rely on the written score as a means of transmitting my ideas and compels me to find strategies for embedding these ideas in the music itself.

[4] As part of a project called 'Fifty for the Future', the Kronos Quartet, one of the leading new music groups in the world, commissioned a string quartet from me, which was premiered in Seattle in February 2016. This piece is now part of a freely accessible web archive destined for young string quartets, to provide them with a new repertoire, which helps them come to an understanding of contemporary music of many different styles. The Kronos Quartet specifically asked me to introduce some extended techniques in the piece.

Chapter 2

Background

Extended Techniques

> It has become clear in recent years that the valid but limited traditional conception of the flute encompasses only a restricted number of the sonorities the instrument can produce. (Dick 1989: v)

All instruments are capable of producing many more sounds than the ones they were originally designed to make. Composers and players can (and do) take advantage of these possibilities to express themselves. Contemporary aesthetics allow for a much broader definition of instrumental sound than was the case one hundred years ago. This is not to say that earlier instrumentalists were not concerned with tone colour; on the contrary, as the early champion of extended techniques Bertram Turetzky points out, the first printed viol method by Sylvestro di Ganassi 'Regola Rubertin' (1543) includes an exposition of registration stating that *sul tasto* produces sad effects and that playing near the bridge produces stronger and harsher sounds (Turetzky, viii). But the range of these and other tone colours has now been greatly extended and elevated to a principal component of some of today's music.

The term 'extended techniques' refers to instrumental techniques that were once considered of secondary importance but that have now been developed and extended to the point where they can be considered primary techniques; in the case of string instruments the obvious examples are *sul ponticello* or harmonics. In recent years the term itself has been extended and has taken on a wider meaning to include techniques that are not based on conventional methods of playing (the electric bow), or that alter the nature of the instrument (putting paper-clips on the strings of a violin). I have chosen to limit my research to the types of technique that derive from and extend the conventional methods of sound production. Of these, I have selected eight that seem to me to be the most important and widely used, and which between them constitute an inter-related

group, the ensemble of which in its totality gives access to some of the most fundamental ideas in contemporary music playing.

In spite of the fact that many of the extended techniques explored in this thesis have been known and available for several centuries, aesthetic tastes have been slow to accept them as musically valid sonorities. We find the techniques of both *pizzicato* and *col legno* in Tobias Hume's 'The First Part of Ayres'(1605). Monteverdi used *pizzicato* and *tremolo* in *Il Combattimento de Tancredi e Clorinda* (1624), both as dramatic illustration and as a musical texture. Carlo Farina's *Capriccio Stravagante* (1627) for four violins uses *sul ponticello, col legno* and playing behind the bridge. But these were special 'sound effects' used to imitate animal sounds like dogs barking or cats fighting, and nothing indicates that they were considered musically interesting in their own right. Two hundred years later, when Beethoven used *sul ponticello* in the fifth movement of his String Quartet op. 131 (1826) as an integral part of the musical composition, it was still considered extremely avant garde, and in spite of Berlioz's use of it in his *Symphonie Fantastique* (1830), we have to wait until the works of Mahler and Schoenberg for it to gain grudging acceptance in the musical community. Audiences are even further behind, and even today, many of the most common extended techniques like *sul ponticello* or microtones remain unfamiliar. Classical string players are taught little or nothing about these techniques at the conservatoires because their teachers were not taught about them, and there is a serious lack of generally accepted repertoire that includes them.

For players who wish to learn these new techniques, there have been some recent important contributions to the study and understanding of extended techniques for strings in book form, notably by Patricia Strange (2001), Arditti and Platz (2013), Barbara Maurer (2014) and a very useful internet resource by Ellen Fallowfield (CelloMap website). These are mainly handbooks of explanation, quoting specific examples from contemporary scores, and the Arditti/Platz volume includes a DVD of Irvine Arditti demonstrating some of the techniques featured in the book. This is indicative perhaps of the beginnings of a general move towards more multi-media supports for the propagation of contemporary playing techniques, which would seem a healthy and welcome development.

Although theoretical explanations are very useful, my proposal here is not to add to the body of written theory of these techniques, but to construct paths of learning where knowledge is gained by practical experience, learning by doing. Carlos Salzedo, one of the pioneers of modern harp technique included a set of original Preludes in his Method for the Harp (1929) and specified: 'It is to be hoped that every composer, conductor and musicologist will become thoroughly familiar with these Preludes, not by studying them in a visual manner, but by actually playing them on the harp' (Salzedo and Lawrence, 1). It is not known how many composers followed his recommendations to the letter, but his techniques were quickly adopted by Bartók, Stravinsky and many others.[5]

The importance of sharing this practical knowledge between performer and composer is underlined by Barbara Maurer, who devotes the first chapter of her book to explaining to composers how to build a working model of a string instrument, so that they can understand the physical possibilities and sensations of playing (Maurer 2014). Helmut Lachenmann, who writes extremely refined and accurate descriptions of the sounds he wants players to produce, experiments them all himself, and does not hesitate to demonstrate them to players dubious of their feasibility (and as I have witnessed on numerous occasions, he demonstrates them extremely well!).

Pianists have a great wealth of literature with the double purpose of pedagogy and concert practice in contemporary techniques ranging from Bartók (*Microcosmos:* 1926-39), to Gyôrgy Kurtag, (*Signs, Games* and *Messages* (1980-2005), *Jaketok* (1973-2017)) and György Ligeti (*Etudes* 1985-2001). These pieces however only deal with playing the piano by using the keyboard, and do not explore the multitude of extended techniques made possible by playing inside the piano, which are nowadays current practice. On the piano, the border is clear between keyboard and non-keyboard playing, and this establishes in some measure a frontier between CPP techniques and post-CPP techniques. On string instruments, there is no such clear frontier, many techniques only differing from CPP practice by a question of degree.

[5] Damped harp chords and notes plucked near the sounding-board in Stravinsky's *Symphony of Psalms* (1930), flat-handed chords in Schoenberg's *Variations for Orchestra* (1929), chromatic octaves and flat-handed chords in Bartok's *Music for Strings, Percussion and Celeste* (1936) (Archambo 97-99)

The development of instrumental techniques by performers

One of the historical strands most closely related to my research is the performer-driven current of composition exemplified by the now established genre of the 'Etude' or concert study. The origins of this genre can be traced back to Baroque composers such as Heinrich Biber (1644-1704), Giuseppe Tartini (1692-1770) and Joachim Quantz (1697-1773), who developed and demonstrated their new compositional, interpretive and instrumental techniques by writing pieces incorporating these features. These works were destined for performance, often by the composers themselves, and usually imply a certain degree of virtuosity.

The emergence of the virtuoso player-composer in the 19th century is best exemplified by Paganini and Liszt. Their composition of virtuoso concert pieces for themselves not only allowed them to showcase their astounding techniques, but it contributed greatly to furthering their art and extending their instrument's possibilities, leaving an important legacy of written works, many of which are now firmly established in the concert repertoire. Paganini transmitted through his studies, notably the *24 Caprices* (1802-1817), many of his own personal technical inventions, introducing and firmly establishing artificial harmonics, left hand *pizzicato* and *gettato,* for example, into the violinist's repertoire. Indeed, Paganini's technical innovations were not simply an addition to his technique, but according to comments made by his contemporaries, seemed to be central to his way of playing.[6]

A similar thread of player-composers opening up new frontiers by their way of playing can be found in jazz. Jazz relies heavily on improvisation, which concert music of the nineteenth century had more or less set aside. Encouraged by the increasing acceptance of the use of non-conventional sounds, (see chapter 4 regarding Russolo, Varese and noise) and ever freer improvisation, instrumentalists in the twentieth century began to explore all the sonic possibilities of their instruments. Players such as Charlie Parker, Ornette Coleman, John Coltrane, Derek Bailey, Anthony Braxton and more recently Fred Frith, John

[6] 'It can be stated with certainty that Paganini has attained his outstanding precision and clarity on the violin above all by playing harmonics' wrote Carl Gruber in 1829 (Stowell, 214)
'Left hand pizzicato was one of the most striking ingredients of Paganini's performing style' (example *Carnaval de Venise*). (Stowell, 223)

Zorn and George Lewis opened up new frontiers of instrumental playing and as a result many techniques were extended or re-invented. In general, these techniques were not notated, improvisation being essentially unwritten, but they passed into the repertoire by personal communication and aural tradition.

With the notable exception of the double bass and players like Barry Guy or Stefano Scodanibbio, (who, as well as being outstanding improvisers, also produced written compositions where their techniques were notated), bowed string players participated to a lesser extent in this revolution of playing techniques until relatively recently. Figures like the violinists Malcolm Goldstein and Jon Rose could be considered as part of a second wave of this revolution.

Despite the general tendency since the eighteenth century for the roles of composer and player to separate, some player-composers have nonetheless continued to evolve and are represented by figures like Heinz Holliger, George Benjamin, Thomas Adès, Jorg Widman, Stefano Scodanibbio and Barry Guy. I myself am now creating pieces based on the many techniques I have learned and developed as a player-composer, with the double aim of furthering the research on these techniques and expanding the playing repertoire of pieces using these aesthetics. I am not alone in hoping that timbre, extended techniques, unpitched sounds and spatial gestures can one day come to be considered as valid and interesting as the traditional pitch, harmony, rhythm triumvirate that have dominated European classical music for so long.

Chapter 3

Inside the Note

This chapter examines and develops some ideas surrounding two playing techniques referred to by players as *sul ponticello* and harmonics. *Sul ponticello* is perhaps the most widely used of all the extended techniques, and is found extensively throughout the contemporary repertoire. This is indicative of the importance given to timbre by composers of this genre, as the technique concerned operates by enhancing the presence of some higher harmonic partials at the expense of the fundamental tone, thus altering the timbre of the note produced. Playing harmonics involves isolating one of these same harmonic partials in order to present this partial as a fundamental note. The techniques of *sul ponticello* and harmonics are closely linked and complimentary, each aiding the understanding and mastery of the other. It is thus natural to study them together in the same chapter.

Both of these techniques are governed by the harmonic series, and they can each be used to better understand the workings of this system. Despite its fundamental importance in both CPP repertoire and in contemporary music, the harmonic series is not generally included in string instrument methods . The harmonic series can be explained relatively quickly to the eye and the brain using words and diagrams, but training the ear to learn how to listen to it and making the body familiar with the feeling of each harmonic when played on an instrument is a much longer process. My pedagogical strategy for this begins by making a distinction between notes and sounds.

The difference between notes and sounds

What we call a 'note' played on a musical instrument is in scientific reality a collection of partials vibrating at different frequencies and intensities. One of these frequencies is called the fundamental, being the perceived pitch of the note. It is to this frequency that standard musical notation refers. The other frequencies

involved are referred to as overtones or partials[7]. These overtones are one of the principal factors that give the note its timbre or colour. Along with other ingredients of the sound, most notably the transients, they allow us to know which type of instrument is playing, for example. One of the main concerns of the pieces being discussed in this chapter is to make this objective scientific analysis correspond to the subjective physical sensations and aural perceptions of the player, enabling her first to hear and feel the individual harmonics in isolation, then to perceive them as ingredients that combine to influence the timbre of 'notes'.

The detailed analysis of sound by computer which first became possible in the second half of the twentieth century gave rise to a whole new approach to composition, an approach which found its fullest expression in the so-called 'Spectral' movement (see glossary), spearheaded by figures like Gérard Grisey (1946-98) and Tristan Murail (born 1947). It was Grisey who said that one of the principal aims of this movement was to compose 'not anymore with notes, but with the nature of the sounds themselves' (2008:46) With this simple remark, Grisey pointed out the relative poverty of our musical notation system: the signs used to indicate pitch and duration in musical notation (which we call notes) do precisely this, leaving out almost entirely the mass of other sonic information which actually reaches the ear – not least timbre, spectral content, noise and many other elements. Grisey also said that sounds are living things that are born, evolve and die (Gérard Grisey, 2008:98). Most of this organic life is ignored by our musical notation system.

The relationship between what we call notes and what we call sounds, as well as the differences that separate them, can be seen to be one of the key issues of contemporary music since 1950. A note is a sign used in musical notation to represent the relative duration and pitch of a sound, or it can be a pitched sound

[7] The words 'partials' and 'overtones' both refer to the frequencies present in a complex sound but there is an important difference in their numeration: overtones are the partials of a fundamental, but the fundamental is not considered to be an overtone. The series of partials, by contrast, begins with the fundamental, which is counted as partial number one. For the mathematics involved in the harmonic series, this is a much more meaningful system, and so I will use the term partial whenever the harmonic series is involved. Partials can be either harmonic or inharmonic. Harmonic partials (usually referred to simply as 'harmonics') are those whose frequencies are an integral multiple of the fundamental.

itself or a pitch class (meaning a named note like A, B, C, etc.). It is the basic building block of our standard musical notation system. Sounds can be defined as audible vibrations. Notes are an abstract idea for the notation of music, whereas sound is an all-inclusive term for what actually reaches our ears. Grisey[8] was calling attention to all the sonic information produced in the performance of a piece of music which is not taken into account by a conventional musical analysis based on 'notes'.

Turning research on harmonics into creative composition

Having identified harmonic partials as a rich source of inspiration and reflection, I began practical experimentation and improvisation on the violin. This gave rise to three pieces, each with a different approach. *Up above our heads* deals directly with the overtones themselves (produced by actions of the left hand), and mostly only the natural harmonics to see what could be constructed using these very pure sounds. *Skating* deals with manipulating the proportions of the partials of a note by encouraging or inhibiting their emission, thus modifying the perceived perception of the note's timbre. And in *Spectral Sunrise*, I explore a mixture of these two techniques, as well as some other techniques inspired by the spectralists' vision of music. In each case, my aim was to explore and to better understand these overtones, but above all to put them to creative use and to embody this research in artistic production.

As already mentioned in chapter 1, I believe that musicians must take some

[8] I met and worked with Gérard Grisey on several occasions, but my closest experience of working with his ideas came after his death when IRCAM (Institut de Recherche et Coordination Acoustique/Musique) in Paris asked me to collaborate in realizing a version of *Prologue* for viola with live electronics. The piece was originally written for solo viola, but Grisey had later added a series of natural resonators (open piano, tam-tam, snare drum) in front of which the viola would pass, creating different resonances. He had made preparations, before his premature death, for a computerized version of this version using 'virtual' resonators, and thanks to the efforts and skills of Eric Daubresse, his former sound designer, we were able to bring this to completion in 2001.

Prologue for solo viola by Grisey is a seminal work, which opens his large-scale cycle *Les Espaces Acoustiques*. It was written to precede *Partiels*, which is widely regarded as being one of the founding pieces in the field of spectral music, featuring as it does many of the defining characteristics of this school. The entire cycle of *Les Espaces Acoustiques* is based on the spectral analysis of one note – a low E played on bass trombone. From the richness of information contained in this note, Grisey constructs a monumental edifice of an hour and a half of music which starts with solo viola, goes from small ensemble to large ensemble, and culminates with full orchestra plus four French horn soloists. This increased consciousness of the sonic potential and especially the harmonic spectrum of tones had a direct influence on my own work.

personal responsibility for the sonic result of the techniques they use, which means they need a fully assimilated understanding of the processes at work. In that sense, I wanted to give these pieces a double function, one as a purely artistic expression, and the other as a learning path, literally a trail which passes through certain situations, events or even obstacles requiring some experimentation before they can be successfully navigated. This is a way of transmitting my tacit knowledge of these techniques over and above the more explicit advice given in the score.

Violin Spaces n° 1: Up above our heads (video A)

To gain a better understanding of harmonic partials, I decided to deal with them first in their purest form on string instruments, the natural harmonics. The word 'harmonic' comes from the ancient Greek 'harmonikos' which means 'skilled in music'. Here it is used to refer to harmonic partials on a string instrument that are produced by touching the vibrating string lightly at a nodal point (left hand technique).

Historically speaking, the first few natural harmonics of the series were known and used by string players from earliest times[9], often employed as an alternative to fingering the octave of the open string, or for adding a warmer gentler colour, as in an echo. On the larger, slower string instruments like the double bass, players developed their harmonic technique extensively, as this afforded them a useful short cut to virtuosity on figures like arpeggios, particularly useful in the Baroque and Classical repertoires (e.g. Karl von Dittersdorf *Concerto for Bass* 1772). An early example of harmonic writing in the violin repertoire is the *Menuet* (1763) by L'Abbé le fils composed entirely in harmonics. Paganini (*Caprices pour violon* 1802 -1817*)* added a new layer of virtuosity by composing and playing with natural and also artificial harmonics used at great speed. Berlioz

[9] Although most string instrument were developed with multiple strings, there were some that only had one (called monochord instruments) and these instruments often used the harmonic series extensively. The best example of this in European music is the tromba marina (or marine trumpet), a monochord, which was popular from the 15th to the 18th century. It is a perfect demonstration of the possibilities of the harmonic series on a single string, having a large and varied repertoire of pieces composed entirely in natural harmonics. As its name suggests, the timbre is reminiscent of the trumpet, and much of the repertoire resembles trumpet calls, which are also largely based on the harmonic series.

in his celebrated *Traité d'Instrumentation* (1844) remarked that 'harmonics have a peculiar quality of mysterious softness, and the extreme height of some of them gives to the violin a vast upper range.'

In the twentieth century composers such as Schoenberg, Berg, and Webern saw the enormous timbral possibilities of these harmonics and began to use them widely. Today, the 'spectral composers', (Grisey, Murail) and composers they have influenced such as Saariaho and Haas use them as a fully integrated part of their language. Salvatore Sciarrino has written many of his pieces for solo strings entirely in harmonics (*Sei Caprici* 1976*, Tre Notturni Brillanti 1975*). A recent piece by Henrik Strindberg, *The Fifth String* (2010), for solo violin, takes full advantage of harmonics used in multi-string arpeggios.

The physical sensations of the player when producing harmonics are very different from the 'normal' tactile experiences of playing their instrument. The written notes of the score have to be translated not only into a mental knowledge of what the resultant note will be, but also into the tactile experience of that note. The left hand has to come to know the 'feel' of each harmonic node and where to find it (as the finger touching the string is no longer in contact with the fingerboard, most of the geographical clues and sensations are now absent). The bow arm has to learn the exact dosage of speed, position and pressure required for each harmonic, sometimes compensating for the weaknesses of the harmonics in the lower positions, sometimes taking advantage of the resonant freedom of the more open ones. The ear and brain have to learn to live in this 'upper floor' of hearing, often far above the normal register, and they must develop the skills necessary for identifying the characteristic timbral colours of each type of harmonic. For all of these reasons, composition with harmonics should ideally be done paying attention to the tactile experience of the player, allowing sufficient time for harmonics to speak, understanding the relative difficulty of certain harmonics and recognising the individual colours of each one (for example, the seventh harmonic has a very distinctive colour and tuning, slightly covered and minutely but deliciously low)

My first ideas for the piece came from exploring the notion of splitting a fundamental into its constituent harmonics, using a sharp attack on the lowest notes of the violin to 'launch' soaring harmonics which are in fact already present in the first attack (see figure 1).

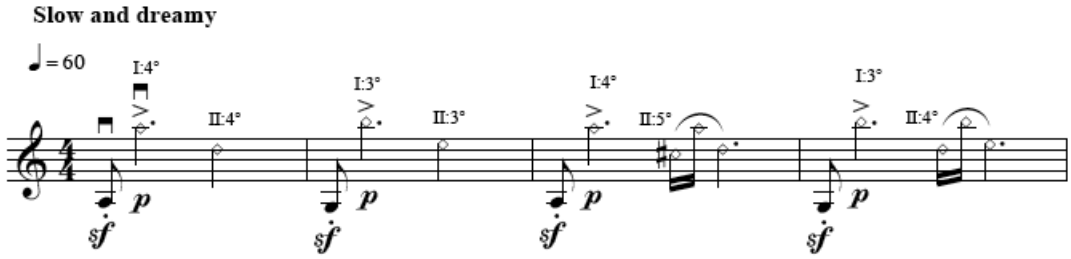

Figure 1: *Up above our heads*, bars 1-4 (video 1). All extracts from the *Violin Spaces* are under copyright to Schott Music. They appear here by kind permission of Schott Music.

As well as the musical interest of this gesture, it also fulfils one of the pedagogical aims of this piece, which is to draw the player's attention to the presence of overtones, particularly in low notes.

It is surprising to note that the basic harmonic series is not generally taught to string players, given that it is fundamental to a real understanding of harmonics. It seemed essential to me to include an exposition of this series in the piece. Fig. 2 shows how the harmonic series is first presented:

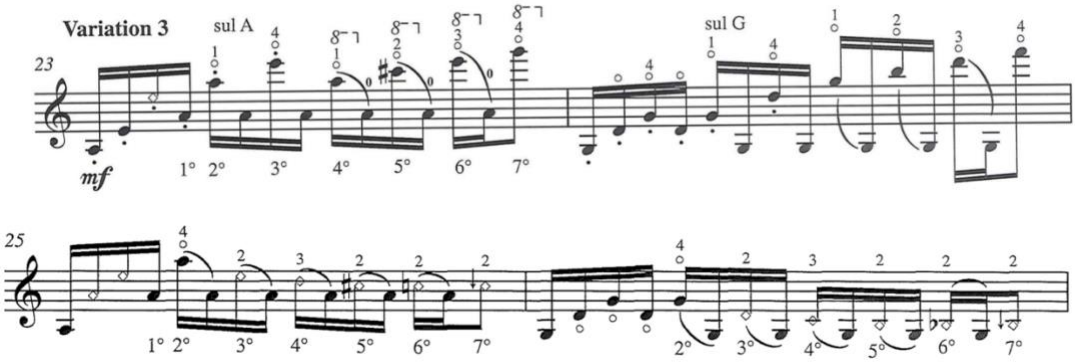

Figure 2: *Up above our heads*, bars 23-26 (video 2)

This passage features the first seven natural harmonics of the harmonic series, first on the A string, then on the G string. In bars 23 and 24 they are shown going up the string, towards the bridge. In bars 25 and 26 they are shown at the other end of the string, coming down towards the nut. The sounding pitches produced are the same, due to the symmetrical nature of a string, but the fingering pattern is completely different and the timbre gives the effect of an echo.

I have purposely included in the score the numbers of the harmonic series, a type of information that is not always deemed to be necessary for the player. An

unfortunate historical misunderstanding exists because many violin technique handbooks of the CPP assign the term 'first harmonic' to the octave harmonic, which is in reality the second harmonic of the harmonic series. What seems a logical numbering from the viewpoint of violin technique effectively prevents any violinist using it from gaining a clear grasp of how the harmonic series functions, as by counting this way the octaves will fall on harmonics 1, 3, 7, 15 etc. Using the correct numbers (1, 2, 4, 16) reveals the mathematical logic of the series, which is why I adopt an overall strategy of encouraging the player to think in terms of these numbers. It is also why I use harmonic numbering rather than follow an abstract tablature notation. Tablature has the advantage of allowing players to quickly execute the action required to produce the desired sound, but prevents them from understanding why their action produces this result. Tablature ensures that they remain slaves to the score, and cannot devise alternative strategies to produce the same effect. My chosen notation for harmonics, on the contrary, requires them to know which harmonic of which fundamental corresponds to the desired pitch, thus deepening their understanding of the harmonic series, and leaves open the possibility of having an alternative method of playing this same pitch.

I notate harmonics in a shorthand similar to the notation used by Xenakis (*Kotos*, 1977), Grisey (*Les Espaces Acoustiques,* 1974-85) and many others, namely indicating the string in question and the number of the harmonic required, for example I:4° in bar one refers to the fourth harmonic of the first string.

Which fingers the players use to play these notes is an integral part of how they will understand the harmonic series and so I propose here, in the small numbers in the score which give suggested fingerings, my suggested patterns of thought for assimilating how the harmonic series is built up. This is what I call *strategic fingering*, which increases the players' understanding of what they are doing. This is another example of 'knowing with the fingers'. Special care is taken in the choice of these fingerings to ensure that the player mentally divides the series into its constituent octaves, with clear reference points for the 2^{nd}, 4^{th} and 8^{th} harmonics, which correspond to octave divisions. These are to be played always using the first finger, which becomes the 'octave marker'. Inside each octave a distinctive fingering pattern is suggested, using widely spaced fingerings where the intervals are wide, and consecutive fingerings when the intervals are

small. Harmonic passages like this one would usually be executed by a CPP trained violinist using only one finger, which is not only inefficient, but also reveals nothing of the numerical system or the individual identity of these harmonics. My suggested fingerings are a proposition for standardising these fingerings and establishing an accepted technique for these harmonics. They are also a technical advance in the execution of these harmonics, and make possible the virtuoso passages which follow in this piece. Strategic fingerings are one part of what I call *strategic notation*, which will be explained case by case throughout this exposé.

Another example of a notation that clarifies an action can be seen in the 'trembling harmonics' which are present in *Up above our heads* and also in *Spectral Sunrise* (video). My use of this effect was partly inspired by the works of Kaija Saariaho, most notably *Vent Nocturne* (2006), which was written for me and in which I collaborated closely with the composer during its composition. Kaija has worked together over many years with my colleague, the cellist Anssi Karttunen, and has an intimate knowledge of string technique, particularly as regards the production of harmonics. In Fig.3, from *Up above our heads,* the notes on which this trembling harmonic effect (sometimes referred to as a vertical trill) takes place are clearly notated, priority being given to the two essential pieces of information; where and how to place the fingers (the noteheads) and what action they perform (a trill line suggests their oscillating movement):

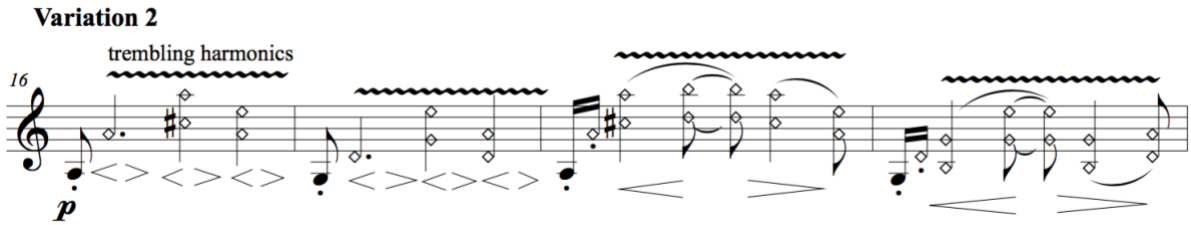

Figure 3: *Up above our heads,* bars 16-19 (video 3)

Trembling harmonics are developed further in this study in an effect I call 'shooting star tremolo'. This is done on a trembling harmonic by gradually lowering the pitch of the trilling finger keeping the fundamental constant. The result is a shower of ascending harmonics: as the upper finger is lowered in pitch, the length of the string between the fingers is reduced, producing progressively

higher harmonics. Instead of a complicated graphic design to indicate both the tremolo and the descent of the fingers, I choose to give the players two tools with which they can realise their own appropriate rendering of this passage: the poetic image of shooting stars and a clear indication of the harmonics on which to produce this effect. It is indicated by the words 'shooting star harmonics', the trill sign, and the descending *glissando* lines on the trilling fingers, as in Fig. 4:

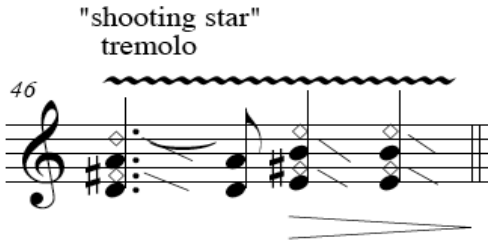

Figure 4: *Up above our heads*, bar 46 (video 4)

Inspiration and title

The relative purity of the harmonic sounds creates a crystalline musical world where the ear, with practise, can learn to recognise the individual sonorities, tunings and characteristics of certain harmonics, especially the 7th and 11th ones. These harmonics have strikingly 'natural' pitch, very different from tempered piano pitch. I will address this important issue of tuning in chapter 5 in relation to microtones. The qualities of purity, naturalness, clarity and of course height (harmonics being by nature, 'higher' than the notes they come from) gave definition to the artistic universe which constructed itself as I worked on the techniques needed to produce and manipulate the harmonics. I noticed also my tendency in these improvisations to adopt a 'singing' melodic style, usually slow, but with great flexibility and freedom to ornament rapidly.

My real inspiration for this precise piece came from the 'after-impression' of a song I heard by chance; 'Sister Rosetta goes before us' by Sam Philipps interpreted by Alison Kraus (video). This song was itself inspired by an earlier song by Sister Rosetta Tharpe (1915-73) called 'Up above my head'. My inspiration came not directly the song itself, but from a reconstructed memory of the feeling of the song – slow, languorous with a high penetrating voice resting on

low rhythmic footsteps. Translating this half-memory into music using only the vocabulary of harmonics led me to a slow regular walking speed tempo, with evolving cyclic repetitions of increasingly elaborate harmonics. The rhythms subdivide little by little, just as the fundamentals split into mathematically proportioned offspring. The clear, symmetrical shapes and sounds generated by the series suggested to me the idea of using the pre-existing form of theme and variations, where a simple theme is presented, then progressively embellished and developed.

Violin Spaces n° 2: Skating (video B)

The other study from the Violin Spaces under focus in this chapter, *Skating*, is also concerned with overtones. I would like to make a distinction between harmonics produced by touching string nodes with the left hand, which was the subject of *Up above our heads,* and the overtones produced by bowing techniques which enhance certain partials, which is the subject of *Skating*. Here, my aim is to show both listener and player the possibilities of producing overtones by special techniques of the bow, especially when playing on the section of the string nearest the bridge.

The technique called *Sul ponticello*

Several basic techniques are explored in this piece, some of which I had come across in already written pieces, others of which were discovered in improvisation sessions. Most of these can be seen to have something to do with the technique called *sul ponticello*, which, despite being already well established and used in practically every contemporary piece of music for strings, remains badly defined, barely understood and frequently misused. As Patricia Strange points out when discussing *sul ponticello*:

> The term, in its traditional usage, had only one meaning: play near the bridge. Contemporary performers, however, have come to realise that the technique can yield a wide variety of timbres ranging from a slight coloration of the pitch to a complete elimination of the fundamental that produces a clangourous, almost non-descript timbre. (Strange & Strange 2001:3)

Carlo Farina (1600-1639) included *sul ponticello* in his *Capriccio Stravagante* of 1627, as a burlesque imitation of farmyard animals. Beethoven uses it in his *Quartet op 131* (1826) and Berlioz in the *Symphonie Fantastique* (1830). Arnold Schoenberg adopted it as one of his regular Klangfarbe ('sound colours') for string instruments, and Berg and Webern continued to develop its use. In spite of all this, the exact nature of the desired sound remains unclear. Part of the problem is that the resulting sound of playing near the bridge depends not only on exactly how near the bridge one plays, but also on a number of other factors:

1: the speed and angle of the bow
2: the pressure used (the weight on the bow)
3: the length of the string (meaning whether and where it is 'stopped' by the left-hand finger)
4: the pressure of the left-hand finger and the amount (thickness) of the bow hair in contact with the string.

Introducing a scale of degrees of *sul ponticello* (e.g. *poco ponticello, molto ponticello* etc.) is useful in that it indicates how much the effect should be applied, but does not solve the basic problem of exactly what quality of sound is meant. As Irvine Arditti remarks:

> Different sorts of ponticello have long been asked for, especially by composers such as Xenakis, who was very fond of hearing only the high partials of the pitches. This means the bow has to be very close to the bridge. Lachenmann on the other hand, with completely different results in mind asks for light bowing, completely on the bridge, producing a 'toneless' sound. (Arditti/Platz p 27, 28)

The naming of an action has a fundamental effect on the manner of its execution. *Sul ponticello* is a very unsatisfactory and misleading name; in reality, the *sul ponticello* effect has little to do with the bridge, this is simply a geographical term for indicating the end of the string (in fact the other end of the string works nearly as well). Schoenberg did not help matters when he demanded that his *sul ponticello* indications should be played 'not near the bridge, but actually ON the bridge' – a probably necessary exaggeration to persuade reluctant musicians of

the time to radically change their notion of what an 'acceptable' sound was. Playing with the bow on the bridge itself produces mostly 'white noise', and not pitch ('tonlos', as Lachenmann describes it in the quote by Arditti above)

The fact that this most common of all extended techniques is an indication of where to place the bow rather than a description of the intended sound highlights an important idea in contemporary string playing: that normally associated facets of playing technique can, if required, be dissociated. The three fundamental components of bow technique, namely: speed, position, and weight, are considered in CPP teaching manuals as being totally inter-dependent, each one expected to adjust or 'compensate' for small differences in the other two in order to maintain a homogenous sound. In some contemporary techniques, one or more of the three is required to behave with complete independence. In CPP textbook playing, when the bow comes nearer to the bridge, the player is instructed to reduce the speed of the bow and to increase the pressure, in order to produce a powerful, singing sound. *Sul ponticello* technique does precisely the opposite, speeding up the bow and releasing the pressure, and it is by this 'imbalance' that the fundamental is successfully split into its constituent harmonics[10].

Approaches to techniques used in *Skating*

My studio-based improvisations and explorations in overtone production suggested four basic types of technique to be investigated:

[10] Variation depends on where the bow is placed in relation to the bridge (even on the bridge) and how the bow is articulated. The resultant sound is characterised by the presence, the elimination, or the distortion of the higher partials; the effect can be explained by what is known as 'Young's Law'. In 1800 scientist Thomas Young found that different sets of spectral frequencies along the string can be suppressed or amplified by bowing at different points on a string. For example, consider the midpoint of a string, the point at which the 2nd harmonic (the first overtone) has its node. (A node is where the wave crosses the point of zero amplitude, as shown in the depiction of a sine wave in figure 1.3). If one excites the string by bowing at this point, the even numbered partials are eliminated from the spectra of the sound, creating a square wave (having only odd-numbered partials). By the same token, if one bows the string next to the bridge near the fundamental node, as in the execution of sul ponticello, the fundamental pitch will be suppressed. This produces a very different spectrum, with the first overtone (second partial) acting as the new fundamental. If one bows the string on a loop (amplitude peaks), that particular node will be amplified. However, it should be noted that owing to the width of the bow hair, more than one note will usually be suppressed or amplified. Therefore, one should use the side of the hair when more precision is required. A composer can notate a desired spectrum and harmonic content by specifying at what point and how the player is to bow the string. Strange (2001:28)

1: techniques designed to split the note into its partials ('splitting')

2: techniques that sustain and develop these overtones (*ponticello*)

3: techniques that produce unpredictable partials in the highest register (e.g. trills, *vibrato*)

4: techniques using the weight of the arm to increase the pressure on the bow, in extreme cases going to overpressure and saturation, distorting the sound and producing inharmonic sounds (*ponticello pressato*)

These four sound-worlds can be referred to in an intuitive manner, using metaphors associated with light: words like bright, scintillating, shimmering, starry, dazzling; or with weight: gravelly, crushed; or with effect: cutting, sharp in the sense of incisive. This gives us a clue to the type of mental states they can induce in the player or listener. Keeping in mind this very basic classification, I first worked on each technique separately to develop it on its own terms, and to see how far it could be taken. I then alternated and combined different sounds in order to create dialogues between them, which brings their differences clearly into view. Then I tried to weave them into a shaped texture and from this to create a path, which subsequently became the musical form of the piece.

In my experiments, I quickly became aware that total control of the exact details of *sul poticello* playing, for example predicting exactly which harmonics will be brought out, is not possible, neither in the writing nor in the realisation. The score provides guidelines by indicating the fundamental note and which type of bow action to use, also giving a musical context that guides the player in her realisation choices. I see this impossibility of total control as a musical richness and a certain freedom for the performer. As mentioned in the introduction to this chapter, musical responsibility for the sounds produced by extended techniques have to be partially assumed by the players, emphasising once again the blurring of the line between composer and interpreter.

The idea of making a piece by exploring the overtone content of a single note was exploited in depth by Giacinto Scelsi (*Quattro pezzi su una nota sola*, 1959) and, partly due to his influence, by the Spectral composers (Grisey, *Partiels* 1974). *Skating* begins by exploring the richest fundamental note on the violin, the open G string, progressively introducing its various possibilities.

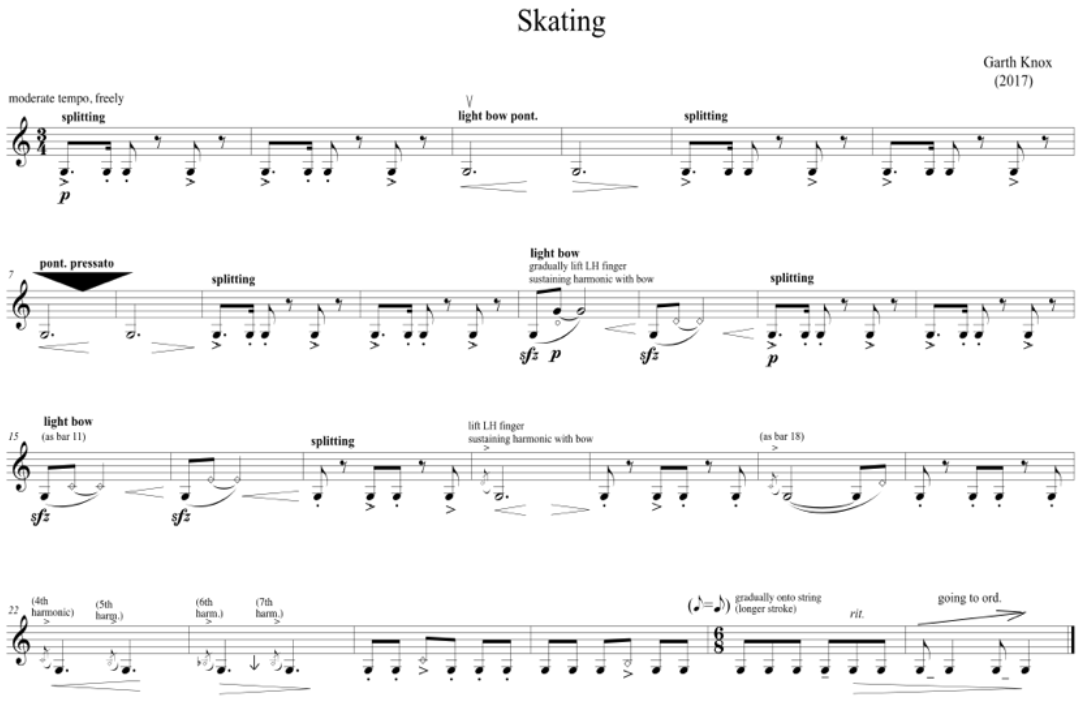

Figure 5: *Skating*, opening section (video 5)

Several different techniques for 'splitting' the fundamental and revealing one or more of its partials are shown in Fig. 5 above; a simple sideways 'slice' with the bow (bars 1, 2), a fast light bow near the bridge (bars 3, 4), touching a node with the left hand then slowly taking it away using the bow alone to sustain the harmonic produced (bars 11, 12). There is an element of ritual to this beginning, an initiation for the ear to the *ponticello* sound world. This is important for the player and also for the listener, that the ear is invited to concentrate on a single note and made aware of its spectral content. Armed with this imagery, string players can then use their bows as a musical scalpel, dissecting the global perception of a note and bringing out the constituent harmonics one by one, in the process creating new music from a single note. As the artist with his brush can mix a chosen colour on his palette, so the string player can refine the timbre of a note using the bow as a filter. This means learning to listen to the note in spectral terms, not as a synthesis of its partials, but as a cluster of them.

Once this ritual introduction is finished, a free-flowing running figure skates over the strings, experimenting with different bow pressures (Fig.6):

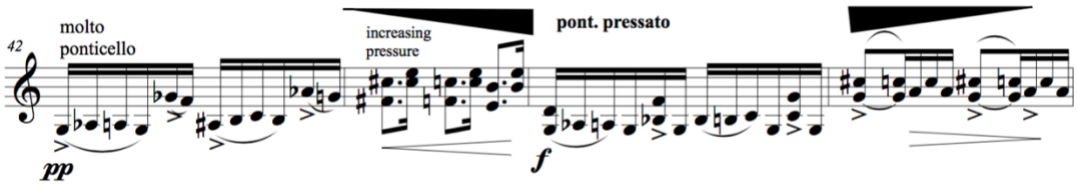

Figure 6: *Skating*, bars 42-45 (video 6)

The black triangle in bar 43 of Fig. 6 indicates increasing bow pressure required to produce *ponticello pressato*. The triangle in bar 45 indicates the release of this pressure. Triangles showing increase then decrease appears in Fig. 6, bar 7. This notation is already widespread (Saariaho, Grisey) and effective, thanks to its intuitive linking of weight with the heavy width of a black line. My intention here is to show the player the effect on the sound of varying unilaterally the pressure or weight of the bow without the habitual compensatory adjustment of the bow speed or placement. Rather than using the notation to control to an exact degree the individual ingredients of the action independently of their collective result, I aim to create an interactive link between the action and the sonic result of that action. Throughout the piece, various unorthodox techniques (imitation of Mongolian throat singing, double trills, excessive bow speed) are used to open the ear to the potential sounds contained in a single note. All these sounds can then be reproduced at will by using the techniques shown in the piece. Verbal instructions which evoke a hoped-for result and which guide creativity are proposed, such as 'looking for overtones with bow' at bar 32, or 'looking for overtones with vibrato' at bar 36.

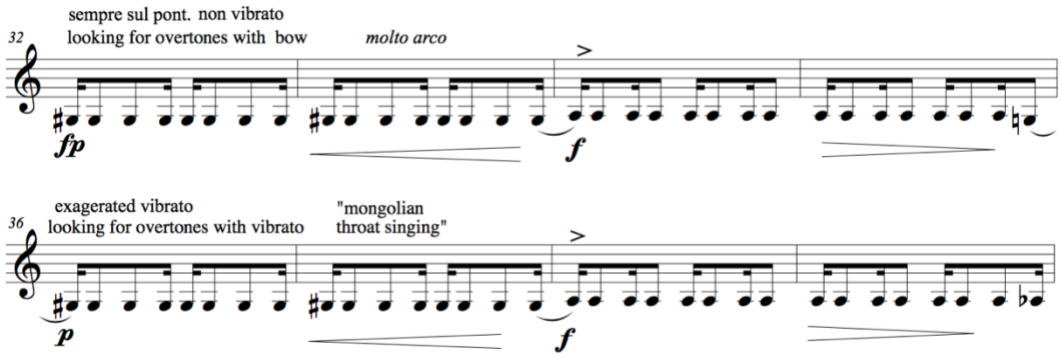

Figure 7: *Skating*, bars 32 – 39 (video 7)

Inspiration

The title *Skating* came to me from the agreeable sensation of liberation felt when escaping the usual frictional resistance of the string by releasing the pressure on the bow and gliding over the string near the bridge. It gave me the impression of skating at great speed over a frozen pond, sometimes biting into the ice to change direction (heavy bow) or suddenly braking and producing a shower of ice particles (double trills). In contemporary techniques, the temporary dissociation of the three components of bowing mentioned above opens the door not only to new sounds, but to new physical sensations, in this case the exhilarating freedom of a skater.

Satellites movement n° 2: Spectral Sunrise (video K)

To conclude this chapter, I briefly point out the use of some spectral techniques which helped inspire the string quartet movement *Spectral Sunrise* (video), again emphasizing the fact that the individual players have final control over the detail of what they play, the composer giving only general outlines. This corresponds to the spectral way of treating sounds as living things so that their apparition, their presence and their disappearance has an organic nature.

There are three passages in this piece that are based on the idea of opening up and revealing the spectrum of one note. This idea, already explored in detail in the solo violin pieces, is developed further here by taking advantage of the wider resources of the string quartet to produce a composite sound combining the four instruments. The 'opening' of a note in this piece represents a musical 'sunrise', with increasing luminosity, vibration and intensity. Each of these chosen notes corresponds to one of the open strings of the instruments, and the harmonic spectrum of each note is filled out, explored and brought to life by different types of activity.

In the passage below (Fig. 8), the first of these 'sunrises', the note D is the fundamental, played repeatedly by the cello with micro-variations: changes in vibrato, pitch, intensity, bow contact and position, all of which bring out different aspects of the spectrum of D. The first violin performs free harmonic glissandos on the middle two strings (D and A), which produces the natural harmonics of

these two notes in a fairly random manner. As there are no 'wrong notes' possible in this kind of *balayage*, the first violin is encouraged to be as free and creative as possible, both rhythmically, timbrally and dynamically, and with the added instruction to move the bow from the D string to the A string and back '*a piacere*' following his or her artistic instincts (video).

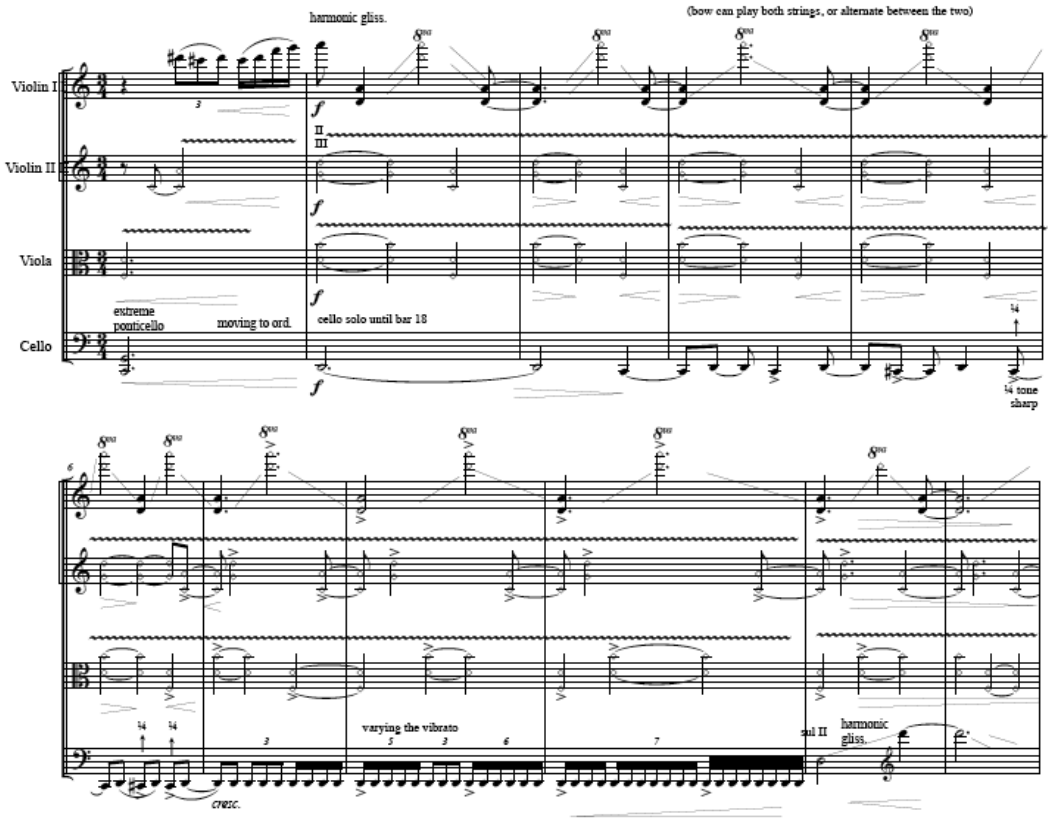

Figure 8: *Spectral Sunrise* for string quartet, bars 8-18 (video 8)

The second violin and viola sustain 'trembling harmonics' (video), a technique already mentioned above when discussing *Up above*. This gives the impression of the inner vibration of the harmonics, producing a shimmering halo and sometimes encouraging other harmonics of the series to sound. This is the meaning of the trill line over these parts. Thus harmonic writing and exact rhythmic notation are replaced by spectral indications that can be interpreted with great freedom by the players. The composer delegates a certain amount of responsibility to the players, in the same way that a painter may define the shape and the given colour for a large surface then leave the detail to trusted assistants in whom he has confidence.

The three pieces presented in this section, *Up above our heads*, *Skating* and *Spectral Sunrise* all came from my explorations of harmonic partials on string instruments, an investigation prompted by reflections on the differences between notes and sounds, and the timbral qualities of sounds as determined by their spectral content. These reflections and experimentations enabled me to imagine three artistic universes with their own laws and conditions, three different initiatory paths through the jungle of harmonic partials.

Baroque parenthesis

I should point out at this point that some characteristics of the piece could be seen to show an influence of the Baroque tradition. While in no way do I see myself as a neo-Baroque composer, I do admire and identify with many of the qualities of the music of that period. The non-separation of composer and interpreter, the lightness of touch, the joyous exhilaration of the playing style, the freedom from the printed page, the emphasis on resonance over projection due to the small-scale dimensions of the performance spaces in use at the time, the physically relaxed style of playing are all things which correspond to my actual music desires and practices.

The sections of the study where the 'light bow' technique is employed (for example bars 46, 50 or 54) are particularly significant in this respect. The type of physical action involved, and indeed even the sounds produced, have some relation to the historically informed performance practices used in performing eighteenth century music, especially regarding the type of contact used between the bow and the string. In this period, partly due to the nature of Baroque instruments and bows and partly to the musical taste of the times, the bow (which was lighter, and curved concavely) was held very lightly and used energetically with speed, with no real attempt to get hold of the string or to force the sound.

As Romantic tastes took over, and as larger concert halls demanded a more projected style of playing, instruments were modified accordingly and began to require a more centred bow contact with more pressure and weight being applied to the bow. As an indication of this different type of bow contact, the violinist Sheila Nelson points out that between 1600 and 1800 violin bows lengthened from an average of 15 inches to 25 inches, and that from having from 80-100 bow

hairs in the Baroque period bows today average 150-200 bow hairs (Nelson 2003:85). This strong bow contact is still the technique most generally taught today. Students become accustomed to 'gripping' the string firmly with the bow. If this is applied to *sul ponticello* we can obtain sounds in the '*ponticello pressato*' register, but a successful 'light bow' action requires unlearning this approach and learning to let go, both physically and mentally.

To emphasise this connection with historical performance practice, several features common to music from the Baroque period are included in the composition of *Skating*; for example, 'unequal' bowings (where groups of notes are bowed in asymmetrical patterns) requiring frequent retakes of the bow (e.g. bar 40).

Another example of Baroque influence would be the use of 'echo' sections where small figures are repeated with a different nuance (in Baroque music, usually loud first, then quiet). I extend this idea by repeating figures using a different timbral technique for the second figure. My use of this 'echoing' technique includes sounds produced by playing on the 'wrong' side of the bridge (bar 99 and following), a technique essential for developing the finger control necessary for guiding delicate movements of the bow in the proximity of the bridge (and also for facing up to and mastering the fear of the bow 'falling' over the bridge). No universally accepted notation exists as yet for playing the strings between the bridge and the tailpiece. For musical and pedagogical reasons, playing on these strings and getting used to crossing over the bridge is an important part of the piece. In order to reinforce the mental image of an echo, I chose to notate this using x noteheads written at the same pitch as the note that is being 'echoed', and the explanation for its interpretation is written beside its first occurrence, as in fig 51:

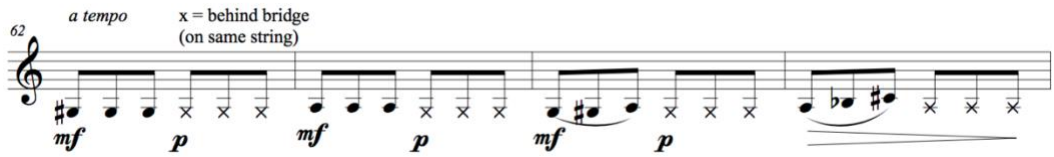

Figure 9: *Skating*, bars 62-65 (video 9)

Chapter 4

The Sounds Formerly Referred to as Noise

The previous chapter dealt with the technique of *sul ponticello* examined in parallel with the harmonic partials. It seems logical to continue in this chapter with a study of *sul tasto*, the complementary opposite number of ponticello, examined in parallel not only with the inharmonic partials (see footnote 12 on p.41), but also to the study of noise elements in general and their place in music. Although *sul tasto* is not explicitly a 'noise' technique, it does include in its execution an element of sound made by the bow that is low in pitch content and that evokes wind or breath, both of which could be considered as noise elements.

The discussion on overtones in chapter 3 shows that the 'notes' we hear being played on a musical instrument are considerably more complex in structure than they first appear. But not only do they contain numerous harmonic partials, they are almost always accompanied by another element that standard string pedagogy usually fails to take into account: noise. In this chapter, I explain to which noise or noises I am referring, how they have influenced my thoughts about music, and how by practical and personal investigation, I created two violin studies based on them.

Although the derivation of the word 'noise' itself is fairly clear (from the Greek 'nausea' which refers both to the roaring sea and to the sickness it causes), its many definitions continue to be the subject of animated (noisy) debate.[11] The musicologist Torben Sangild proposes three types of definition: one which refers to musical acoustics, a second which refers to the idea of distortion in a communication, and a third based on a subjective reaction, which classifies unwanted sound as noise (Sangild, 2002: 12-13). Not having the space here for a full-scale discussion of these definitions, I will concentrate on three types of sound containing noise elements that have relevance to our discussion here about music:

[11] Jacques Attali's book on noise (Attali:1977) is often quoted as a source, but some confusion arises from its English version, in which his original word 'bruit' is translated as 'noise', which is both inexact and problematic. A closer translation of the way he uses this word would be 'sound' in English, which can include both noise and music.

1: purposefully produced unpitched sound

2: accidental, unintentional or parasitic noises, which are part of the sound produced when playing a musical instrument.

3: onomatopoeic or illustrative noises intended to evoke or imitate external sounds of different types, such as animal noises, cannon shots, natural sounds (wind, water etc.), or human vocal sounds etc.

The scientific definition of an unpitched sound as referred to in the first category is quite complex[12]. I use the terms 'unpitched' and also 'white noise' in scores not in their scientifically exact sense, but as useful labels to convey types of sound production easily intelligible to musicians. For me, pitchless means that the noise elements of the sound are sufficiently strong as to prevent the ear from being able to assign a definite pitch to it, and I use 'white noise' to refer to an unpitched sound, which has breath-like qualities.

The second category, the 'parasitic' noises includes the squeaking sounds made by the sliding hands of guitarists, key clicks of woodwinds, breath sounds of flutists, percussive sounds of the harpsichord, and of special interest to me, the various friction sounds made by the bow when playing on a stringed instrument.

It was by the third category of sounds that noise first found its way into concert music: illustrative noises. These 'sound effects' on instruments are as old as the instruments themselves, and their inclusion in written compositions eventually opened the door to more abstract conceptions of noise.

[12] Pitch in music is the perceived frequency of a sound, allowing a listener to differentiate between two sounds by classing them 'higher' or 'lower' than each other. To have pitch, a sound must comprise a periodic wave. Pitch is a perceptual property, and factors such as intensity, distance, or presence of multiple frequencies can make the perceived pitch differ from the measured frequency. As we saw in chapter 3, a sound perceived as one note can contain many partials. Harmonic partials are frequencies that are a whole number multiple of the fundamental and their presence does not usually disturb the perception of the fundamental. However, if the overtones are inharmonic partials, that is to say, frequencies which are not a whole number multiple of the fundamental (f x 1.7, f x 3.95 etc.) then the ear has great difficulty in identifying a fundamental and assigning a pitch to it. These sounds are referred to as inharmonic. There are differing degrees of inharmonicity, the highest degrees tending towards white noise (like the hiss of an unturned radio) where all the frequencies are present in all ranges at equal intensity. Some percussion instruments, for example tam-tam or cymbals, are referred to as unpitched in common terminology, even though they do possess pitched elements.

Noise in music

String instruments were among the first to have noises specifically written into their playing scores. Percussive effects in imitation of drumming were already in use by the early 17th century, the first known example being the indication of '*col legno*' (tapping on the strings with the stick of the bow) found in Tobias Hume's *First Part of Ayres* for viola da gamba (1605). Monteverdi's '*Combattimento di Tancredi e Clorinda*' (1624) uses *pizzicato* and *tremolo* to imitate the noise of battle. Carlo Farina (*ca.*1600-1639), also used *col legno* to mimic the sound of a drum in his *Capriccio Stravagante* (1627), adding effects such as *glissando*, *tremolo*, *pizzicato* and *sul ponticello* to produce imitations of animal noises (cats, dogs, chickens). Heinrich Franz Biber in his *Battaglia* (1673) added to these techniques the novelty of placing a sheet of paper under one of the strings of the double bass, to imitate the rattle of a snare drum and asked for *pizzicato* to be played fortissimo to represent the snap of gunshots.

The increasing noisy sounds of industrialisation found their way into music in the early twentieth century through percussion instruments that imitated factory noises, shiphorns, and trains. The theoretical leap that led to the first experiments of 'abstract' or 'pure' noise music, was provided by Luigi Russolo in his 'Art of Noise' (1913). In this manifesto, he announces the end of conventional musical instruments, proposing to replace them by his 'intonorumori' instruments (noise machines). Russolo wanted to produce new aural emotions 'not by incorporating a succession of life-imitating noises but by manipulating fantastic juxtapositions of these varied tones and rhythms' (Russolo 1913).

The 1920s saw a multiplication of the number of pieces that included industrial noise, from George Antheil's *Ballet Mécanique* (1923) (whose instrumentation included 16 pianos, 3 airplane propellers and 7 electric bells) to Sergei Prokofiev's ballet *Le pas d'acier* (1926), culminating in the music of Edgar Varèse, considered by many to be the father of 'noise music'. In 1931 Varèse composed *Ionisation* for an ensemble of thirty-five unpitched percussion instruments, which he described as 'a study in pure sonority and rhythm'. He also introduced the notion of defining music as organised sound, asking even 'what is music but organized noises?' (Varèse 1966).

In the 1940s Pierre Schaeffer introduced his 'musique concrète' based on the idea of recording and manipulating everyday sounds in order to use them as the building blocks of a sonic art form (*Cinq études de bruit* 1948). John Cage in his *Sonatas and Interludes for prepared piano* (1948) effectively replaced certain notes on the piano keyboard with noise. In his writings, he further eroded the frontier between music and noise saying in his lecture entitled Indeterminacy:

> Finally I said the purpose of this purposeless music would be achieved if people learned to listen; that when they listen they might discover that they preferred the sounds of everyday life to the ones they would presently hear in the musical program; that that was alright as far as I was concerned.

Applying a more mathematical approach to composition, Iannis Xenakis used stochastic calculations (normally used to model natural phenomenon such as the song of cicadas in a field or the collision of rain with hard surfaces) to produce the unconventional timbres of *Metastaseis* (1954) with conventional instruments. In Karlheinz Stockhausen's *Momente* (1962), the members of the four choirs clap their hands, shuffle their feet and talk in order to make the link between noises produced by the audience and those produced by the performers. One of today's leading composers, Helmut Lachenmann, describes his music as 'musique concrete instrumentale'. He uses conventional orchestral instruments to produce highly controlled, refined and organised noise (*Mouvement*, 1984). There are presently several different currents and styles that are referred to as 'Noise Music' both in the classical field (Peter Ablinger) and in the more popular fields of jazz and rock (Merzbow).

My own use of noise

In my own works, I consider that noise elements are an important component of timbre and provide material which is useful for adding a rougher, physical, naturalistic element to a piece of music which may otherwise appear too polished or neutral. The types of noise which interest me most, and which I have developed in my *Violin Spaces*, include the small apparently accidental and parasitic noises produced by instruments and instrumentalists when performing music. In the case of the violin, these include the sliding noise of the left hand, the percussive

sounds produced by *pizzicato*, especially in the left hand and above all the noise produced by the friction of the bow hairs when playing any part of the instrument (including the strings). These sounds are for the most part unpitched, although they can often be judged to be 'higher' or 'lower' in relation to another unpitched sound. Pure white noise is rare, and most noise can be considered to have some kind of relative pitch-spectrum. It is thus possible to preserve the notions of 'rising' and 'falling' figures, while completely doing away with identifiable pitches. Indeed, in noise music, most of the basic musical gestures can be conserved, even though the musical vocabulary has been fundamentally altered.

My pedagogical strategy here aims to enable the player to manipulate noise elements as musical material, by putting her in a context where these are the only sounds available, and inviting her to construct some kind of categorization or hierarchy of sounds, no matter how basic. Thinking in terms of the sounds themselves, and comparing them with each other is the key to using them as expressive elements.

Having decided to use noise as the basis for a composition, I began by making myself very aware of these sounds and by listening to them first in a very open way. This means temporarily suspending the mental filter which blocks out 'undesired' noises, and resisting the labelling process, by which the brain assigns a probable source and a value judgement to each detected sound. Delaying this process allows the qualities of the sound to be heard as potential music. Decisions can then be taken as to which elements of the sound are deemed to be useful and which are not. Finding strategies which focus the attention on these 'parasitic' sounds allows them to be developed as musical elements 'per se', and provides an enriched vocabulary of sounds, one which was already present but subjacent in the CPP context.

Accidental, 'parasitic' noises provide clues as to how to exploit the natural sounds of the instruments and their potential for producing noise 'on purpose'. The white noise element of the bow sound for example can be isolated from the pitch produced by the string simply by bowing on areas other than the string (e.g. the body of the instrument). The slightly crushed sound produced by an accidental excess of pressure on the bow can be reproduced and amplified by consciously increasing pressure and learning to control the noisy distortion sounds which

result. The same applies to noisy bow attacks and to left hand finger sounds on the fingerboard.

In the two *Violin Spaces* that deal with noise I took two very different approaches. In *No pitch, no problem* the noises are treated as abstract sonic elements to be combined among themselves without any outside reference. In *The Raven*, I used the poem by Edgar Allen Poe as a backdrop, in front of which I use noise elements, which can be seen to have a relation to the atmosphere of the poem (breathing sounds, flapping wings, knocking on the door). No attempt is made to tell the story of the poem, the poem simply allows me to bring together these elements, which then follow their own musical discourse. Inevitably, the reference to the poem changes the way people listen to the sounds, and this is part of my conscious strategy to give the listener a context in which they can relate to noise.

Violin Spaces n° 3: No pitch, no problem (video C)

The number and variety of noises that can be produced on a violin are practically infinite. In this study, I chose to concentrate on only three types of noise, and in each of these types to use only a few carefully chosen examples.

1: percussive noises produced by striking the strings, with the bow or with the left hand. Noise can be produced by striking any part of the instrument, but to avoid any issues of potential damage to instruments, or inhibition because of this fear, I use only sounds produced by striking the strings.

2: white-noise type sounds (unpitched sustained hissing noise), produced by bowing on the body of the instrument, or on the bridge itself, without touching the strings. A variant of this is to play on the strings while they are damped by the left hand, or to play on the part of the string behind the bridge

3: distortion type noises, produced by bowing on the damped strings using overpressure on the bow. This is explored in two different directions – one in the normal bow direction (at right angles to the string), the other following the direction of the string.

To enable the player (and the listener) to grasp the nature of each sound and to begin to imagine a grammar of noise combinations, the characteristics of each sound produced is compared and contrasted with other sounds from within the same group. This is a conscious strategy to give the player some basic notions of noise classification. For example, in group 2 (see figure 10), the notes marked 'ribs' are played on the side of the instruments (the ribs) and the others on the corner of the bridge, without touching the strings. These two 'white' noises can be classified by their differences – the rib noise sounds lower than the bridge sound, which appears high by comparison, thus introducing a simple high-low category separation between them. My choice of notation (rib sound is notated lower on the stave) reflects this difference, and helps to visualise it.

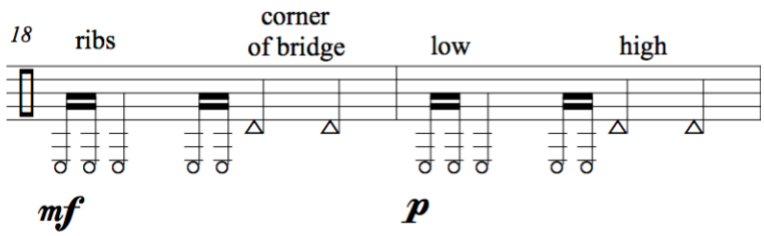

Figure 10: *No pitch, no problem*, bars 18-19 (video 10)

These sounds, because they are produced by the movement of the bow remaining in contact with the instrument, can be sustained or stopped at will, giving another method of distinction – short or long:

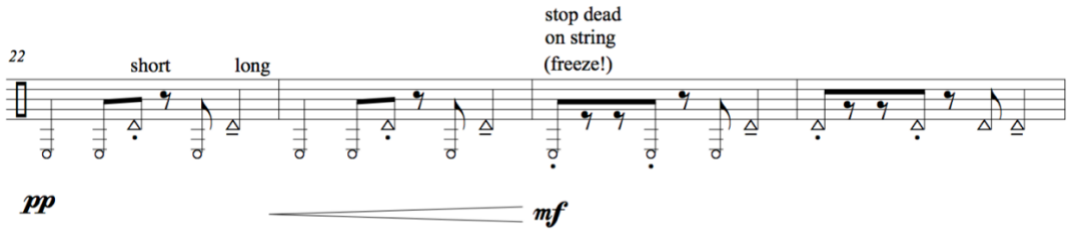

Figure 11: *No pitch, no problem*, bars 22-24 (video 11)

In the first noise group, the percussive sounds, the left hand has only two actions to perform: either to close on the string in a 'slapping movement', which damps the string and produces a percussive sound of hand against fingerboard, or

to open suddenly, plucking all the open strings at once (this of course produces the pitches of the open strings, but these are the only pitches in the piece and they are invariable, they can also be considered as noise). The sound produced by the closing of the hand can be described as 'dry' (a short, suffocated sound) and the sound produced by its opening as 'wet', which in acoustic terms means a sound which rings for some time after its initial attack

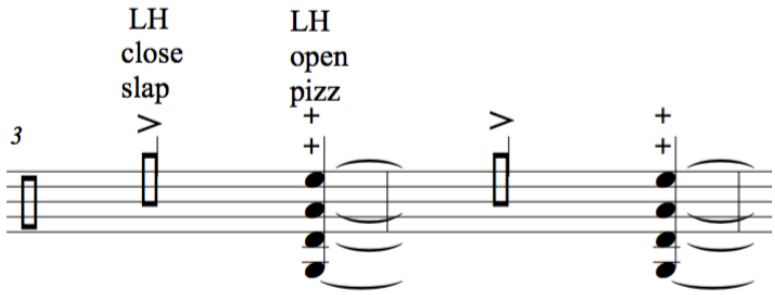

Figure 12: *No pitch, no problem*, bars 3-4 for the left hand only. (video 12)

In the third group, the distorted sounds, the two bow directions produce radically different sounds. Moving the bow across the string at right angles with overpressure crushes the sound in a fairly constant manner, producing a gravelly distortion which is quite regular. Moving along the string, the 'sideways crush', which I also call 'frogsong' gives a thinner band of sound and because of the changing length of the vibrating string appears more 'melodious' or 'expressive': the contrast here could be called harmonic (frogsong) against inharmonic (crush bow)

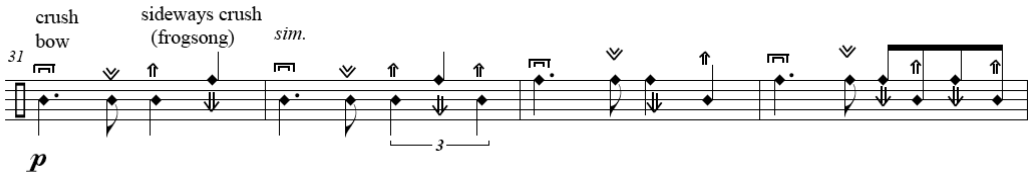

Figure 13: *No pitch, no problem*, bars 31-34 (video 13)

The small detail of noise production cannot be totally transmitted or controlled by written notation, so my strategy is to supply the players with the raw materials for the noises I imagine, to invite them to make category distinctions of a low order, and then to let them construct and play the piece according their

own creative imagination. I say 'construct' because not only are there groups of bars which are to be repeated an unspecified number of times, the choice being left to the player, but in the final section the players are invited to combine the modules proposed in the order they like and to introduce variations of sound, dynamic and rhythm – in short, to improvise on the material presented and to make their own piece out of it. The piece concludes with a three-bar coda.

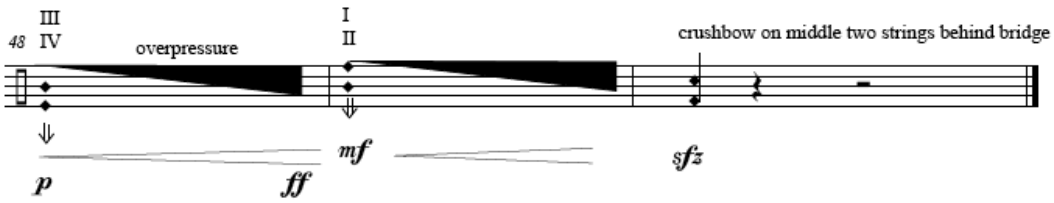

Figure 14: *No pitch, no problem*, bars 48-50 (video 14)

Violin Spaces n° 4: The Raven (video D)

This piece was inspired by my investigations of an already existing string technique called *sul tasto*. *Sul tasto* is an opposite and complimentary effect of *sul ponticello,* a technique explored at length in chapter 3. The words *sul tasto* in Italian mean literally 'on the fingerboard', meaning to place the bow on the part of the string that is over the fingerboard. By placing the bow in a position like this, far from the bridge and near the middle of the string, the string's natural vibrations are inhibited and high harmonics are suppressed, producing 'a very hollow sound'[13]. The fundamental sounds less present and the listener becomes more aware of some of the 'parasitic' noise sounds that are generated in the act of playing an instrument.

[13] Just as *sul ponticello* has evolved into a technique that is much more complex than that described by Ganassi, the technique of *sul tasto* has also been greatly developed. There are a variety of sounds that are available with *sul tasto,* depending on the precise point at which the bow makes contact with the string and how it is drawn across the string. Young's Law must again be considered because of the possibilities of amplifying or suppressing certain harmonics in the spectrum. The curve of the bridge and the placement of the nut effectively cut out the even numbered harmonics when the bow is placed over the fingerboard. This spectrum is a characteristic of an electronic square wave, which is often described as an 'extremely hollow sound.' (Strange 2001:84)

The most obvious of these unintentional noises is the white noise sound made by the bow as it strokes the string. This sound is always present but is usually 'covered' by the pitched sounds and has generally been considered impure or uninteresting, thus ignored. When attention is drawn to this sound, the resemblance to wind/wave sounds and to human breath is striking. Bringing out this quality in a pitched note is called *flautando* (literally, 'like a flute'). The breath noise itself can be isolated and produced without pitch either by playing on the strings while damping them with the left hand, or by playing on the body of the instrument. The types of white noise produced by these two techniques are sufficiently distinct to make a written dialogue between them musically interesting, as in bars 13-15 (video). The conventionally notated melody as in bars 9 and 10 is to be played extremely flautando with the bow, and fingered very lightly with the left hand so as to produce a pitched sound which is full of breath noise (video)

These techniques produce three basic types of sound which can be classified as follows:

1: white noise produced by playing with bow on body of violin.
2: white noise containing elements of relative pitch produced by playing with bow on string blocked by fingers.
3: *flautando* pitch containing elements of white noise produced by bowing *sul tasto* on lightly fingered string.

During the improvisation/exploration stage of preparation for this study, I was struck by the very evocative nature of the sounds produced by the bow, like breathing or even whispering, and the ghostly, otherworldly aspect of the sound. I intuitively thought of the poem '*The Raven*' by Edgar Allen Poe, and wondered if this could serve as a launching platform for the piece. The dark night, the faint tapping on the door, the flapping of the wings, the supernatural atmosphere, all of these could be turned into expressive musical elements, not as direct illustrations of the narrative of the poem, but as coherent components of a musical universe.

Having opened the door to a poetic interpretation of the sounds, I felt that the actual breath sounds produced by the player could be a part of this universe,

providing a fourth type of sound. The breathing sounds made by a player are usually unmentioned and ignored, so to give them real existence I notated some audible breathing sounds on a second stave (see Fig.15 below). In this way, the first sounds made with the bow (bar 2, played on the body of the instrument) emerge from the breath sounds, clearly establishing their inseparable nature. Here the performer is not merely 'executing' the piece, she literally embodies it, 'breathes' the music and has a direct physical and psychological relationship with it. The piece immediately takes on a theatrical aspect. At the same time, the act of writing down the breathing sound with musical notation allows it to be controlled, shaped and timed so that it becomes an integral part of the composition.

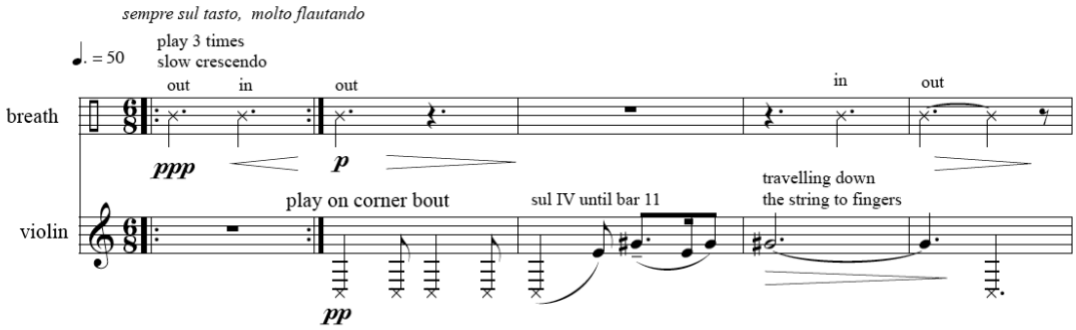

Figure 15: *The Raven*, bars 1-5 (video 15)

White noise is usually defined as a sound that vibrates at all the frequencies, thus making it impossible for the ear to identify a fundamental pitch. But it is rare to find such an evenly distributed signal. Usually noise emits signals in many frequencies but not all, and can be assigned relative values such as high or low or at least higher or lower than another sound. When sound engineers use filters to remove or reduce parts of the spectrum of white noise, they use terms such as 'pink noise', 'blue noise' etc., according to which bands of frequencies are involved. This idea is also explored in *No pitch, no problem*, but here it is taken further as the left hand can control the relative pitch of the blocked string. For example, in Fig.16 below, all the strings are blocked by the left hand, but the lower strings give a clearly lower sound than the higher ones, and this relative pitch can itself be altered by moving the 'block' of the left hand to a higher or lower position.

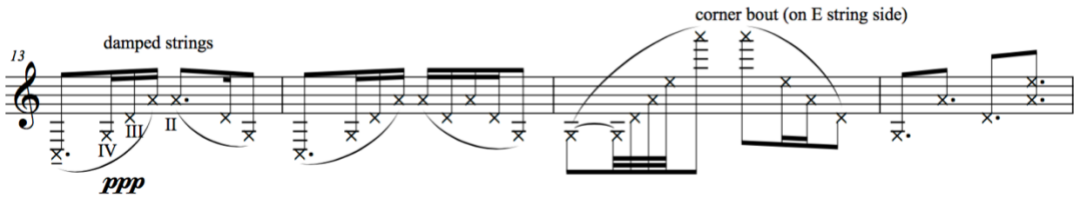

Figure 16: *The Raven*, bars 13-16 (video 16)

At bar 18, the bow noise begins a regular breathing rhythm, while a finger of the left hand taps on the body of the instrument (see Fig.17). This represents the Raven's beak tapping on the window; at the same time, it constitutes an answer by the left hand to the action of the right hand. Just as the right hand is performing its habitual action (drawing the bow) - although in an in-habitual place (on the body of the instrument) - the left-hand finger also performs its normal function (tapping downwards), but it is placed on the body of the instrument, instead of on the string and so produces an unpitched percussive sound.

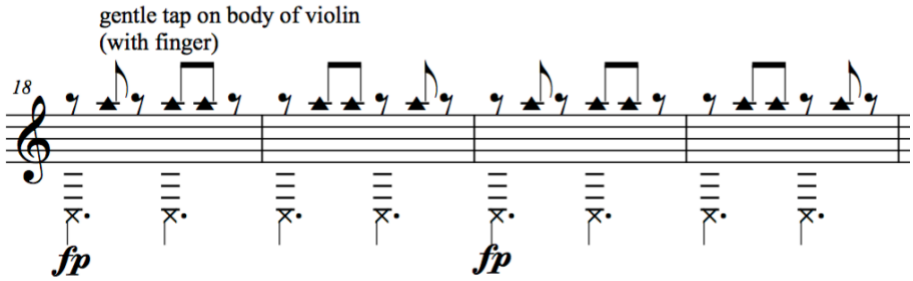

Figure 17: *The Raven*, bars 18-21 (video 17)

Playing on the string so far away from the bridge means the string is less tight and can even become fragile. Increasing the bow pressure on it quickly produces saturation noises; the overpressure employed in bars 28 and 30 as seen in Fig.18 exploits this effect. This is again an effect hard to quantify or to notate, the performer will have the responsibility of controlling the sounds to ensure that they correspond to the musical context and dynamic.

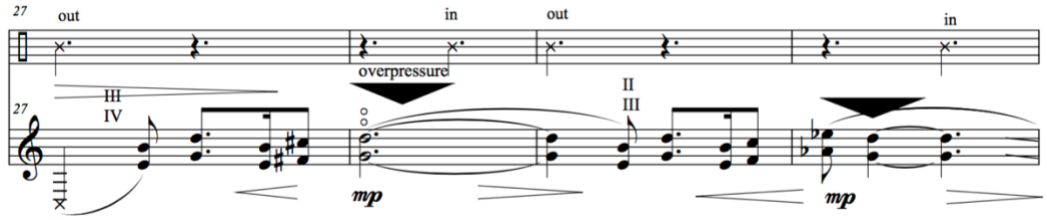

Figure 18: *The Raven*, bars 27-30 (video 18)

Building on the idea of 'pitched noise' first mentioned in relation to bar 13 above, bar 44 (bottom stave) as seen in Fig.19, features a rising scale played by bouncing the bow hair against the side of the instrument, slowly moving towards the point of the bow, gradually shortening the length of hair which vibrates, with the effect of raising the pitch (using the bow hair as a string). Here, exact pitches would be extremely difficult to reproduce, but a rising 'scale' of relative pitches is easier, more interesting and more fitting musically.

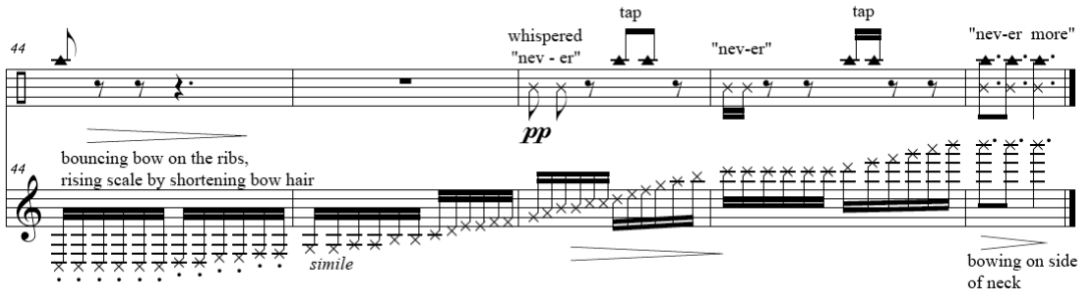

Figure 19: *The Raven*, bars 44-48 (video 19)

In the last bars of the piece, shown in Fig.19 above, the whispered voice of the player is introduced, saying the only word pronounced by the raven in Poe's poem, 'nevermore', which alternates with the finger tapping. This word is the source of all the rhythms used in the finger tapping sections. Again the performer embodies the piece, which breathes and now speaks through hers, and she has gained a dramatic presence that goes far beyond the mere action of executing the instructions on the page.

My strategy for leading a CPP trained violinist to engage with noise elements begins by placing the performer in the central position of a theatrical situation, in which she is both the protagonist and the principal listener. It obliges

her to treat the natural sound of her own breath as a musical sound because it is notated it on the page, inviting her to 'perform' her own breath as an artistic action. Then she is encouraged to mix with this the noise-rich breath sounds which the bow is capable of producing when manipulated in a certain way. And finally she makes pitched notes clothed in clouds of white noise appear out of this texture. This last step calls on the existing familiarity with the technique of *sul tasto* and builds on this pre-existing knowledge.

Experimentation with unpitched and percussive sounds on string instruments leads to the realization that there is no dividing line between music and noise, nor fixed definitions, only a scale of degrees governed by the prevailing fashion of what is acceptable in music of a given period. Melody and harmony, so long considered basic essentials without which music could not exist, in today's context prove to be no more than possible elements, available for use in musical composition, but far from being indispensable. As Luciano Berio once remarked 'music is everything we listen to with the intention of listening to music, and anything can become music.' (Berio 2006: 49).

Chapter 5

Strings are not Keyboards

For several centuries, conventional European music theory and composition has been dominated by keyboard instruments, especially the piano, to the point where many musical gestures and techniques which would be natural on a string instrument, but which are difficult or impossible on a keyboard, have been ignored or tacitly discouraged. Even the pedagogical methods used to teach string instruments and the conception of left-hand technique are strongly influenced by the keyboard. I show in this chapter how keyboard orientated notation and the technical limitations of keyboards have inhibited experimentation on string instruments in many areas, bringing my focus to bear especially on two specific techniques; microtones and sliding. The two studies that I present here are a concrete attempt to redress the balance, being specifically conceived as creative explorations of these two invaluable string techniques.

The limitations of keyboard instruments

A key on a wind instrument is a mechanical aid for the finger to cover a hole, whether some lever-like device which closes a hole too distant for the finger to reach, or a pad which covers a hole which would otherwise be difficult to cover comfortably with the naked finger. On these instruments, the keys are integrated among the holes which are directly closed by the fingers. They are fitted on the body of the instrument and can be used, or not used, as the case requires. On instruments where all the notes are played by means of keys, the keys are grouped together in an orderly pattern, forming a keyboard, which becomes the principal interface between the player and the sound produced.

The technical innovation of having a keyboard yields many advantages, but also imposes some important limitations, especially on stringed keyboard instruments such as the piano. Firstly, a keyboard is designed to play pre-selected, pre-tuned discreet notes, which means that it can only play the scale it is tuned to, and each note will have a constant tuning, whatever its musical context. Secondly, it usually means that making the pitch slide upwards or downwards once the note

is played is not possible (although there are exceptions, and some specially designed twentieth century keyboards for electronic instruments do have this possibility). There are other important limitations, such as the inability of most stringed keyboard instruments like the piano to get louder or softer while sustaining a note, but I will concentrate here on the techniques of microtones and sliding.

The dominant notation system is inevitably used in teaching music to beginners on all instruments and this means that the young apprentice violinist of today is taught a system which implies that a string is divided into a series of discrete 'notes', separated by bands of forbidden areas which are 'wrong' and therefore to be avoided. The simple truth is that string instruments are continuous pitch instruments. There is no point on a string which does not produce a pitch and our projected divisions of tones and semitones onto it are merely conventions adopted from instruments which by their physical nature have to make quantum divisions of pitch, notably keyboards.

String playing in other cultures

In folk music, perhaps precisely because it does not rely on notation, discreet notes, 'correct' tuning and techniques aiming to move cleanly between one note and another note are not seen to be positive factors in expression. In many extra-European cultures, notably classical music from the sub-continent of India, string instruments are used to imitate the voice, especially the sliding melismatic intonations so characteristic of many Indian singing styles. Consequently, in these cultures techniques have been developed which involve playing many contiguous notes with the same finger, sliding freely between them. Their scales divide the octave into many intervals which differ from ours, and they freely employ microtones of great subtlety and refinement. All of these ideas can be seen as refreshing inspirations for enriching our relatively limited European 'classical' vision of the use of string instruments.

The 20th century

Partly as a result of coming into contact with extra-European music, and partly as a realisation of all the musical possibilities offered by other sound sources,

innovative music unsuitable for keyboards began to appear progressively throughout the twentieth century. The cellist Rohan de Saram, in his *Conversations* (2013), defines the beginnings of contemporary music in the 20th century as the moment when pieces appeared which simply could not be performed on a keyboard, and adds:

> It would hardly be possible to perform, for example, a score of Xenakis, Lachenmann or Sciarrino on the keyboard, unless specifically written for a keyboard, whereas it would be possible to realise on the keyboard all the works by any of the classical composers, right up to the time of Stravinsky, Bartók or Schoenberg. (Steinheuer&De Saram, 2013:175)

In this context, I will now explain the background, methodology and addition to knowledge of each of the two *Violin Spaces* presented here, which are based specifically on two non-keyboard techniques, sliding and microtones.

A short history of *glissando*

It would be wrong to say that sliding between notes does not exist in classical violin music. It is used, and even has its own Italian technical term - *glissando*. But despite clear historical evidence (fingerings in manuscripts and contemporary commentaries) which show that it was widely employed in the 18th and 19th centuries, as well as numerous phonograph recordings from the early twentieth century featuring violinists who slide freely and expressively (for example Fritz Kreisler performing his own *Liebeslied*, recorded in 1930, which can be heard on YouTube), it is used very little in present day interpretations of classical music. It is often considered to be in 'bad taste' or too romantic. The Historically Informed Performance (HIP) movement in the 1960s and 70s 'cleaned up' some of the excess of over-romantic interpretations of Baroque music, but over-zealous application of this 'cleanliness' made musicians reluctant to slide. More recent research is slowly re-authorising slides in certain repertoires. But even in cases where sliding is employed, it is usually taken to mean sliding from one note to another – crossing this forbidden territory 'between' the notes to arrive safely on a 'real' note on the other side.

In contemporary music, the situation has evolved greatly. Here sliding is considered a valid expressive tool, whether it be from one note to another, or as an end in itself with no precisely defined starting or finishing point, merely a geographical indication. Xenakis uses this idea to great effect in many of his string pieces, for example *Nomos Alpha* for cello (1965) or *Mikka* (1971) for violin. Glissando can be seen as a mental liberation from certain artificial limitations imposed by classical notation for string players, and also as a physical liberation from the constraints of playing in pre-defined positions and handshapes. The left hand can caress the string in a very tactile, sensual way and can let itself be guided directly by the ear instead of following a memorized hand position, or being concerned about exactly which 'note' it is playing. This makes possible a new kind of gestural music, where the movement itself takes on meaning, over and above its departure and arrival points. This type of playing is also naturally suited to improvisation. Graphic notation, where the interpreter is asked to play visual shapes, is an ideal notation for these gestures.

Extra-European glissando and the relationship with the instrument

As mentioned above, traditional Indian violinists slide frequently and freely all over the instrument. The physical freedom of movement of their left hand is greatly aided by their playing position – sitting cross-legged on the floor and supporting the instrument by resting the scroll of the violin against their foot. Our western playing position makes it more difficult to slide freely (especially downward slides) because the left hand has to play the note and hold the instrument at the same time. But this can be turned into an advantage. Studying sliding can teach us much about holding the instrument, and our contact with it. Because keyboards are generally large and immobile, a teaching system dominated by keyboard players tends to forget, deny or even suppress the physical liberty, which come naturally on other instruments. In the case of the violin, teachers insist on the virtues of holding the instrument still and applying the arms and fingers on a rigidly immobile violin, as if it was fixed to the ground. This classical purity and separation of player and instrument takes away all the spontaneity of the instrumentalist who wants to be as one with his instrument. Sliding freely on the string is an ideal technique for rediscovering this dynamic of

movement. Instead of holding an instrument and then playing on it, holding and playing are the same action. The question of the relationship between player and instrument comes up in a different way in each of the Violin Spaces, and can be seen as an ongoing fundamental reflection which underlines the entire collection of pieces.

Classification of glissando

My preliminary improvisations with glissando led to making a distinction between two types of slide on the violin:

> 1a: Small slides done by moving only the finger concerned (i.e. not moving the left arm). The intervals can be surprisingly big (up to a minor third in each direction).
> 1b: Big slides done by moving the whole left arm as a unit, in a movement similar to vibrato.

The two possible directions of the slide make a fundamental difference: Sliding upwards (in pitch) gives increased stability to holding the instrument and can be done in complete relaxation. Sliding downwards involves finding a resistance to the outwards movement of the instrument. This means using the chinrest in an efficient way.

Violin Spaces n° 5: Sliding (video E)

My study for *glissando* is called *Sliding* for obvious reasons, and it begins with a kind of 'warming up' session for each finger (Fig.20). The first phrase is played entirely with the first finger (bars 1-4), the second phrase with the second finger (bars 5-8), the third phrase with the third finger (9-12) then fourth finger plays bars 13 and 14.

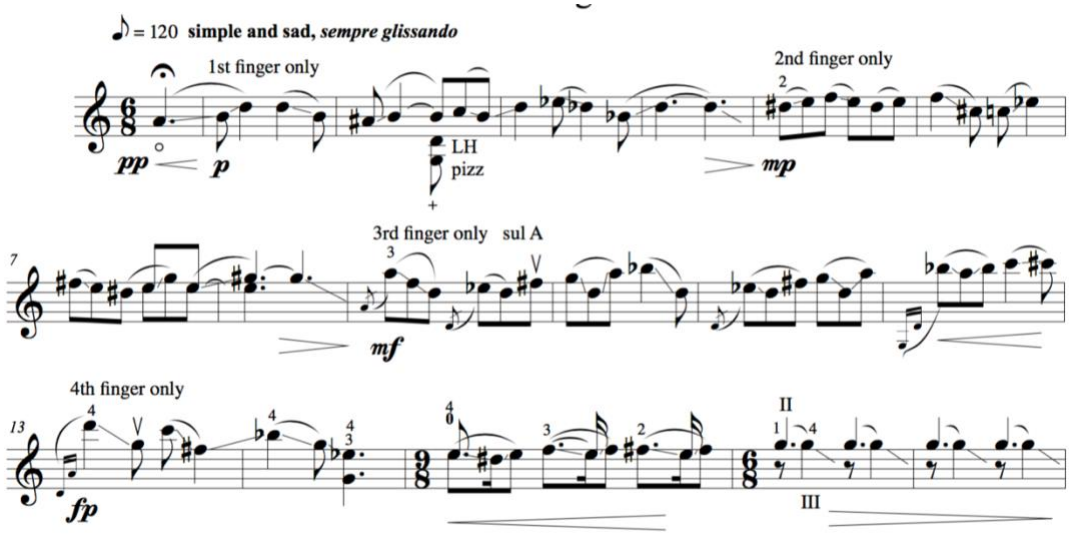

Figure 20: *Sliding*, bars 1-17 (video 20)

Although this sounds very mechanical, my improvisations revealed that the feeling of each finger on the string is very different and suggests a different way of sliding, so I took this into account in proposing the different types of movement in each phrase. This is a good example of 'thinking with the fingers'. Sliding is a way of empowering the left hand, and encourages it to play its part – an answering voice to the bow in the perpetual exchange between the hands, so important in string playing.

To explore the expressiveness of small slides performed 'inside the hand' (meaning without changing the position of the arm), bars 18 to 25 (Fig.21) propose a whole series of these, always taking an open string as a pitch reference.

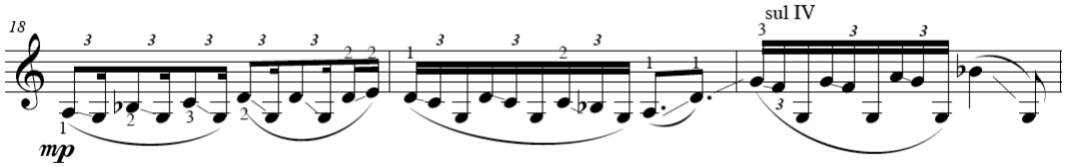

Figure 21: *Sliding*, bars 18- 20 (video 21)

I find the contrast of slides which blur our sense of pitch with the absolutely stable fixed points of the open string richly evocative and appealing on an instinctive level. A similar effect is used in the passage from 25 to 27 (Fig.22), where a note is played 'unison' across two strings, and referenced to the repeated open E string.

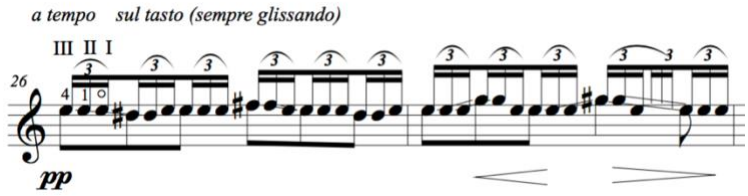

Figure 22: *Sliding*, bar 26-27 (video 22)

Another action I judged to be successful in improvisations was sliding continuously with the left hand over several strings, broken up and 'highlighted' by the bow, and this is shown in Fig.23, across two strings:

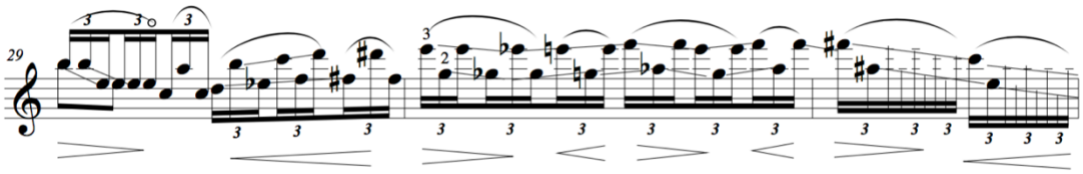

Figure 23: *Sliding*, bars 29-31 (video 23)

In figure 24 an example of sliding across four strings is shown.

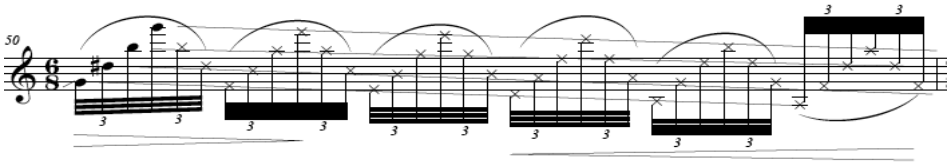

Figure 24: *Sliding*, bar 50 (video 24)

Finger substitutions (meaning sliding one finger into the place of another while playing) show the expressive possibilities of a single note, as in Fig.25:

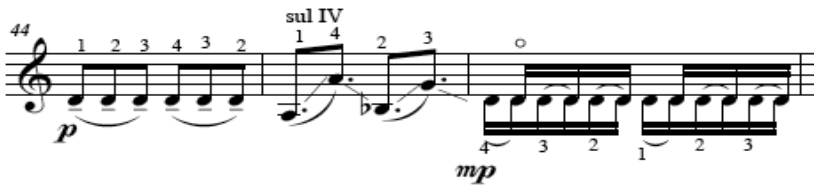

Figure 25: *Sliding*, bars 44-46 (video 25)

At bars 49 and 50 the main theme is cited again, this time in the lower octave on the bottom string, which allows thicker, more grainy slides, and the piece finishes with the same note being played on each string in turn, exploiting the entire register of the violin and giving an impression similar to the engravings of M.C. Escher which show perpetual ascent which goes nowhere.

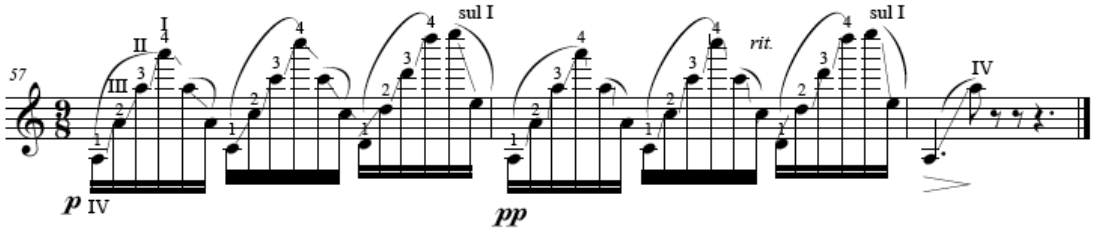

Figure 26: *Sliding*, bars 57-59 (video 26)

Glissando is one of the techniques where it is almost impossible to convey the small detail of what a composer may wish (speed, curve, intention) by written notation. The best possible solution would be to create the musical context where the function of the *glissando* is clear and to notate the intention to slide, leaving the musical responsibility to the interpreter. For example, looking again at the opening bars of *Sliding* as seen in Fig.20, a simple sentimental tune is written with *glissando* lines and an instruction to play the entire phrase with the first finger. Even though this line is absolutely straight and lacks the richness of a hand-drawn line, it plays an important part in 'authorising' the players to slide; its very abstraction gives them confidence in their own personal interpretation of the piece. When sliding over all four strings I use four lines (one for each string) to show that each 'voice' continues even when the bow has moved to another string. This notation in effect shows the action of left hand (a continuous downwards slide). The noteheads and crosses indicate when each string is heard without indicating exactly what pitch will sound:

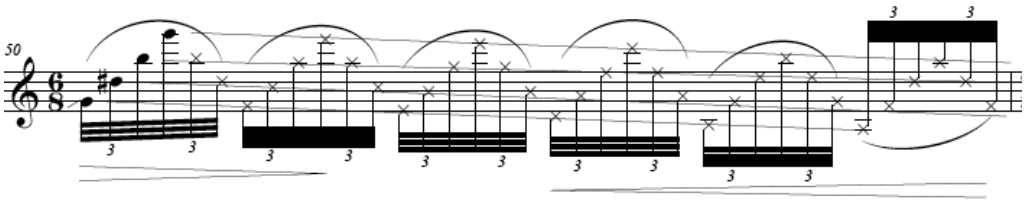

Figure 27: *Sliding*, bar 50 (video 27)

Violin Spaces n° 6: Microtonal Blues (video F)

Microtonal Blues addresses the issue of microtones. We saw in chapter 3 on overtones that the tuning of certain natural harmonics is very different from the tempered tuning system of the piano. String instruments have the possibility of reproducing these exact pitches. In fact, string instruments can produce any imaginable pitch, and can divide an interval into any number of equal or unequal parts. The limits here are not technical, they are perceptual. It is our hearing capacity that defines the size of the smallest interval.

Temperament in music

There is a scientific case for thinking that the octave is a natural interval, given that the ratio of the frequencies of two notes an octave apart is a perfect 2:1, and it is no surprise to find this interval almost universally recognised across cultures. An octave is a very large interval, so naturally there is a need to divide it into smaller ones, and this is where the consensus starts to break down, each culture finding its own solutions. In classical European music, the octave is divided into twelve semitones, but the exact tuning of these semitones is still a subject of lively debate. Pierre Francesco Tosi, the renowned Italian singing teacher of the 18th century wrote in his influential *Opinioni dei Cantori* (1723):

> Not everyone understands that there is a major semitone and a minor semitone, because the difference cannot be demonstrated on an organ or harpsichord if it doesn't have split keys (in Duffin 2007:48)

The problem of temperament is a huge subject, which I cannot explore fully here for reasons of space, but putting it extremely briefly, there is a mathematical contradiction between using the 'pure' intervals of scientific ratio, and making all these intervals fit into an octave[14]. In the eighteenth century, in the historical

[14] The easiest example to grasp is that while the octave represents a ratio of 2:1, the pure fifth is in a ratio of 3:2. If we tune a series of twelve fifths to this ratio (say starting on an A and tuning a note one fifth higher each time) we should get to a note (A) exactly seven octaves above our original note. If we play seven perfect octaves upwards from the low A, we would expect to arrive on exactly the same note. Checking the mathematics behind this, we see that seven octaves = (2^7) = 128, but twelve fifths = $(3/2)^{12}$ = 129.746, which gives a note exactly one 'comma' (see glossary) higher than the pure octave calculation.

context of the Enlightenment, when scientific systems were established to rationalise nature, the system of 'equal temperament' was devised to solve this problem. Bach gave this solution its defining masterpiece by writing his *Well-Tempered Clavier* (1722), which includes pieces in all of the 24 keys. This collection of pieces is often considered to be one of the great founding pillars on which classical European music rests. And as the cellist Rohan de Saram points out:

> without equal temperament, the particular type of harmonic language which has been at the very heart of Western music in all its manifold expressive and structural possibilities since the time of Bach could not exist. (Steinheuer & De Saram, 2013:175)

Thus the system of equal temperament brings great advantages, but as always, this comes at a price. Equal temperament tries to hide the problem of tuning described above by distributing the small discrepancy of the extra comma among all the notes, so each one is only compromised by a small amount, but they are nonetheless compromised. The instruments most concerned by this development are the keyboard instruments, because they have no way of altering their tuning when changing key, and because of their great range, combined with their potential of being able to play in all the keys. Melodic instruments that can adjust their tuning on a case to case basis, like string instruments, have no need of this compromised system, and can use 'purer' intervals. Indeed, for violinists, equal temperament is counter-intuitive and goes against the natural possibilities of the instrument, but because of the overwhelming dominance of keyboards, they have been obliged to adopt it, at least when playing with keyboards. It remains however, a constant source of difficulty and disagreement.

A short history of micro-intervals

In spite of the difficulty of fixing the exact size of a semitone, some composers of the twentieth century proposed to divide these semitones still further, into quartertones. In this case, what I have up until now been treating as the keyboard's weakness (its pre-determined tuning) becomes its strength. Ivan Wyschnegradsky (1893–1979) had a quartertone piano constructed specially for

himself, and he composed many works using quartertones, notably the *Twenty-four preludes in all the tones of the chromatic scale diatonicized with thirteen sounds* (1934) for two pianos in quarter tones. He also published a *Manual of Quarter-tone Harmony* in 1932. Béla Bartók was also interested in quartertones, but more from the folk music aspect, and he included them in the cadenza to the first movement of his *Second Violin Concerto* (1938), employing them as expressive deviations around a central note. He also included quartertones in the last movement of his *Sonata for Solo Violin* (1944), but after consultation with Yehudi Menhuin, the dedicatee, he made an alternative version without quartertones. György Ligeti used microtones derived from the harmonic series in the first movement of his *Sonata for Viola* (1994). I mention these examples in order to identify four different ways of using microtones in composition:

1: division of the octave into 24 quartertones (Wyschnegradsky)
2: expressive microtones or folk tuning (Bartók in the *2nd Violin Concerto*)
3: harmonic tuning (Ligeti in the *Viola Sonata*)
4: scientific divisions using cents

My approach to microtones in *Microtonal Blues*

On a string instrument, playing each of these microtonal systems implies using a different technical approach, so I decided to construct a piece that touches briefly on each one of these approaches in turn. Thinking of the pedagogical aspect of my work, I looked for a starting point, a first microtone that could be grasped easily by non-specialists and upon which I could build. There are no written microtones anywhere in standard classical music (which of course does not mean that they were not used in actual performance), but everyone is familiar with the 'blue' notes in jazz, which are usually placed about halfway between the major third and the minor third, giving a quartertone. I decided to include this in *Microtonal Blues,* as can be seen on the first note of bar 18 in Fig.28:

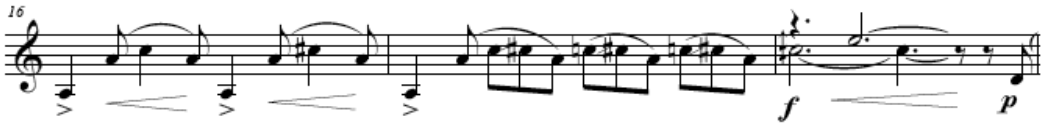

Figure 28: *Microtonal blues*, bars 17-19 (video 28)

Taking this already existing shared knowledge of at least one microtone as a starting point on which to build, I chose a blues tempo for the piece (bars of 4/4 with a sense of swing) to make the most of this colour. This clear musical context facilitates the placing of the 'blue' notes in a natural way. The feeling of swing is very useful in marking out a sense of inevitability about where the music is going and makes it possible to aim for an exactly-pitched arrival point well in advance. This proved to be very useful for my strategy of dividing intervals both spatially on the fingerboard and aurally.

Having chosen a basic style for the piece, I explore in the first part the idea of dividing an interval into equal parts. First a whole tone (from E to F sharp), is mentally divided into four parts by playing the E on the first beat of the bar then incrementally raising the pitch of the note by one quartertone on each beat (see Fig.29) reaching F sharp on the first beat of the next bar (the note A fulfils the function of a bourdon and a stable harmonic reference). Rhythmically, this means that the whole tone (E to F#) is timed to be completed exactly on the arrival of the first beat of the next bar.

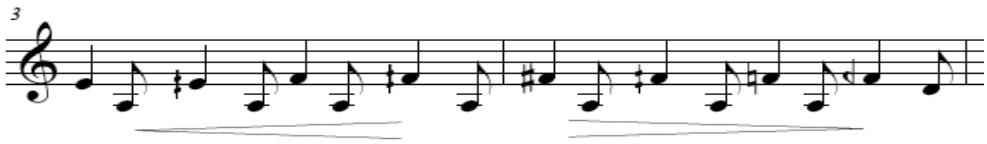

Figure 29: *Microtonal blues*, bars 3-4 (video 29)

Combining subdivisions of pitch with subdivisions of physical space on the fingerboard and working inside subdivision of time (rhythm) is a strategy which plays on the ability to be able to predict the future of a regular motion and facilitates the calibration of the progressive raising of the pitch.

The incremental raising of one finger is a good intuitive way to learn quartertones. However, in playing music that uses these notes as a basic scale and

which may involve rapid passages of not necessarily contiguous notes, techniques using all the fingers may prove more efficient. The division of a whole tone into four quartertones can be done using the four fingers as measuring units. When dividing a whole tone into two semi-tones, usually two fingers are used to do so. The tone can be divided into four quartertones simply by placing each of the four fingers in the physical space of a whole tone.

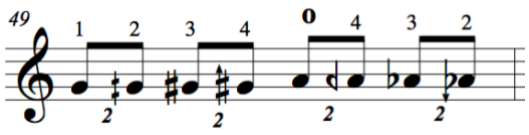

Figure 30: *Microtonal blues*, bars 49 (video 30)

The even division of the octave into quartertones, as in the music of Wyschnegradsky, is only one example of the infinite possibilities of microtones on string instruments. Other cultures divide the octave in many different ways. For example, in Turkish music, much use is made of thirds of a tone. Similar techniques to the ones described above can be used to play these accurately:

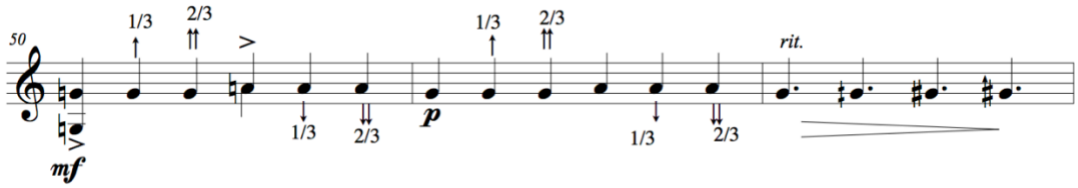

Figure 31: *Microtonal blues*, bars 50-51 (video 31)

Using a physical division by the hand and a strong sense of the point of departure (the note G, here reinforced by the open G string) and the point of arrival (the note A, reinforced by the open A string) combined with rhythmic inevitability (a steady pulse clearly divided so that arrival coincides with a strong beat) thirds of a tone are included in the piece in a natural, verifiable way.

There is no obligation to divide intervals into equal parts, and much of the strong colours and expressivity in folk music round the world comes from non-standard tuning and expression by intonation. In *Microtonal Blues*, I explore the idea of dividing the interval of one fifth, which is the distance between two strings

on the violin, into what I call the natural intervals of the hand. This simply means defining the bottom note and the top note of the fifth as being the outer boundaries of an area (and these notes are well marked and immovable, being open strings), then placing within that area each of the four fingers in its 'natural' position, where it is comfortable for the finger, without worrying about its relation to the other fingers. For each player, the pitches obtained will be slightly different, this will be quite literally their personal 'fingerprint' for these intervals, and they can reproduce them easily at will. Playing a simple folkish tune with this tuning system then becomes a personal expression.

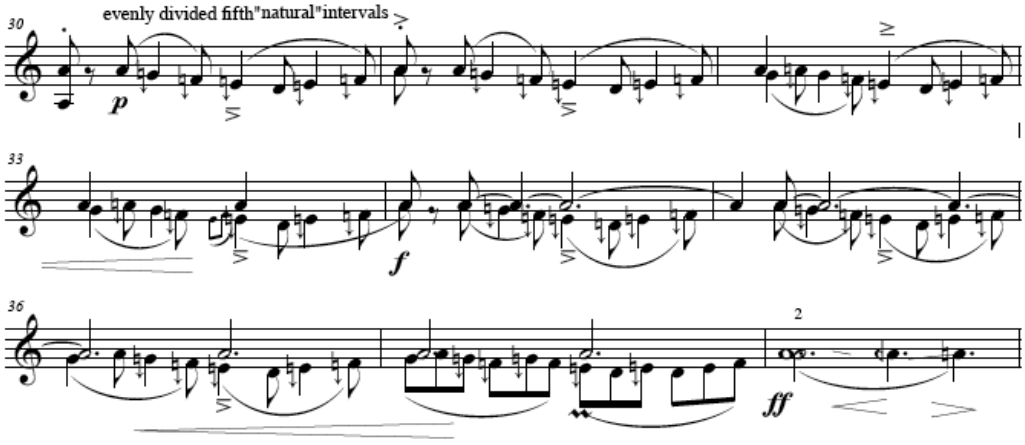

Figure 32: *Microtonal blues*, bars 30-38 (video 32)

In the example given in Fig.32, the 'personalised' tuning of the note E in particular, being the second degree of the scale, will be instantly recognisable and humanly very expressive. Spanish baroque music has a musical form call *tiento* (later called toccata, meaning literally 'touched') which was originally an improvisational piece based on the tactile exploration of the instrument, a perfect example of thinking with the fingers. My system of tuning with the fingers in this passage can be seen as a natural extension of this (Fig. 32)

Another idea explored in this piece is the system used by piano tuners to control and verify intonation between two notes. This means becoming aware of 'beating', a kind of audible interference produced by two notes played simultaneously when they are close to each other in pitch. To use this idea, as

shown in Fig.33, I ask the players first to play two notes in unison, then to move them apart, listening carefully to the beating effect that is produced. Then I ask them to play clear rhythms between two notes that are similarly but not identically pitched, then to produce a beating at this same speed and rhythm by adjusting the pitch of the lower note till the beating is the right speed.

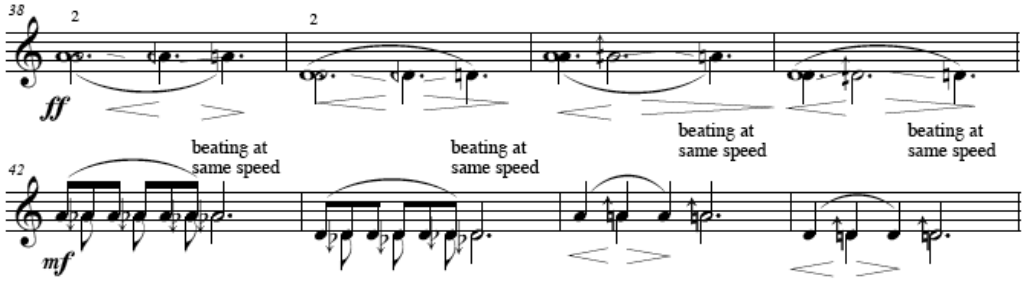

Figure 33: *Microtonal blues*, bars 38-45 (video 33)

Another way of thinking about microintervals is to use 'harmonic' tuning, meaning that the pitch of the notes imitates the natural intervals of the harmonic series. A good example of this is the *Viola Sonata* by Ligeti, which begins with a short scale where one of the notes (a B natural) is to be played a quarter of a tone lower than tempered tuning, to imitate the tuning of the eleventh harmonic of F. The seventh harmonic of the harmonic series also has a distinctive tuning, being 11 cents lower than the equivalent note on the piano (see chapter 3 on the harmonic series). In bar 25 of *Microtonal blues* (Fig. 34) I ask the players to imitate this tuning. On the third beat of each bar in this example, the note G is to be played as the seventh harmonic of the series based on A, alternately as a stopped note then as an actual 7th harmonic of A. The ear can thus correct the hand by aural imitation.

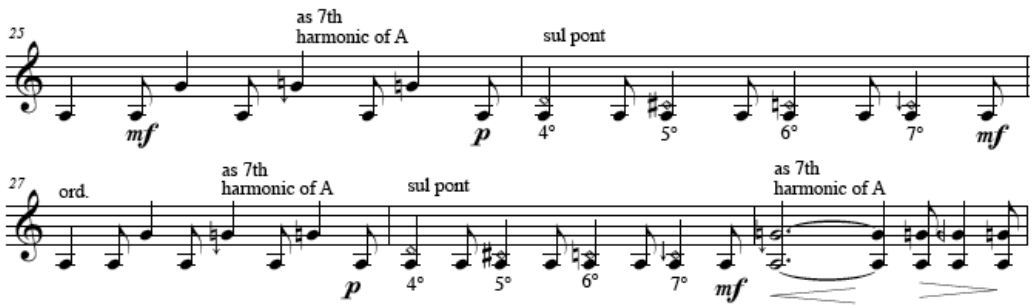

Figure 34: *Microtonal blues*, bars 25-29 (video 34)

Another illustration of this same idea can be found in *Spectral Sunrise*, where in each of the three cadenzas between the sunrises a solo instrument begins with a figure which includes a quartertone on the note which corresponds to the 11th harmonic of the fundamental.

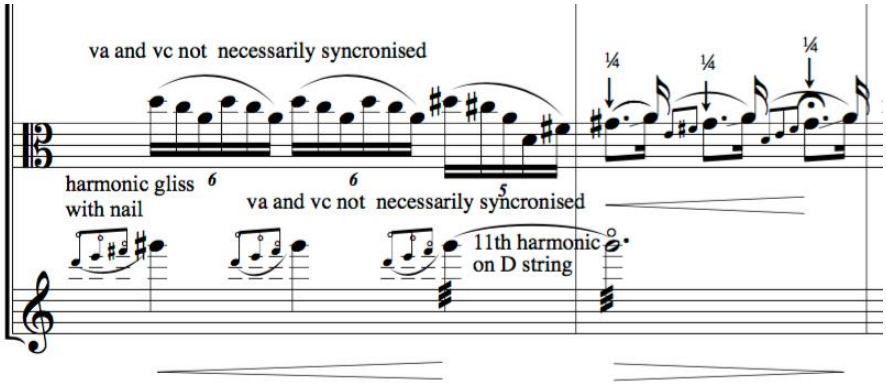

Figure 35: Satellites bar 21-22, viola and cello (video 35)

By making the cello play the 11th harmonic of the open D string before the viola has to find her low G sharp makes it a simple job for the violist, who can simply adjust her finger to the exact tuning of the cello, who is playing the same note. In this context, the quartertone is no longer a theoretical concept, but an empirically verifiable natural occurrence, and can be used expressively with confidence.

The use of intonation (tuning) as an expressive tool, the freedom to play non-tempered, extra-European or even self-invented scales and the sensation of gliding along a continuum when playing a string are for me among the fundamental features of music making on a string instrument. These very natural, intuitive ways of playing were among the discarded victims of our keyboard-dominated notation and teaching theories and their tendency to rationalise and standardise everything, especially during the 19th century. We are now progressively breaking free from these constraints, and my pieces are a conscious attempt to repossess these creative spaces and to expand them even further.

Chapter 6

With or Without the Bow

> 'The study of the violin is incomplete. Pupils are not taught pizzicato. As a result a whole host of passages in arpeggios involving all four strings, or in repeated notes with two or three fingers on the same string in rapid tempo – passages which any guitar player will show you (on the violin) - are said to be impossible and consequently proscribed for composers.' Hector Berlioz (Berlioz 1969:401)

The bow is often taken for granted in violin playing. It should not be forgotten that the bow was a secondary development, an added extra to already existing instruments (the ancestors of our modern violin) and that there are many things that can be done without it, the most notable example being *pizzicato*. When the bow is employed, it is generally limited to the standard 'pushing and pulling' across the string. My ambition was to explore other directions, dimensions and possibilities of the bow, taking advantage of its natural urge to jump, bounce, strike or rub, to say nothing of its enormously important visual element.

In this chapter I will discuss the pieces I wrote to explore these ideas. Written to be played entirely without the bow, the violin study *Ten fingers* is an affirmation of the independence of the bowless violin, a re-balancing of the relationship between the specialized and differentiated left and right hands and a joyous dance to the playful sound of the fingers in direct contact with the string. *Geostationary,* the first movement of my string quartet is also included here; although it is not exclusively written in *pizzicato*, this is the main driving force of the movement.

The two pieces written to explore the bow's possibilities, the violin study *Rick O'Shea* and *Dimensions* from the string quartet, are virtuoso displays for the bow showing all kinds of vertical, sideways, circular, *legno*, *gettato*, and whip bow strokes, and taking full advantage of its theatrical aspect.

Pizzicato

The first known written indication of *pizzicato* (the term used to describe plucking the strings of a bowed instrument) is found in Tobias Hume's '*The First Part of*

Ayres' for viola da gamba, published in 1605. Monteverdi used it in '*Il combattimento di Tancredi e Clorinda*' in 1624, Bach employed it occasionally but as we can see by Berlioz' comments at the head of this chapter, even by the nineteenth century it was still not considered by violinists to be worthy of study. Despite some noteworthy exceptional uses of pizzicato (e.g. Tchaikovsky *4th Symphony,* 3rd movement) this did not change until relatively recently.

The resurgence of this neglected technique began in the 20th century, and was led from the bottom upwards. Double bass players, especially in jazz, were among the first to realize the potential of *pizzicato*. Players like Scott La Faro and later Charlie Mingus influenced not only jazz players but launched a slow burning revolution in the classical string section, beginning in the bass section and gradually spreading upwards. This is largely because *pizzicato* generally works best with longer strings, and hence with bass instruments, but violinists too have many possibilities to extend their techniques. The right hand in CPP playing is usually treated as a unit and not as individual fingers. When not holding the bow, these fingers can be individualized and technically developed, just as the fingers of the left hand have been. Although the plucked sound on those instruments that have been adapted to projecting a bowed sound (like the violin) does not sustain as well as on the plucked instruments, which generally have frets and sometimes metal strings (like the guitar), violins can produce a wide range of very convincing sonorities and effects. Thanks to the possibility of amplification, even effects which were once considered too quiet to be heard can become a viable proposition. Béla Bartók was one composer who gave *pizzicato* an important place in his work, (3rd movement of string quartet no 4 (1928), *Duos for 2 violins* (1931), Music for strings, percussion and celeste (1936)) and he even invented his own type of *pizzicato* called the 'Bartók' *pizzicato* (slapping the string against the fingerboard) which is widely used today.

The possibilities of *pizzicato*

From a timbral point of view, the finger has many of the same possibilities as the bow. A string can be plucked *ordinario, sul tasto* or *sul ponticello*, for example. Using the nail, or different degrees of fleshiness also has a decisive effect on the timbre (video). Technically, the most important technique that needs to be

incorporated into the canon of techniques is the alternating finger technique, one of Scott La Faro's principal contributions to bass players. Without multiple finger technique, the speed of running passages is severely limited and very tiring, *tremolo* is impractical and chord voicing is almost impossible (video).

Playing without the bow makes possible a perfect symmetry between the hands, each one capable of producing sound from the string. They can play the strings, they can collaborate to produce complex rhythms, they can cross over (behind each other) they can talk to each other, etc. The left–right dichotomy is now a body–instrument dichotomy.

Violin Spaces n° 7: Ten fingers (video G)

and

Satellites movement n° 1: Geostationary (video J)

My violin study in *pizzicato* is called *Ten fingers* for obvious reasons, and uses many kinds of multiple finger techniques. A driving rhythm facilitates the fast movements, building up a momentum that can carry the body through the difficult moments. Like a juggler beginning with two balls, then adding more and more balls progressively, techniques are added cumulatively, and each new level of complexity is more spectacular than the last one.

The fullest resonances in pizzicato on the violin are obtained by plucking the open strings or the octave harmonics. *Ten fingers* begins with these (Fig.36), establishing a model of the desired resonance of all the notes, to be imitated throughout.

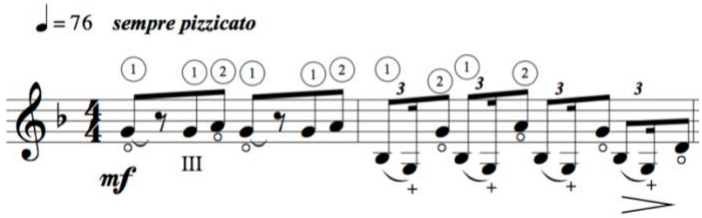

Figure 36: *Ten fingers*, bars 1-2 (video 36)

An important innovation here is that fingering is specified for the right hand *pizzicato* hand, above the stave in small circles (see bar 1 and following).

Normally finger indications are only given for the left hand, and pizzicato is done with any finger which comes to hand (!), but the very act of identifying and individualizing the fingers of the right hand confers on them greater independence. This is a deliberate pedagogical strategy (another example of strategic fingering) employed to encourage players to adopt the alternate finger *pizzicato* technique mentioned above in relation to Scott La Faro. In guitar technique, text-books and notation, the fingers of both hands are clearly named and indicated. I considered using these names, but decided in the end to adopt a numbering system for the right hand which uses the same numbers that are assigned to the fingers of the left hand, (1, 2, 3,4) which encourages a clear symmetry of the hands. To indicate to which hand the numbers refer, I chose to put circles around the numbers that refer to the right hand.

CCP violin music has no indications for the thumbs, as they are never used. My position on string technique is that the fingers are dependent on the thumbs and that their participation and the conscious control of them is a fundamental factor in playing. I also saw musical possibilities for the active participation of the thumbs in this piece. Needing to invent a sign for them, I decided to use the letter 'T' —inside a circle for the right thumb and without a circle for the left thumb, following the system for the other fingers:

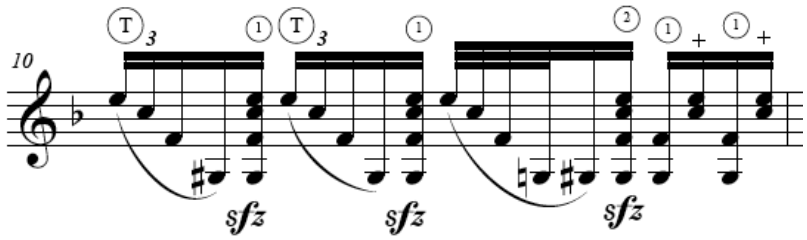

Figure 37: *Ten fingers*, bar 10 (video 37)

This innocent 'naming of parts' for both thumbs and fingers not only plays an important role in the individualisation of the right-hand fingers, it also underlines the symmetrical co-operation between the hands in this study. Naming the thumbs calls them explicitly into consciousness, even when not being used.

Using two fingers of the right-hand in alternation doubles the speed at which *pizzicato* is possible. When this is combined with 'hammering on' and

'pulling off', two techniques borrowed from guitar technique, then certain passages can be executed at breath-taking speed as in Fig.38:

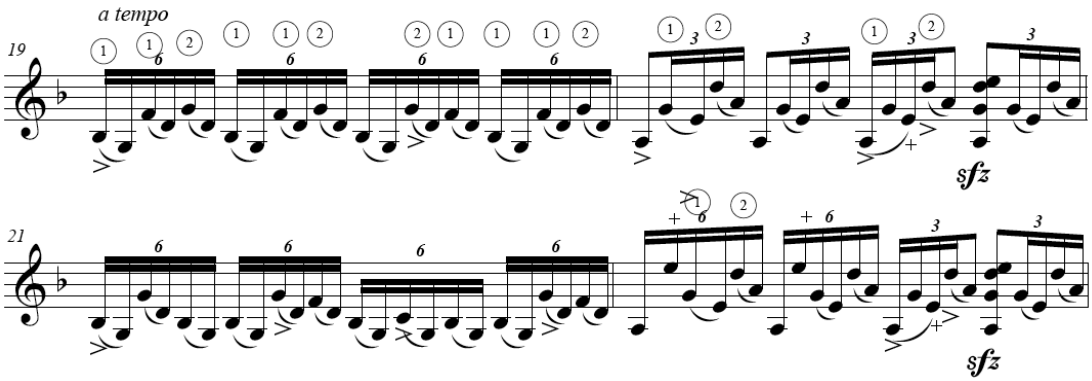

Figure 38: *Ten fingers*, bars 19-22 (video 38)

'Hammering on' means putting down a left-hand finger with sufficient force to make the note sound audibly. 'Pulling off' means lifting a left-hand finger in a way that makes the open string sound. This is done by pulling slightly sideways then releasing the string (see video 9, 02:10). In Fig. 38 above, bar one has a series of 'pulled off' notes. My convention for writing slurs in *pizzicato* is that the first note of the group is plucked by the right hand, all other notes under the slur being produced by the left hand. The first time this occurs in the piece, in bar 2 (see fig 36) the first note (B flat) is plucked by the right hand and the second note (G) is played by pulling off the left-hand finger, which was playing B flat, making the open string sound. This re-articulation of the open G string is indicated here by the + symbol, meaning a left hand pizzicato, and this figure serves as a model for the execution of all slurs. The beginning of *Geostationary* from my string quartet (Fig.39) uses the lowest fingered note on the viola (D flat) continually hammering it on and pulling it off to build up an ostinato (viola part bars 3-7, video):

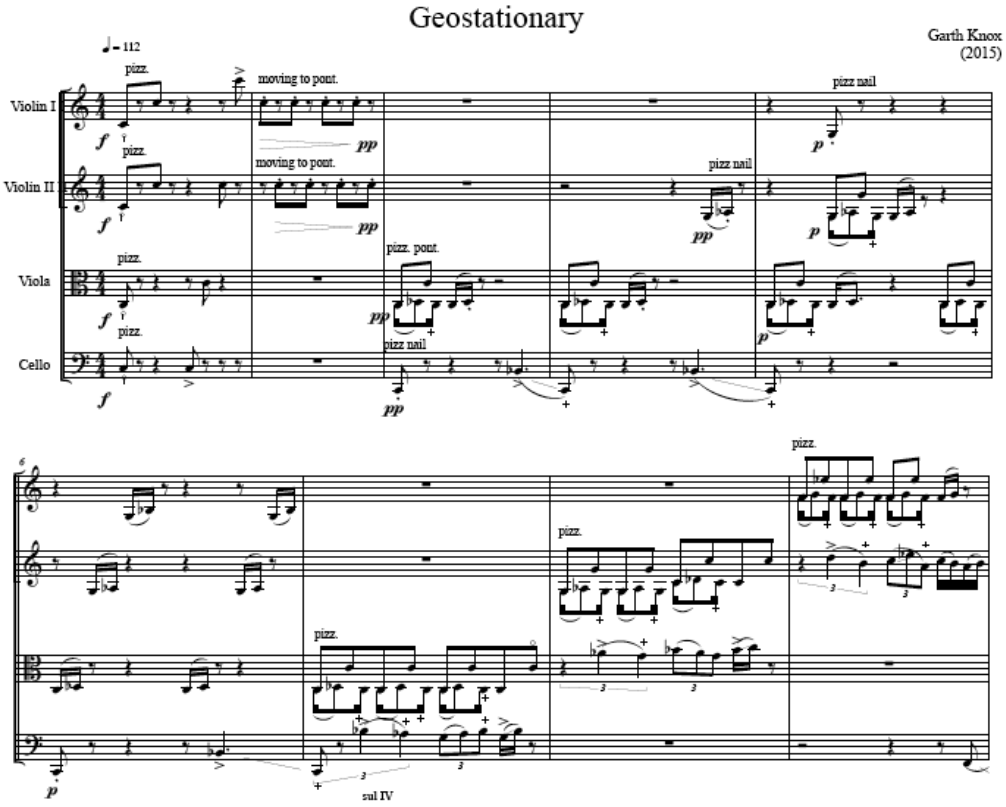

Figure 39: *Dimensions*, bars 1-9 (video 39)

In *Ten fingers*, guitar-like strumming in bars 13 and 14 (Fig.40) is used to evoke the sound of the flamenco guitar. The percussion techniques in bars 15-17 underline this effect by imitating the sound of the heels of the dancers on the floor.

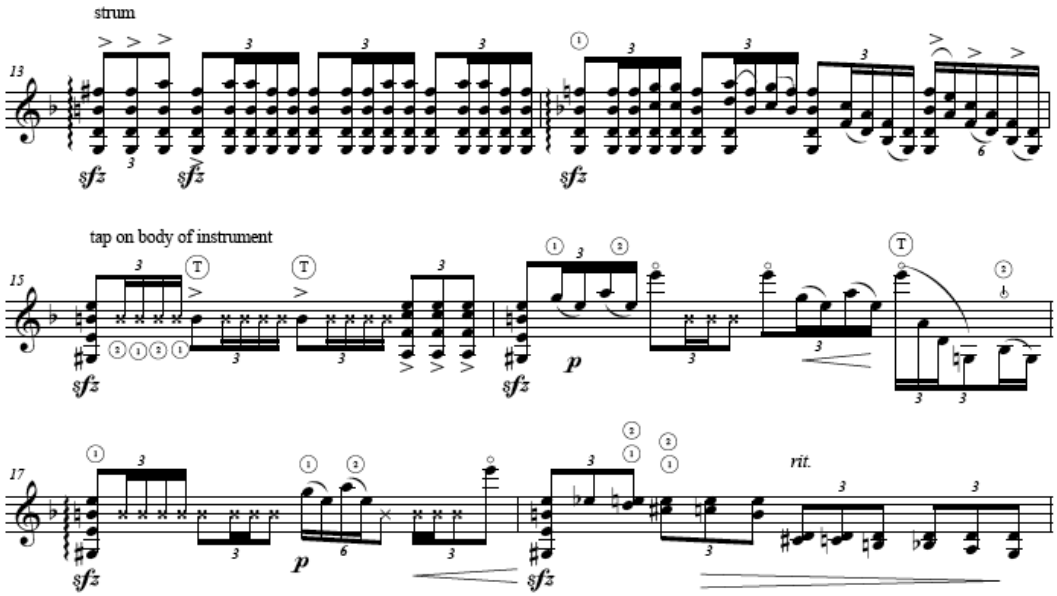

Figure 40: *Ten fingers*, bars 13-18 (video 40)

The open E string of the violin with its special ringing sound is employed as often as possible and the hands unconsciously imitate this sound for the stopped notes also. Full advantage is taken of the four-string structure of the violin. A single gesture across the strings produces four notes or sounds in either an upward or downward movement. For example, I use a technique of flicking the strings with a right-hand fingernail, which gives a sound similar to the *rasqueado* type strokes used by flamenco guitarists. The special attack is done by holding the chosen right-hand finger against the thumb, which restrains it, then releasing the finger in a flicking movement against the string. This works especially well just after a rising arpeggio played with the flesh of the finger. I call this technique quite simply a 'flick' (video).

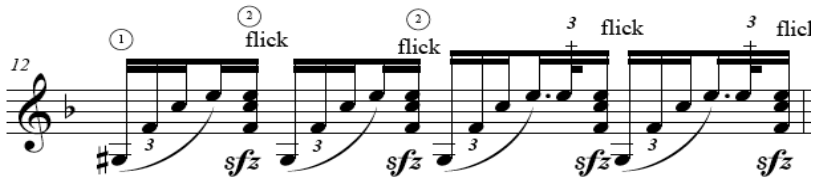

Figure 41: *Ten fingers*, bar 12 (video 41)

When the left-hand fingers hold down notes that are a little distance away from the nut, they effectively divide the string into two parts and either of these parts can be plucked (Fig.42). The string between the fingers and the nut (henceforth referred to as the string 'behind' the fingers) gives a very particular muted timbre when plucked, very different from the sound obtained when plucking the part of the string which is normally plucked i.e. the part between the fingers and the bridge (henceforth referred to as 'in front' of the fingers). Recognisable and predictable pitches are obtained by plucking behind the fingers. These are entirely decided by the placement of the left hand on the conventionally marked notes, making it unnecessary to mark the pitches actually obtained by plucking behind the fingers. I myself first came across this 'behind the finger' pizzicato technique when playing Luciano Berio's *Notturno* (1993), for string quartet, but many other composers have also used it. George Crumb uses a bowed version of this technique to create the sound of an other-worldly viol consort in *Black Angels*.

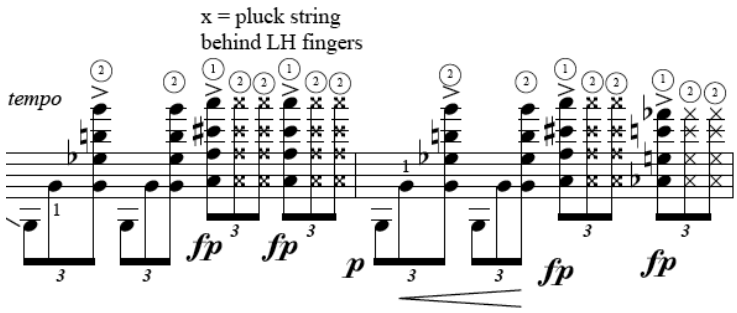

Figure 42: *Ten fingers*, bars 28-29 (video 42)

Strategically used on weak beats, as opposed to the normal *pizzicato* which are placed on the strong beats, these behind-the-finger *pizzicatos* provide not only what I consider to be an interesting colour, but also make a striking physical gesture, as the violinist is obliged to make an extended arm movement to reach behind the fingers. When the pitches of the held notes are altered, as in the last beat of this example, it affects the pitches of the strings in front of the fingers and also those of the strings behind the fingers, but in opposite directions. When we raise the written pitches, the pitches obtained by plucking behind the fingers are lowered and vice versa because the fingers decide at which point the string is divided into two, and moving this point lengthens one end of the string and shortens the other.

A special effect used in the string quartet movement *Geostationary*, to illustrate the contradictory notion of a constant movement that stays still (inherent in the title of the piece), is a *pizzicato* I call 'looping pizz' (e.g. cello bar 92, video). This action is repeated many times, like a perpetual motion, producing a constantly rising *pizzicato*, which starts again on every beat.

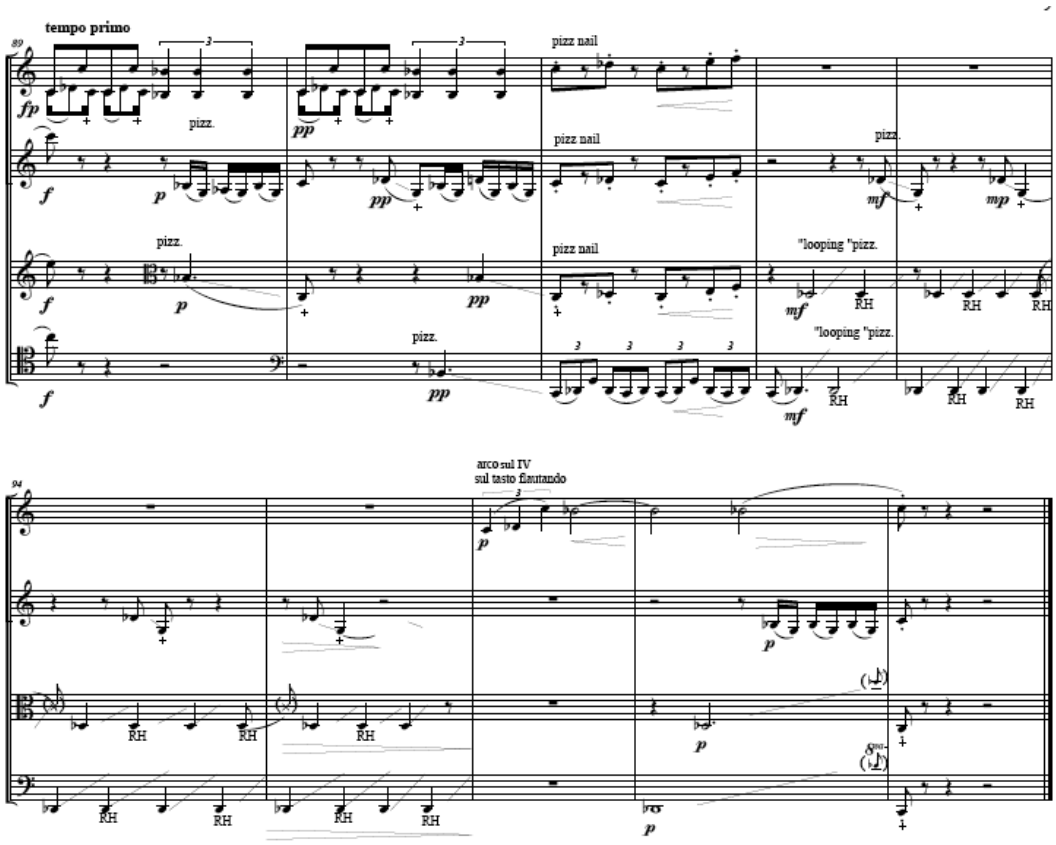

Figure 43: *Geostationary*, bars 89-98 (video 43)

Pizzicato is in general a happy dancing sound character-wise, and the piece reflects this. I find the sound of flesh plucking strings very human and communicative. Going down the arm from the shoulder to the fingers, each part of the arm is progressively more articulate and more sensitive, culminating in the fingertips, which have one of the highest concentrations of nerve ends in the body. Allowing the fingertips to articulate directly on the string brings a directness and a lucidity not present when playing with the bow. The sound becomes much more attack-driven, more exciting and stimulating. I find the interplay between the hands when playing alternate notes with each hand extremely satisfying, and this complementary action brings into focus the natural body symmetry, which is less evident when using the bow.

I mentioned above the conventional use of a small cross to indicate left hand *pizzicato.* In use since Paganini's day, this sign however gives no indication of which finger of the left hand should be used to pluck the string, mainly because it is often self-evident or without importance. In certain passages of *Ten fingers,* it is of prime importance to know which finger to use, for technical and musical

reasons. My proposition to fill this gap in notation is to adapt the cross to include the number of the left-hand finger that should pluck the string, and to enclose this number in a triangle to differentiate it from the numbers in circles used for the right hand (Fig. 44).

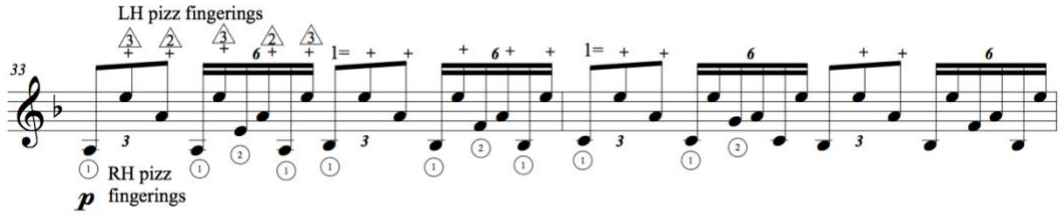

Figure 44: *Ten fingers*, bar 35 (video 44)

Exploring the possibilities of the bow

The bow has many more resources than the ones generally exploited in string music. Some of its more obvious qualities have been explored and used in great depth, as we can see by the wide, varied and abundant violin literature available today, but even this repertoire is far from having exhausted its possibilities. The bow's actions have generally been restricted to a very two dimensional coming and going in a movement parallel to the bridge. Furthermore, for most of the time it is left in constant contact with the string, neutralising all its enormous potential for bow attack noises, ictus, bounce and 'bite'.

The accepted image of a continuous bow is imagined to be a smooth and gentle rubbing of the string producing a sonorous, continuous singing sound. Seen under the microscope, the bow's contact with the string is anything but smooth. A series of 'hooks' on the surface of the bow hairs, made even more rigid and sticky by applying tree resin, seize the string and hang on till the pull of the bow is too strong for them to resist. When this happens, the bow hair breaks free of the string and slides against it, resulting in a jerking motion of the string as the bow frees itself, then a floating motion as the hair slides along the string until the string is recaptured by another series of hairs. The cycle is repeated over and over again as the bow is pulled past the string. This saw-like motion produces an angular waveform in the string called the Helmholtz motion (Woodhouse/Galluzzo 2004) which (thanks to the extreme rapidity and proximity of the sounds produced) is

interpreted by the brain as being one long continuous, smooth sound. The small biting attacks produced by the hairs can be heard much better when playing short notes lifted off the string; this is why a large part of *Rick O'Shea* is devoted to these. And of course, bouncing is a major component also. This is what the bow really wants to do, and this is when it really takes on a life of its own.

Another neglected property of the bow is its visual aspect. In string playing, unlike with many less visual instruments, the listener sees what he hears, thanks to the very explicit rhythmic movements of the bow. The violin and the viola, unlike the cello, have the added advantage of being able to be played while standing up or even moving around. I wanted to take this visual aspect into account in the writing of the piece itself, creating a kind of miniature instrumental theatre, which takes place on and around the body of the violin and the musician.

Violin Spaces n° 8: Rick O'Shea (video H)

and

Satellites movement n° 3: Dimensions (video L)

The study called *Rick O'Shea* aims to explore the possibilities of the bow as the leading actor in a three-dimensional play(ground). The natural bounce of the bow has been explored to some extent in classical music (Paganini again contributing greatly to this) but I wanted to take it much further as well as to explore other orientations and directions of the bow. Orthodox string teaching defines only two possible directions of the bow – the 'up' bow, and the 'down' bow. In fact, neither of these directions corresponds to a common-sense grasp of where up and down really are. They rather refer to moving through the bow from the 'bottom' end (the heel) to the 'top' end (the point). I decided to take 'up' and 'down' very literally to produce what I call a 'vertical' stroke (perpendicular to the floor) as in Fig. 45 (video):

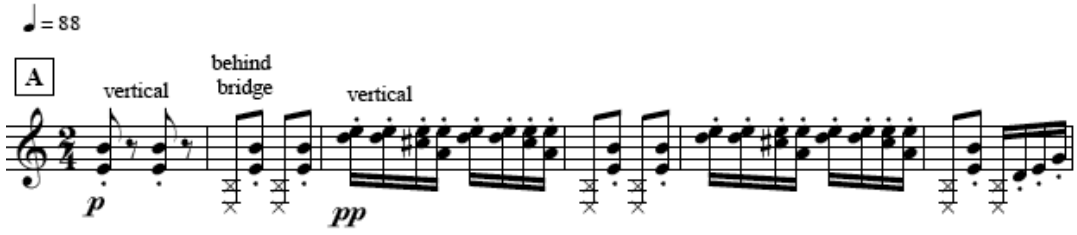

Figure 45: *Rick O'Shea*, bars 1-6 (video 45)

From a notational point of view, there are several ways of indicating a bouncing bow in classical violin music, but none of them means a totally vertical bounce, without sideways movement. Because I wanted to put this at the heart of my study, I had to think how to convey this idea. To be as simple and short as possible, I write the word 'vertical' with dots over the notes. The bounce can also take place on the strings behind the bridge, as in bar 2, giving a percussive drum effect. In this way, the natural bounce of the bow is fully exploited. Combined with an awareness and acceptance of the accompanying 'noise' factors in the bow attack (which can be fully controlled and modified at will), it gives a very rich basis on which to ground the piece.

In *Rick O'Shea*, and also in *Dimensions* from the string quartet, I wanted next to explore a sideways movement, moving the bow hair up and down the string (in the plane of the string) which gives a noise-rich wiping sound combined with some pitch.

Widely used by Salvatore Sciarrino (*3 notturni brillante (1974)*, *Sei Capricci (1976*)), he first called it *tremolo* between *tasto* and *ponticello* (or TP for short) in his early pieces, then changed his appellation to '*spazzolato*' meaning 'brushed'. I prefer to call it 'sideways' bow, as this clearly indicates the direction of the gesture. For my pedagogical strategy, the spatial idea of the gesture is very important, as well as the notion of moving the bow in a different dimension, so this stroke is always indicated by vertical arrows, upwards or downwards, to show the perpendicular (with respect to the bridge) movement of the bow along the string (Fig.46, and see video).

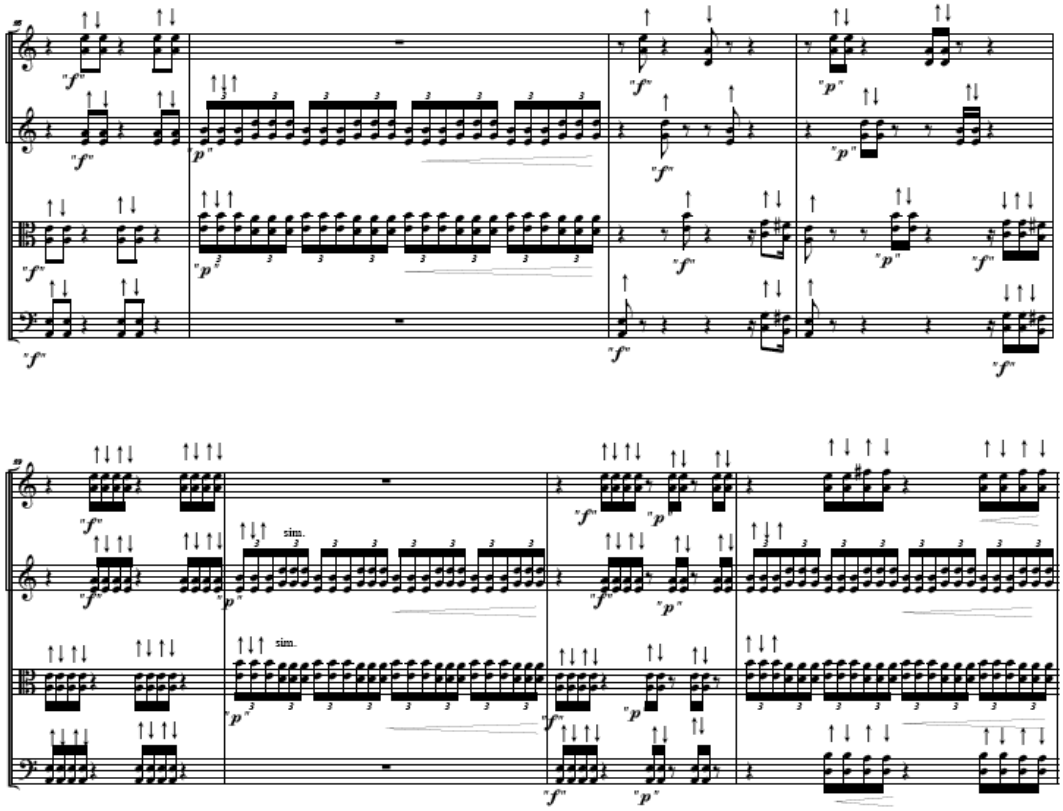

Figure 46: *Dimensions*, bars 25-32 (video 46)

Continuing the dimensional explorations, I next introduce some circular bowing (video). As the name suggests, this involves moving the bow in a circular manner along the plane of the string, in effect combining the brushing stroke with a normal back and forwards bow stroke. A 'phasing' effect is produced, giving strong interference with the pitch emission combined with the brushing sound. This technique is now relatively widespread in contemporary music, and often has some kind of circular symbol to indicate it, although we do not yet have a universally agreed one. As I use long passages of circular bowing, I need a sign indicating the duration of this effect. For this reason, I chose to use a continuing spiral of circles, a kind of visual onomatopoeia / a visual iconic equivalent, which can be extended to the length of the passage in question, or used in a short version as a reminder at the beginning of each line (figures 47 and 48).

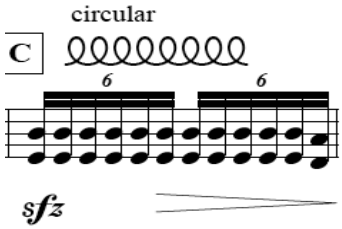

Figure 47: *Dimensions*, letter C

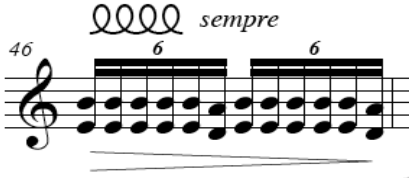

Figure 48: *Rick O'Shea* bar 46

My convention with this effect is that each written note is executed with a demi-circle of bow, so over two notes a complete circle is made. This is explained in detail in the playing instructions. Again for pedagogical reasons, the gestural element of the movement is privileged over a verbal explanation, and the sound produced is used as a guide for the self-regulation of the movement.

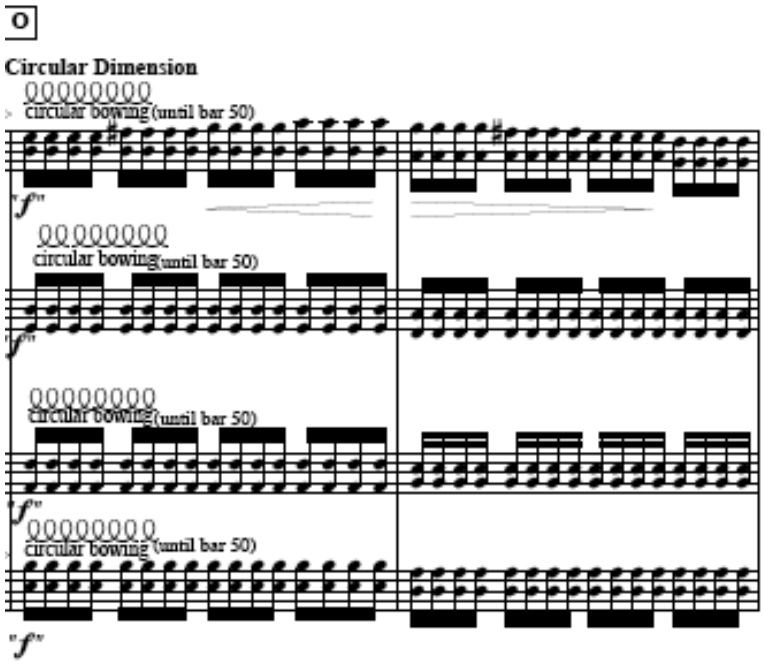

Figure 49: *Dimensions*, bars 46 and 35-36

In the discussion of noise in chapter 5, mention was made of '*col legno*', using the wood of the bow to play the strings. This can be either striking the string, as Tobias Hume used it in his viol music, which gives a percussive, almost military effect, or stroking the string '*col legno tratto*' as introduced by Schoenberg and especially Webern (*Six Bagatelles* 1934). Both techniques are employed here, as well as fast alternations between the hair of the bow and the stick (Fig.50, and see video).

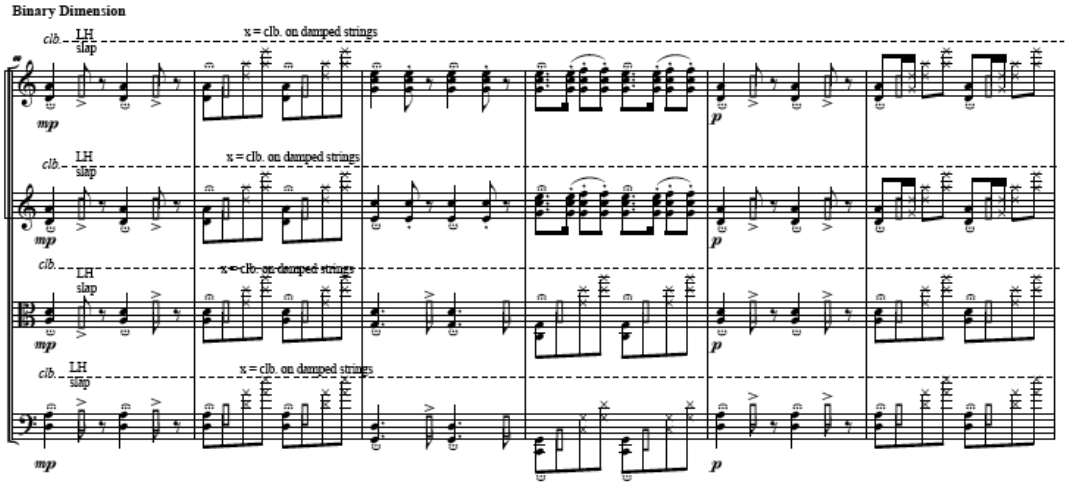

Figure 50: *Dimensions*, bars 69-74 (video 50)

All these movement are treated choreographically as well as musically, to produce a miniature spatial juggling act, as the natural sounds become more and more distorted and more and more acrobatic.

The sound of the bow travelling very fast through the air has always fascinated me, and I included what I call the 'whip' sound in *Dimensions* (Fig.51 and see video).

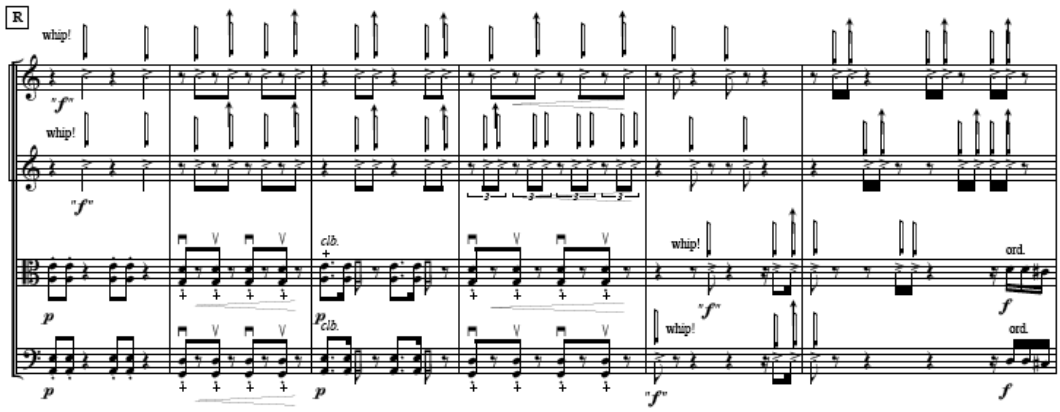

Figure 51: *Dimensions*, bars 93-98 (video 51)

This small image of the bow means to whip the bow through the air, making a whishing, whipping sound with the hair. This effect comes back at the very end to close the piece with a spectacular unison gesture.

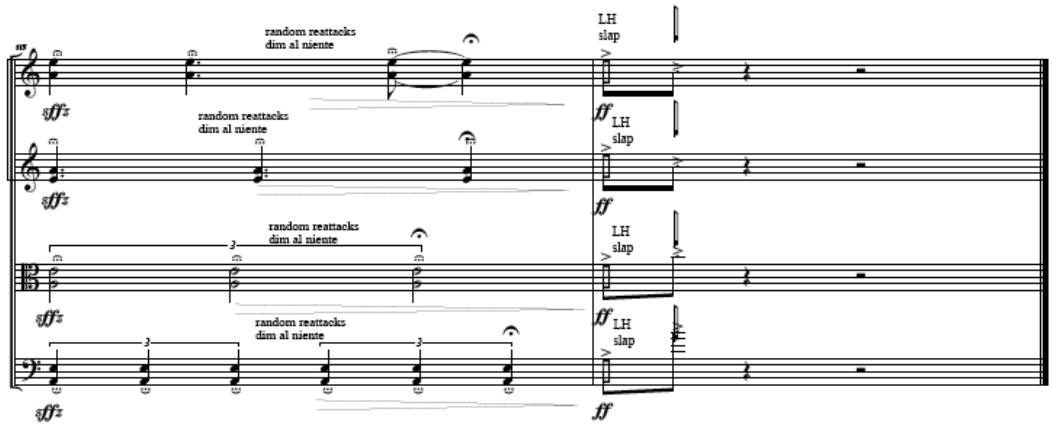

Figure 52: *Dimensions*, bars 115-6 (video 52)

As will be clear from watching the video of the performance, this last movement of the quartet combines sound and gesture, using the often-neglected visual aspect of the bow to choreograph the performance. It allows the performers to help the audience to hear by making visible the sounds which they are hearing.

Another bowing technique employed in the study is a heavily saturated 'chopping' sound done by using overpressure at the heel while executing a circular bowing stroke. Again using a term that speaks to the imagination of the player, as another example of strategic notation, I call it 'helicopter' bowing (video). I thought of this name because it gives an immediate indication of the desired

sound. It is also a personal reference to Stockhausen's 'Helicopter Quartet' because it was while sitting in a helicopter playing the premiere of his piece that I first had the idea. This is again a choice of giving the player information about the final result as well as the technical indication. I notate this bowing by simply writing repeated notes with the word 'helicopter' over them, changing the noteheads into crosses to indicate the significant noise content in the desired sound (Fig.53).

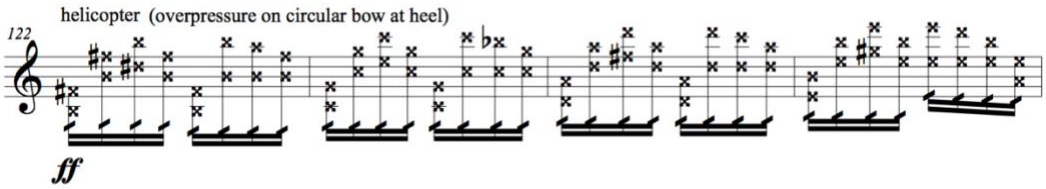

Figure 53: *Rick O'Shea*, bars 122-5 (video 53)

All of these suggestions of notation have been tried and tested with students and practising musicians, and an invaluable exchange of ideas on this subject with them has shaped my propositions. The importance of notation in shaping our apprehension of sounds and techniques cannot be underestimated. I hope to have explained here the emphasis given in my work to choosing the appropriate notation for each idea. Wherever possible, I have used my *strategic notation* to guide the players' understanding of the sounds and of the techniques employed to obtain them, in order to give to the players the possibility of manipulating these sounds to best serve their creative choices.

In this chapter, I have tried to show how by considering the violin and the bow as separate instruments in themselves, I worked on developing the potential of each of them individually. The self-imposed limitations of this approach were very stimulating constraints, and forced me to imagine new creative resources, not with the idea of solving a problem, but in order to pursue further the new and unexplored paths which opened up before me.

Chapter 7

Conclusion

My research work has used studio-based experimentation techniques on extended techniques for strings involving analysis, improvisation and performance practice to produce a set of musical pieces. These pieces, the collection of eight *Violin Spaces* and a string quartet, *Satellites,* are free-standing concert pieces in their own right, and as such will go on to have a life of their own on the concert stage. They will also provide learning paths and precious pedagogical material for teachers and students wishing to enlarge their musical studies and horizons. My research aims to further develop these possibilities for the future, to ensure the diffusion of these ideas to musical audiences by public performances, and to transmit the knowledge contained in the pieces by the pedagogical approach inherent in the research.

The addition to knowledge brought about by this research, over and above the pieces themselves can be listed in the following categories:

1: Contribution to the evaluation and comprehension of some sounds and techniques. For pre-existing extended techniques like *sul ponticello, harmonics, sul tasto, glissando* or *pizzicato*, this means clearly defining their characteristics, their techniques of execution and their function. For *ponticello, harmonics* and *pizzicato*, this also means supplying mental tools for their understand and manipulation, namely the *strategic notation* as exposed above.

2: Contribution to the further extension of these techniques. All the techniques proposed in this collection have been extended beyond their customary borders. By focusing on each one separately, it is possible to understand and to master the essential features of each technique, and this naturally leads to its extension, often in response to a musical need generated by the logic of a composition. This has in some cases led to the generation of new techniques, and the inclusion of these means that they

are now documented, notated and available for use by other composers for original compositions, or by players in their improvisations.

3: Contribution to a reflection on notation in order to make it as clear and uncluttered as possible. Some of these notation propositions are devised as strategic notations, in the sense that they help to clarify thought about these techniques, and at the very least the naming of these sounds greatly facilitates their reproduction and manipulation.

4: Contribution to consolidating the importance of timbre in music and the attention drawn to it. My studies are really studies first and foremost for the ears, both the ears of the player and the ears of the listener. My intention is to draw attention to sounds which are already present, but which are often ignored or unnoticed. My aesthetic innovations in these pieces are therefore not to be found in the melodies, harmonies or rhythms of the music, or even the styles but lie in the sounds themselves. Using new sounds, sometimes even unexpected ones, in place of conventional string sounds, turns a very familiar form, like a waltz for example, into a path of discovery where the familiar elements (rhythm, harmony) facilitate the perception of the most important new proposition – the sound. This follows the logic of the historical shift towards timbre-based music mentioned in chapter 2; and this, combined with the influence of spectral thinking on my music as mentioned in chapter 3, leads to my research with extended techniques, which is the subject of this thesis.

As with any research, the degree of acceptation and recognition of my research will depend on the success of its propagation and diffusion. The printed versions of my *Violin Spaces* have been published by Schott Music editions in 2018, and the score and parts of my string quartet *Satellites* (also a recording) is already available on the web-site of the Kronos Quartet (kronos.org). The Kronos Quartet themselves have already played *Satellites* more than thirty times in all corners of the globe, and many young quartets have adopted the piece into their repertoire. The Dutch violinist, Diamanda La Berge Dramm, the dedicatee of the *Violin Spaces*,

has programmed performances of these all over Europe in the coming years, and videos are available on YouTube. I myself am regularly invited to conservatoires across Europe and America to lead masterclasses and workshops, giving me the opportunity to diffuse my ideas to young musicians at first hand.

Glossary

artificial harmonic	a harmonic whose fundamental is played with a finger (not an open string)
balayage	French, meaning scanning, or sweeping over a space
col legno	Italian, meaning 'with the wood' (of the bow)
comma	a very small discrepancy in tuning between two tuning systems. There are several different sizes of comma
CPP	Common Practice Period: usually defined as being circa 1650 to 1900, corresponding to the era between the formation and the dissolution of the tonal system
equal temperament	a system of tuning which 'standardizes' the intervals, allowing an instrument to play in all keys
extended techniques	Common Practise Period based techniques which have been developed and extended
fundamental	the first partial of a note, usually the lowest frequency of the signal, and the main pitch identified
gettato	Italian, meaning 'thrown'. Usually means throwing the bow onto the string and letting it bounce
glissando	Italian, meaning 'sliding'
harmonic	an overtone of the fundamental note, produced on a string instrument by touching the string lightly at a nodal point and bowing or plucking the string
harmonic series	the series of natural overtones produced by a vibrating string or other vibrating medium

microtone	an interval smaller than a semitone
neumes	early form of music notation, signs used to represent pitches, and later also rhythms
nodal point	points on a string at exact integer division points
overtone	any frequencies detected in a signal which are higher than the fundamental
partial	any frequencies detected in a signal, including the fundamental
pitch	the perceived frequency of a sound
pizzicato	Italian, meaning 'plucked'. Usually with a finger (or nail) of the right hand, but can also be executed by the left hand, especially on open strings
spectral music	(or **spectralism**) is the name commonly given to a compositional technique developed mainly in France in the 1970s. The term itself was first used by Hugh Dufour, one of the four central 'spectral' composers, along with Gérard Grisey, Tristan Murail and Michael Levinas. It refers to the 'spectrum' of sound, and to a common way of explaining one of the basic ideas of spectralism – that just as white light can be split into its spectrum (as in a rainbow), so a musical sound can be split by analysis into its constituent partials (overtones).
sul ponticello	Italian, meaning 'on the bridge'. A technique where the string is played at a point nearer to the bridge than the normal contact point. The resultant sound is characterised by the enhancement, the elimination, or the distortion of the higher partials

sul tasto	Italian, meaning 'on the fingerboard'. A technique where the string is played at a point further away from the bridge than the normal contact point. The resultant sound is characterised by the suppression or the distortion of some partials, especially the higher ones.
timbre	the characteristic quality of a sound, sometimes referred to as tone colour
tremolo	Italian, meaning 'trembling'. An irregular, usually fast repetition of a note
white noise	a signal where all frequencies are present in equal proportions, like the hissing of a radio

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Listening suggestions

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Xenakis Iannis *Mikka* for solo violin (1971)

Xenakis Iannis *Nomos Alpha* for solo cello (1965)

List of Videos and Figures

Complete Videos:

Violin Spaces n° 1: Up above our heads (video A)

Violin Spaces n° 2: Skating (video B)

Violin Spaces n° 3: No pitch, no problem *(*video C*)*

Violin Spaces n° 4: The Raven *(*video D*)*

Violin Spaces n° 5: Sliding (video E)

Violin Spaces n° 6: Microtonal Blues (video F)

Violin Spaces n° 7: Ten fingers (video G)

Violin Spaces n° 8: Rick O'Shea (video H)

Satellites movement n° 1: Geostationary (video J)

Satellites movement n° 2: Spectral Sunrise (video K)

Satellites movement n° 3: Dimensions (video L)

Explanatory video for techniques used in *Satellites* (video M)

Context of *Satellites* : Kronos Quartet (video N)

Figure 1: *Up above our heads*, bars 1-4 (video 1). 24
Figure 2: *Up above our heads*, bars 23-26 (video 2) 24
Figure 3: *Up above our heads,* bars 16-19 (video 3) 26
Figure 4: *Up above our heads*, bar 46 (video 4) 27
Figure 5: *Skating*, opening section (video 5) 32
Figure 6: *Skating*, bars 42-45 (video 6) 33
Figure 7: *Skating*, bars 32-39 (video 7) 33
Figure 8: *Spectral Sunrise* for string quartet, bars 8-18 (video 8) 35
Figure 9: *Skating*, bars 62-65 (video 9) 37
Figure 10: *No pitch, no problem*, bars 18-19 (video 10) 44
Figure 11: *No pitch, no problem*, bars 22-24 (video 11) 44
Figure 12: *No pitch, no problem*, bars 3-4 for the left hand only (video 12).....45
Figure 13: *No pitch, no problem*, bars 31-34 (video 13) 45
Figure 14: *No pitch, no problem*, bars 48-50 (video 14) 46
Figure 15: *The Raven*, bars 1-5 (video 15) 48
Figure 16: *The Raven*, bars 13-16 (video 16) 49
Figure 17: *The Raven*, bars 18-21 (video 17) 49
Figure 18: *The Raven*, bars 27-30 (video 18) 50

Figure 19: *The Raven*, bars 44-48 (video 19) 50
Figure 20: *Sliding*, bars 1-17 (video 20) 57
Figure 21: *Sliding*, bars 18- 20 (video 21) 57
Figure 22: *Sliding*, bar 26-27 (video 22).....58
Figure 23: *Sliding*, bars 29-31 (video 23) 58
Figure 24: *Sliding*, bar 50 (video 5, 01:48) (video 24) 58
Figure 25: *Sliding*, bars 44-46 (video 25) 58
Figure 26: *Sliding*, bars 57-59 (video 26) 59
Figure 27: *Sliding*, bar 50(video 27) 59
Figure 28: *Microtonal blues*, bars 17-19 (video 28) 63
Figure 29: *Microtonal blues*, bars 3-4 (video 29) 63
Figure 30: *Microtonal blues*, bars 49 (video 30) 64
Figure 31: *Microtonal blues*, bars 50-51(video 31) 64
Figure 32: *Microtonal blues*, bars 30-38 (video 32) 65
Figure 33: *Microtonal blues*, bars 38-45 (video 33) 66
Figure 34: *Microtonal blues*, bars 25-29 (video 34) 66
Figure 35: Satellites bar 21-22, viola and cello (video 35) 67
Figure 36: *Ten fingers*, bars 1-2 (video 36) 70
Figure 37: *Ten fingers*, bar 10 (video 37) 71
Figure 38: *Ten fingers*, bars 19-22 (video 38) 72
Figure 39: *Dimensions*, bars 1-9 (video 39).....73
Figure 40: *Ten fingers*, bars 13-18 (video 40) 73
Figure 41: *Ten fingers*, bar 12 (video 41) 74
Figure 42: *Ten fingers*, bars 28-29 (video 42) 75
Figure 43: *Geostationary*, bars 89-98 (video 43).....76
Figure 44: *Ten fingers*, bar 35 (video 44) 77
Figure 45: *Rick O'Shea*, bars 1-6 (video 45) 78
Figure 46: *Dimensions*, bars 25-32 (video 46).....80
Figure 47: *Dimensions*, letter C.....80
Figure 48: *Rick O'Shea* bar 46.....81
Figure 49: *Dimensions*, bars 46 and 35-36 81
Figure 50: *Dimensions*, bars 69-74 (video 50).....82
Figure 51: *Dimensions*, bars 93-98 (video 51).....83
Figure 52: *Dimensions*, bars 115-6 (video 52).....83
Figure 53: *Rick O'Shea*, bars 122-5 (video 53) 84