University of Tasmania

Harmonic Based Extended Techniques and their Compositional Applications:

An Investigation in New String Techniques

An Exegesis Submitted to

Conservatorium of Music

in partial fulfilment of the requirements for the degree of

Bachelor of Music with Honours (or Bachelor of Music (Elite) with Honours)

by

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Hobart, Tasmania

October 21, 2019

Declaration

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Rhys Gray

October 21, 2019

Abstract

I propose to explore a range of extended techniques that utilise the harmonic series and assess how they can be used in my, and other people's, creative practice. These techniques include (but are not necessarily limited to) multiphonics, subharmonics, and half-harmonics. Due to the scope of this project, stringed instruments will be the primary focus. For the purposes of brevity, these harmonic-based extended techniques will simply be referred to as 'techniques' throughout the paper, except for when differentiation between standard techniques is needed.

While some techniques such as harmonics are well established and understood, others, such as subharmonics, are still immature in terms of both repertoire and resources available. The timbral potentials of these techniques are uncharted territories and collectively represent a whole sound world that remains relatively inaccessible to contemporary art music composers.

To identify where further research is required, I will conduct a review of the literature and resources that are readily available to composers to assess what techniques require further investigation and refinement. By researching these techniques and the mechanics behind them, using document analysis, and analysing recordings made, I will gain a better understanding of how these techniques can be implemented in my practice. As part of both the analysis of techniques and my compositional practice, I will assess not only the compositional potential, but also the practicality of techniques. Reviewing the feasibility and notational aspects of the

techniques will render the exegesis a practical document to reference for performance and composition.

I aim for my resulting exegesis to become a useful reference source for artists interested in learning about the mechanics, qualities, and potential implementations of these harmonic based extended techniques. The works that I compose accompanying the exegesis will show idiomatic treatment of the techniques and serve as references as such in the exegesis. The dissemination of the material I research will contribute to the accessibility of new sound possibilities for artists.

Thank you to my supervisor, Matthew Boden, my teachers Dr. Maria Grenfell and Dr. Scott McIntyre, my piano teacher Sally Ward for inspiring my passion in music, my family, and my cats Buttercup and Millie.

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Introduction

I propose to explore a range of extended techniques that utilise the harmonic series and assess how they can be used in my, and other people's, creative practice. These techniques include (but are not necessarily limited to) multiphonics, subharmonics, and audio-processed harmonics. Due to the scope of this project, stringed instruments will be the primary focus. For the purposes of brevity, these harmonic-based extended techniques will simply be referred to as 'techniques' throughout the paper, except for when differentiation between standard techniques is needed.

While some techniques such as harmonics are well established and understood, others, such as subharmonics, are still underdeveloped in terms of both repertoire and resources available. The timbral potentials of these techniques are uncharted territories and collectively represent an entire sound world that remains relatively inaccessible to composers.

To identify where further research is required, I will conduct a review of the literature and resources that are readily available to composers to assess what techniques require further investigation and refinement. By researching these techniques and the mechanics behind them, interviewing professionals, and analysing recordings made, I hope to gain a better understanding of how these techniques can be implemented in my practice. As part of both the analysis of techniques and my compositional practice, I will assess not only the compositional potential, but also the practicality of techniques. Reviewing the feasibility and notational aspects of the

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Chapter 1

Literature Review and Methodology

Literature Review

This study builds on and contributes to the catalogue of resources available to composers interested in implementing harmonic based extended techniques in their practice. The topic of 'harmonic based extended techniques and their compositional applications' is broad, and I will be unable to explore the entire corpus of techniques available to all instruments as this falls outside the scope of this exegesis. This is by design, as certain instruments lack certain facets of research, while others are already well documented, the most obvious example being string harmonics, which are common practice. This broad topic affords a certain level of flexibility to explore what is both novel and feasible given my available resources, all under the unifying theme of harmonic based extended techniques.

Many of the techniques that this study deals with are still in their comparative infancy, especially notationally. As such, engraving the works produced in the course of this study is a more subjective matter, rather than the well-established practice that it normally is. A review of the available literature makes it clear that attempts have been made to standardise contemporary music notation, but have either fallen short, or are now outdated. Kurt Stone organised an international conference on new musical notation in 1974 in Ghent, Belgium, and then produced the treatise *Music Notation in the Twentieth Century* in 1980 as a result of the conference.[1] This, along with Gardner Read's 1979 *Music Notation*, served as a strong base for the standardisation of music notation, but both are mired

1. Kurt Stone, *Music Notation in the Twentieth Century* (New York: W. W. Norton & Company, 1980), xiii.

by their age and computer-based notation not being widespread.[2] It is therefore unsurprising that both omit stringed multiphonics, subharmonics, and the many other techniques covered in my study, which largely postdate publication. Gould's 2016 book *Behind Bars* immediately became the gold standard of engraving manuals, her decades of notational and editorial experience at Faber Music lending weight to her comprehensive treatise.[3] But the same new techniques are omitted from Behind Bars, with Gould stating:

> 'I have been highly selective in the choice of extended instrumental and vocal techniques included in this book, but it is intended that this should give the reader the facility to create notation for other techniques not in common use.'[4]

Gould's book is less proscriptive than its forerunners, and focuses more on creating a consistent style language, providing the reader with the tools of standardised and codified 'common practice' notation to build new extended technique notation. As such, for all notational aspects, I will be drawing upon the Gould for the philosophy of engraving, if not exact notation, which has the benefit of almost forty years of usage and review against its peers.

Gould provides the tools which Ellen Fallowfield uses to construct a notation method for string multiphonics in her PhD 'Cello Map', the framework of which this exegesis will follow. A detailed, process-oriented review of technique informs the creation of resources which are then analysed.[5] Fallowfield's analysis produced the

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2. Gardner Read, *Compendium of Modern Instrumental Techniques*, 1st ed. (Westport, Connecticut: Greenwood Press, 1993).

3. Elaine Gould, *Behind Bars*, 1st (London: Faber Music, 2011).

4. Ibid., iii.

5. Ellen Fallowfield, "Cello Map: A Handbook of Cello Technique for Performers and Composers" (Thesis, University of Birmingham, 2009).

website cellomap.com, a manual of techniques for performers to use. She states that her text maps:

> '[. . .] "actions that a cellist can make" onto "sounds that a cello can produce". In other words, we have tried to reduce the cello and cellist to scales of actions and sounds, and show how cellists can influence sound (loudness, overtone content, pitch. . .) by their actions (bow speed, contact point, stopping position. . .). This standpoint is a deliberate move away from providing performers and composers with catalogues of special effects and extended techniques. Instead, we would like to provide information about how the cello works that can serve the imagination of performers and composers.'[6]

This approach 'future proofs' the thesis by abstracting the elements into their most base form, showing all of the sounds a cello can make using all of the actions a cellist can perform. While the website is comprehensive, Fallowfield seemingly avoids making any judgement calls on the compositional applications of the techniques that she reviews, and the reader is left to draw their own conclusions on the compositional effectiveness of any given technique. Fallowfield does, however, note that a repertoire gap exists for etudes exploring multiphonics for the cello, and indeed, the entirety of the string family. As part of my practice-led research, it seems fitting to compose a piece that addresses this repertoire gap.

Bertram Turetzky's book, *The Contemporary Contrabass* was written to exemplify the contrabass as a serious solo and melodic instrument, which was underrepresented in the literature.[7] He theorised:

> '[. . .] concertizing was the key, which in the 1950's was impossible mainly due to the lack of literature. I attacked this problem in two directions: 1. Locating original contrabass music from the eighteenth and nineteenth centuries, and 2. Commissioning twentieth century music.'[8]

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6. Ellen Fallowfield, "Cello Map," accessed May 31, 2019, `http://www.cellomap.com/`.

7. Bertram Turetzky, *The Contemporary Contrabass*, 1st Edition (California: University of California Press, 1974).

8. Ibid., vii.

His practice-led research centered on seeking to understand the techniques that contemporary composers would use in solo contrabass repertoire. Turetzky deliberately omitted including any guidance or judgements on notation, or categorisations of the difficulty of the techniques, stating that

> '[. . .] the time between this printing and the second edition will suffice to suggest and select the best notational concepts from a more substantial literature than we possess now.'[9]

The second edition saw Turetzky call for more experimentation with multiphonics, stating:

> 'I know of no music employing string multiphonics [. . .] this is entirely new ground, it remains for composers and performers to build the usable technique.'[10]

The specification of both composers and performers being needed to 'build the usable technique' is peculiar, until one re-examines the context, in which Turetzky knew of these techniques, and was attempting to rectify it through commissioning new literature. Performers and researchers such as Fallowfield are necessary to establish the technique, but without composers implementing the research carried out by them and contributing to a pool of repertoire to show the correct usage of the technique, it is impossible for a 'usable technique' to be built.

Thomas Howell's 1974 book, *The Avant-Garde Flute* followed Turetzky's contrabass technique book, as part of Turetzky's *The New Instrumentation* series, which was published by California Press until Scarecrow Press took over in 2004.[11] It is relatively conservative in its content, and has many omissions. Howell's

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9. Turetzky, *The Contemporary Contrabass*.

10. Betram Turetzky, *The Contemporary Contrabass*, 2nd Edition (California: University of California Press, 1992), 138.

11. Fallowfield, "Cello Map: A Handbook of Cello Technique for Performers and Composers," 4.

contributions are overshadowed by Robert Dick's *The Other Flute*, which was released the following year, and was notably used as the primary reference for microtonal flute fingerings by John Cage in the preface to his piece *Music For.*[12] *The Other Flute* is a thorough performance technique manual, presenting each fingering and its resultant multiphonics one after the other, using a chart of descriptions to specify the qualities.[13] It specifies the following: 'exact pitch, ease of response, starting time, stability, dynamic range, timbre, and, if present, noise level, residual tone, and degree of modulation.'[14] While this text focuses more on instruction, it is an efficient system, providing much more information in less space than Howell's fingering charts, which were presented without any accompanying context. Dick sorts the multiphonics into four classes graded by difficulty. The multiphonics are presented in order of their method of production; multiphonics derived from natural harmonics, from fingerings of chromatic pitches, and those based on microtonal segments. The scope of my research is limited to the multiphonics based on natural harmonics. From the perspective of a composer, Dick's book provides ample resources on the qualities of each multiphonic, but generic descriptions of their characteristics; enough for a composer to assess whether any given multiphonic is worth investigating with a flautist. While the scope of my research focuses on stringed instruments, Dick's method of cataloguing different fingerings is a logical and comprehensive model to follow. *The Contemporary Violin* is one of the more recent books in Turetzky's

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12. John Cage, *Music for : Parts for Voice and Instruments without Score (No Fixed Relation), Title to Be Completed by Adding to "Music for"– the Number of Players Performing.* (Henmar Press, 1984), `https://login.ezproxy.utas.edu.au/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=cat02831a&AN=UTas.b2468591&site=eds-live`.

13. Robert Dick, *The Other Flute*, Second Edition (New York: Multiple Breath Music Company, 1989), 86-135.

14. Ibid., 84.

The New Instrumentation series.[15] It provides a comprehensive review of various violin techniques, but attempts to shy away from any implication of notational authority, most notable in the section on multiphonics, which seems to contradict rules codified by Gould (though to be fair, the Gould postdates Strange).[16] Fallowfield identified issues with the presentation format of *The Contemporary Violin* in the literature review of her thesis:

> 'The reader will find [information about col legno battuto] under the first chapter heading: 'Bowing Technique', the subheading 'Col legno battuto'. Later, chapter three: 'Percussion Techniques' includes the subheading 'The Bow', in which col legno battuto is described again.'[17]

Though the scope of my study is significantly smaller in scale, presentation of the findings is paramount to maintain accessibility as a resource. Given that my study focuses on harmonic based extended techniques, overlap of techniques such as multiphonics is possible, and therefore needs to avoid the structural pitfalls of Strange's layout where information is repeated. Fallowfield's later concern of a need for a balance between subjectivity and level of detail when describing technique and sound is also relevant to both the Strange book and doubly so to the study. These manuals merely describe the qualities of various techniques, whereas my study will be dealing with the compositional applications of the techniques. Taking the extra-musical content such as blending, appropriateness for use in pitch sets, and other aspects of composition into account poses a threat to the usability of my study due to information overload. Marcus Weiss and Giorgio Netti discuss the reasons for

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15. Patricia Strange and Allen Strange, *The Contemporary Violin: Extended Performance Techniques*, 1st ed. (Los Angeles, California: University of California Press, 2001).

16. Strange and Strange, *The Contemporary Violin: Extended Performance Techniques*, 134; Gould, *Behind Bars*, 257-258.

17. Fallowfield, "Cello Map: A Handbook of Cello Technique for Performers and Composers," 12.

limiting their study to extended techniques in the introduction to their book *The Techniques of Saxophone Playing*, stating:

> 'It might indeed be conceivable to compile a multi-dimensional "Encyclopaedia of Saxophone Playing" [, however] the demands on presentation and readability would be so complex as to make such a text impractical'[18]

So far, all of the literature reviewed (with the exception of the Gould and other engraving manuals) has been written either with the performer in mind, or has been written by an instrumentalist. Much of the composer-focused literature is found in the form of orchestration manuals, such as Samuel Adler's *The Study of Orchestration* and Walter Piston's *Orchestration*.[19] Attempting to cover the breadth of the art of orchestration, let alone composition, necessitates the omission of extended techniques. This is the inverse of the issue Weiss and Netti encountered, where their study required an omission of ground-level theory regarding the technical aspects of saxophone playing. Read's *Compendium of Modern Instrumental Techniques* touches upon multiphonics, but delegates to Dick, Howell, and many of the other books from Turetzky's *The New Instrumentation* series for notation and structure.[20] It becomes apparent that no matter the author, instrument, or technique, the work of packaging extended technique information for composers is left to somebody else. Composers seek to cover the entirety of the craft, while performers seek to cover the entirety of the instrument. Therefore, there is a dearth of resources for composers seeking to incorporate harmonic based extended techniques into their practice. My study addresses this by covering the playability, notation, and implementation of harmonic based extended techniques across relevant instruments.

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18. Marcus Weiss and Giorgio Netti, *The Techniques of Saxophone Playing* (Kassel: Barenreiter-Verlag Karl Votter, 2010), Introduction.

19. Samuel Adler, *The Study of Orchestration*, Third Edition (New York: W. W. Norton & Company, 2002); Walter Piston, *Orchestration*, First Edition (London: Victor Gollancz Ltd., 1969).

20. Read, *Compendium of Modern Instrumental Techniques*, 160.

Through practice-based research, the exegesis produced by my study will document the process of composing using these techniques, refining the methodology and notation through the creation of several new works. The resulting document will fill a hole in literature aimed at composers by acting as a practical manual for those interested in implementing harmonic based extended techniques in their own practice.

Methodology

My research topic "Harmonic Based Extended Techniques and their Compositional Applications" is a review of techniques, and how they can be incorporated in my own practice. As such, it is highly subjective, and the research methodology will reflect this, being largely qualitative based. Quantitative based research, such as the analysis of techniques using spectral analysis will be used to support subjective claims. Each technique will be reviewed individually, as they are discrete from one another. Because many of the techniques are uncommon or difficult, consultation with players is paramount to undertake a fair assessment of the techniques. Document analysis of technique manuals will augment oral history research into the qualities and attributes of techniques.

To make an educated opinion on the value of a technique, data must first be collected. Compilation of techniques both in isolated, controlled environments, and in context in musical works will allow a full and accurate use of the analytical method on recordings. Using a Fast Fourier Transformation as in Riera's thesis on saxophone multiphonics, the prominent harmonics of each technique will be uncovered, for harmonic analysis.[21] Examination of techniques in musical context will allow for value judgements to be made about the musical effectiveness of the technique. The recorded data will be treated, and then interpreted and analysed, with the results being implemented in new works.[22] Through this process, my research will feed into my practice.

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21. Pablo Ernesto Riera, Martín Proscia, and Manuel Eguía, "A Comparative Study of Saxophone Multiphonics: Musical, Psychophysical and Spectral Analysis," *Journal of new music research* 43, no. 2 (2014): 202–213, accessed May 9, 2019, https://login.ezproxy.utas.edu.au/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=rih&AN=A891785&site=eds-live.

22. Rita Torres and Paulo Ferreira-Lopes, "Multiphonics as a Compositional Element in Writing for Amplified Guitar (2)," *Journal of Science and Technology of the Arts* 4, no. 1 (December 27, 2012): 61–69, accessed May 9, 2019, doi:10.7559/citarj.v4i1.67, http://artes.ucp.pt/citarj/article/view/67.

A holistic approach, taking both the sound possibilities and the player implications ("is this technique too difficult for the average player?", "do I need to write for specific artists if I want to use this technique?", etc.) is necessary to evaluate its overall potential for incorporation in my practice. To overcome this, oral history methodology will be used to gather first-hand experiences and opinions on techniques. In Barnett's "Aspects of Vocal Multiphonics", she conducts several interviews with singers to better understand the way the technique functions from a performer's perspective.[23]

Interviewing musicians able to play these techniques will deepen my understanding of the mechanics and technical aspects of creating these techniques. While my research is concerned with how I personally can incorporate these techniques into my practice, an effort to interview peer composers will be made, especially those that share common compositional traits with me. Their experiences with composing for these extended techniques will provide more data points to draw comparisons from, and contemporary composer's compositions and feedback were a valuable component of Dr. Sarah Watts' thesis to assess the effectiveness of the techniques.

Augmenting the interviews, document analysis will be used on technique manuals that detail the production and quality of techniques. By building off the framework of classification articulated in Robert Dick's seminal *The Other Flute* and extending it to accommodate a variety of techniques, comparisons across different techniques will be able to be made.[24] Through this, an understanding of the technical and mechanical aspects of the techniques will be gained. Techniques will be assessed

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23. Bonnie Mara Barnett, "Aspects of Vocal Multiphonics," *Interface* 6, nos. 3-4 (December 1977): 117–149, accessed May 9, 2019, doi:10.1080/09298217708570239, http://www.tandfonline.com/doi/abs/10.1080/09298217708570239.

24. Dick, *The Other Flute*.

on their practicality, ease of use, timbral qualities, and compatibility with my practice. Notation for the techniques varies from composer to composer, and where a common notational standard has not been developed (such as violin subharmonics), a document analysis of current notational standards will be undertaken, making reference to Elaine Gould's seminal text on music notation, *Behind Bars*.[25] Through this, and subsequent consultation with players, development of a consistent and effective notational language can be achieved.

Through the collection of data from a multitude of sources and a range of different methods, it will become evident how harmonic based extended techniques are to be treated idiomatically. By undertaking a holistic review of the techniques including performer and composer points of view, the qualitative research I perform will enable not only me to incorporate these techniques into my own practice, but future composers that are interested in these techniques.

25. Gould, *Behind Bars*.

Chapter 2

Assessment of Harmonic Based Techniques and Repertoire

Goals for this chapter:

1. Explain sound production of stringed instruments. 2. Explain the way in which the techniques differ from standard sound production. 3. Explain the qualities of the techniques. 4. Explain the notation.

Harmonic based techniques invariably make use of the harmonic series in one way or another. The harmonic series is a sequence of tones in which the frequency of each is an integer multiple of the fundamental frequency. The earliest forms of tuning systems were based around these, but modern instruments are tuned using equal temperament. The pitch of sound on stringed instruments is determined via tension, effecting the speed (and consequently pitch) the string vibrates at. Altering the tension is most commonly achieved via fingerings on the instrument's fingerboard, but bow pressure can also play a part in pitch production (see subharmonics).

The objective categorisation of techniques is a Sisyphean task due to the variability of the techniques, but general guidelines can be made; Dick's *The Other Flute* makes good use of quantifying qualitative data about the properties of multiphonics, and the idea of his tables will be used, adapting the format to each technique.[1]

To be able to pass any judgement on the techniques, we must first understand these techniques' capabilities, limitations, qualities, considerations, and values. Without references to other composers' works, any implication of authority on what constitutes as 'idiomatic' writing is baseless. As such, references to other works will be used to support claims. Where no such references are available, it will be marked

1. Dick, *The Other Flute*, 84.

as the author's personal opinion. Even without any available references to substantiate compositions as idiomatic, their creation contributes to the literature, and thus can be used if not as an example, a warning on what not to do.

Background

All of the techniques covered in this exegesis involve the excitation of a string instrument's string in a non-standard way. A small amount of understanding the physics behind these techniques is required, though they are not fully understood. Strings create sound via the Helmholtz motion, which

Subharmonics are perhaps a misnomer, and do not *technically* fall under the branch of harmonic based techniques. This is because their production is not by ways of the overtone (or undertone) series, as the pitches that can be produced do not follow any discernable ratio based pattern.

Subharmonics

First discovered by Mari Kimura, subharmonics are a type of overpressure which produces a sound lower than the fundamental.[2] When the bow is drawn across the string, the drag of the bow twists the string, creating torsional oscillation. Under the right conditions, these can interact with the string to produce an identifiable pitch lower than the fundamental.[3] One of the newest string techniques, subharmonics are still in their comparative infancy, and their notation has not been formalised.

Subharmonics represent an incredible opportunity for solo string repertoire. On higher pitched instruments, their use can provide harmonic support (particularly in cadenza passages) and extend the range of the instrument. On lower pitched instruments, subharmonics function better as a timbral mechanic, much like overpressure.

Subharmonics are explored in my works *the veldt*, and *doppelganger*.

Subharmonics in the literature

Subharmonics share a common relative with woodwind and brass instrument in pedal tones. They operate in similar ways, though the method of production differs greatly, and the reliability of production of subharmonics is much lower than the equivalent on brass instruments. Because of these commonalities, it is not unreasonable to make comparisons between subharmonics and its equivalents, especially in regards to notation and implementation in works.

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2. Mari Kimura, "How to Produce Subharmonics on the Violin," *Journal of new music research* 28, no. 2 (1999): 178–184, accessed April 11, 2019, https://login.ezproxy.utas.edu.au/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=rih&AN=A212434&site=eds-live.

3. "Subharmonics.," *New Scientist* 191, no. 2571 (September 30, 2006): 60–60, https://login.ezproxy.utas.edu.au/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=asn&AN=22720971&site=eds-live.

Possibly the first person to make use of the technique, Crumb described what we know as subharmonics as 'pedal tones'.[4] The use of square noteheads and a separate stave for the resultant pitch makes the technique clear and readily understandable.[5]

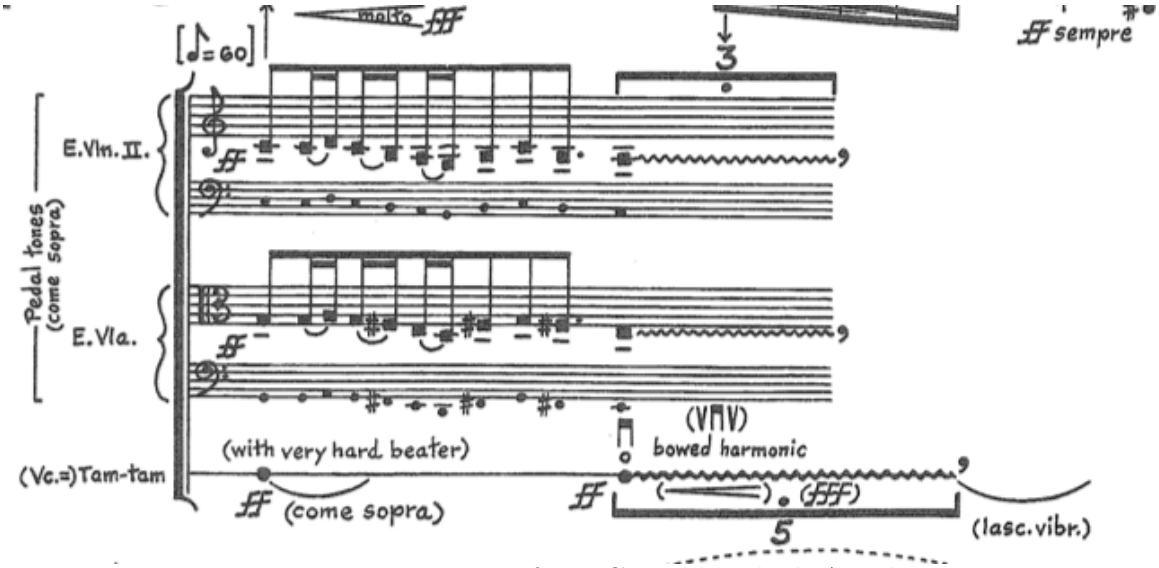

Figure 2.1: Excerpt from Crumb's *Black Angels*

Gerard Grisey's *Vortex Temporum* features overpressure, with a subharmonic of specifically a seventh.[6] He notates the subharmonic technique using a triangular filled notehead showing the intended pitch, along with a double down-bow, with an arrow above it, shown in Figure 2.2. Somewhat abstracted out, this hides the intended effect behind symbols, and is slower to sight read.

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4. George Crumb, *Black Angels (Images 1) [Music] : Electric String Quartet.* (Peters, 1971), `https://login.ezproxy.utas.edu.au/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=cat02831a&AN=UTas.b1139221&site=eds-live`.

5. *Black Angels*, in collab. with George Crumb and Cikada Quartet (London: Cala Records, 1995).

6. Gerard Grisey, *Vortex Temporum.*

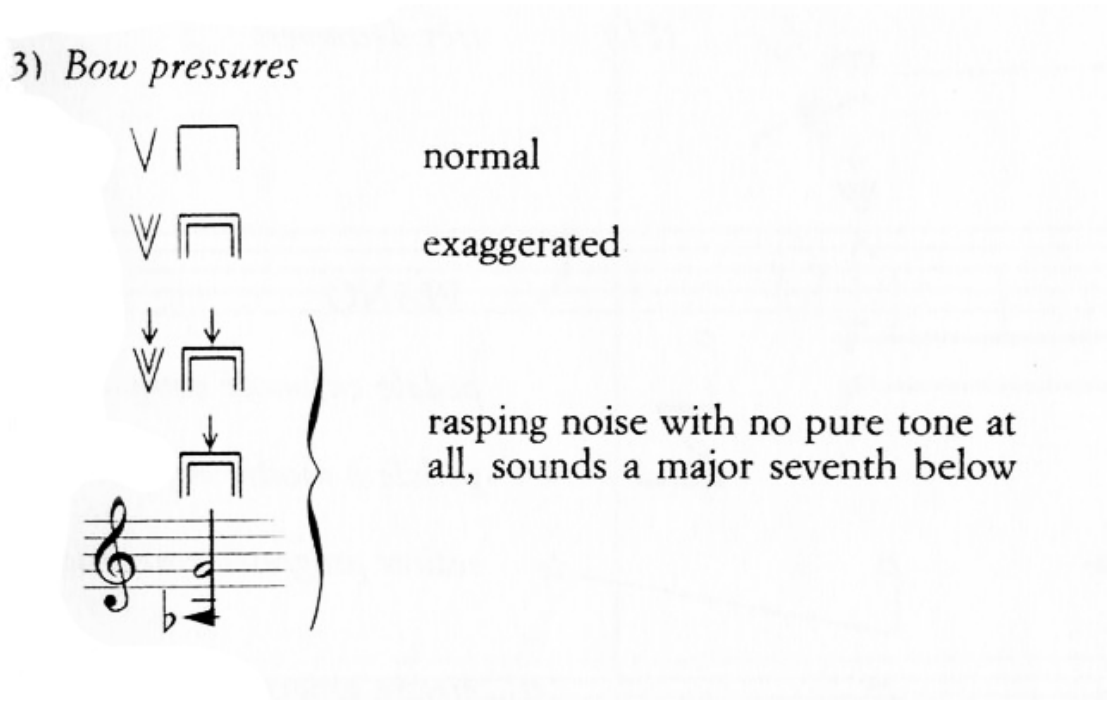

Figure 2.2: Excerpt from Grisey's playing instructions for *Vortex Temporum.*

Mari Kimura's *Gemini* (Figure 2.3) is an example of idiomatic usage of subharmonics on the violin.[7] Kimura's notation practice of using a harmonic denoting the intended pitch below the fundamental is similar to the standard notation of harmonics, which Gould states is to 'write harmonics as the player will finger them.'[8] Unfortunately, this method proved somewhat counterintuitive in practice, as the notation was too similar, and caused sight reading issues.

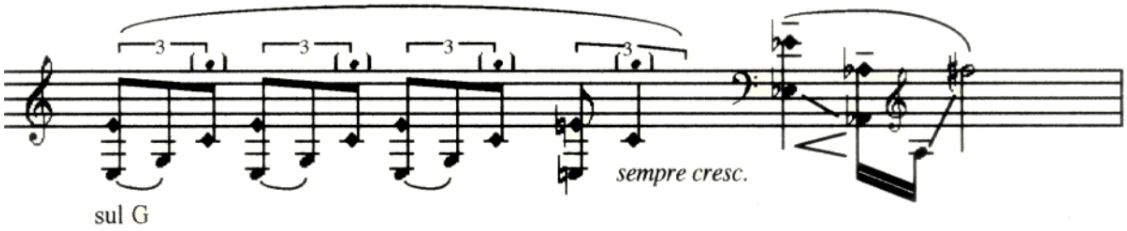

Figure 2.3: Excerpt from Kimura's *Gemini*

7. Mari Kimura, *Gemini*, 1992.

8. Gould, *Behind Bars*, 413.

Botting notes that experimentations with octavic subharmonics yielded a pitch slightly flatter than an octave. He states

> 'I developed a left hand finger technique whereby I rotate my hand slightly clockwise, pivoting on the finger stopping the string, which has the effect of sharpening the subharmonic enough to be more in tune with the fundamental.'[9]

Players may find that subharmonics are easier on older strings, and they may also find that adding twists to the string may also help, or hinder the production of subharmonics, as shown in Table 2.1.[10]

Table 2.1: Relation between twists in string and resultant subharmonics

	1/2	1	2	3	4	5	6
minor 2nd	x	x					
major 2nd	x	x					
minor 3rd	x	x	x				
major 3rd	x	x	x	x			
perfect 4th				x	x		
diminished 5th					x	x	
perfect 5th	x					x	x
minor 6th							x
octave	x	x	x	x	x		

Sekulic describes subharmonics as:

> '[. . .] a sound that sounds an octave lower than g string. To produce this sound it is of great importance the use of bow [sic]- the place, speed, and pressure. It is however extremely unsustainable and unpredictable, thus it is difficult to use it much in the compositions.'[11]

9. Thomas Botting, "Developing a Personal Vocabulary for Solo Double Bass Through Assimilation of Extended Techniques and Preparations" (Thesis, University of Sydney, 2019), 111, https://ses.library.usyd.edu.au/bitstream/2123/20352/1/botting_ta_thesis.pdf.

10. Kimura, "How to Produce Subharmonics on the Violin."

11. Dejana Sekulić, "Do You Hear Me?" (Essay, Royal Conservatory Brussels, 2012), 15, http://dejanasekulic.com/essay-do_you_hear_me.pdf.

Sekulic erroneously claims that subharmonics are solely producible on the G string, and can only produce an octave. Kimura's work, and my own experiments on a contrabass show that subharmonics are possible on any string, and octaves, major sevenths, and minor seconds are all readily achievable without specialist practice.[12]

Notation of Subharmonics in the literature

The example used on Long's website, *The Modern Double Bass* (Figure 2.4) features a square notehead with the intended sound at pitch in a bracketed notehead, with harmonics and a technique line of 'S.H'.[13]

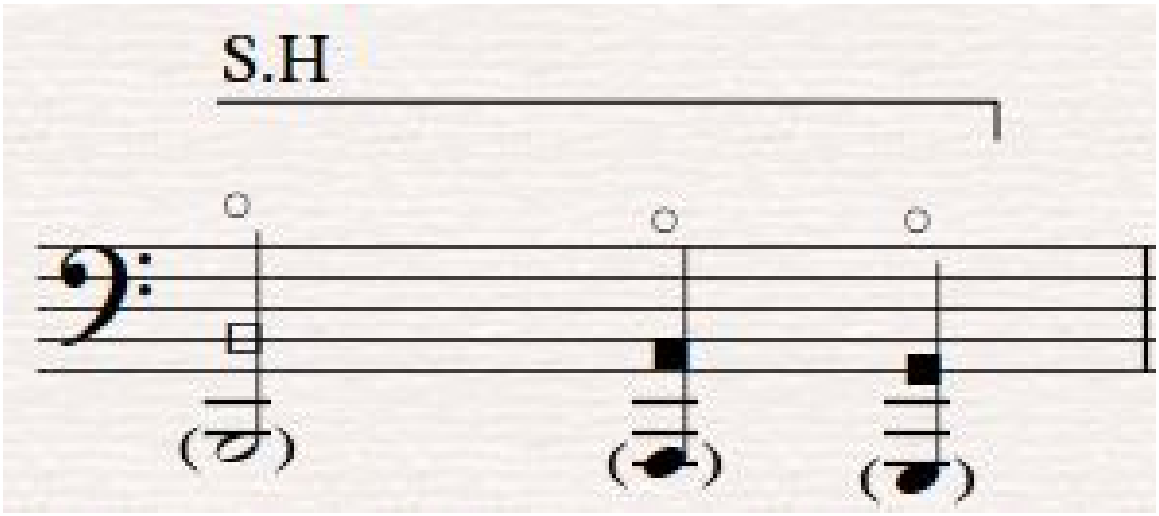

Figure 2.4: Notation of subharmonics from Long's website, The Modern Double Bass [14]

It is the author's opinion that this is somewhat redundant, as just square noteheads with the intended produced pitch would be enough to delineate the technique. The technique line is supernumerary, and it would only be advisable to use it in extended passages of uninterrupted subharmonics.

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12. Kimura, "How to Produce Subharmonics on the Violin."

13. Ashley John Long, "Subharmonics," 2019, accessed September 21, 2019, `https://www.themoderndoublebass.org.uk/subharmonics.html`.

Jean-Claude Risset's *Variants*, written for Kimura, is a work that makes use of both subharmonics and digital processing of live sound.[15] It uses a separate stave for the subharmonics and digital processing, as seen in Figure 2.5.

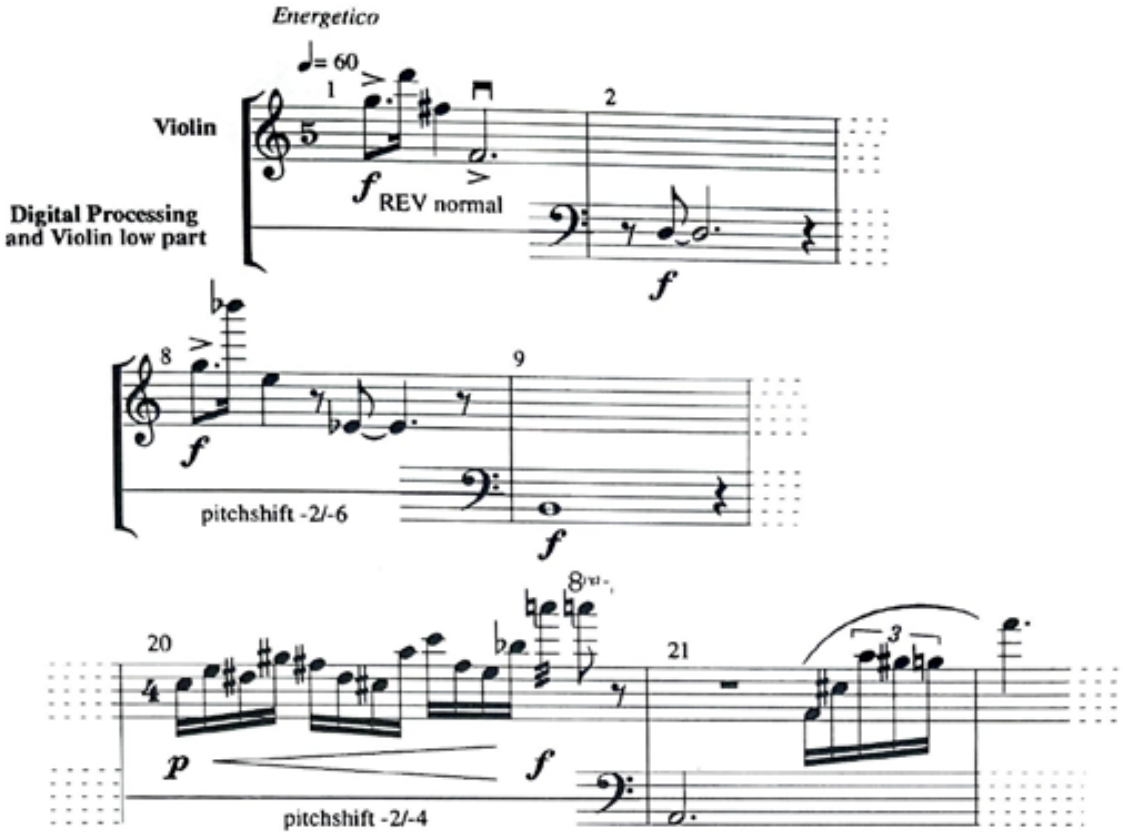

Figure 2.5: Excerpt from Risset's *Variants*

Rowe also wrote a work for Kimura, and uses a regular notehead for fingering, with a square bracketed cue sized notehead, as seen in Figure 2.6.[16] This combines the best of both worlds, keeping the score free from clutter when not needed. It should be noted that Rowe uses notation that has fallen out of style to notate *normale* harmonics, notating the fingering position with the diamond notehead, and

15. Jean-Claude Risset, *Variants*, 1995, `http://composers21.com/compdocs/rissetjc.htm`.

16. Robert Rowe, *Submarine*, 1996 (revised 2004).

the resultant pitch with a harmonic circle above it. Harmonic circles always denote resultant pitch, and the inclusion of the fingering obfuscates this.[17]

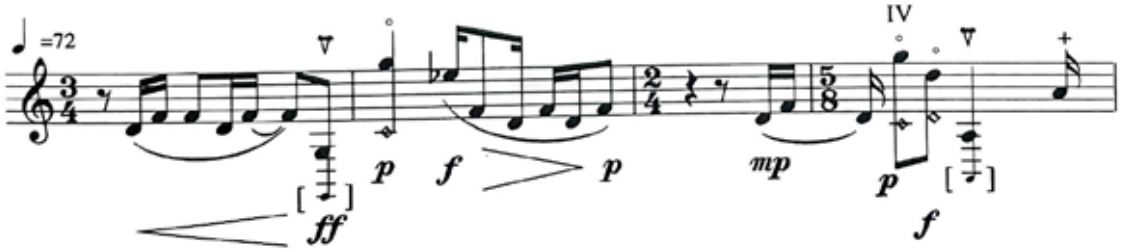

Figure 2.6: Excerpt from Rowe's *Submarine*

17. Gould, *Behind Bars*, 420.

Multiphonics

Multiphonics are most commonly the domain of wind, and occasionally brass instruments, but they are an emerging technique in string writing. They are produced when fingerings split the string between two natural harmonics, allowing for the string to resonate at multiple frequencies. Multiphonics on stringed instruments are difficult, but with appropriate preparation and notation, are feasible. Production of multiphonics, as with wind instruments, is not guaranteed, and can be dependant on a variety of external factors, including the humidity, make of the instrument, bow used, and other variables that are outside of the control of a composer.

Multiphonics are fragile, and require much preparation to execute reliably. Despite this, they can be used to achieve harmonies that are not otherwise achieveable through double-stopping, and lend themselves well to drawn out or slow passages of music. Multiphonics' exact pitching makes them ideal for music that uses ratios, microtones, or tone rows.

Multiphonics are explored in my piece for violoncello, *crossing the rubicon*, and contrabass work *the veldt*.

Multiphonics in the literature

Fallowfield explores multiphonic production on the cello in her thesis CelloMap comprehensively, with video recordings of all possible multiphonics and permutations, including pizzicati.[18] These are isolated, though, and give little indication to the difficulty of the multiphonics.

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18. Fallowfield, "Cello Map: A Handbook of Cello Technique for Performers and Composers."

Ashley John Long's 'The Modern Double Bass' website serves a similar purpose as Fallowfield's CelloMap for the double bass.[19] He divides them into different categories as detailed in Table **??**, some of which have more information and detail than others.

Type	**Description**
'Natural' multiphonics	Chart of different fingerings, similar to Fallowfield.
Pizzicato multiphonics	Description of technique, production, and result.
Textural multiphonics	Description of technique, production, result, and considerations.
Multiphonics behind the bridge	Description of technique.
Artificial multiphonics	Chart of different fingerings, similar to Fallowfield.
Percussive multiphonics	Description of technique, production, result, and considerations.
Timbral multiphonics	Description of technique.
Transformative multiphonics	Description and production of technique
Multiphonics through Variations in Finger Pressure	Description of technique, production, result, considerations, and example.

Despite the varying degrees of detail, his work on cataloguing multiphonics is more in depth than many other resources.

Notation of Multiphonics in the literature

It should be noted that multiphonics are markedly different to the multiphonics of wind instruments due to the fingering systems. While wind instruments achieve multiple tones by exploiting the construction of their instrument, string multiphonics are produced agnostic of specific fingerings. As such, the challenges that string multiphonic notation face are different to wind instruments. With no fingering chart necessary, string instrument multiphonics also have no frame of reference for what sounds can be expected to be produced. String instruments also are not solely monophonic instruments, so notating the resultant multiphonic on the stave produces confusing results. Compounding this issue, string instruments are a subset of harmonics, which use a different notehead to denote the fingering pressure

19. Ashley John Long, "The Modern Double Bass," accessed September 2, 2019, `https://www.themoderndoublebass.org.uk/`.

difference. This means that any resultant pitches would need to be notated with regular noteheads, to discern the fingering pitch from the resultant. Therefore, another system of denoting multiphonics must be used, as the existing wind literature is not suited for the purpose.

Buene uses a chart of diamond noteheads with their corresponding intended multiphonic in the score for his work for two double basses, *Blacklight*.[20] It mimics Fallowfield's charts of corresponding nearby quartertones, though the diamond notehead is already used in common repertoire for harmonics, not an extended technique. This has the potential to cause confusion, and could be easily avoided with a symbol or 'M' denoting the special quality of the multiphonic.

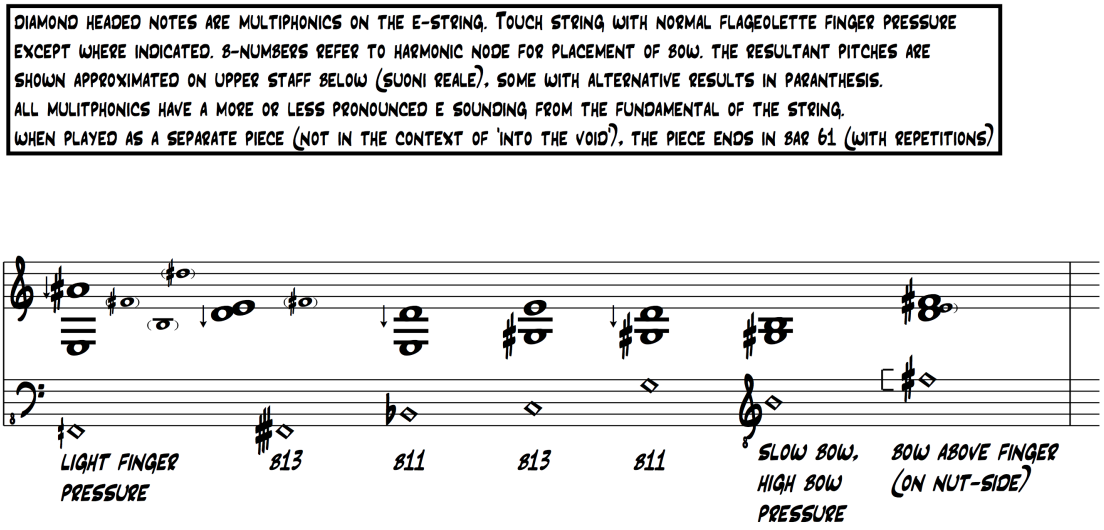


Figure 2.7: Excerpt from Buene's Blacklight.

Thelin's thesis on double bass multiphonics states:

> 'Multiphonics is [sic] always notated with the harmonic diamond sign, in tablature notation indicating finger positions rather than musical pitches. I suggest using the symbol M. above or below the note to indicate that it is a

20. Håkon Thelin, "Multiphonics on the Double Bass" (Norwegian Academy of Music, 2011), 39-42, http://haakonthelin.com/multiphonics/uploads/files/4%20Multiphonics/Multiphonics%20on%20the%20Double%20Bass.pdf.

multiphonic sound, together with the indication on which string to play the note (in Roman numerals).'[21]

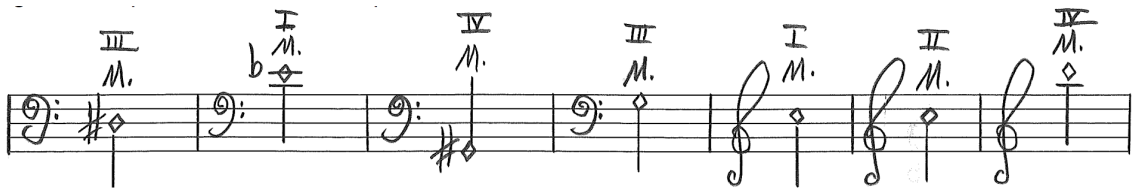


Figure 2.8: Excerpt from Thelin's thesis.

His notation suggestion is a somewhat less sophisticated version of Fallowfield's suggestion to notate the approximate pitch down to the cent necessary to produce the multiphonic. Due to the symmetry of the production of harmonics on the string, Fallowfield specifies both upper and lower positions necessary to produce the same multiphonic.[22]

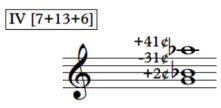
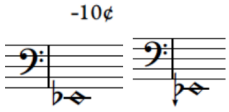
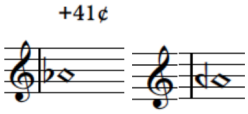
Multiphonic	Resulting pitches	Location of multiphonic on the lower half of the string (the position of the highest contributing harmonic) LH side: exact position RH side: approximate position	Location of multiphonic on the upper half of the string (the position of the highest contributing harmonic) LH side: exact position RH side: approximate position
IV [7+13+6]			

Figure 2.9: Excerpt from Fallowfields's website.

[23]

21. Thelin, "Multiphonics on the Double Bass," 6.

22. Fallowfield, "Cello Map," index/the-string/multiphonics-and-other-multiple-sounds/fingeringcharts.html.

We can see this in practice in Oliver Thurley's work for solo contrabass, *yet another example of the porousness of certain borders*, where he adds another stave showing the intended pitches to be produced.[24]

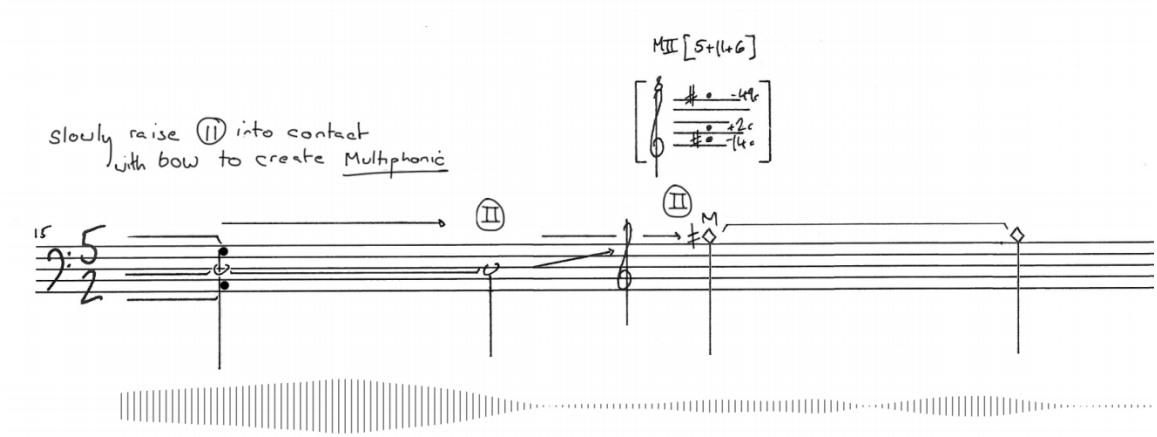


Figure 2.10: Excerpt from Thurley's *yet another example of the porousness of certain borders*

Thurley embraces the fragility of these multiphonics, and uses their variability as a feature, rather than a hindrance. Slow, quiet transitions between multiphonics, double-stopped harmonics, and other extended techniques make the occasional unintentional destabilisation of a multiphonic a point of textural interest, rather than a flaw.

It becomes apparent through the examination of the literature surrounding multiphonics that they are still an emerging technique, but are not shrouded in mystery or disinformation as subharmonics are.

24. Oliver Thurley, *Yet Another Example of the Porousness of Certain Borders*, 2014, `http://oliverthurley.co.uk/scores/yaeotpocb-score.pdf`.

Half-Harmonics

Half-harmonics is a term assigned to the fingering pressure found somewhere in between a regular note and harmonic. The technique is not difficult to produce, and the resultant sound is not dissimilar to the fragility of a multiphonic, producing both the fundamental pitch, and the harmonic. It should be noted that the half-harmonic is a modifying left-hand technique; it can be applied to multiphonics (although the resultant sound would likely be more noise than discernably either of the two techniques), but is not compatible with subharmonics due to the bow pressure needed to produce subharmonics eliminating the possibility of half-harmonics being produced. The terminology has not been formalised, but is most widely known as half-harmonics, although some works describe the technique without ascribing a name.

Half-harmonics are explored in my work for violin, *what are you doing with the humans*.

Half-harmonics in the literature

Half-harmonics, like the other techniques covered in this exegesis, have relatives in the wind and brass literature. Half-fingered and half-valved techniques appear in the respective nomenclature, and share common attributes of speaking poorly with bleedover into partials with the half-harmonic technique. Unlike multiphonics, the mechanical production of the technique is not dissimilar to the wind and brass facsimiles; all three families' respective techniques revolve around pressing almost to the point of a *normale* sound, but not quite, resulting in a pinched sound. Because of this, it is not unreasonable to draw parallels between the half-valved and fingered literature, and half-harmonic literature.

Half-harmonics do not feature heavily in the literature, with the most notable work being Sciarrino's 6 Caprices for solo violin.[25] It should be noted that Sciarrino wrote these in response to Paganini's caprices. They appear to take the same approach to composing in the same philosophy as New Complexicists, in the sense that the written score is the Platonic ideal, and that approximations are all that are expected. This is supported by the fact that many performers play them as harmonics.

Lachenmann also makes use of them, and states it is

> [...] 'important not to produce any harmonics here; the result should be a veiled, almost immaterial and hardly perceptible coloring of the dominating string sound produced by the stopped note'[26]

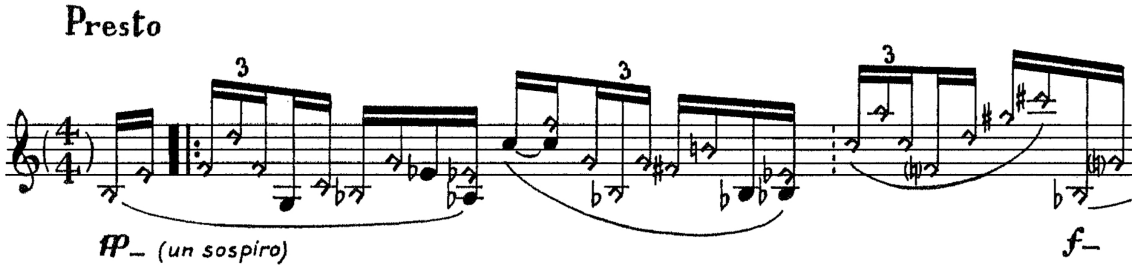


Figure 2.11: Excerpt from Sciarrino's 5th capriccio from *6 Capricci for Violin*

Sekulic adds to this quote, stating in *Do you hear me?* that the stopped note:

> '[...] which, as indicated, is only lightly touched, in conjunction with the flautato bowing.'[27]

25. Salvatore Sciarrino, *6 Capricci Per Violino*, 1976.

26. Helmut Lachenmann, *Musik Für Streichquartett*, 1972, foreword.

27. Sekulić, "Do You Hear Me?," 28.

Notation of half-harmonics in the literature

Perhaps the most straight-forward technique covered in this exegesis, notation for half-harmonics have just a single variable of finger pressure to convey in notation. The use of standard notation, modified to reflect the idea that the technique fits in 'half way between' two well established techniques (normale and harmonics) would be ideal, conforming to Gould's ideology of maintaining uniformity.

Chapter 3

Compositions and Implementation of Techniques

My folio of works comprises of four pieces. *doppelganger*, for solo viola, *the veldt*, for solo contrabass, *crossing the rubicon*, for solo cello, and *what are you doing with the humans*, for violin. These works all deal with different facets of the techniques that I have researched in this exegesis. Through the process of practice based research and reflection on the implementation of these pieces, it is hoped that a clear identity of idiomatic treatment of these techniques will be elucidated. Shortcomings are still valuable data points due to the lack of information readily available about the treatment and usage of these techniques. It is envisaged that these works are to be used as etudes, both for musicians as testing grounds for the capabilities of the techniques, and for composers seeking to study scores to better understand how to implement these techniques in their own works. Through the process of journalling my compositional intent, it will become clear what the function of each piece is. Comparisons and contrasts to pre-existing literature and works will support the techniques' idiomacy.

Due to the scope of this exegesis and time constraints, it was not possible to obtain recordings of each piece in full. Excerpts have been recorded where possible, and are supported by examples of other works from the literature, and instructional videos that support the idiomacy of the treatment of the techniques. As the goal of the exegesis is to produce a practical document that future composers can refer to, the entirety of the scores are included in the appendices of this exegesis. To aid the reader in referencing the relevant document quickly, hyperlinks are provided initially to the corresponding scores. Excerpts are provided for further references to the scores.

Background

Implement the techniques in a musical context.

Research statement/problem

Compositions will show both how these techniques can be used idiomatically, and how they can inform my craft.

Aim and scope of thesis

Writing works which will increase the collective understanding of how to implement these techniques.

Significance of work

Incorporating these techniques into my compositional process will show the pitfalls and ways that these techniques can be used.

what are you doing with the humans

what are you doing with the humans is a solo work for violin that explores half-harmonics. It is a non-programmatic work, and the title was inspired by a question that my supervisor posed to me while I sought ethics approval for the exegesis. Half-harmonics are perhaps one of the simplest techniques to achieve, produced by applying finger pressure halfway between that required to create a harmonic, and a *normale* sound. This means that the scale of finger pressure is thus;

Table 3.1: Finger Pressure & Resultant Sound

Finger pressure	Result
Open	Fundamental
Touching	Harmonic
More pressure	Half-harmonic
Fingerboard	Normale

The one-dimensional nature of this facet of the techniques leaves little variability in the implementation of the technique. Thus, *what are you doing with the humans*explores the relationship between half-harmonics and other finger pressures. Rapid change between half-harmonics, regular harmonics, and *normale* makes the work an exercise in finger control, as well as an introductory work to half-harmonics. Below, I demonstrate the rapid changes of the half-harmonics in mm. 5 of *what are you doing with the humans*.

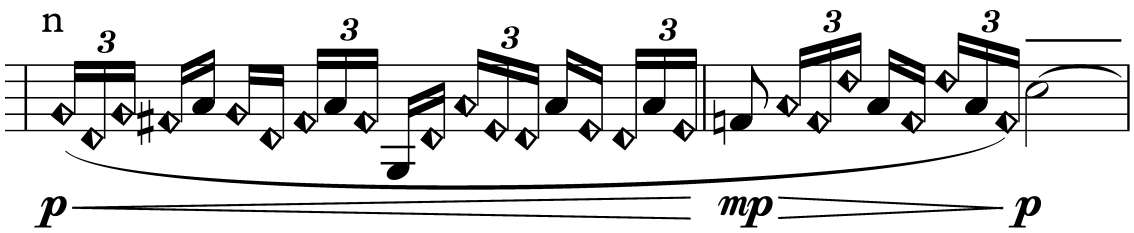


Figure 3.1: Excerpt from *what are you doing with the humans*

In mm. 27-32, I use the D string to provide additional available harmonics; the fifth D string harmonic, octave D string harmonic, and a fourth artificial harmonic using a stopped A are all readily available underneath the violinist's fingers. Thus, the difficulty is not in the fingering on the fingerboard, but the quick changes between harmonic, half-harmonic, *normale*, and artificial harmonic. Through this facet of eliminating needless complexity, the work serves as an etude targeting specifically the production of half-harmonics.

*what are you doing with the humans*takes inspiration from Sciarrino's fifth Caprice, and serves as a stepping stone to the more difficult work.[1] In practice, the pitch content of my work was obscured by the glassy texture of half-harmonics, rendering large portions of it as noise. With the knowledge that properly performed, the harmonic content would be obscured, I leant into this, writing in a more tonal style than I do usually.

1. Sciarrino, *6 Capricci Per Violino*.

Another facet of half-harmonics that I wanted to explore was the timbral aspect of them, bar 27 shown in Figure 3.2. Similar to a multiphonic in their rich harmonic content, half-harmonics do not have the purity of tone that regular harmonics have, and are more often a type of multiphonic, as evidenced by Fallowfield's example. I explore the interplay of half-harmonics, regular harmonics, and *normale*, double stopped minims and semibreves slowly changing from one mode of pressure to another. In this way, violinists that play *what are you doing with the humans*will become familiar with different modes of pressure played concurrently.

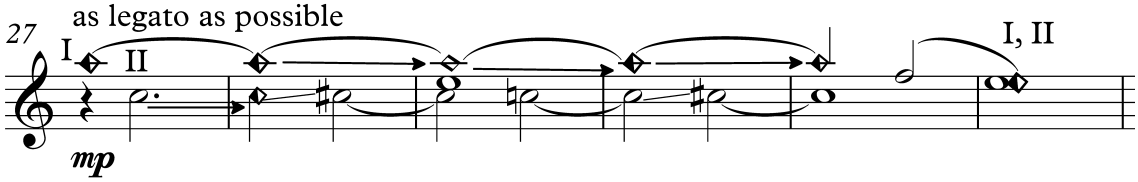


Figure 3.2: Excerpt from *what are you doing with the humans*

Notationally, the rapid changes between half-harmonics and other techniques were an ideal testing ground for different notation types. Notably, the issue of half-filled diamond noteheads not having any distinction between crotchets and minims is not an issue due to the bulk of the work dealing in smalled divisions of the beat. The considerations of how to best notate half-harmonics are discussed further in section 4.

Ultimately, I opted to implement the half-filled diamond noteheads, finding them to most accurately present the information in a way that was inobtrusive, and built upon pre-existing notation. It should be noted that this is contrary to the opinion set out in Dimpker's seminal thesis on notation, *Extended notation. The depiction of the unconventional*, but conforms to Gould's opinion on the matter.[2]

2. Christian Dimpker, "Extended Notation: The Depiction of the Unusual" (University of Plymouth, 2012), 120-121, `https://pearl.plymouth.ac.uk/bitstream/handle/10026.1/3184/2013Dimpker10320048PhD.pdf?sequence=3&isAllowed=y`; Gould, *Behind Bars*, 61.

doppelganger

*doppelganger*is a piece for solo viola, written to explore the lower register of the viola using subharmonics juxtaposed with upper harmonics. The pitch distance between subharmonics and harmonics sidestep the viola's usual role occupying the middle register.

Findings of *doppelganger*

Workshopping an early draft of *doppelganger*with a violist, I found that the pressure needed to 'find' a subharmonic was fleeting, and could not be reproduced for long periods of time. As such, I amended the score to treat subharmonics largely as a 'special effect', and not ascribe importance to their pitched content. I found that subharmonics are unable to be performed *laissez vibrer*, the force neccessary to achieve

crossing the rubicon

*crossing the rubicon*is an exploration in multiphonics. I wanted to explore multiphonics as I explored half-harmonics in the piece section 3. Unfortunately, while workshopping with Sarah, I found the non-binary nature of multiphonics precluded this from being a possibility. I discovered several facets of the technique that were not previously discussed in the literature found in Fallowfield's work.[3]

For each pair of nodes that produce multiphonics, the lower of the two is easier to pitch due to the logarithmic correlation between string length and pitch; that is to say, because the gaps between semitones are correlationally larger as the pitch lowers, the pitching can be more precise.

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3. Fallowfield, "Cello Map."

Double-stopped multiphonics are feasible, but because the angle of attack can impact the partials the multiphonic produces, the shift between single strings and double stopping can stop the multiphonic from speaking clearly. Aurally, double stopped multiphonics seem to be more effective with the *normale* note on a lower string than the multiphonic.

the veldt

Inspired by the eponymous short story by Ray Bradbury, *the veldt*is a composition for solo contrabass that explores both multiphonics and subharmonics. Similarly like the namesake, this world is filled with danger but also beauty. It is non-programmatic, and my intent with Veldt was to create a soundworld and space that the performer was able to 'roam around' in, and features several sections of improvisation on pitch-sets.

Findings of *the veldt*

Writing for contrabass, I found subharmonics came most easily on the G string. Subharmonics on the lower strings did not speak as well, and it was difficult to discern the lower frequency's shifts. Because of this, *the veldt*uses the technique as a textural tool, rather than a melodic or defined pitch.

Because of the techniques used, a second stave displaying the music notated at actual pitch was necessary. In contradiction of Gould's recommendations, I opted to notate it in treble clef, rather than treble transposed down an octave.[4] This is because the multiphonics activate partials well above those usually expected, resulting in the advice not being relevant.

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4. Gould, *Behind Bars*, 423.

Chapter 4

Findings and Research Implications

This is where I will be presenting my research as a manual for composers. Because my folio of works has some degree of overlap in usage of techniques, this chapter will deal with each technique, rather than be a review of findings from each piece singularly. Where relevant, I will include my experiences working with performers.

Due to the limited number of permutations of these techniques, the Dick model of categorization is unnecessary, as space is not at a premium.[1] It will also take into account how common the technique is, as well as notational challenges.

Subharmonics

Subharmonics are a difficult technique, that lend themselves to solo works, or works where they can be brought to the forefront. They are notably different to overpressure, but bleed over into non-pitched overpressure is common. This, plus the difficulty in their execution, makes them unsuitable for melodic content.

> 'To play subharmonics, one should place the bow at the 6th partial of the harmonic series of the fingered pitch, and bow with excessive pressure and an absolutely consistent speed. The increased pressure will distort the vibration of the string, producing a phase loop which, in turn, produces the subharmonic. Subharmonics are achieved through precise control of torsional oscillation, which usually produces the sound of an amateur string player's heavy handed, slow bowing. The production of subharmonics can be aided by using older strings (which work better due to fats building up on the strings). Making a counter-clockwise half-twist in the string can also make it easier to produce octave and major second subharmonics (additional twists can help achieve lower subharmonics, at the expense of higher ones).'

1. Dick, *The Other Flute*.

'In all cases for an octave subharmonic, the position will always be at the 6th partial of the harmonic series as it directly relates to the fingered pitch.'[2]

'Place the bow at the 6th partial of the harmonic series of the fingered pitch and bow with excessive pressure and an absolutely consistent speed. The increased pressure will distort the vibration of the string, producing a phase loop which, in turn, produces the subharmonic.'[3]

Curiously, older strings work better for production of subharmonics due to the fats that accumulate on the string, and the lower strings are more suitable due to the pressure needed.[4] Composers looking to use this technique should be aware that it is not a standard technique, and instrumentalists will need copious amounts of practice and guidance in order to fully realise this technique.

Instrument specific considerations for subharmonics

Subharmonics are easier to produce on the contrabass with a lighter bow, preferably a cello bow, or alternatively a French style bow.[5]

Notation of Subharmonics

Subharmonics should be notated with a square notehead, and a small notehead (optionally in parenthesis) at the desired pitch. The technique description and notation should be included in the performance notes. If the resultant pitch falls well outside the stave, a second stave can be used in the appropriate clef to ensure

2. Long, "The Modern Double Bass."

3. Ibid.

4. Kimura, "How to Produce Subharmonics on the Violin."

5. Long, "Subharmonics."

that the performer knows what pitch is intended, as seen in Figure 2.5.[6] It should be noted that Risset's notation omits a fingered pitch, which is not recommended.

Works featuring subharmonics

- Mari Kimura - 6 Caprices for subharmonics for solo violin, (1997)
- Mari Kimura -Gemini for solo violin, (1993).
- Mari Kimura -ALT in three movements for violin solo, (1992).
- Joshua Burel - Sonata No. 2 for violin and piano "Subharmonics"
- Jean-Claude Risset - Variants
- Robert Rowe - Submarine

Multiphonics

Multiphonics are easier to achieve on larger instruments, due to the need for precise ratio-based fingering to achieve the resonance of multiple partials. The technique description and notation should be included in the performance notes.

> 'Multiphonics are notated as a harmonic position, with an 'M' and the string number (I-IV). The theoretical sounding pitches are given in a bracketed staff above the main stave. String multiphonics are achieved through clusters of close harmonic nodes, and by playing a harmonic close to the highest partial. Above the sounding pitches, the sounding partials are given (i.e. M IV [4th + 13th + 9th + 15th + 5th]). Note that not all of these pitches will actually sound in practice. The bow should exert slightly more pressure than usual and should be drawn with a consistent speed which should be slower than for harmonics.'

6. Risset, *Variants*.

Instrument specific considerations for multiphonics

Notation of Multiphonics

Much has been written about multiphonics, and they are a well established technique in woodwind writing. The notation between them differs, though; precise fingering charts above resultant pitches do not translate precisely into string writing. Fallowfield's method of denoting the multiphonic with a diamond notehead is vastly preferable to the alternatives.

Works featuring multiphonics

- Mari Kimura - 6 Caprices for subharmonics for solo violin (1997)
- Andrew Greenwald - On Structure (2a) - for clarinet, violin, and cello
- Stefano Scodanibbio - composed e/statico (1980)
- Håkon Thelin - oibbinadocS (2004)
- Håkon Thelin - Glasperlenspiel (2010)
- Michael Liebman - Sonata for double bass, 2. movement Legato sonore
- Kaija Saariaho - Lichtbogen (1986)
- Kimmo Hakola - Thrust, Rubato (1989, rev. 1991)
- Eivind Buene - 'Blacklight' (2019)

Half-harmonics

Notation of Half-harmonics

Half-harmonics can be notated in one of several ways (see Figure 4.1), but regardless of the chosen symbol, should be included and described in the performance notes.

It should be noted the first and last of the examples in Figure 4.1 do not have discrete noteheads for crotchets and minims like regular diamond noteheads. As such,

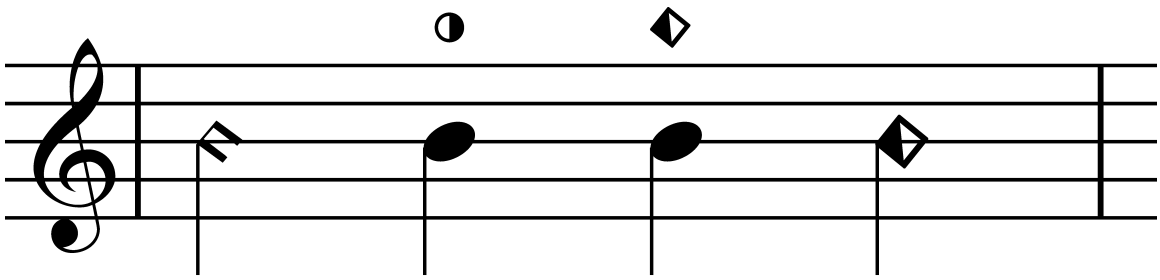

Figure 4.1: Half-harmonic notation examples

if there is rhythmic ambiguity, rhythms should be clarified above the stave as normal. The first example, as seen in Sciarrino's *Six Capricci for Violin* (Figure 2.11) shows the ambiguity of this. It should be noted that the 'slant' of the regular harmonic notehead is opposite to the unfinished diamond, going from up to down. This helps differentiate the two, but is perhaps not enough to make it easily distinguishable.

The second example unfortunately is not without issues, either; (*normale*) harmonics denoted with a circle are exclusively for the resultant pitch.[7] While half-harmonics *do* produce the notated pitch, rapid transitions between half-harmonics and *normale* harmonics using half-filled circles may cause confusion due to the translation between a symbol that denotes pressure needed and a resultant harmonic respectively, as illustrated in Figure 4.2 This is compounded by the circle notation's inability to handle harmonics that fall well outside the range of the staff (i.e. major 3rd and minor 3rd harmonics), resulting in a need for at least two types of notation; circular half-harmonics, and diamond noteheads for problematic *normale* harmonics.

The third example of notation displayed in Figure 4.3 is a non-standard symbol, and also suffers the same issues that plague the previous example.

Appending text rather than a graphic may produce good results, as seen in Figure 4.4.

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7. Gould, *Behind Bars*, 419.

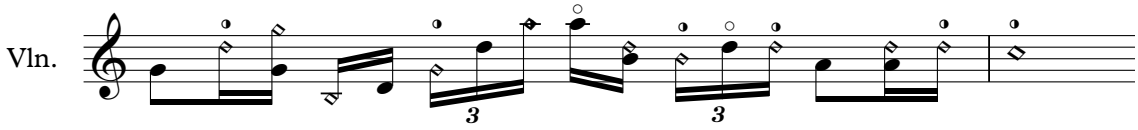


Figure 4.2: Half-harmonic circular notation

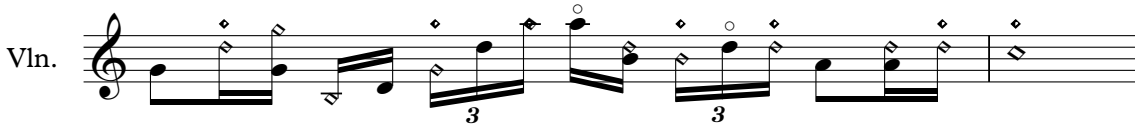


Figure 4.3: Half-harmonic diamond symbol notation

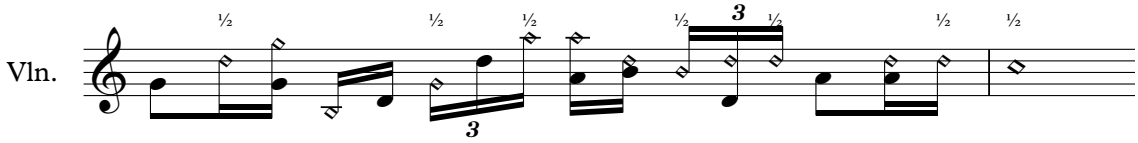


Figure 4.4: Half-harmonic displayed with text

Compare this with Figure 4.5 and Figure 4.6, which is an example of Sciarrino's half-empty notation as seen in Figure 2.11.

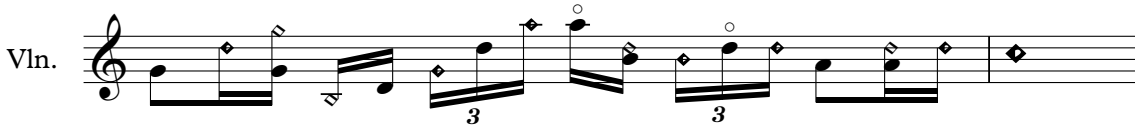


Figure 4.5: Half-harmonic half-filled notehead

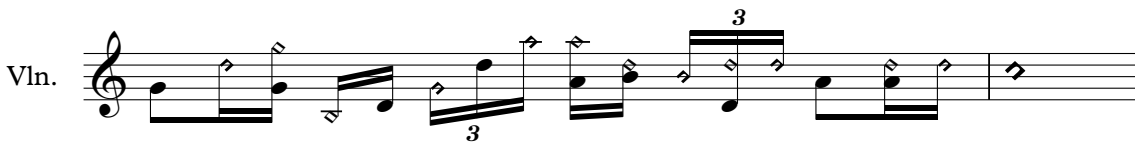


Figure 4.6: Half-harmonic half-empty notehead

It should be noted that the half-filled notehead as depicted in Gould and Figure 4.5, nor the Sciarrino style half-empty notehead as seen Figure 4.6 are not available in modern versions of Sibelius or Dorico as of the time of writing.[8] The flagship Standard Music Layout Font (SMuFL), Bravura, includes the half-harmonic circle as depicted in Figure 4.2, but is only available on Dorico and the Sibelius port of Bravura, Norfolk.[9]

Works featuring half-harmonics

- Robert Rowe - Flood Gate (1989)
- Salvatore Sciarriono - 6 Capricci for violin (no. 5) (1976)
- Helmut Lachenmann, Gran Torso
- Trevor Bača - Al-Kitab Al-Khamr (2015)
- Claudio Pompili - Scherzo Alla Francescana (1990, revised 1994)
- Mary Bellamy - Transference (?)
- Sam Park - The Colour of Light (2010)
- Jack Symmonds - Hell Is Murky (2018)

Reflection

Quisque ullamcorper placerat ipsum. Cras nibh. Morbi vel justo vitae lacus tincidunt ultrices. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. In hac habitasse platea dictumst. Integer tempus convallis augue. Etiam facilisis. Nunc elementum fermentum wisi. Aenean placerat. Ut imperdiet, enim sed gravida sollicitudin, felis odio placerat quam, ac pulvinar elit purus eget enim. Nunc vitae

8. Gould, *Behind Bars*, 424.

9. W3C Committee, "Standard Music Font Layout (SMuFL)," March 5, 2019, `https://w3c.github.io/smufl/gitbook/`.

tortor. Proin tempus nibh sit amet nisl. Vivamus quis tortor vitae risus porta vehicula.

In conclusion, these techniques are underrepresented because of a variety of reasons, one of them being that there is a lack of resources dedicated to writing for them. Nam dui ligula, fringilla a, euismod sodales, sollicitudin vel, wisi. Morbi auctor lorem non justo. Nam lacus libero, pretium at, lobortis vitae, ultricies et, tellus. Donec aliquet, tortor sed accumsan bibendum, erat ligula aliquet magna, vitae ornare odio metus a mi. Morbi ac orci et nisl hendrerit mollis. Suspendisse ut massa. Cras nec ante. Pellentesque a nulla. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Aliquam tincidunt urna. Nulla ullamcorper vestibulum turpis. Pellentesque cursus luctus mauris.

Impact and Further Research

This will help inform other composers interested in writing for these techniques. Further research can be carried out into other harmonic based techniques on wind and brass instruments. Nam dui ligula, fringilla a, euismod sodales, sollicitudin vel, wisi. Morbi auctor lorem non justo. Nam lacus libero, pretium at, lobortis vitae, ultricies et, tellus. Donec aliquet, tortor sed accumsan bibendum, erat ligula aliquet magna, vitae ornare odio metus a mi. Morbi ac orci et nisl hendrerit mollis. Suspendisse ut massa. Cras nec ante. Pellentesque a nulla. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Aliquam tincidunt urna. Nulla ullamcorper vestibulum turpis. Pellentesque cursus luctus mauris.

Appendices

FOR SOLO VIOLIN

what are you doing with the humans

October 21, 2019

Rhys Gray

Program Notes

*what are you doing with the humans*is a solo work for violin that explores half-harmonics. It is a non-programmatic work, and the title was inspired by a question that my supervisor posed to me while I sought ethics approval for my exegesis; a simple phrase laden with possible contexts, spurring the imagination to try and complete the meaning.

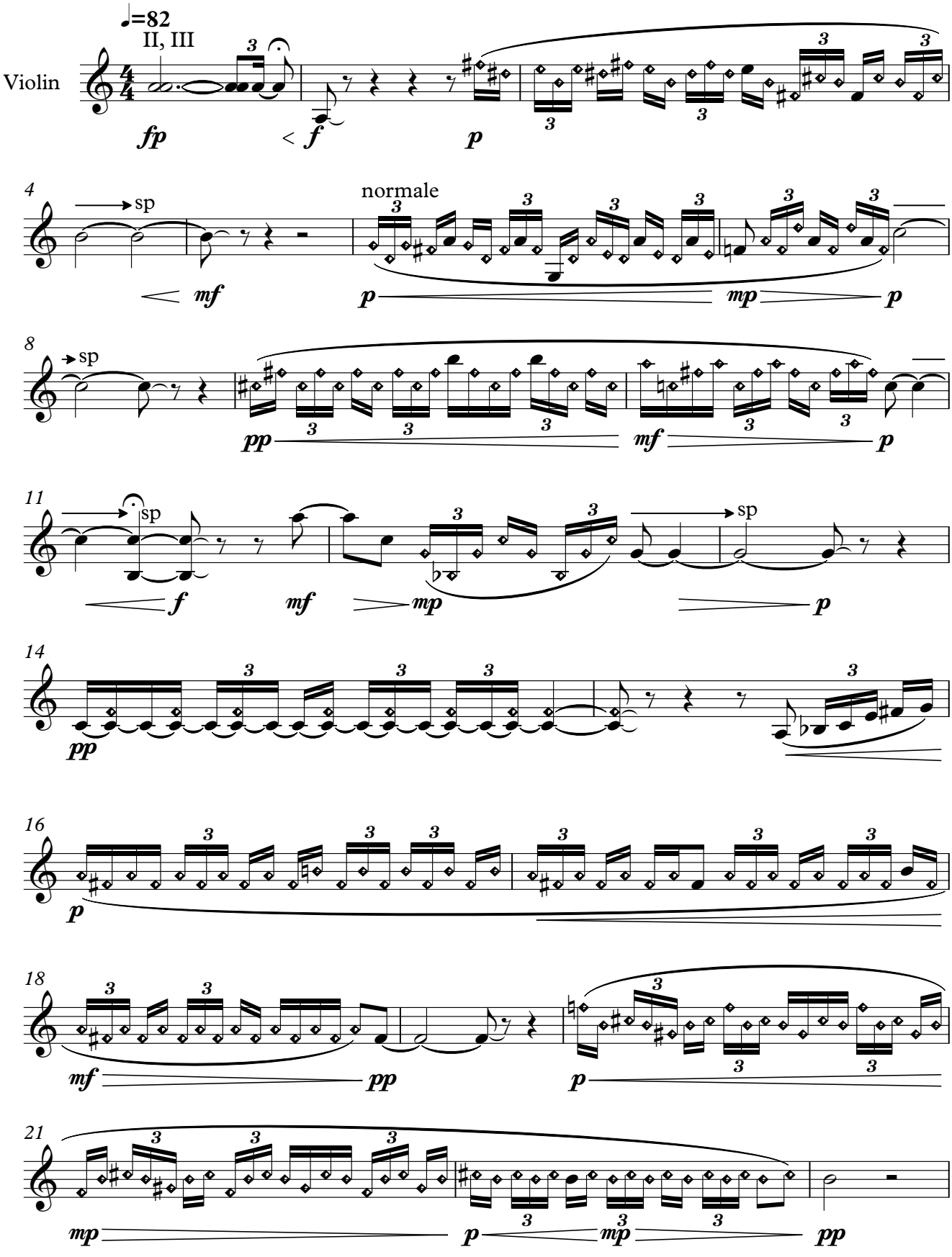
It is, in a way, an etude, treating the half-harmonics in a way similar to those found in Sciarrino's *6 Caprricio for violin*. Half-harmonics are produced by applying left hand finger pressure halfway between that required to create a harmonic, and a *normale* sound. The sound that is produced should be a mixture of the stopped string pitch, the harmonic pitch, and a resistant, slightly noisy quality.

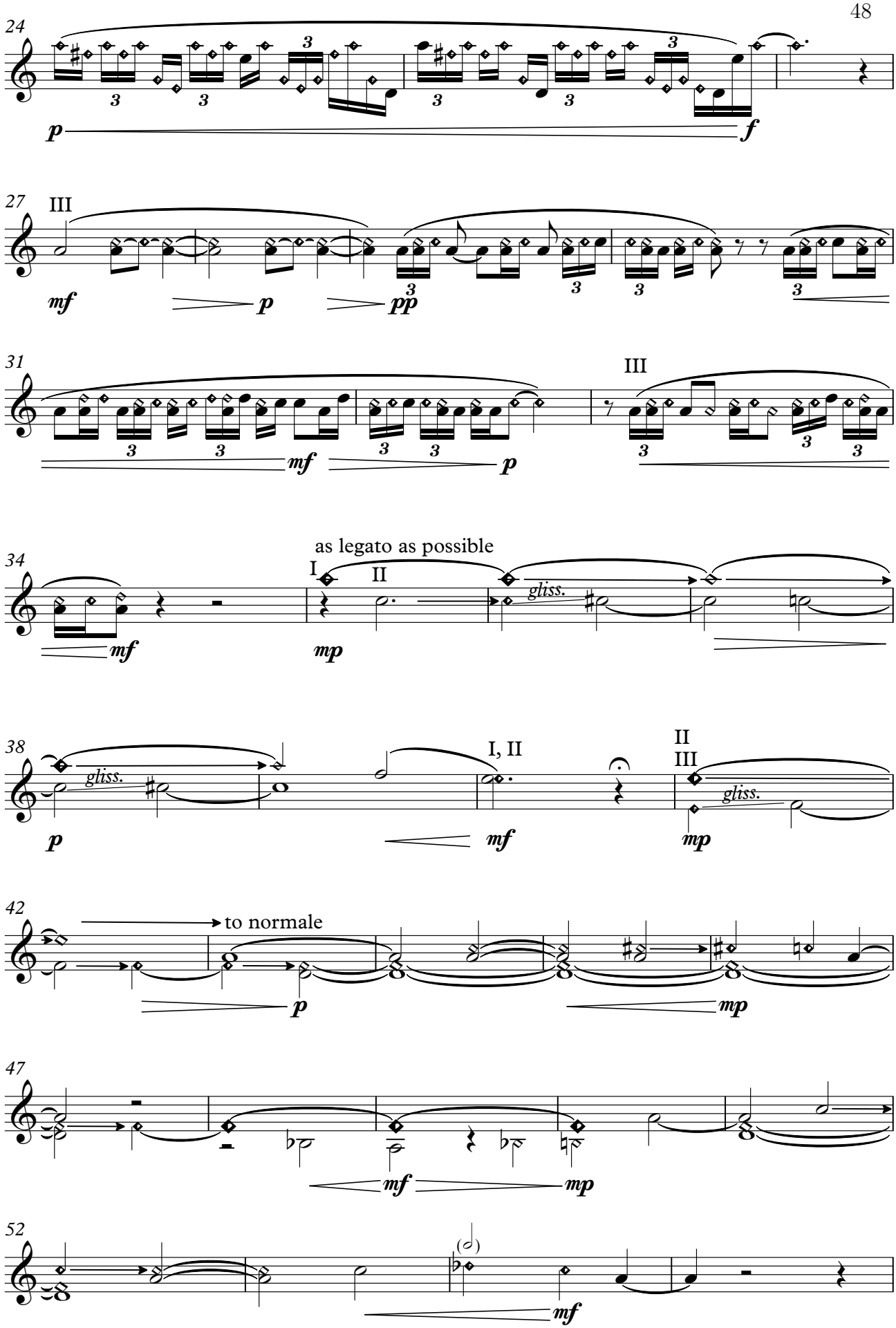
Notation

- Half-harmonics are notated in the score as a half-filled diamond notehead.
- sp denotes *sul ponticello*.
- msp denotes *molto sul ponticello*.
- similarly, st denotes *sul tasto*, and mst denotes *molto sul tasto*

what are you doing with the humans?

Rhys Gray




24
p
f
27
III
mf
p
pp
31
mf
p
III
34
as legato as possible
I
II
mf
mp
gliss.
38
gliss.
p
I, II
mf
II
III
mp
gliss.
42
to normale
p
mp
47
mf
mp
52
(𝅗𝅥)
mf

FOR SOLO VIOLA

doppelganger

October 21, 2019

Rhys Gray

Program Notes

Doppelganger is a piece for solo viola, written to explore the lower register of the viola using subharmonics juxtaposed with upper harmonics.

To play subharmonics, one should place the bow at the 6th partial of the harmonic series of the fingered pitch, and bow with excessive pressure and an absolutely consistent speed. The increased pressure will distort the vibration of the string, producing a phase loop which, in turn, produces the subharmonic.

Subharmonics are achieved through precise control of torsional oscillation, which usually produces the sound of an amateur string player's heavy handed, slow bowing.

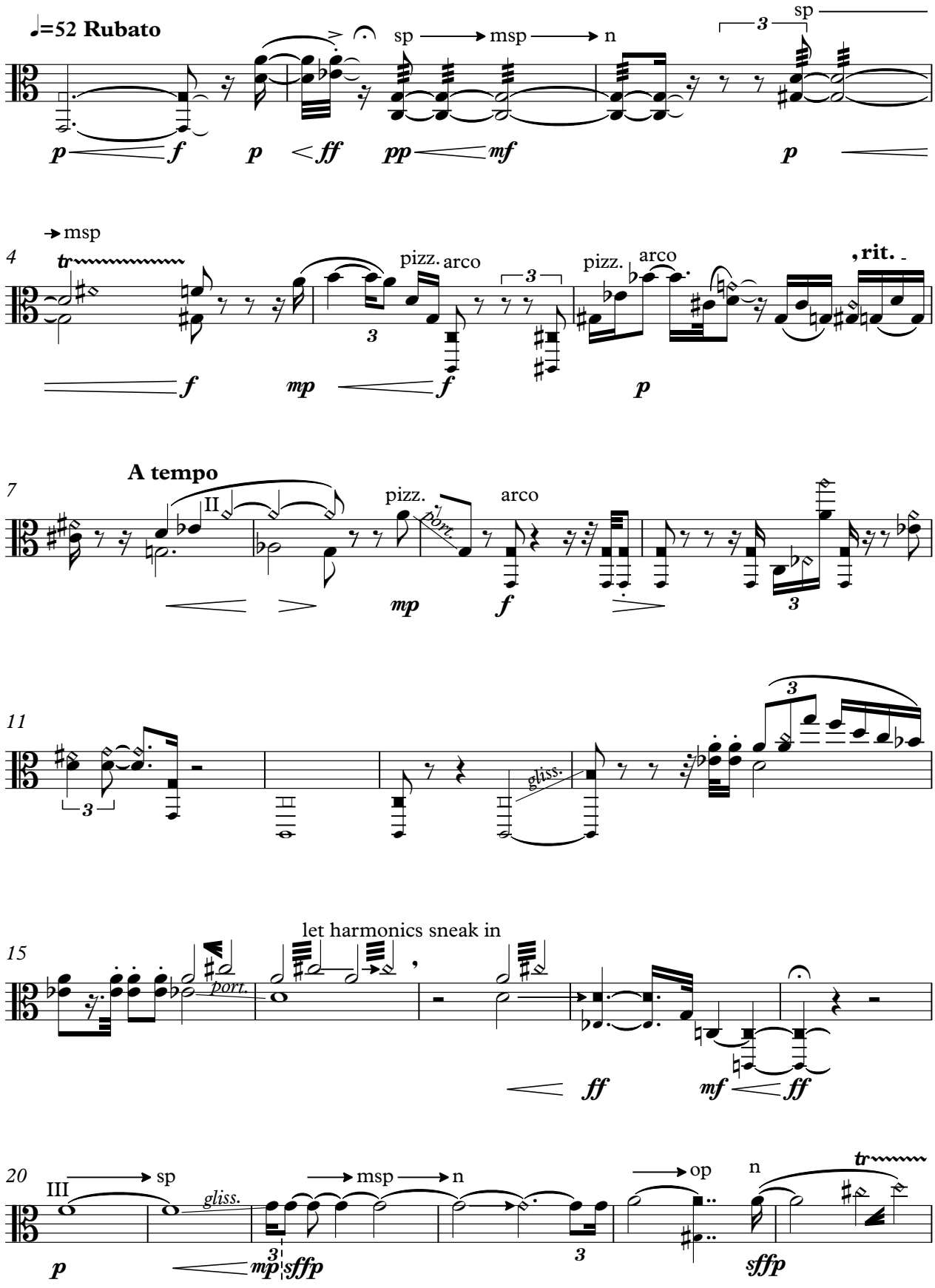
The production of subharmonics can be aided by using older strings (which work better due to fats building up on the strings). Making a counter-clockwise half-twist in the string can also make it easier to produce octave and major second subharmonics (additional twists can help achieve lower subharmonics, at the expense of higher ones).

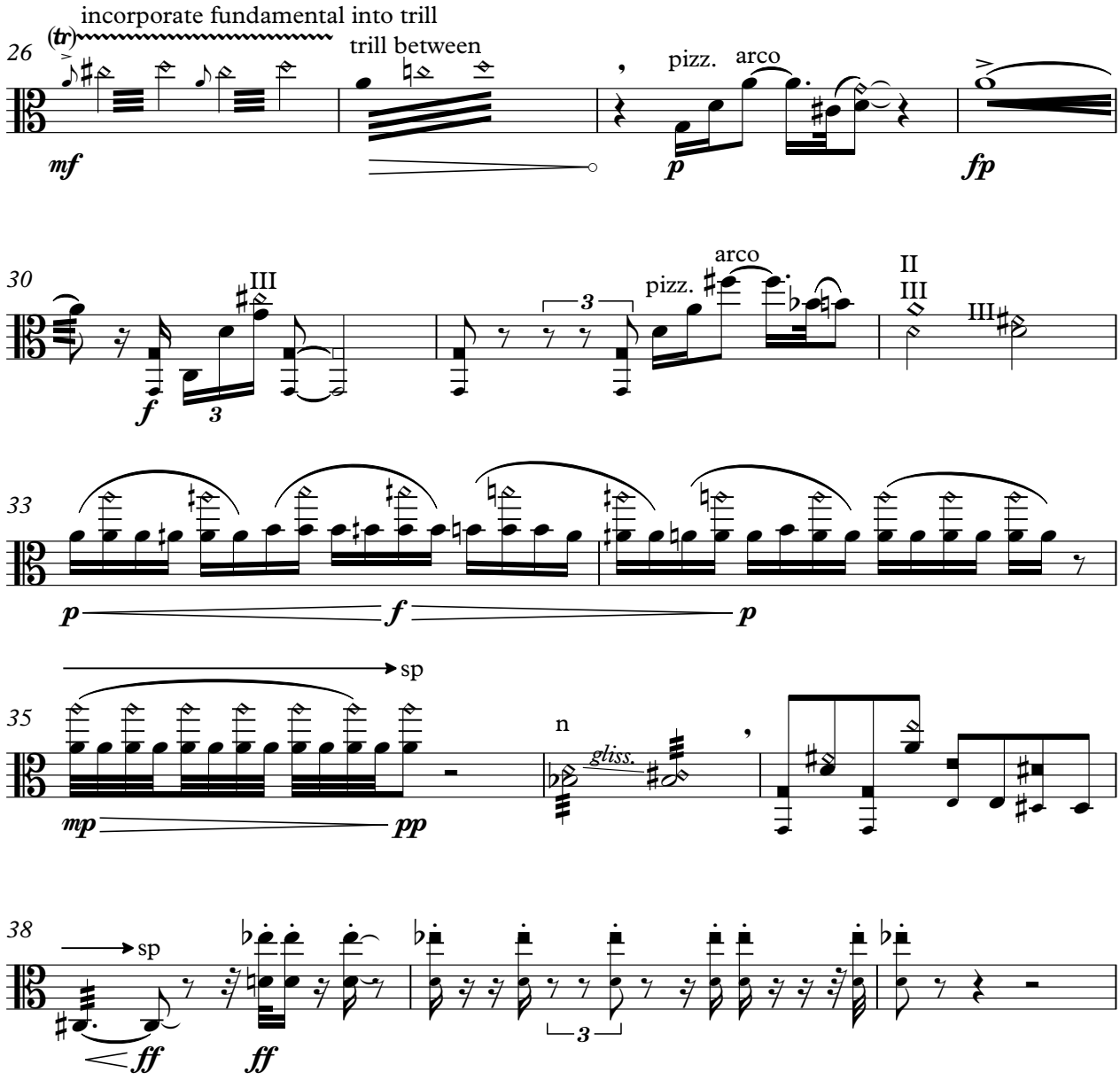
Notation

- Subharmonics are notated in the score using a square notehead for the fingering, with a small notehead at the desired resultant pitch.
- sp denotes *sul ponticello*.
- msp denotes *molto sul ponticello*.
- similarly, st denotes *sul tasto*, and mst denotes *molto sul tasto*

Doppelganger

Rhys Gray




incorporate fundamental into trill
(tr)
trill between
26
mf
pizz.
arco
p
fp
30
III
f
3
pizz.
arco
II
III
III
33
p
f
p
sp
35
mp
pp
n
gliss.
38
sp
ff
ff
3

FOR SOLO VIOLONCELLO

crossing the rubicon

October 21, 2019

Rhys Gray

Program Notes

*crossing the rubicon*is a piece for solo violoncello, written to explore multiphonics.

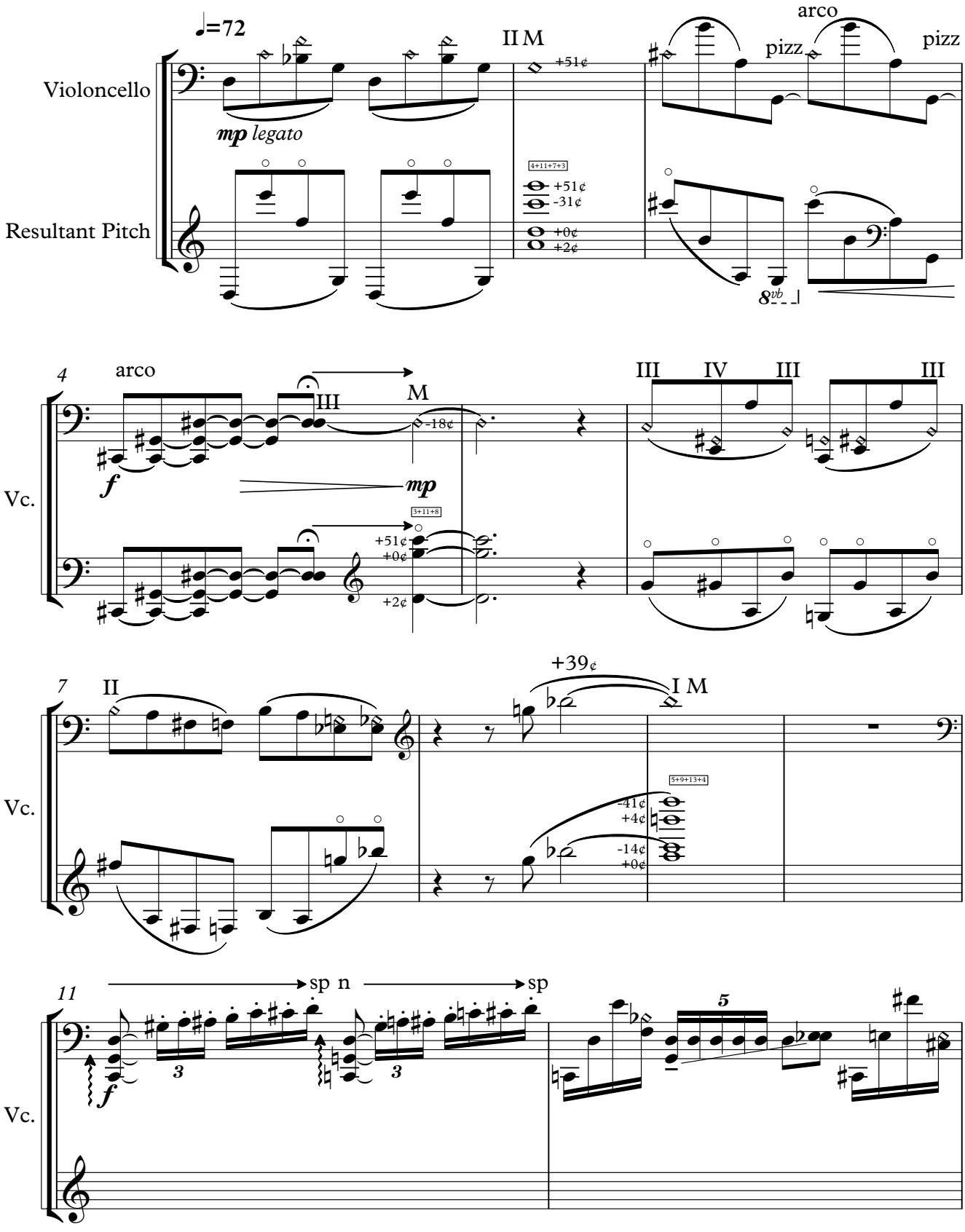
Multiphonics are notated as a harmonic position, with an 'M' and the string number (I-IV). The theoretical sounding pitches are given in a bracketed staff above the main stave. String multiphonics are achieved through clusters of close harmonic nodes, and by playing a harmonic close to the highest partial. To aid the performer during their practice, the sounding partials are given (i.e. M IV [4th + 13th + 9th + 15th + 5th]). Note that not all of these pitches will actually sound in practice. The bow should exert slightly more pressure than usual and should be drawn with a consistent speed which should be slower than for harmonics.

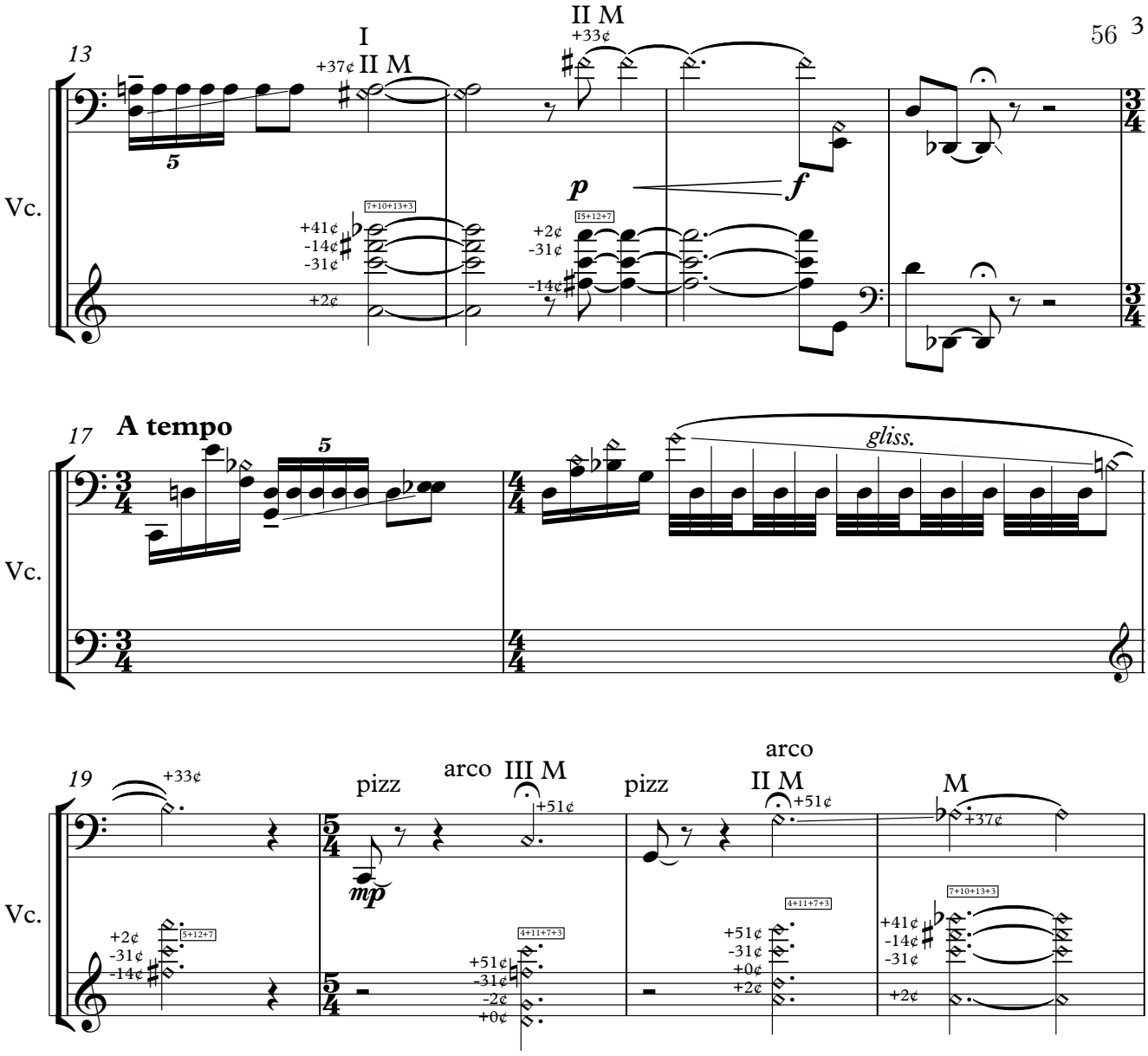
Notation

- Multiphonics are denoted with a diamond notehead, marked with an M. Precise tuning in cents (i.e. +41c) is provided to help the performer pitch the multiphonic.
- Sounding pitch for multiphonics and harmonics is provided in the lower stave.
- n denotes *normale*.
- sp denotes *sul ponticello*.
- msp denotes *molto sul ponticello*.
- similarly, st denotes *sul tasto*, and mst denotes *molto sul tasto*

to/do

Rhys Gray




13
I
II M
+37¢
II M
+33¢
Vc.
p
f
+41¢
-14¢
-31¢
+2¢
7+10+13+3
+2¢
-31¢
-14¢
15+12+7
17
A tempo
gliss.
Vc.
19
+33¢
pizz
arco
III M
+51¢
pizz
arco
II M
+51¢
M
+37¢
Vc.
mp
+2¢
-31¢
-14¢
5+12+7
+51¢
-31¢
-2¢
+0¢
4+11+7+3
+51¢
-31¢
+0¢
+2¢
4+11+7+3
+41¢
-14¢
-31¢
+2¢
7+10+13+3

FOR SOLO CONTRABASS

the veldt

October 21, 2019

Rhys Gray

Program Notes

Inspired by the eponymous short story by Ray Bradbury, *the veldt*is a composition for solo contrabass. Similarly like the namesake, this world is filled with danger but also beauty. It is non-programmatic, and my intent with Veldt was to create a soundworld and space that the performer was able to 'roam around' in, and features several sections of improvisation on pitch-sets.

Subharmonics

To play subharmonics, one should place the bow at the 6th partial of the harmonic series of the fingered pitch, and bow with excessive pressure and an absolutely consistent speed. The increased pressure will distort the vibration of the string, producing a phase loop which, in turn, produces the subharmonic. Subharmonics are achieved through precise control of torsional oscillation, which usually produces the sound of an amateur string player's heavy handed, slow bowing. The production of subharmonics can be aided by using older strings (which work better due to fats building up on the strings). Making a counter-clockwise half-twist in the string can also make it easier to produce octave and major second subharmonics (additional twists can help achieve lower subharmonics, at the expense of higher ones).

Multiphonics

Multiphonics are notated as a harmonic position, with an 'M' and the string number (I-IV). The theoretical sounding pitches are given in a bracketed staff above the main stave. String multiphonics are achieved through clusters of close harmonic nodes, and by playing a harmonic close to the highest partial. To aid the performer during their practice, the sounding partials are given (i.e. M IV [4th + 13th + 9th + 15th + 5th]). Note that not all of these pitches will actually sound in practice. The

bow should exert slightly more pressure than usual and should be drawn with a consistent speed which should be slower than for harmonics.

Notation

- Subharmonics are notated in the score using a square notehead for the fingering, with a small notehead at the desired resultant pitch.
- Multiphonics are denoted with a diamond notehead, marked with an M. Precise tuning in cents (i.e. +41c) is provided to help the performer pitch the multiphonic.
- Sounding pitch is provided in the stave below.
- sp denotes *sul ponticello*.
- msp denotes *molto sul ponticello*.
- similarly, st denotes *sul tasto*, and mst denotes *molto sul tasto*

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