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Extending techniques: developing the saxophone's capacity for lower-end dynamics and microtonal playing

Extending Techniques: Developing the saxophone's capacity for lower-end dynamics and microtonal playing.

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List of abbreviations and notation

𝄲 Quarter-tone sharp

𝄳 Quarter-tone flat

♯𝄲 Three-quarters of a tone sharp

𝄳♭ Three-quarters of a tone flat

𝄮 Eighth-tone sharp (natural pitch 1/8 sharp)

𝄯 Eighth-tone flat (natural pitch 1/8 flat)

𝄰 Semitone sharp pitch, raised by an eighth-tone (natural pitch 5/8 sharp)

𝄱 Semitone sharp pitch, lowered by an eighth-tone (natural pitch 3/8 sharp)

𝄬 Semitone flat pitch, raised by an eighth-tone (natural pitch 3/8 flat)

𝄭 Semitone flat pitch, lowered by an eighth-tone (natural pitch 5/8 flat)

Dynamic markings are written in ***bold italic letters***.

Saxophone key names are written in *italic letters*.

This document uses Scientific Pitch Notation.

When the note names are followed by 'written pitch', the notes given are the transposed pitches in either B♭ or E♭.

Copyright statement

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Abstract

Adolphe Sax believed his invention, the saxophone, was the link between louder and quieter instruments. Changes to the instrument and to playing techniques have lessened the saxophone's ability to play quietly, and subtone techniques are now utilized for playing at lower-end dynamics. This PhD proposes a new method for playing the saxophone at lower-end dynamic levels. This method uses breath control to allow lower-end dynamic playing on the saxophone. The new method has been tested through its use in different musical compositions and in combination with different extended techniques. The new method for playing the saxophone at lower-end dynamic levels has been found to have greater applicability than existing techniques and is demonstrated in numerous recordings that accompany this work. Prominent saxophonists have said that the saxophone is not able to play notes between the semitones. Modifications to the saxophone keywork mechanisms have made some microtones possible whilst prohibiting others. Existing saxophone literature has documented quarter-tone scales but has been slow to expand further microtonal possibilities. This research has developed and proposed new models and new techniques for microtonal saxophone playing. This has been demonstrated on different saxophones, including those with distinct keywork mechanisms. The numerous fingering patterns that have resulted from this work are documented in the appendices. The microtonality that results from using extended techniques, slap-tonguing and key percussion, has also been documented. Recordings of the new models for microtonal saxophone playing accompany this research. The use of microtonal saxophone playing has been discussed in relation to different compositions. The research documented here is of relevance to saxophonists and composers who wish to play or use such techniques.

Chapter 1 Introduction

This research has developed from my own performance practice as a saxophonist. At a certain point in time I realised that I had, almost without noticing it, become interested in playing the saxophone at lower-end dynamic levels and playing the saxophone microtonally. Although I am unable to identify the moment at which this happened, looking back I am able to see steps along the route which led me to where my playing is now.

There were definite reasons behind the development of my playing, both for playing at lower-end dynamics and for microtonality. Whilst the wider issues with current saxophone playing will be discussed later in this chapter, my first steps along this path were due to a combination of feelings of inadequacy when playing, and a personal stubborn streak. The feelings of inadequacy were apparent in various performances and rehearsals where I had not been able to fulfil a composer's wishes, or had not felt that my level of performance was comparative to that of other instruments.

Two examples might serve to illustrate the situations that I found myself in. In 2002 I moved to France to study the classical saxophone, something that I had long dreamt of doing. Whilst there I took chamber music lessons and played as part of a saxophone quartet. The ensemble started studying *Premier Quatuor* by Singelée. In one rehearsal I can remember that the tutor repeatedly asked me to play quieter in a section of the music. Each time I tried to respond to the comments and play even quieter. When I believed that I had reached the limits of my ***pianissimo*** abilities on the saxophone, the tutor once again re-iterated that I needed to play quieter. Out of sheer frustration I decided that I would form my embouchure and move my fingers, whilst not actually playing a note for anybody to hear. This new level of '***pianissimo***' was deemed quiet enough. Whilst this might be an indictment of my own playing, rather than of the abilities of the saxophone, it has nevertheless stuck in my memory. It was some time later before it became clear to me that this was not a problem unique to my own playing, and that a new strategy was needed for playing extremely quietly on the saxophone which did not mean sticking the soprano saxophone bell between your legs, or stuffing the bell of the instrument in an attempt to mute it. A playing technique was needed that I had never been taught, one which would allow the saxophone to play competently at lower-end dynamic levels without resorting to half solutions.

As a saxophonist I have always been in search of more: a new piece to play, a different sound to try out. I have never been able to contentedly play the music that many other saxophonists revel in playing: either the original compositions, such as Glazunov, Ibert, Creston, or the transcriptions that have found their way into the saxophone's repertoire.[1] In 2006, whilst studying with Christophe Bois of the Diastema Saxophone Quartet, I started working on *Graffiti* by Roger Redgate, a piece that I had bought simply because it was listed on the back cover of another piece that I was playing. I scheduled a performance of the piece. The style of the music was met with non-comprehension amongst my fellow students. Although microtonality only forms part of the difficulties a player must overcome when performing *Graffiti*, in this piece I had found another level of saxophone music.

Early in my saxophone-playing life, because I liked the book's title, I had purchased a copy of Londeix's *Hello! Mr. Sax* (1989). The book contained fingering patterns the likes of which I had never seen before, but it also contained guidelines and set limitations about what can and cannot be done on the saxophone. One of these which has occupied my ideas for some time has been Londeix's statement that not all "1/3, 1/4, and 1/5 tones and micro-intervals" can be played on the saxophone (1989, p.24). My instant response was to challenge this negative assertion.

I continue to believe that more can be done on the saxophone than has previously been done and has been documented up to now. The work I have undertaken as part of this research has been to extend the saxophone's perceived limits and specifically to demonstrate two areas: that the saxophone can be played at lower-end dynamic levels, and that the saxophone can play in many microtonal settings.

1.1 Research context

This research looks separately at the two different subject areas: lower-end dynamics production and microtonality. Each area begins with a look at the existing literature relevant to the theme. Whilst Adolphe Sax occupied himself with developing a repertoire for the saxophone, the only manner in which he passed on his ideas for how he believed the instrument should be played, was through the lessons he gave at the military music department of the Paris Conservatoire. He did not write a saxophone method book under his own name. This means that the information available about early saxophone playing technique comes not from Sax, but rather from a small number of musicians who had quickly adopted the instrument. These books detailed quite differing views on how the saxophone should be played, but many of the more recent books still cover the same basic elements of playing as these early books. For example, one of the early saxophone method books, Mayeur's *Grande Méthode Complète de Saxophones* (1867) was subsequently re-worked into *Nouvelle et Grande*

[1] For all the compositions studied for this research, the date of composition, if known, has been indicated in square brackets following the publication data in the list of scores in the bibliography.

Méthode de Saxophone (1896a).[2] In 1933 Georges Chauvet augmented Mayeur's *Grande Méthode Complète de Saxophones* (1867), and then in 1963 Marcel Perrin re-edited Mayeur's *Nouvelle et Grande Méthode de Saxophone* (1896a). Similarly, Klosé's saxophone method books were all written before his death in 1880. Much of the same material from these books was incorporated in de Ville in the early 20th century. Klosé's *Méthode Complète* was first revised by Emile Derigny, and then in 1950, by Eugène Gay (Levinsky, 1997, p.258). The most significant change in Gay's re-worked text relates to modifications made to the instrument, which are documented in the new keywork found in the fingering pattern chart (1950, pp.8-9). Gay's re-working of Klosé's text is limited to adding a few new etudes, or modifying the existing ones by specifying articulations, breathing and dynamics (1950): there is no development in the discussion of playing technique.

The study of early literature is undertaken in order to identify some general trends in teaching and playing for the saxophone. Through it a precedent set by early method books to re-publish or re-work and augment pre-existing material may be established, which has continued well into the 20th century. Re-using the material in saxophone method books points toward a stagnation in the development of saxophone playing techniques which will in a larger sense have influenced this research.

More recently, practice-based research has led some musicians to strive to document playing techniques and extended techniques on a range of instruments. These have been undertaken in a variety of ways and address different aspects of instrumental playing. Titre's *Thinking through the guitar* (2013) and Fallowfield's *Cello Map* (2009) both document a variety of playing techniques on instruments where the physical actions required to form sounds are all external. Whilst Titre's work groups different techniques together Fallowfield's work documents the techniques in a new manner, separating them by the different actions that can be made on the different parts of the cello in order to produce the sounds. Whilst Fallowfield's work highlights an alternative way of documenting cello techniques, it is hard to see how this form of documentation could be brought to bear on saxophone playing technique, where so many of the preparations and actions required to be made are internal.

Both Roche's blog about extended playing techniques on the clarinet (2014), and Rees' research about extended techniques on the Kingma flutes (2014) relate to instruments whose playing techniques are more similar to the saxophone, with many of them being internalised. The work completed by Roche, and by Rees, concentrates on documenting playing techniques and extended techniques that have already been developed, and are already in use. Their work, and that by Titre, and Fallowfield, contributes to a much-needed discussion about the clarification of what different

[2] Mayeur died in 1894 (Greenwood, 2005, p.3), and this new version of the book was published in 1896, bringing into question whether he authored the book. Two of the patents which documented the changes to the saxophone, patent numbers 246847 part 1 and 246847 part 2 (Dullat, 1995, pp.115-121), were also filed after his death.

extended techniques are and how they can be used. Rees, Roche, Titre, and Fallowfield,[3] have each used a variety of different methods to document their work, including audio and video, and websites. Their use of these different means of documentation point towards a new way to share this information with both performers and composers. Drawing upon similar ways of documentation, this research is presented together with numerous audio recordings. It is hoped that the work presented here could, at a later date, be transferred to a website and additional video recordings could be made.

The research work by Fallowfield, Rees, Roche, and Titre, is relatively broad in nature, and each documents several different playing or extended techniques. The research presented here differs from these models, in that it concentrates solely upon two areas of saxophone playing. Whilst the explanations and descriptions of the different techniques found in the four sources mentioned above tend to be quite short, the depth of research undertaken here has called for a distinct approach, one which provides microscopic details rather than an overview.

In place of re-documenting playing techniques and extended techniques on the saxophone that have previously been documented by Londeix, Rascher, Rousseau, Kientzy, Delangle and Michat, and Weiss and Netti, amongst many others, this research takes their work only as its starting point. It does not aim to discover different ways of documenting pre-existing techniques, but rather endeavours to push saxophone playing technique forward and to develop new extended techniques.

As part of my research I undertook interviews with a range of classical saxophone players and teachers. These were players across a wide age range, from people in their thirties to eighties. The saxophonists were chosen for the role they have played or are currently playing in the development of the classical saxophone and came from a range of countries in Europe and from North America. The interviews were not meant to be an all-encompassing survey of everybody who plays the saxophone, but strategic people were chosen for their influence upon the classical saxophone and how it is played. The interviews were conversational, without specific questions and the interviewees were free to talk about any aspects of saxophone performance that they felt relevant.

The interviews highlighted a number of concerns about the future of the saxophone. When talking with other saxophonists it was clear that similar situations to the ones in which I found my playing to be inadequate had been experienced by other players. Frustration with the saxophone and its playing techniques was widespread: nearly each interviewee had a tale to tell about a ‘saxophonistic incident’.

The discussions varied from covering the ways in which the saxophone is taught, to how information about saxophone playing and saxophone playing techniques are addressed, or not addressed at the

[3] Fallowfield’s doctoral thesis was in written form, but has since been transferred to a website containing audio and video recordings alongside the descriptions of the different actions (http://www.cellomap.com/).

World Saxophone Congress. Geiss said that “we have no real congress. We play but don’t explain” (personal communication, March 17, 2012. All further quotations are taken from this interview).[4] The World Saxophone Congress was initiated with the express intention to establish “the saxophone as a medium of serious musical expression” (Liley, 2003, *Beginnings/Statement of Purpose*). Its purpose was, “above all… the dissemination of all pertinent information about the saxophone to performers, students, teachers, composers, the general musical public, and to any and all other appropriate persons” (Liley, 2003, *Beginnings/Statement of Purpose*).

If different aspects of saxophone playing and saxophone playing technique are not covered at the congress, which provides a means of reaching a large number of saxophonists, then they would have to be covered by individual teachers, but Delangle expressed a worry about the movement towards playing transcriptions on the saxophone that he has witnessed during his time teaching at the Paris Conservatoire:[5] “But now they all play transcriptions. I have to say, please bring something new! Bring something new, but what is..? You cannot spend all your life playing pieces for other instruments” (personal communication, November 30, 2012. All further quotations are taken from this interview, unless otherwise specified).

The discussion about the movement for playing transcriptions rather than original repertoire is a bit like the chicken and the egg, which came first? Weiss said that “I think in general, very general, I would say my approach is somehow that of a saxophonist lacking music so I’m just a vampire, I’m going into the field and trying which one could work and they work differently” (personal communication, February 7-13, 2011. All further quotations are taken from this interview, unless otherwise specified). Geiss also touched on the lack of repertoire when he mentioned than an orchestral director had once told him that the saxophone has “no music and no performer[s]” (personal communication, March 17, 2012). The saxophone, of course, has had music written for it, the Londeix repertoire books are testament to this.[6] It also has performers: the 2015 World Saxophone Congress hosted 380 recitals (International Saxophone Committee, *Statutes 2015*).

The playing of transcriptions may, though, have had an influence on the development of saxophone repertoire. It is therefore perhaps the quality of the music that the orchestral director is referring to rather than a total lack of repertoire. For example, Hemke said that: “we look for as good music as we can and sometimes we have to go to transcriptions in order to do it” (personal communication, March 17, 2012. All further quotations are taken from this interview, unless otherwise specified). Several of the interviewees expressed concerns about the saxophone’s repertoire and the quality of composition

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[4] Details of the date and place of each interview are listed in [Appendix A].

[5] Conservatoire Nationale Supérieur de Musique et de Danse de Paris (CNSMDP).

[6] Londeix (1971), Londeix (1985), Londeix (1994), Londeix (2003), and Ronkin (2012).

for the instrument. Alongside Hemke's statement above, Sampen said: "I think there's a tremendous amount of new music being written, which is exciting. I think there's a tremendous amount of pieces which aren't very good and that hasn't changed over the decades, it continues to be a problem. We don't have great pieces" (personal communication, March 17, 2012. All further quotations are taken from this interview).

Similarly, it is perhaps the quality of the performer and the level of technical playing ability of saxophonists that the orchestral director is referring to, rather than a total lack of players. The level of saxophone playing technique was also spoken about in the interviews: two highlighted the unwillingness of some composers to write for the saxophone. Geiss said that he had met a French composer who had not wanted to write for the saxophone because of its sound (personal communication, March 17, 2012), and McAllister spoke about an American composer who will not write for the instrument because "he's heard bad saxophone" (personal communication, March 19, 2012. All further quotations are taken from this interview).

When speaking about the use of vibrato on the saxophone, and the phenomenon of playing it at four undulations a beat at a metronome mark of crotchet = 72, Harle said:

> I can never understand that... it's sort of like asking me why I'm not the Martian. I just don't get that, I don't understand what connection it has with what we're supposed to be doing [it blocks out the expression, I feel] ....it's part of the sound in inverted commas... the vibrato is part of the sound, and I think that that may be because nobody's really worked out how to play the instrument properly (personal communication, October 11, 2012. All further quotations are taken from this interview).

This statement shows that Harle believes there to be a lack of understanding of saxophone playing technique. Whilst he is referring to the use of vibrato, the unwillingness of composers to write for the saxophone, as mentioned in the interviews with Geiss and McAllister, and the comments made to Geiss by the orchestral director all point to a deficiency in saxophone playing technique. Whilst this might have resulted in a lack of 'good' repertoire, and a lack of performance opportunities, it is only saxophonists who are able to change this situation.

In contrast with my inward-looking search for the reasons why I felt that my playing was inadequate, others have looked towards external aspects for the reasons behind the current situation. Rather than bemoaning the lack of decent repertoire, and accepting the status-quo, my research aims to find a way forward by developing new methods and techniques for playing the saxophone.

1.2 Research area and research questions

My research specifically addresses two areas of saxophone playing: lower-end dynamics production, and microtonality.

It will:

- propose new methods and techniques for extremely quiet saxophone playing
- propose new models and techniques for microtonal saxophone playing

For the purposes of my research I have defined microtonality as concerning intervals that are smaller than a semitone. Whilst it is more difficult to define playing quietly, for the purposes of my work this has been set as quieter than ***pianissimo***.

To develop these two aspects of saxophone playing, this research examines existing methods of playing at lower-end dynamic levels and existing microtonal source material for the saxophone. In order to be able to propose new method and techniques it asks a number of sub-questions. These are split into the two different research areas.

Lower-end dynamics:

What are the existing methods used for playing extremely quietly on the saxophone?

What are the difficulties a player faces when playing the saxophone extremely quietly?

How can extended techniques be integrated into extremely quiet saxophone playing?

Microtonality:

What is currently deemed microtonally possible on the saxophone?

What are the challenges a saxophonist faces when playing microtonally?

How can microtonality on the saxophone be developed?

How can extended techniques on the saxophone be harnessed for their microtonality?

1.3 Methodology

My research is practice based and has very largely been undertaken with a saxophone in my hand. The two areas of saxophone playing covered by my research differ: one can be written down (microtonality) and the other is less easy to define in written terms (lower-end dynamics). This has meant that they have required different approaches and that my research has been reported in different ways. The methodology behind my research therefore also differs, but in both areas I have studied features of the instrument and its historical development that may have influenced what is possible. I have looked at what saxophone method books have written regarding the possibilities of the instrument and how lower-end dynamics and microtonality have been documented and taught. I have also looked at the influence of saxophone culture and trends, interviewed a number of saxophonists relevant to this research, and finally the research has been tested and demonstrated through the study and performance of a number of recent and new compositions. Different members and different generations of the saxophone family have been utilized in this research, and the relationships between instrumental development and playing techniques have been considered.

Whilst the research on microtonality has, at points, used various tuning machines in order to provide exact data, the research on lower-end dynamics has not taken a scientific or quantitative approach. This is because it is difficult to control all the possible variables involved in playing the saxophone in order to provide reliable data. It is for this reason that a demonstrative approach has been taken, where the recordings allow listeners to hear the difference between playing techniques, and the relative differences in dynamic levels.

1.4 Explanation of layout

The research I have done is presented here in three different ways: the main thesis, the appendices, and the recordings. The different elements that make up this portfolio of my work can be used in conjunction with one another: the appendices show the results of various parts of my research, and the recordings serve to highlight matters discussed in the thesis and documented in the appendices.

Whilst the appendices and recordings were made to enhance and clarify the playing techniques presented here, they are also of use separately. These aspects of my work may be of particular interest to performers and composers. The majority of the appendices comprise microtonal fingering patterns that have been developed as part of this research. Other saxophonists may now incorporate them into their playing, and composers may refer to them when writing for the saxophone.

The recordings serve to allow the microtonal fingerings patterns in the appendices to be listened to. Many of the recordings also show the aural results of applying different playing and extended techniques. The recordings are particularly beneficial in my discussion about playing at lower-end dynamics on the saxophone. This is an aspect of playing which is difficult to document. So that an appropriate volume level may be set on the device used to listen to the recordings relating to lower-end dynamics [Recording 1/1.] is a test track which contains notes played at different dynamic levels.[7]

[7] Details of how to use [Recording 1/1.] to set the volume level during play back can be found in [Appendix B2].

Following this introduction, the main thesis is split into two parts: lower-end dynamics production (Chapters 2 and 3) and microtonality (Chapters 4 and 5). Chapters 2 and 4 incorporate the relevant literature review and outline the research context of my work, looking at the influence of changes to the instrument and study existing documentation for present and past performance techniques. They also study the limitations of current practice. Chapter 4 also looks at notational issues relevant to microtonal saxophone playing.

Chapter 3 details my technique for playing at lower-end dynamic levels and how I have developed it. A number of compositions have been discussed to show how I have applied and further developed my technique. This chapter is accompanied by nearly 100 recordings which have been made to clarify what has been achieved.

Chapter 5 documents my development of microtonal saxophone playing. It explains how I have worked through issues, and augmented my work through its application in different compositions. This chapter is also accompanied by numerous recordings. The appendices contain the results of the development of hundreds of different fingering patterns that I have used in this research work.

This is followed by Chapter 6, the conclusion, which draws together the practice-based elements of the portfolio with the main thesis.

The final element in my research portfolio was the recital presented in February 2014. This recital comprised four works which have been discussed in this thesis: *Nano* by Mc Laughlin, *ALI* by Mincek, *breath* by Pisaro, and *Kontr-atrofia/Contr-atrophy* by Zych. The recital served as the link between my research and my practice as a saxophonist. Whilst the recordings which accompany this thesis contain extracts of three of the four compositions (Mc Laughlin, Pisaro, and Zych), in the recital they could be heard in their entirety. The recital served to show the developments that have been made in lower-end dynamics and microtonal playing on the saxophone as part of this research.

Chapter 2 Lower-end dynamics on the saxophone

As mentioned in chapter 1, the need to be able to play at lower-end dynamics on the saxophone, was emphasised to me when playing in a saxophone quartet setting. Achieving balance in a chamber music setting is frequently a challenge. The aim of this chapter is to examine reasons why the saxophone is difficult to play quietly. It will study existing techniques for playing at lower-end dynamics and highlight their limitations.

This chapter will study changes in saxophone performance technique and discuss how ideas regarding performance technique may have changed the music currently played. It will look specifically at breathing and blowing techniques, embouchure position, and the influence of these on the saxophone's lower-end dynamic range. It will look at how the saxophone has changed since it was invented by Adolphe Sax, and how changes made to the physical instrument may have also influenced the saxophone's ability to play at lower-end dynamics. It will study existing techniques for playing lower-end dynamics on the saxophone, known as subtone, and identify problems subtone techniques cause for the integration of a number of extended techniques. Finally, it will look at just how quietly composers have requested that the saxophone plays, looking at the use of lower-end dynamic markings in a selection of existing compositions. The study of these pieces will show why a new technique for playing lower-end dynamics on the saxophone is needed.

2.1 The development of saxophone playing technique

Adolphe Sax had clear ideas about where he believed the saxophone should be placed amongst other instruments. The reasons behind his choice were due, in part, to the dynamic range of different instruments. In his 1846 saxophone patent (patent number 3226)[8] Sax stated that "in general, wind instruments are either too harsh or too weak in sonority" going on to say that "the ophicleide… produces a sound so disagreeable that it must be kept out of resonant halls because of its inability to be played softly" (cited in Hemke, 1975, p.47). If Sax believed the ophicleide was not able to play softly, then the bassoon was not able to play loudly enough: "the bassoon… has such a weak sound that it can be used only for accompanying and filling parts… for specific ***forte*** effects… it is absolutely useless" (cited in Hemke, 1975, p.47).

[8] This was Sax's first patent application for the instrument. He submitted it in Paris, France, on March 21, 1846 (Haine, 1980, p.53), and it was granted on June 22, 1846 (Cottrell, 2012, p.48).

In developing the saxophone, Sax was seeking to position it as an instrument that could play both loudly and quietly, and he said that "the saxophone is able to change the volume of its sounds better than any other instrument" (cited in Hemke, 1975, p.48).

Kastner, an acquaintance of Sax, extolled the dynamic capabilities of single reed instruments: "En un mot, avec l'anche simple, on est maitre (*sic*) de l'intonation, on obtient avec la plus extrême facilité toutes les nuances d'intensité, depuis le ***Pianissimo*** jusq'au ***Fortissimo***" (Kastner, 1846, p.22, fn.1).[9]

He wrote of the saxophone:

> Le Saxophone semble appelé à jouer un rôle des plus importants dans nos orchestres de symphonie et dans nos musiques militaires, par le volume aussi bien que par la portée de sa voix, qui lui assigne pour ainsi dire le rôle d'intermédiaire ou de concordant entre les instruments faibles et les instruments forts, si bien qu'il n'écrase point les premiers, et ne se laisse point écraser par les seconds. Cet inestimable avantage auquel viennent se joindre un timbre entièrement original d'un éclat et d'une suavité extrêmes, une justesse et une égalité parfaits dans toute son échelle, une grande facilité d'exécution, une agilité prodigieuse (Kastner, 1846, p.1).[10]

Other contemporaries of Sax also praised the dynamic range of the saxophone. In 1843 Castil-Blaze called the bass saxophone the "bull of the orchestra", yet he noted that the "huge vibrant full rich gratifying sounds of the saxophone can be softened almost to the final degree of ***pianissimo*** without effort, without constraint" (translation cited in Hemke, 1975, pp.26-27). Berlioz wrote that: "Le saxophone, délicieux instrument de cuivre à bec de clarinette dont le timbre est nouveau, qui se prête aux nuances les plus fines, aux plus vaporeux effets de la demi-teinte, comme aux majestueux accents du style religieux" (Berlioz cited in Haine, 1980, p.147).[11]

Such praise of the capabilities of the saxophone for lower-end dynamic playing is in contrast with more recent discussion of its abilities. In an article about Ibert's *Concertino da Camera*, Rascher called the composition "the idiomatic solo work" (Patrick, 2014, p.246). Rascher's article listed some of the reasons why he believed this to be so. These reasons include the use of ***crescendo*** into the

[9] "In one word, with the single reed, we are master of the intonation, we can obtain with the greatest of ease all the degrees of dynamics, from ***pianissimo*** to ***fortissimo***" (Kastner, 1846, p.22, fn.1).

[10] "The saxophone appears to be called to play one of the most important roles in our symphony orchestras and in our military music, due to the volume as much as by the range of its voice, that assigns it the role of intermediary or the corroborator between the weak instruments and the strong instruments, it does not erase the first, and is not crushed by the second. This invaluable advantage which joins an entirely original timbre with extreme clarity and smoothness, an accuracy of tuning and evenness in all its ambitus, a great ease of execution, a phenomenal agility" (Kastner, 1846, p.1).

[11] "The saxophone, delicious brass instrument with a clarinet mouthpiece whose timbre is new, which lends itself to the finest dynamics, to the most nebulous shades of colour, as well as to the majestic accents of the religious style" (Berlioz cited in Haine, 1980, p.147).

higher register, as Rascher claimed that “to play ***pp*** in the higher register is not easy” (Patrick, 2014, p.247). Other works also written for Rascher, such as Glazunov’s *Concerto* or Larsson’s *Konsert* use the higher register and also the altissimo register, but frequently either at louder dynamic markings or with ***crescendos*** into the register.

Rascher also wrote about the need for a composer to be certain that “a musical idea must be expressed on the saxophone, and not on any other instrument” before he composes for it (Patrick, 2014, p.151), but his reasons for classifying Ibert as idiomatic music seem to imply that his ideal of idiomatic music for the saxophone would be to make things easier for the performer by virtue of the context, or avoid techniques that are difficult to play by classifying them as non-idiomatic. Indeed, Marcel Mule, who regularly performed Ibert’s *Concertino da Camera*, generally chose not to use the altissimo register, saying that “Ibert did not object to those who wished to perform his work with the high tones, but the inclusion of the altissimo notes was in no way requisite for public performance” (Rousseau, n.d. p.59). Tomasi’s *Ballade*, written for Mule, makes no use of the altissimo register, but does ***crescendo*** into the passages in the higher register; Pituch has said that the saxophone solo part for this composition is “composed quite idiomatically for the instrument” (1998, p.51).

The idea of idiomatic music has since been championed by Londeix. In his work on “Musique POUR et DE saxophone”[12] he has classified compositions as being either ‘for’ or ‘of’ the saxophone, and said that music ‘of’ the saxophone cannot be played on other instruments (Londeix, 2010).

He is an avid advocate for the creation of compositions which “can only be played on the saxophone, by saxophone virtuosos” (Umble, 2000, p.107). Londeix has stated that Denisov’s *Sonate* “is characterized by the use of a very idiomatic language for the saxophone” including the use of double and triple multiphonics (Umble, 2000, p.224). His repertoire list in *Méthode pour étudier le saxophone* only uses the word idiomatic to refer to “pieces that call for contemporary [extended] techniques” (1997, pp.71-73). The assumption then, is that it is these extended techniques which have led Londeix to call a work idiomatic, but many of these techniques can equally be produced on other instruments, as documented in Bartolozzi (1982), Bok (2011), Rehfeldt (1994), and Veale, Mahnkopf, Motz, and Hummel (1998), etc. The inclusion of extended techniques do not therefore make a composition idiomatic.[13]

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[12] “Music FOR and OF the saxophone” (Londeix, 2010).
[13] The use of vibrato on the saxophone, as developed by Mule (Rousseau, n.d., pp.84-85), is considered a standard part of playing the French classical style of composition for the saxophone and therefore not generally thought of as an extended technique. It has, though, become an idiomatic part of the classical saxophone sound, a part that when not used, opens up other possibilities: “The saxophone, as it has no really hearing [aural] history, except the one from jazz, for a big audience the saxophone, when you play it without vibrato, classically straight, they don’t know what that instrument is. That, for me, that kind of whiteness or

Having identified the requests by both Rascher and Londeix for idiomatic saxophone music, and having shown that the inclusion of extended techniques does not per se make a piece idiomatic, what is then idiomatic music for the saxophone? Perhaps it is the way in which the extended techniques are used which make a composition idiomatic. Rascher's assessment of Ibert's *Concertino da Camera* could certainly be interpreted in this manner. Another composition, *Hard* (1988) by Lauba, uses multiphonics, *c5* key percussion and a number of different articulations taken from *Hello! Mr. Sax* (Londeix, 1989). As with Ibert's *Concertino da Camera*, the altissimo register is almost exclusively used at louder dynamics, therefore heeding Rascher's statement that "to play ***pp*** in the higher register is not easy" (Patrick, 2014, p.247). An extended phrase in the altissimo register, marked ***ppp***, is also marked "ad lib." (1989, p.8). The saxophonist is directed to play "Sib (*sic*) grave avec lèvres serrées sans hauteurs de notes définies toujours à l'aigu (suivre le dessin des notes)" (Lauba, 1989, p.8).[14] Whilst the player is therefore required to play quietly in the altissimo register, the 'ad lib.' marking arguably avoids the necessity to play specific notes in this register quietly.

Could the requests for idiomatic music therefore be interpreted as requests for easy, or easier to play music? Both of these works by Ibert and Lauba are examples that illustrate how the quest for idiomatic music has resulted in compositions for the saxophone which either avoid difficulties entirely, or adapt extended techniques in order to make them easier to play. In both compositions the difficulties posed by playing in the lower-end dynamic range have been avoided.

Speaking about the performance of new music for the clarinet, Heaton has said that it "poses new challenges for performers, not only in terms of extended techniques, extremes of speed, range, dynamics, and articulation, but also in the range of compositional styles a player must negotiate" (2006, p.86). In a similar reflection on the broad nature of contemporary saxophone performance, Delangle and Michat say that today's saxophonists are "free from any musical 'establishment'" and come from "a state of 'No Fixed Repertory'" (1998, p.161).

Hemke has argued that "new instruments require new techniques and new compositions, but the techniques are often predicated on the demands of the composition" (1975, p.256), whilst more recently Delangle and Michat have asserted that "basic [saxophone] technique (Boehm system) is based on the concept of 'everything is playable'" (1998, p.161). Is everything playable because saxophone playing technique has already been perfected? It could equally be because compositions tend to be kept within 'idiomatic' styles, or even because those compositions which prove more

transparency in history in hearing of the saxophone gives me a lot of possibilities" (Weiss, personal communication, February 7-13, 2011).

[14] "Low B♭ with tight lips, without definite note pitches, always high (follow the shape of the notes)" (Lauba, 1989, p.8).

difficult to play do not become part of standard repertoire, and therefore the techniques which they require do not become part of standard playing techniques. A survey of the composers whose works have been performed at the World Saxophone Congress between 1969 and 2012, shows that the most frequently performed composer of original works for the saxophone is Lauba. When asked how he would like to see the saxophone develop further, Londeix replied with praise for a recent recording of the music of Lauba: “la musique qu’on entend là, c’est *impossible* de l’entendre avec un autre instrument” (personal communication, June 24, 2010. All further quotations are taken from this interview, unless otherwise specified).[15] Lauba, a composer who has worked closely with Londeix and attended his saxophone classes on a regular basis,[16] apparently understands the saxophone: “he know[s] the saxophone sometimes better of [than] me, because it was no problem of the technique” (Londeix, personal communication, June 24, 2010).

The notion of idiomatic saxophone music put forward by Rascher is that saxophone players know best how their instrument should be played, whilst Londeix believes that composers who work closely with saxophonists will also understand how the saxophone should be played. Such stances lead to the rejection of composers’ ideas that stretch current playing technique. No boundaries are crossed and no new playing techniques are developed.

If the demands of a composition are always kept within what is idiomatic, or easily possible on the saxophone, players could become complacent, thereby neglecting to develop or master certain techniques. This idea was supported by McAllister. When in discussion he said: “if it's [it is] ***pianissimo*** it needs to be ***pianissimo***, and I think that has been ignored in our profession for a long time” (McAllister, personal communication, March 19, 2012).

Whilst in conversation with Harle, he, like Geiss and van Oostrom, questioned the level of current saxophone performance: “The standard of playing on the instrument is not high enough for the general public, and it remains possibly worse than it was at the beginning of the 20th century” (Harle, personal communication, October 11, 2012). Sax had clearly defined ideas about how the saxophone should be played, as expressed in his letter requesting that he was made professor of saxophone for the military musicians at the Paris Conservatoire.[17] Details of early saxophone performances showed

[15] “The music that we hear there, it’s *impossible* to hear it with a different instrument” (Londeix, personal communication, June 24, 2010).
[16] “During four years he come in the class about two times each week” (Londeix, personal communication, June 24, 2010).
[17] “Parmi les artistes qui jouent aujourd’hui du Saxophone, il n’y en a pas encore un seul qui soit en état d’enseigner tous les individus de la famille entière,… et aucun de ceux qui en jouent le mieux ne possède encore la voix (la qualité du timbre)… Si donc l’enseignement du Saxophone était abandonné à un autre professeur que moi, il en résulterait infailliblement déviation du timbre que j’ai voulu et réalisé” (n.d., cited in Rorive, 2014, p.130).

the instrument to be capable of playing in a large tessitura (Hemke, 1975, pp.20-29), with a large variety of sounds (Blanchard, translation cited in Hemke, 1975, pp.28-29),[18] and with the "finest dynamics" (Berlioz cited in Haine, 1980, p.147).

The discussion with Harle continued:

> For all the flag waving… the standard of playing is still not high enough for public consumption in my view.
>
> ...you know, if you had a violinist come on and didn't know, couldn't play a bottom C or a bottom G on their instrument without breaking it the octave above, they'd be laughed off the stage, but 50% of people who call themselves professional saxophone players can't pick a low C out of the instrument and play it without cracking it…
>
> What standard is that supposed to be judged by...
>
> Nobody's been bothered to tell them how to fucking well do it" (Harle, personal communication, October 11, 2012).

Looking at the earlier quotes regarding lower-end dynamics on the saxophone there does appear to be a distinct difference between the positive quotes by Berlioz, Castil-Blaze, et al., and the 20th century notion of idiomatic music for the saxophone. This notion of idiomatic music and the drive towards it by prominent saxophonists may therefore have had a negative influence on the development of lower-end dynamic playing on the saxophone. This influence is not just seen in compositions that avoid potentially difficult dynamic markings, but also, after more than half a century of playing idiomatic music, may have resulted in players no longer knowing the correct techniques for playing quietly.

Fallowfield has said that "the challenge for developing technique is finding something idiomatic, even specific to the cello, even though the sound itself might be far removed from cello sound as we know it" (2009, p.176). The saxophone has already developed a repertoire of idiomatic compositions. Extended playing techniques have also been developed, for example multiphonics, different articulations, key percussion, that are specific to woodwind instruments, single reed instruments, and closed-key single reed instruments, in turn. As the emphasis upon idiomatic music for the saxophone

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"Amongst the artists that today play the saxophone, there is not yet a single one who is in a state to teach people all the members of the entire family,… and none of those who play the best yet possesses the voice (tone quality)… If therefore the teaching of the saxophone is given to another professor but me, it will result without fail in a change to the timbre that I wanted and am myself capable of" (n.d., cited in Rorive, 2014, p.130).

[18] In the *Revue et Gazette Musicale de Paris* dated September 10, 1843, an article, simply titled "Adolphe Sax", was published. In it the author, Henri Blanchard, sings the praises of the saxophone, saying that "its sound can be modified better than any other instrument" (translation cited in Hemke, 1975, pp.28-29).

may well have led to music which does not require the further development of performance technique, the aim of this study is to find something un-idiomatic: to try to play the saxophone in a way that was not thought possible.

2.2 Existing saxophone playing techniques

2.2.1 Breathing and blowing

The correct technique for breathing in, regards saxophone playing, has been written about in numerous books, from some of the earliest, to the more recent.

As the following quotes show, many of these books emphasize the need to inhale a large amount of air.

> Pour obtenir de beaux sons sur le Saxophone, il faut aspirer une suffisante quantité d'air (Cokken, 1846, p.4).[19]
>
> Sans un grand volume d'air, qu'on doit savoir comprimer et ménager longtemps, il n'existe point de force ni de timbre dans le son; de plus, il n'est guère possible de bien phraser. Le son d'un instrument résulte du timbre et du degré de force (Mayeur, 1867, p.8).[20]
>
> Always take care to draw a good breath before attacking the tone (Mayeur, 1896b, *The tone*).[21]
>
> It is obvious that the ordinary amount of breath taken into the lungs for normal purposes will not be sufficient also to play a wind instrument (Davis, n.d., p.34).
>
> Our first task is to get the maximum amount of air into the lungs (Teal, 1963, pp.32-36).
>
> The inhalation before our note should be relaxed and quite full, taken through the sides of the mouth rather than the nose, thereby quickly obtaining a large reservoir of air to draw upon (Horch, 1998, p.77).

Other aspects of breathing in correctly, such as not puffing out the chest or raising the shoulders, have also been covered in Cokken (1846, p.4), Davis (n.d., p.34), and Teal (1963, p.34), but little has been written about how much air flow should go into the instrument. The emphasis on taking in a large amount of air presupposes that this will all be used when exhaling, blowing into the instrument.

[19] "To obtain beautiful sounds on the saxophone, you must breathe in a sufficient amount of air" (Cokken, 1846, p.4).

[20] "Without a great volume of air, that we must be able to reduce and manage for a longtime, there does not exist the force nor the timbre in the sound; furthermore, it's not possible to phrase well. The sound of an instrument is the result of timbre and the degree of force" (Mayeur, 1867, p.8).

[21] This is the English language version of Mayeur's *Nouvelle et Grande Méthode de Saxophone* (1896a).

Players would otherwise have to constantly pause to empty their lungs of 'stale' air before taking a new breath, "because stale, unused air remains too long at the bottom of the lungs causing asphyxia" leading to the "destabilization of one's playing ability" (Londeix, 1997, p.8).

How air should be blown into the saxophone has been written about in even less detail. Of the six books mentioned above, the subject is not covered at all in Mayeur (1896b) or Davis (n.d.). Typically, books give general advice such as not puffing the cheeks out (Cokken, 1846, p.4), or about managing and conserving the air (Mayeur, 1867, p.8.). Some of the method books speak in vague terms. For example, Prost gives only a general description: "la maîtrise du son nécessite un contrôle de l'air et de l'embouchure" (Prost, n.d., p.29).[22] Teal asks us to note the pressure of the air stream (1963, p.36), which could imply either high or low pressure, and Horch says: "I aim to reach the required air velocity as quickly as possible and then maintain and keep the velocity constant" (Horch, 1998, p.77).

It is in his description of the style of saxophone playing developed by Bichon that Prost speaks in greater detail:

> Serge Bichon, professeur honoraire du CNR de Lyon a lancé un nouveau type de sonorité, très centrée, avec une forte pression d'air, riche en harmoniques, donnant une couleur équilibrée et séduisante à l'instrument classique. Cette nouvelle conception s'étendra sur l'ensemble de ses élèves, Claude Delangle par example, ayant ainsi des répercussions sur la nouvelle génération issue du CNSM (Prost, n.d., p.101).[23]

Buckland is more explicit in his explanation of how air should be put through the saxophone:

> We know that we need fast air to make the saxophone function at its optimum, so how do we generate fast air?
>
> We use our abdominal muscles and the muscles in our lower back to SUPPORT the diaphragm….
>
> These muscles alone are not sufficient to create enough air speed for a well-supported sound on the saxophone. We need to create some resistance in order to funnel or focus the air into the saxophone, and through this funnelling, air speed is greatly increased. This is where the embouchure comes in (2012, p.24).

[22] "Command of the sound requires control of the air and the embouchure" (Prost, n.d., p.29).

[23] "Serge Bichon, honorary professor of the CNR [National Conservatoire of the Region] in Lyon, has initiated a new type of sonority, very centred, with a strong air pressure, rich in harmonics, giving the classical instrument a balanced and seducing colour. This new concept, will spread amongst all of his students, Claude Delangle for example, thereby having an impact on the next generation hailing from the CNSM [Paris Conservatoire]" (Prost, n.d., p.101).

The term ‘fast air’ implies that a substantial amount of air should be pushed through the instrument at all times, and the assumption can be made that ‘fast air’ will dispense more into the saxophone than potential ‘slow air’. None of the books differentiate between the amount of air needed for loud playing and that needed for softer playing, nor how the air should be blown into the instrument. Whilst it may be deemed too obvious to state that more air will be needed to play the instrument loudly than that needed to play it quietly, for Buckland, ‘fast air’ and focussed air flow seem integral to playing at all dynamic levels. It is my argument that the idea of fast and focussed air flow actively limits lower-end dynamics on the saxophone, and the technique behind my method for playing extremely quietly on the saxophone, which will be explained in chapter 3, is in contradiction with the ideas and techniques described in the sources mentioned on the previous two pages.

Buckland writes that:

> All the air we use in playing the saxophone needs to be (and can actually only be) focussed and controlled at one point: the point where the saxophone enters the mouth/the point where you cover your saxophone – the magic square centimetre control surface of reed and mouthpiece that sits just inside your mouth (2012, p.24).

This implies that there are no other points at which air can be controlled. Whilst the air is focussed at the point at which it leaves the body and goes into the saxophone, the control of the air at this point, between leaving the body and entering the mouthpiece, is only of the most basic variety. It is true that air must be controlled in order to go into the mouthpiece rather than stay in the mouth and expand the cheeks, or escape from gaps between the lips. However, control of the air is achieved elsewhere, by managing the actual amount of air going into the instrument from the lungs.

Explanations of the breathing and blowing process, which can be found in two older books, are likely closer to what is needed in order to be able to play at lower-end dynamics on the saxophone. Weber has written that: “Tone should be produced by blowing *gently* in the mouthpiece… just enough pressure should be brought to bear upon the reed to control it” (C. Weber, 1897, *The Saxophone*). Whilst this quote shows that control of the embouchure should be maintained thereby controlling the reed, the word ‘gently’ implies a different sort of breath than the maintained velocity and support and the term ‘fast air’ used in the other sources.

Finally, Kastner is the only source that discusses the relevance of the amount of air taken into the lungs:

> Il faut calculer l'inspiration dont on a besoin, ne donner ni trop, ni trop peu d'air; en un mot demeurer maître de sa respiration comme aussi d'augmenter ou de diminuer à volonté l'intensité, ou encore d'arrêter le son tout court (Kastner, 1846, p.27).[24]

If you need to calculate how much air you need to blow into the saxophone, you must also first calculate how much air you breathe in. Therefore, the essence of controlling the air going into the saxophone depends upon the very first step of breathing, taking in the correct amount of air. It is my argument that the amount of air taken into the lungs must directly correlate to that which is needed to be used when blown into the saxophone.

2.2.2 Embouchure position and pressure

In order to respond to Buckland's claim (on page 36) that "all the air we use in playing the saxophone needs to be… focussed… at one point" (2012, p.24) the position of the mouthpiece in the mouth and the manner of forming the embouchure needs to be examined. Mayeur suggested placing close to half of the mouthpiece in the mouth (Mayeur, 1896a, *Position du bec dans la bouche*), whilst Beeckman says "le bec du Saxophone doit être placé dans l'intérieur de la bouche jusqu'à une profondeur d'environ dix millimètres (Beeckman, n.d., p.8).[25] Cragun recommends taking "about one third of the mouthpiece in the mouth" because "if you take too much mouthpiece in the mouth, the tone will be loud and coarse; if too little, it will not be full and round" (1923, p.9).

Different ideas regarding the formation of the embouchure have emerged and there have been obvious discrepancies between the method books regarding some of these techniques.

Saxophone method books showed that there was a non-linear progression between using a single lip or a double lip embouchure, where the top teeth are covered by the upper lip. For example:

> Quelques virtuoses prétendent cependant (en parlant de la clarinette qui est un instrument à anche simple, comme le Saxophone) que la pression des lèvres doit être toujours la même, afin que l'anche puisse fonctionner librement; mais Mr. Sax est d'un avis contraire, du moins en ce qui touche le Saxophone; et il admet même que dans certains cas, on peut maintenir le

[24] "You must calculate the air you need to breathe in, not too much, not too little air; in one word stay master of the breathing as also augmenting or diminishing at will the intensity [dynamics], or even stopping the sound short" (Kastner, 1846, p.27).

[25] "The saxophone mouthpiece should be put inside the mouth up to a depth of about ten millimetres" (Beeckman, n.d., p.8).

> bec avec les dents de la machoire (*sic*) supérieure, ce qui procure une grande solidité et n'occasione (*sic*) aucune fatigue (Kastner, 1846, p.27).[26]

> Beaucoup de clarinettistes jouant de saxophone portent la lèvre supérieure sur le bec: ce moyen est bon pour la clarinette et non pour le saxophone: d'abord on a moins de force et beaucoup moins de son, et puis de cette manière on se fatigue plus vite. Le bec étant ainsi tenu par les dents et la lèvre inferieure avec une légère pression, qui s'oppose seulement à la sortie de l'air par les coins de la bouche, doit avoir un movement libre: une pression trop forte rapprocherait l'anche de la table, et empêcherait la vibration necessaire à la qualité du son, qui serait courte et étouffé (Mayeur, 1867, p.8).[27]

Whilst Kastner regarded single lip embouchure as for use only in special circumstances, Mayeur was clearly in favour of it. Mayeur's stance against the double lip embouchure was also found in the re-edition of his method book: "Ce qui est nuisible à la largeur du son, c'est de reployer la lèvre supérieure sur les dents, de cette manière le son est petit" (Mayeur, 1896a, *Position du bec dans la bouche*).[28] Fontbonne's 1907 method book contradicted this, stating that the top of the mouthpiece is to be held only by the upper lip (Hemke, 1975, p.272), but by 1913, Blémant's method book once again negated the idea of only using the lips to hold the mouthpiece, calling it an "obstruction to the production of fullness of tone" (Hemke, 1975, p.273).

Despite the differing opinions regarding single or double lip embouchure the importance of finding the correct amount of pressure to be exerted on the mouthpiece and reed was clear: "Les lèvres alors exercent sur l'anche et le bec une légère pression qui, si elle était trop accentuée, produirait des sons aigus et nasillards" (Beeckman, n.d., p.8).[29]

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[26] "Some virtuosos pretend however (speaking about the clarinet which is a single reed instrument just like the saxophone) that the lip pressure should always be the same, in order to make sure that the reed can operate freely; but Mr Sax is not of the same opinion, at least concerning the saxophone; and he admits even that in certain cases you can hold the mouthpiece with the teeth of the upper jaw, which allows for a great solidity and does not cause any tiredness" (Kastner, 1846, p.27).

[27] "Many clarinettists who play saxophone put the upper lip on the mouthpiece: this method is good for the clarinet, and not for the saxophone: firstly you have less strength and a lot less sound, and also you get tired sooner using this technique. The mouthpiece which is held by the teeth and the lower lip with a light pressure, that only prevents the air from escaping by the corners of the mouth, should have free movement: too much pressure would move the reed closer to the table [of the mouthpiece] and block the vibration necessary for the quality of the sound, which would be short and muffled" (Mayeur, 1867, p.8).

[28] "What is harmful to the breadth of the sound, is to fold the upper lip around the teeth, in that way the sound is small" (Mayeur, 1896a, *Position du bec dans la bouche*).

[29] "The lips then exert a light pressure on the reed and the mouthpiece which, if it was too accentuated, would produce high and nasal sounds" (Beeckman, n.d., p.8).

Many of the early saxophone method books believed that the amount of embouchure pressure should change for different playing situations. The following quotes, by Mayeur and Kastner, again highlight contrasting views.

> La pression des lèvres se règle généralement sur le diapason de la note à exécuter, c'est-à-dire qu'elle se resserre pour les notes aigus et se relâche pour les notes graves (Kastner, 1846, p.27).[30]
>
> Il faut une petite pression progressive pour les notes graves, et maintenir la même pression pour les notes aiguës que celle que l'on donne au sol (au-dessus des lignes). Ainsi remarquez que c'est tout l'opposé de la clarinette; de cette manière vous arrivez à avoir une grande égalité sur l'instrument en ménageant le grave et en augmentant l'aigu (Mayeur, 1867, p.8).[31]

In the exercises contained in the method book, Mayeur gave a reason behind his idea of increasing the embouchure pressure for lower notes: "Il faut a (*sic*) partir du SOL une légère pression de la lèvre inférieure sur l'anche et insensiblement jusqu'au SI grave afin de ménager la force des notes graves" (Mayeur, 1867, p.25).[32]

Mayeur clearly believed in a firm embouchure, as his later book stated that any relaxation or loosening of the lips must be avoided as it could cause the sound to tremble (Mayeur, 1896b, *The Tone*). Despite this he did not believe in increasing the pressure on the reed when playing quietly:

> Dans le ***piano*** le son doit être attaqué avec beaucoup de douceur. Dans le ***pianissimo*** la pression de l'anche ne doit pas être augmentée. Il faut éviter de faire entendre le vent dans l'instrument, le son doit être pur et vibrer comme dans le lointain (Mayeur, 1867, p.9).[33]

Discussion of such adaptations to the embouchure, dependent on pitch or dynamic level, decreased in saxophone method books, and by the early 20th century, Eby wrote: "you must acquire a definite embouchure; that is, a definite placing of the lips on the mouthpiece and after you have learned the best position do not change it from day to day" (Eby, 1923, p.xvi).

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[30] "Lip pressure is generally adjusted depending on the register of the note to be produced, that is to say tightened for high notes and loosened for low notes" (Kastner, 1846, p.27).
[31] "You need a small, progressive pressure for the low notes and keep the same pressure for the high notes as the one you use for G (on top of the stave). So note this is entirely the opposite of the clarinet; in this way you achieve a big evenness on the instrument by handling the low register carefully and increasing the high [register]" (Mayeur, 1867, p.8).
[32] "From G onwards you need a light pressure of the lower lip on the reed and imperceptibly until low B in order to manage the power of the low notes" (Mayeur, 1867, p.25).
[33] "In ***piano*** the sound should be started very gently. In ***pianissimo*** the reed pressure should not be augmented. You have to avoid making the wind in the instrument audible, the sound should be pure and vibrate as if coming from far" (Mayeur, 1867, p.9).

The importance of embouchure formation and pressure, and the relationship between these aspects of the embouchure, and dynamic levels, has in recent method books only been spoken about in relation to subtone playing, a technique that can be used for playing at low-end dynamic levels.

In the discussions about developing a technique for playing lower-end dynamics on the saxophone in chapter 3, it will be seen how this research included playing using single and double lip embouchures, as well as making changes to embouchure position and pressure, in order to find the influence of these variables on other aspects of playing the saxophone.

2.3 Techniques for playing quietly

Londeix specifies that the "***p*** of accompaniment", which he says should be played "with a less brilliant tone colour", is "an easily realizable technique for saxophones; it is made by utilizing the technique referred to in jazz as 'subtone'" (1989, p.84).

Delangle and Michat describe subtone as "a surprisingly soft sound [which] can be obtained in the low register" (1998, p.175). They identify three methods of playing subtone:

> Lower-jaw pressure is replaced by the tongue under the lip, or the tongue lightly touching the reed (as if pronouncing the word 'the'). Alternatively, the embouchure can be moved towards the end of the mouthpiece, holding it only with the lips and without pressure from the teeth (Delangle and Michat, 1998, p.175).

Two of these techniques for playing subtone, placing the tongue on the reed and playing using "little mouthpieces and loose embouchure" are also documented and described in Weiss and Netti (2010, p.162). It is, though, worth noting that both Delangle and Michat's, and Weiss and Netti's understanding of the technique known as subtone differs from Roach's description of the subtone technique used in jazz and rock music, where "subtone is generated by pulling the jaw down and back towards the tip of the reed" to give a "very warm tone with much less definition than normal" (1998, p.90). A similar description of subtone playing, as "a warm, fuzzy soft sound", which is achieved by "dropping the jaw and using a slower airstream" is given in Easton (2006, p.254).

Using the tongue to either support the bottom lip in place of the bottom teeth, or placing it in constant contact with the reed, prevents the possibility of playing some other techniques; the most basic aspect of which, is any form of articulation. These subtone techniques are therefore not suitable for combination with tongued notes.

Delangle and Michat state that by using either subtone technique "the reed is partially prevented from vibrating and the upper partials are subdued" (Delangle and Michat, 1998, p.175), a point confirmed in

Londeix: “The question is to be able to make heard the fundamental of a sound without its natural overtones or harmonics” (1989, p.84). Similarly Weiss and Netti have said that subtone playing can be described as making the sound “overtone-weak” (2010, p.161) and that “the difference between a normal tone and a subtone… is very clear” (2010, p.162). Using subtone technique to play quietly on the saxophone therefore leads to a distinct change in the sound.

Weiss and Netti also point out that “the transition between normal and subtone playing is… difficult with respect to embouchure technique and cannot always be smoothly executed” (2010, p.162). When such a technique can only be used for either entire sections of playing or isolated tones, as “a fast alteration with the normal sound is not possible” and would result in “a very noisy mix of ‘accidents’” (Weiss & Netti, 2010, p.163), it must be questioned why subtone has been both suggested, and used, not only for a change in timbre, but also as a means of playing quietly on the saxophone.

Whilst the subtone techniques that have been described by Delangle and Michat (1998, p.175) may, at times, be requested by composers, it seems strange that an instrument, the inventor of which deemed to have such a wide range of dynamic possibilities, has had to resort to using such a technique in order to play quietly. Using this technique for playing quietly then causes more problems than it solves; fatiguing the embouchure, occupying the tongue unnecessarily, destabilizing the embouchure position and causing a change in timbre.

Redgate has said that “to lip up or down… changes the kind of sound the performer makes and indeed can affect the dynamic control” (Redgate, 2007, p.145). Therefore, the use of a loose embouchure seems contra-indicated when trying to play quietly as it could also have an influence on other aspects of playing the saxophone.

Londeix has called into question the ability of a musician who cannot play quietly: “Accepting that the instrument can play a true ***p***, it is the musician who cannot play very softly who should be scrutinized” (Londeix, 1989, p.85), but, has also written that whilst “it [use of the subtone technique] is sometimes notated above the staff by the words ‘subtone’ or ‘subt.’; it seems, however, to be self-evident and generally understood and expected when a composer writes ***ppp***, ***pppp***, and ***ppppp***” (Londeix, 1989, p.84). Londeix’s statement is perhaps an over-generalisation; this claim would mean that sections of the first and second movement of Denisov’s *Sonate* would be played using subtone. This seems unlikely, as the highest note marked ***ppp*** is an E6 (written pitch) and, as Weiss and Netti point out, “beginning with the middle register and especially in the higher register… subtone playing does not make any sense” (2010, p.162).

There is currently not a way to play lower-end dynamics on the saxophone which does not cause either the embouchure to fatigue which can lead to instability and trembling (double lip embouchure), or does not occupy the tongue unnecessarily thereby stopping all forms of tongue articulation (tongue on the reed subtone). The next section will also show that it is difficult to integrate extended techniques into playing quietly on the saxophone when using the subtone technique.

2.4 The difficulties of integrating extended techniques into lower-end dynamics on the saxophone

As has been discussed, extended techniques have become a standard part of many compositions for the saxophone, and Londeix has classified music which contains such techniques as idiomatic (1997, pp.71-73). Whilst there are of course numerous extended techniques, this section will look at four different extended techniques. It will briefly explain what the extended techniques are, how they are played, and highlight any reasons why there can be difficulties when trying to integrate them into playing when using existing subtone techniques to achieve lower-end dynamic levels.[34]

2.4.1 Slap-tonguing

Londeix has described slap-tonguing as a “brutal, violent, hard” sound which is “blasted” (1989, p.97) and as “a sort of smacking sound… that is quite pronounced, through the use of the tongue, at the time that the note is played” (1997, p.81). Weiss and Netti describe slap-tonguing as “a strong marcato” that “can be performed as a short staccato” (2010, p.142). They have defined three types of slap-tonguing and allocate each a dynamic range in which they are possible: ‘standard slap’ ***p*** – ***fff***, ‘secco slap’ ***pp*** – ***mf***, ‘open slap’ ***mf*** – ***fff*** (Weiss and Netti, 2010, pp.142-143). To play a slap-tongue, the tongue presses “the reed against the mouthpiece, thus creating a vacuum before the tongue is quickly withdrawn. The reed comes away from the mouthpiece violently and hits it hard” (Delangle and Michat, 1998, p.179).

Regarding standard articulation Bumcke has written that when playing quietly, a “note must not be articulated with the hard sound of ‘t’, but with the soft sound of ‘d’, the player thinking of such words as ‘day’, ‘do’, ‘dee’” (Bumcke, 1926, p.39). If such care needs to be taken for standard articulation of a note when playing quietly, then the techniques for different forms of articulation therefore also have to be studied and possibly adapted before they could be integrated into playing at lower-end dynamics. It goes without saying that, as a form of articulation, slap-tonguing cannot be done if the tongue is

[34] Chapter 3 details some solutions to some of the problems discussed here.

already occupied by being held touching the reed or placed behind the lower lip for using subtone technique. If using only the lips to hold the mouthpiece (double lip embouchure), it would be difficult to hold the mouthpiece stable enough to press the reed to it.

2.4.2 Multiphonics

These are multiple sounds on the saxophone that are the result of using an adjusted fingering patterns.[35] Numerous fingering patterns have been documented by a number of authors, the two most substantial being Kientzy (1982), and Weiss and Netti (2010). Some multiphonics sound easily - Weiss and Netti say that "a large dynamic range corresponds to an immediate, fast response" - whilst "sounds with a dynamic range from ***ppp*** to ***p*** or with a generally narrow dynamic range have a correspondingly slower and also trickier response" (2010, p.62). What Kientzy, and Weiss and Netti fail to mention in their explanation of multiphonics, despite indicating it on their fingering pattern charts, is the role that the position and pressure of the lower jaw and lip has in sounding different multiphonics. This is indicated in Weiss and Netti, and in Kientzy by arrows pointing in different directions around a nominal mouthpiece-shaped icon.

The double lip embouchure, one of the subtone techniques for playing at lower-end dynamics, relies upon changing the level of pressure the embouchure puts on the mouthpiece and reed. Playing using "little mouthpiece and loose embouchure" (Weiss and Netti, 2010, p.162), also dictates the embouchure position and embouchure pressure. But, in order to be able to play a range of multiphonic sounds, the embouchure has to be allowed independent movement and cannot be fixed in place or pressure due to the constraints of the dynamic level.

The other technique for playing at lower-end dynamics is putting the tongue on the reed, an act which partially prevents the reed from vibrating and subdues the upper partials (Delangle and Michat, 1998, p.175). It is these upper partials which sound in different multiphonics. If the reed is not allowed to vibrate freely and the upper partials are subdued, then the full multiphonic will most likely not sound.

Multiphonics are also dependent on the correct air pressure (Bartolozzi, 1982, p.51), as documented clearly in Weiss and Netti (2010), and the pitches that sound can change with different dynamic levels.

[35] This definition refers to type 2 multiphonics, not type 1. These categories of different multiphonic have been defined by Bok (2011, p.40).

2.4.3 Altissimo register

The term altissimo register is used to refer to notes played on the saxophone that are higher than F♯6 (written pitch). Rousseau calls the "high tones above the normal range" either harmonics or overtones (Rousseau, 2002, p.iv), these are notes played on the saxophone that are not the fundamental note which sounds from each different fingering pattern.

Playing in the altissimo register has many of the same issues of embouchure position and pressure as multiphonics. The altissimo register requires the embouchure to be stronger and a "very slight forward movement of the [lower] jaw" (Rousseau, 2002, p.2). Therefore, using the subtone techniques which require a change to embouchure position or pressure, would impede the production of notes in the altissimo register.

Weiss and Netti have said, using subtone technique in the higher register does not make sense (2010, p.162), but notes in this register have the tendency to be strident, and we are reminded of Rascher's statement, that "to play ***pp*** in the higher register is not easy" (Patrick, 2014, p.247).

2.4.4 Key percussion

"Key noise: a percussive effect obtained by slapping down the pads without blowing" (Delangle and Michat, 1998, p.180). Weiss and Netti define the dynamic range of key percussion as between ***pp*** and ***p*** (2010, p.176), and Londeix has described the technique as "soft and delicate", "no louder than the ***p*** of a darbukka" (1989, p.75). This is therefore an extended technique which appears to naturally lend itself to use when playing at lower-end dynamics.

Key percussion is produced by closing the keys without blowing (Londeix, 1989, p.75). Therefore, the amount of air put into the saxophone does not matter, but the integration of key percussion into playing using subtone techniques could still cause some difficulties. Weiss and Netti have written that the mouthpiece should be closed with the tongue when playing key sounds with a closed embouchure, as it reinforces the resonance (2010, p.177), but placing the tongue on the reed, or opening the embouchure can both cause pitch differences to occur. This aspect will be discussed further in chapter 5 (with regards microtonal pitch differences).

Despite the apparent suitability of key percussion for integration into lower-end dynamics, there is also interference from the keywork mechanisms of the saxophone. Weiss and Netti have warned that, because of the relatively large keys and good resonating body of the saxophone "already during normal saxophone playing, key sounds are often (too) clearly audible" (2010, p.176), whilst conversely Delangle and Michat have said that sometimes the “tone is so diminished [when playing key percussion] that only the key noise seems to be left” (1998, p.180).

2.5 The use of lower-end dynamic markings in compositions

The last note in the second movement of Jascha Gurewich’s *Concerto* in E minor has a dynamic marking of ***pppp*** (1926, p.5). This is to my knowledge the earliest composition for the saxophone to include such an extremely quiet dynamic. The pitch to which it is attributed is a semibreve A4 (written pitch), a note in the middle of the saxophone range. This note is played using keys *1* and *2*, which means that air does not have to travel far down the length of the tube which forms the saxophone’s body. Ferron says that B♭3 is the only note that “comes out” from the bell (Ferron, 1997, p.24). The sooner the air can escape from the body of the instrument, the easier the note is to play.

Some of the later compositions where lower-end dynamics have been used in the saxophone part include:

- Aperghis’ *Alter Ego* for solo tenor saxophone has the same dynamic marking throughout: ***pppp***.
- Ferneyhough writes a diminuendo from ***ppp*** to ***pppppp*** in the soprano saxophone part for *Shadowtime* (2004, p.63). ***pppppp*** was to be reached whilst playing a B3 (written pitch).
- Finnissy has used the same dynamic marking, ***pppp***, in combination with frullato, breath noise, underblowing and multiphonics (1977, pp.25-28) in the soprano saxophone part for *Lost Lands*.
- Netti writes ***pppppp*** for a multiphonic in the third movement of *necessità d’interrogare il cielo* (n.d., p.iii-10).
- Sciarrino writes ***pppp*** for the four alto saxophone soloists in *La Bocca, I Piedi, Il Suono* (1997).
- Sotelo’s *Argo* a marking for ***pppppp*** (1987, p.2).
- Staude writes ***ppppppp*** with a crescendo to ***ppp*** for breath noise, used in conjunction with key noise and sounding tones in *Obduktion* (1988, p.2).
- Voirpy writes “***il più p possibile***” for multiphonics close to the end of *Motum V* for solo alto saxophone (1981, p.5).

Combelle wrote that, “Les notes graves sont difficiles à obtenir ***pp***…. Quant à obtenir un ***pp*** dans les notes graves *si♭*, *si♮*, *ut* et *ut♯*, il faudra se contenter d’un ***pp*** relatif” (Combelle, 1911/1934, p.5).[36] A

[36] “The low notes are difficult to obtain ***pp***.... Concerning the production of a ***pp*** with the low notes B♭, B, C and C♯ we will have to accept a relative ***pp***” (Combelle, 1911/1934, p.5).

relative dynamic might be a possibility when there is a smaller dynamic range, for example ***pp*** to ***mf*** could be played ***p*** to ***f***, or even ***mp*** to ***ff***. When there is a large range of dynamic markings though, such as that in Finnissy, ***pppp*** to ***fffff*** (1977), or Staude ***ppppppp*** to ***ffffff*** (1988), there needs to be sufficient capability to play both loudly and quietly in order to give room to and differentiate between the different markings. Furthermore, music coming from or going to nothing (***dal niente*** – ***a niente***) must follow these markings, and quite literally start or end at nothing, not at a relatively quiet dynamic. Works for the saxophone, such as the aforementioned piece by Voirpy, have sometimes used the term, 'as quietly as possible', which is also a relative term. For example, Pisaro's *breath* calls for the saxophonist to play "as soft as possible" for the duration of the piece. This differs from the markings in Finnissy or Staude, as it allows the player to make a judgement and to define exactly what 'quiet' is, and the context for projecting that sound, without having to think about the upper dynamic level.

Sprintz asks for a multiphonic to be played as "***ppp posible***" (2004, p.5).[37] This dynamic marking requires the player to relate the dynamic marking to others in the piece through the use of ***ppp***, but also leaves room for some variation in how quiet this is. The word '***posible***' is only used by Sprintz in relation to two quiet dynamic levels: ***ppp*** and ***pp***. The use of '***posible***' for these two lower dynamic levels implies that whilst the louder dynamic levels are set - although in themselves relative - these two levels could be changed. They could therefore be dependent upon either the technical ability of the player, or what is required to be played.

Combelle's comments about relative dynamics could also cause difficulty when playing in combination with other instruments, especially those which are not able to play as loudly as the saxophone. In such a situation the saxophone needs to be able to match their dynamic range and attempt to play as quietly as they do, therefore relative dynamics no longer work.

2.6 Saxophones, mouthpieces, and reeds: extra length, more projection, and the problem of the B♭

Kientzy asserted that the saxophone has hardly evolved since its inception (Vermeil, n.d., p.104), but this statement does not reflect how the saxophone has constantly been developed and changed since its invention in the 19th century. Sax made several changes to the instrument in his subsequent patents, and the instrument has also been further developed by different people and companies since the expiration of Sax's patents.

[37] "***ppp possible***" (Sprintz, 2004, p.5).

In his 1881 patent Sax describes a modification to his existing alto saxophone. In this, his third and final patent relating to the saxophone, a suggestion was made for modifications to the alto saxophone in order to allow the instrument to replace the viola.

> Le saxophone alto en mib (sic), le ton le plus favorable pour les musiques militaires et le plus répandu, représentant la partie d'alto dans le quatuor, se trouve trop court d'un ton pour atteindre au grave la limite extrême du membre de la famille du violon.
>
> J'ai allongé le tube de façon à lui faire gagner deux demi-tons (Dullat, 1995, p.201).[38]

Later in the patent Sax talks of adding three notes, B♭3, A3, and A♭3. In order to add these notes Sax calculated that he would need to add approximately a quarter again to the length of the tube of the saxophone (Dullat, 1995, p.201). The addition of two semitones to Adolphe Sax's original ideas for the saxophone, might have given it the pitch range to allow it to replace the viola, but it also lengthened the body of the saxophone.

Sax's extensions to the lower range of the saxophone did not become standard, and the only member of the saxophone family to regularly have the physical ability to play A3 (written pitch) is the baritone. One of the changes made to the saxophone for the *Evette et Schaeffer* model, as detailed in Mayeur was the addition of a key for B♭ moved using the left hand little finger (1896a, *Avant-Propos*). Other members of the saxophone have retained the ability to play B♭3 (written pitch). This note and this key have become standard parts of modern saxophones. Despite the note's continued presence on modern instruments: "The lowest notes of conical wind instruments have always been notoriously difficult to control ***pianissimo***. Even today, when instrumental design and manufacture have been so refined" (Trier, 1998, p.102).

A quick study of the differing lengths of soprano saxophones can highlight the effect adding notes to the saxophone has had. Whilst the length of an 1857 *Adolphe Sax* soprano with a range from B3 to C♯6 (written pitches) is 58cm, a 1908 *AS Fils* soprano, with a range from B♭3 to E♭6 is 64cm and a 1973 Henri Selmer *Mark VI* soprano with a range from B♭3 to F♯6 is 65cm (van Oostrom, 2009, p.21, p.33, p.50).

[38] "The E♭ alto saxophone, the most favourable sound for military music and the most frequently played, which represents the part of the viola in the quartet, is missing one whole tone in order to be able to reach the extreme limits of the low register of this member of the violin family.
I have lengthened the tube in order to gain two semitones" (Dullat, 1995, p.201).

Saxophonist Leo van Oostrom has discussed the impact of lengthening the tube of the saxophone in order to add more notes:

> De ramp is dus na Sax behoorlijk doorgezet, het ding is ontworpen zoals ie is, de boring is ontworpen als een instrument tot laag B. *Evette-Schaeffer* zetten er een Bes op, die zetten een stuk pijp erop, eigenlijk moet je gewoon overnieuw beginnen.
>
> …en dan nog een keertje bouwt Selmer een lage A op zijn bariton, en op een gegeven ogenblik op die alt, maar gaat ook niet overnieuw beginnen. Vind je het gek dat de bariton met die lage A in negen van de tien gevallen zo beroerd klinkt?!
>
> …het kan niet! You have to start from scratch!" (van Oostrom, personal communication, March 23, 2012. All further quotations are taken from this interview, unless otherwise specified).[39]

The affect lengthening the tube of the saxophone has had on the instrument's ability to play quietly will be discussed further in chapter 3, in relation to work I have undertaken on a Couesnon baritone saxophone.

There have also been other changes to the saxophone, some of which have changed its dynamic range. An article in *Revue et Gazette musicale* detailed Sax's awareness of the "muffled sound produced on ophicleides by the presence of pads" and to remedy this, Sax replaced the pads in ophicleides with brass plates, a system which "resulted in a more brilliant sounding instrument" (Hemke, 1975, pp.44-45). Whilst Blanchard believed that this system could be applied to all "holed" instruments, Sax did not use it on any of his other instruments (cited in Hemke, 1975, p.45). Despite Sax not using brass plates on the saxophone, and despite them not being part of Sax's original designs, modern instruments are now fitted with resonators, which Ferron has said, reduce absorption (1997, p.38).

[39] "So the disaster has largely continued after Sax, the thing is designed as it is, the bore has been designed as an instrument going down to low B. *Evette-Schaeffer* put a B♭ on, put an extra bit of tube, in fact you have to start all over again.
…and then Selmer constructs a low A on their baritone and at the same point in time on that alto, but doesn't start all over again either. Is it strange that nine times out of ten the baritone with the low A sounds so terrible?!
…it's not possible. You have to start from scratch!" (van Oostrom, personal communication, March 23, 2012).

Subsequent patents by different manufacturers all looked to improve or enlarge the sound of the saxophone.

> L'invention a en outre pour but de donner une plus grande sonorité à l'instrument (1901 patent application by Charles Maheu, patent number 156158, in Dullat, 1995, p.15).[40]
>
> L'invention se rapporte aux saxophones et a pour objet des perfectionnements à ces appareils permettant d'obtenir une grande douceur de jeu … en même temps qu'une puissance sonore supérieure à celle obtenue jusqu'à ce jour (Patent number 627830, patent granted June 20, 1927, to Maurice Evette, in Dullat, 1995, pp.87-95).[41]

In patent number 3226 Sax had detailed the saxophone mouthpieces as having a large interior which decreased in size where it joined the instrument.[42] Sax's final patent for the saxophone, number 139884, detailed wooden saxophone mouthpieces that he galvanised first with brass and then with gold, silver or nickel (Dullat, 1995, p.202).

According to Trier, changes made to saxophone mouthpieces have been to enlarge the volume of louder dynamics.

> Saxophones are capable of an immense range of dynamics. A large industry has been set up to produce mouthpieces to help the player achieve these extra decibels….
>
> Metal and alloy mouthpieces do not necessarily mean louder sounds, but it is certain that many of them are expressly designed to that end (Trier, 1998, p.108).

In his first patent, Sax stated that he believed his invention to be capable of a wide range of dynamics, becoming the linking instrument between the louder brass and quieter woodwind and stringed instruments (Dullat, 1995, p.193). Despite Trier's assertion about the possible affects of metal and alloy mouthpieces upon the dynamic levels, Sax does not mention any change to the dynamic capabilities of the saxophone due to galvanised mouthpieces.

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[40] "The invention furthermore aims at giving a bigger sonority to the instrument" (1901 patent application by Charles Maheu, patent number 156158, in Dullat, 1995, p.15).

[41] "The invention concerns the saxophones and aims at perfections made to these instruments, enabling them to achieve a great playing softness… at the same time a superior sonority, more powerful than the one obtained until this day" (Patent number 627830, patent granted June 20, 1927, to Maurice Evette, in Dullat, 1995, pp.87-95).

[42] "Le Saxophone a pour embouchure un bec à anche simple dont l'intérieur très évasé va en se rétrécissant a (*sic*) la partie qui vient s'adapter au corps de l'instrument" (Dullat, 1995, p.194).

"The Saxophone has at its top end a mouthpiece with a single reed whose widened interior [chamber] narrows towards the part which will adapt itself to the body of the instrument" (Dullat, 1995, p.194).

Finally, two saxophone method books have mentioned the importance of the reed:

> Le bec et l'anche jouent également un grand rôle dans la sonorité. Le meilleur instrument aura toujours une vilaine sonorité avec un mauvais bec; de même un bon bec avec une mauvaise anche, l'un ne peut aller sans l'autre (Combelle, 1911/1934, p.4).[43]

> Lorsqu'une anche est bien faite, elle produit le son avec peu de souffle; elle fait les ***pianissimo*** et les ***forte*** dans le grave et dans l'aigu (Mayeur, 1867, p.7).[44]

Whilst the saxophone and its mouthpiece have been changed in order to be able to play louder, there has been no equivalent change in saxophone playing technique which would have balanced these changes to the instrument and allowed the saxophone, and its players, to retain the possibility of playing at lower-end dynamic levels. Without the counter-effect that such a change of technique would allow, the saxophone has become less equipped to play at lower-end dynamics.

2.7 Summary and conclusions

In the numerous saxophone method books available not enough emphasis is placed upon the impact both the breathing and blowing technique, and embouchure position, have on the saxophone's ability to play in the lower-end dynamic range. Additionally, changes and trends in saxophone manufacture may have inadvertently altered the abilities of Sax's invention to play at quiet dynamic levels. The push for idiomatic saxophone music may have limited players from having to deal with the difficulties posed by lower-end dynamics. The result of the combination of these factors is that existing techniques for playing quietly on the saxophone are insufficient, and are not able to be combined with a number of extended techniques. Despite this, existing repertoire demonstrates a desire by composers for the saxophone to be able to play in the lower-end dynamic range: there is clearly a need to be able to play at lower-end dynamics on the saxophone. Chapter 3 will demonstrate how lower-end dynamics can be played on different saxophones including current models whilst using standard mouthpiece and reed combinations. This will be done without the use of mutes, without adapting the instrument in any way, and without resorting to the extreme methods mentioned in chapter 1.

[43] "The mouthpiece and the reed also play a big role in the sonority. The best instrument will always have a ugly sound with a bad mouthpiece; the same goes for a good mouthpiece with a bad reed, one cannot go without the other" (Combelle, 1911/1934, p.4).

[44] "When a reed is well-made, it produces the sound with little air; it makes the ***pianissimos*** and the ***fortes*** in the low and in the high registers" (Mayeur, 1867, p.7).

Chapter 3 Extending lower-end dynamics on the saxophone

Londeix has called “very soft dynamic levels… an integral part of today’s music” (1989, p.85), and said that “today’s composers may… choose to abandon those instruments that cannot play a true ***p***” (1989, p.85), but the demands music places on today’s saxophonists can reach far beyond ***piano***. In chapter 2 compositions for the saxophone were identified that use dynamics markings with as many as seven ***p****’s*. As was discussed in chapter 2, changes made to the saxophone, such as lengthening the bell, or adding resonators to the pads, have increased the louder dynamic levels possible on the saxophone, but at the same time these changes have been detrimental to the lower-end dynamic levels. There is therefore a need for saxophonists to be able to play at lower-end dynamics, and a need for a technique which allows this.

Londeix has said, “playing very ***p*** is a technique that is learned” (1989, p.85), but existing techniques for playing quietly, the different methods of playing subtone discussed in chapter 2, are not applicable in all circumstances and do not allow the integration of some extended techniques. In order to extend the lower-end dynamic range of the saxophone I have developed a technique that is flexible and adaptable within a variety of contexts, that keeps control of the embouchure, and that can be used when playing extended techniques. The technique was developed not by changing the existing techniques used for playing quietly on the saxophone (subtone), but rather by adapting or changing my thinking and behaviour relating to how the saxophone should be played.

This chapter will start by explaining my initial research into playing quietly on the saxophone and how my technique was developed. It will then explain the technique in detail before making suggestions about how it can be applied to existing compositions. This will be followed by a study of how my technique for playing lower-end dynamics on the saxophone was further developed to allow the incorporation of a number of extended techniques. As part of this chapter four compositions will be studied, to highlight how I have used and developed my technique, and discuss any stumbling blocks. These compositions are: *Nano* (2007) by Mc Laughlin, r*eflections, echoes and fugitive flickers which when traced evaporate* (2011) by Isaacs, *breath* (n.d.) by Pisaro, and *Kontr-atrofia/Contr-atrophy* (2012) by Zych.

A number of audio recordings have been made which should be listened to in conjunction with this chapter. The recordings serve to illustrate and highlight the matters discussed in here. They are marked in the text as such: [Recording]. [Recording 1/1.] should be listened to before the recordings relating to lower-end dynamics. It can be used to set an appropriate volume level on the device used to listen to the recordings relating to this chapter. Refer to [Appendix B2] for further explanation.

3.1 Discovering my technique

Whilst I had never been taught a specific technique for playing quietly on the saxophone, I had, in my work as a saxophonist, discovered a need to be able to play at lower-end dynamics. There had been situations where I felt that my existing dynamic range was not sufficiently quiet. I had also faced moments when the existing technique for playing quietly, using subtone, was not suitable.

Having studied existing advice regarding embouchure position and embouchure pressure, and also the inability to use extended techniques if, as subtone does, playing quietly relies upon a change in either of these aspects, I decided that my technique could not be reliant upon altering either of these aspects of the embouchure. Nevertheless my initial research began with a study of the different subtone techniques. What did it feel like to use them? What level of control did I have? What was the sound like? Which extended techniques could I play? What were the difficulties in moving in and out of subtone playing? Most importantly for my research, how quietly could I play?

I found that placing my tongue on the reed was rather uncomfortable; it tickled. It was certainly not a position that I could maintain for long periods of time, but was one that I could move to and from with relative ease. I also found, as my tongue was both stationary and touching the reed, that saliva gathered on it as I played, and the reed began to buzz from it. Whilst the sound had 'pancaked'- it sounded flattened, or compressed, due to a lack of the higher partials - it was not actually that quiet and I could no longer articulate any notes. [Recording 2/1.]

Replacing the pressure from my bottom teeth with the tip of my tongue did not seem to have a noticeable effect on the dynamic level of the saxophone, although it did cause the pitch to drop slightly. Moving to and from this subtone technique was more difficult than placing my tongue on the reed. I lost the ability to play any form of articulation, but was able to sound multiphonics. Whilst the sound had not 'pancaked' in the same way as it had when placing my tongue on the reed, I felt that I had noticeably lost control, as putting my tongue in this position destabilized my embouchure. It was again not a position that I would be able to stay in for long. [Recording 3/1.]

Using double lip embouchure appeared to be the most successful of the different subtone techniques. Whilst my upper lip was not strong enough to hold the position for long, this could be developed. It was a more natural position and one which left my tongue free for articulation. However, whilst I was also able to sound some multiphonics, those which required extra embouchure pressure were not possible. Likewise, when replacing the bottom teeth with the tongue, the pitch was also lowered. It did not seem that this technique had an effect on the dynamic level at which I played. [Recording 4/1.]

These techniques, especially the first two, caused discomfort when used for any length of time. Whilst more was possible with the double lip embouchure, both techniques which used the tongue meant that I was not able to articulate. Any technique for playing at lower-end dynamics on the saxophone, which does not allow the player to articulate, clearly is of only limited use. Furthermore, these techniques are supposedly to be used for playing quietly on the saxophone, but whilst they did change the sound of the instrument, they had little effect on the dynamic levels at which I could play. [Recordings 2/1.-4/1.] To play more loudly whilst using them I would simply need to blow more air through the saxophone.

In chapter 2 the existing techniques used and advice given for breathing air in and blowing air out into the saxophone were discussed. As the existing techniques have been shown to have short-comings, and as the advice given was therefore questioned, I wanted to discover what would result from experimenting with altering the advised levels.

In order to achieve what is deemed the correct air-flow into the instrument, whilst studying in France, I had been taught a simple exercise. This entailed 'holding' a piece of A4 paper in place against a wall using only breath. Standing a few centimetres back from the paper, and blowing air against it from between lips that are pursed as if about to whistle, a correct breath pressure would 'hold' the paper in place. If the paper slipped down the wall, then either the breath pressure was not sufficient, or the air was not properly focussed.

Whilst this exercise has a value in highlighting air pressure and air focus, and is therefore of interest to wind instrument players, I questioned its value and relevance when researching the playing of lower-end dynamics on the saxophone. Was it necessary to push the same amount of air through the instrument at all dynamic levels? Instead of trying to blow as much air as possible through the instrument at all times I began from the opposite end of the spectrum. How little air could be blown through the instrument to still elicit a sound?

My experiment started by moving from blowing air through the instrument without making an audible note, to producing a definite sound. I found that surprisingly little air is needed to sound a note on the saxophone; Weber's statement, that players need to blow 'gently' (C. Weber, 1897, *The Saxophone*), comes to mind. Whilst an 'amount' of air is difficult to quantify, to return to the piece of A4 paper, if it is held it a few centimetres in front of my face and I blow using the same air pressure and flow as I do for playing quietly, then the paper barely moves. [Recording 5/1.] This amount of air flow is far less than advised by the sources discussed in chapter 2.

A test learnt whilst studying in France used the back of the hand to highlight the difference between focussed and un-focussed air. Using the back of the hand to judge the feel of the air blown on it, this test can determine whether the air is focussed as this would feel cold to the touch, or unfocussed, as this air would feel warm. Having used the back of my hand to test and identify the difference between focussed and un-focussed air, I determined these different levels and transferred them to my saxophone. [Recording 6/1.] After experimenting with playing at lower-end dynamic levels using both focussed and un-focussed air, I have come to the conclusion that playing using air that is not focussed is best for playing quietly. This is because focussed air will always put more air through the instrument than un-focussed air, and as determined in the exercise using breath to hold a piece of paper in place, it is better to blow a limited amount of air into the saxophone when playing at lower-end dynamic levels.

Having identified how little air is required to be blown into the saxophone in order to elicit a sound, I reached my first stumbling block. Mistakenly believing that by blowing very little air into the saxophone I could keep playing for a long time between breaths, I had neglected to think of the influence that the build-up of 'stale' air in my lungs would have. The build-up of the stale air kept causing me to stop playing prematurely. Returning to a quote in an early saxophone method book: "Il faut calculer l'inspiration dont on a besoin, ne donner ni trop, ni trop peu d'air" (Kastner, 1846, p.27),[45] I began to develop the idea that the amount of air taken into the lungs must directly correlate to that which is needed to be used when blown into the saxophone. Kastner's advice proved to be correct, and by inhaling less air I was able to play comfortably for longer periods of time.

My findings therefore go against the playing style of Bichon, and the advice given by Buckland et al., which was studied in chapter 2. The sound became reliable at a far lower level of air pressure and air flow than suggested in these sources. This led to a greater ease of playing for lower-end dynamic levels, and to an expansion of lower-end dynamics on the saxophone.

Whilst experimenting with the amount and the focus of the air put into the saxophone, I always aimed to maintain my normal embouchure, in respect of both the position and the pressure. This has meant that it can be held for long periods of time, at least as long as I would be able to play at louder dynamics. The stable position has meant that there is no drop in the pitch. There is also no loss in control. Moving in and out of lower-end dynamics now only entails calculating the amount of breath that is needed, so it can be integrated into pieces with a large dynamic range. Whilst the sound is different, it is not *as* different as when using the subtone techniques that have been discussed.

[45] "You must calculate the air you need to breathe in, not too much, not too little air" (Kastner, 1846, p.27).

The integration of extended techniques into my research on playing the saxophone at lower-end dynamics was a gradual process. The route my research followed in developing and integrating extended techniques will be discussed in section 3.3.

3.1.1 Different mouthpieces, reeds, and ligatures

Chapter 2 discusses how changes to the instrument, and to the material from which the mouthpiece is made, may have affected the ability of the saxophone to play at lower-end dynamics. Londeix wrote about Denisov's *Sonate*, that "the fingerings indicated are one possible solution, as reed, mouthpiece, and embouchure variables may affect the ultimate fingerings employed" (Umble, 2000, p.224). Mason had already written about the effects of using different instruments, mouthpieces, or reeds in his 1970 article. He concluded that it was not the reed or the instrument, but rather the mouthpiece which would affect the outcomes of different multiphonic fingerings (1970, p.4).

Whilst Mason completed his study of multiphonics with a standard Selmer C* mouthpiece, he believed that jazz players had an advantage due to their mouthpiece choice: the inference, though not explicitly stated, is that it would be easier to play multiphonics on a more open mouthpiece (1970, p.4, footnote 4). The Selmer E mouthpiece, with which Giorgio Netti documented the multiphonics in his piece *necessità d'interrogare il cielo* for soprano saxophone, was tested by Mason on the alto saxophone, and appeared to be satisfactory for obtaining the same results that he had obtained with his Selmer C* mouthpiece. Mason believed that given a standard mouthpiece "the composer who makes use of these techniques can be reasonably certain that, given a capable performer, his composition will be playable" (1970, p.4).

By contrast, Daniel Kientzy used a highly unusual set-up, not commonly found in classical saxophone performance, to document the techniques when he wrote his doctoral thesis Saxologie. His book, which documents all known sounds producible on the saxophone (Kientzy, 2002, p.4) used mouthpieces which are more open in combination with extremely soft reeds. For example, his soprano saxophone research was completed using a Selmer G mouthpiece and a Vandoren strength No.1 reed (Kientzy, 2002, p.7). This led me to try applying my technique for playing quietly on other mouthpieces and on other reeds.

As mentioned in section 2.6, Sax had written that his saxophone mouthpiece had a large interior which became smaller at the point at which it joined the instrument, but my standard alto saxophone mouthpiece is a Selmer S90/170. It is considered a fairly 'closed' mouthpiece by its manufacturers (http://www.selmer.fr, *Instruments/Mouthpieces/Presentation*), with a square chamber and a mouthpiece facing curve of 21 millimetres. It was therefore of interest to see if my technique for playing at lower-end dynamics on the saxophone could be applied to other mouthpieces, and whether I would be able to replicate the same results when different mouthpieces were used. The comments about applying my technique to playing on different mouthpieces can be found in [Appendix D1] and heard in [Recordings 7/1.-12/1.].

The first step was a relatively small one, to try a different mouthpiece by the same manufacturer. From this I progressed to mouthpieces by different manufacturers, and then to a mouthpiece made from a different material. The variety of mouthpieces tested are generally used for different styles of playing. Differing chamber shapes and baffles in the mouthpieces allow either more or fewer higher partials to sound, thereby making the sound more or less prominent. Whilst the mouthpieces do therefore produce different sounds, they did not have any noticeable affect on how quietly I could play using my technique. They did though, require different amounts of effort in order to play quietly, and I found that the Meyer 7, the only mouthpiece tested with an elliptical chamber, was much harder to play at a low dynamic level than the other five ebonite mouthpieces. I also found that both the Vandoren mouthpieces were easier to play at lower-end dynamic levels than my usual Selmer S90/170, but perhaps because they were 'freer' blowing to play, they were also more difficult to control and keep to lower-end dynamic levels.

Trier states that whilst metal mouthpieces "do not necessarily mean louder sounds… many of them are expressly designed to that end" (Trier, 1998, p.108). As I am used to playing on an ebonite mouthpiece there was very little difference in the 'feel' of the mouthpiece in the mouth between the above models. The next step was to move my technique to a metal mouthpiece. For this experiment I used a Lawton 6*B mouthpiece. This mouthpiece is narrower, and I initially had some difficulty in adjusting my embouchure to the mouthpiece. Despite this, I was able to apply my technique for playing at lower-end dynamic levels and, as the recordings show, was able to produce similar results on all six mouthpieces.

Trying different sorts of mouthpiece, and mouthpieces made of different material, has revealed that my work on playing at lower-end dynamics is best done on an ebonite mouthpiece. This is not because the metal mouthpiece caused any particular difficulty for applying my technique, or that the results were not as good, but rather it is my personal choice, one which may well have been influenced by the fact that I normally play on an ebonite mouthpiece. The muscles in my embouchure have become well used to this sort of mouthpiece. They are therefore able to control it with relative ease. The different feel of the metal mouthpiece left me feeling exposed and afraid that I would have little control over the sound I was making. Regardless of this, as the recordings show, I was able to apply my technique in order to play quietly on a metal mouthpiece. The main difference between the various mouthpieces was not how quietly they could be played, but rather in the effort required to do so.

In order to single out and test the differences between the different mouthpieces I used the same reed (Grand Concert Select strength No.3), whereas outside of these test conditions, they are likely to be used with different strengths and styles of reeds. Roach's statement that "a real slap-tongue is only easily produced with a fairly soft reed" (1998, p.91) and Kientzy's use of Vandoren reeds with a strength of between No.1 and No.2 on all his saxophones to document the techniques in *Saxologie* (2002, p.7), both allude to the influence that reeds can have on playing the saxophone. In order to discover if softer reeds would also reduce the effort required to play at lower-end dynamics by limiting the breath different strength reeds were tested. It was found that whilst very hard reeds made it more difficult to play at lower-end dynamics, very soft reeds also had a negative impact. The notion that soft reeds can make certain extended techniques easier to play does therefore not apply to playing at lower-end dynamics when limiting the breath used.

I have therefore chosen to keep using the same reeds that I normally use for my work on playing at lower-end dynamics. Choosing not to use softer reeds, as Kientzy and Roach have done, means that no changes are required to my usual playing set-up. This again shows the wide applicability of my work. Whilst my research has therefore largely centred around playing quietly using the type and strength of reed that I normally use [Appendix B1], I have tested different strengths of reed, to see if they have any influence upon the ease with which I can play quietly. My comments about using different strength reeds whilst applying my technique for playing at lower-end dynamic levels can be found in [Appendix D2] and heard in [Recordings 13/1.-14/1.].

I have noted that the 'buzz' associated with reeds was less prominent when I used synthetic reeds rather than those made from cane. This type of reed will be discussed in relation to my work on *Nano*, in section 3.2.1.3.

Having tested different mouthpieces and reeds I wanted to undertake one last test, the role the ligature might have in playing at lower-end dynamics. Returning to my Selmer S90/170 mouthpiece, and my D'Addario Grand Concert Select strength No.3 reeds I decided to try fixing the reed to the mouthpiece with an elastic band. [Appendix D2] This is something that I have had to do on occasion, when the thread on the screw in my ligature had been damaged. Attaching the reed in this way is firmer than my normal ligature. It did seem to cut out some of the higher partials, but again, did not affect my technique for playing quietly on the saxophone by controlling my breath. [Recording 15/1.]

3.1.2 Different saxophones

The experiments detailed in section 3.1.1 and [Appendices D1 and D2], where I applied my technique for playing at lower-end dynamics on the saxophone by controlling the breath to different mouthpieces and reeds, have shown that it can be readily utilised on a variety of playing equipment. The next step was to try applying my technique to other saxophones.

My work on discovering how changes to the saxophone have affected the dynamic levels at which it can play also led me to work on a Couesnon baritone saxophone. Sax's Belgian patent, number 5469, which was granted on January 16, 1851 (Haine, 1980, p.190), specified the lowest note of the saxophone as B3 (written pitch) although Sax's later patents (numbers 70894 and 139884) both mentioned the possibility of lengthening the bell of the saxophone.[46] Whilst he first detailed lengthening the bell of the instrument (although without adding extra range/keys) as early as 1866, and extended the range of the alto saxophone in 1881, many saxophone manufacturing companies continued to produce the instruments with a range extending down to B3 (written pitch). This Couesnon baritone saxophone, which is thought to be from around the turn of the 20th century, has a range designated by the keywork as between B♮3 and E♭6 (written pitches). The instrument has been lovingly restored by Sascha Schalken, who documented the process in *Ann's Little Book of Baritone* (n.d.). My Couesnon baritone does not have resonators on the pads as most modern saxophones have, and Schalken has used soft, untreated leather to make the pads. The saxophone is also smaller in size than a modern baritone, and more similar in size to that of a modern tenor saxophone.[47] As can be seen from the photograph, the bell of the instrument is comparable to that of a modern tenor saxophone.

[46] Dullat, 1995, pp.27-31, 197-204.
[47] The Couesnon baritone saxophone is a higher-pitched instrument, tuning to approximately A=452Hz.

Figure 1: Photograph of a Selmer series III tenor saxophone (left) and a Couesnon baritone saxophone (right)

Some of the changes that have been made in the design of the saxophone since Adolphe Sax's early instruments would appear to have affected the quiet dynamic capabilities of the saxophone. The most prominent of these changes is the result of adding B♭3 (written pitch) to the instrument. Lengthening the bell, to enlarge the lower range of the instrument, is something that has adversely affected the ability of the instrument to 'speak' freely, especially in the lower register. Playing on this saxophone demonstrated just how quietly it would be possible to play on an instrument which has more similarities to Sax's original instruments. The result is a sound which is noticeably different, more mellow and with audibly fewer higher partials present in the sound. [Recording 16/1.] The problem of the B♭ is not one which affects the entire range of the instrument: the notes played using the palettes of the left hand, for example, are not affected by lengthening the bell, as the air would escape from the open tone holes of the instrument way before it reached the bell.

Whilst I discovered that the Couesnon baritone, with its shorter range, was in general easier to play, I also realize that this is a subjective matter, and that this may not be just down to the length of the bell. There are other variables, such as the different material from which the instrument is made, which could influence the ease with which the instrument can be played.

Contrary to my expectations it was not overly easy to play quietly on the Couesnon using my technique. The saxophone is definitely quieter overall, and it is more difficult to play loudly on it. It is light, much lighter than modern instruments, and so seemed to need less air to make a sound. Therefore air would need to be controlled even more in order to play at lower-end dynamics on such an instrument.

In conclusion, I have found that my technique can successfully be applied to different mouthpieces, reeds, and ligatures, as well as to different saxophones. The influence that changes to the instrument have had on its ability to play at lower-end dynamics is limited, although I have found that the lower range of the Couesnon speaks easier at lower-end dynamics than on a saxophone that has B♭3 (written pitch). Though the use of the Couesnon saxophone, with a smaller range, is an easy solution for playing quietly in the lower pitch range, it is not always possible, as during the 20th century many works have been written for the saxophone which make use of the now-standard, extended range. Therefore, circumstances require that it is a superior playing technique which is needed, as this would give players the ability to play at lower-end dynamics on all saxophones.

3.2 Developing my technique

The development of my technique, as outlined in section 3.1 was an organic process. It is one that has been developed through its application in a number of compositions. The following three case studies, *Nano* (2007) by Mc Laughlin, *reflections, echoes and fugitive flickers which when traced evaporate* (2011) by Isaacs, and *Early one morning* (2014b) by C. Fox, detail how I have developed and refined my technique through its use in these compositions.

3.2.1 Mc Laughlin - *Nano*

My work on extending the lower-end dynamics capability of the saxophone initially centred round Mc Laughlin's composition *Nano*. This piece is a verbal score with six steps which was not originally intended for performance on the saxophone. It requires the performer to play a series of descending microtonal steps for the duration of one breath. This must be repeated with shorter or longer pauses in between. As a composition which can be played on a number of different instruments, the first choice I needed to make was which saxophone I would use. My choice of the alto saxophone was largely due to the microtonal aspects of the work, which will be discussed in chapter 5, but did of course also have an influence on the dynamic levels at which I could play.

The score for *Nano* requests that the performer plays "either as quiet as possible (close to noise/air but with a definite sense of pitch), or with a normal tone and a very gentle dynamic" (Mc Laughlin, 2007). I quickly realised that one of the options, to play with "a normal tone and a very gentle dynamic" (Mc Laughlin, 2007), would not be possible due to the microtonal content of the work. This is because microtonal pitches on the saxophone tend to have a different timbre from the semitone pitches, a matter which will be discussed further in chapter 5. The other option was to play "as quiet as possible" (Mc Laughlin, 2007).

My work on *Nano* began when I was still experimenting with using subtone techniques to play quietly. Having read Londeix's description of subtone as the technique which "permits the player to strive for the softest piano" (1989, p.85) I initially tried to apply subtone techniques to *Nano*. For this I applied the different methods of playing subtone that had been identified by Delangle and Michat (1998, p.175). These are, as discussed in section 2.3: replacing lower-jaw pressure under the lip with the tongue, pressing the tongue lightly to the reed, using a loose embouchure and little mouthpiece, and using a double lip embouchure to ensure the top teeth do not touch the mouthpiece.

The first subtone technique that I applied was replacing the lower teeth with the tongue. This was quickly dismissed. The duration of *Nano* is flexible but does have a minimum time of six minutes. I felt that it was not possible to hold this position for several minutes, and that it did not noticeably improve my ability to play quietly on the saxophone. [Recording 17/1.]

I swiftly moved on to the next subtone technique, placing the tongue on the reed. This technique did affect the sound, as discussed in section 2.3. It also brought with it the same change in sound as discussed in section 3.1. I found that I had difficulty in applying this technique to my playing for longer periods of time. When using this technique for several minutes without stopping, one of two things would happen: either my mouth would dry out, and it would become uncomfortable and difficult to keep my tongue against the reed, or conversely that there would be a build-up of moisture in my mouth which would, due to the tongue's place on the reed, have an increasingly negative affect on the sound quality: there would be a 'buzz' of saliva in the sound. [Recording 18/1.]

The composer had stated the minimum duration for *Nano* to be six minutes, with breaks of between one and five seconds at the end of each phrase. The short breaks left me with little time to do anything about the build-up of moisture on the reed. The solo nature of the piece also meant that if moisture did build up on the reed I would not be able to do anything about it. The duration of the composition, combined with the short breaks, would make it difficult to negotiate the issues posed by this playing technique, and I therefore felt that this method was not ideal for use in *Nano*.

The next subtone technique that I tried to use for *Nano* was the double lip embouchure, which removes contact between the upper teeth and the mouthpiece. My main concern with this method of playing subtone was to do with the stability of the instrument. In order to be able to play the microtonal pitches that the composer required, I was using my right hand thumb to press keys down, rather than as an anchor for the instrument. This is discussed further in section 5.3.3. By using my right hand thumb in an active role, and taking my upper teeth away from the mouthpiece, I would be removing both the points of contact with the instrument which hold it stable. There would no longer be an anchor point between me and the instrument. 'Breaking' the embouchure to take a breath would be particularly risky. The score states that "each pitch should be stable" (Mc Laughlin, 2007), and therefore I felt that I needed to keep my top teeth on the mouthpiece, otherwise I would risk losing the stability. [Recording 19/1.]

Finally I tried one last option for subtone playing which has been suggested by Weiss and Netti. It combines a very loose embouchure with taking less mouthpiece into the mouth (Weiss and Netti, 2010, p.162). They say that due to the loose embouchure, the reed is not "fixed between the upper teeth and lower lip as in the normal embouchure" and that "the upper teeth can even be completely taken away from the mouthpiece so that, also on the top, only the lips hold the mouthpiece" (2010, p.162). Following my experiments with the double lip embouchure I decided that it was best to keep my top teeth firmly on the mouthpiece, but even with this position, the loose embouchure was not a particularly satisfactory solution, as it impacted upon the stability of the pitches. [Recording 20/1.]

An additional problem with using any subtone technique in order to play quietly is the change to the sound. Hemke has said that "subtone provides contrast in timbre to the 'normal' sound" (1976, p.6). The sound of subtone playing has been described by Weiss and Netti as "dull" and "overtone-weak" (2010, pp.161-162), but Mc Laughlin did not request this sort of sound in the score. It was at this point that it became clear that I would have to search for an alternative method of playing very quietly on the saxophone. Pierre-Stéphane Meugé has said that “sometimes the solution is not found by the mind of the player, but by his fingers, his breath” (cited in Redgate, 2007, p.145).

Weiss and Netti have specified the ‘components’ of the embouchure as: “the parameters of lip pressure, the pressure point on the reed, the angle of the airstream, and also the pressure of the air stream” (2010, p.153). If I did not want to change the lip pressure (and play with a loose embouchure), change the position of the mouthpiece in my mouth, place the tongue on the reed, or indeed play on a different saxophone, then I therefore only had one option left to adjust, my breath. As I developed my technique, as explained in section 3.1, I began to try to apply it to *Nano*.

With a normal embouchure, I began by trying to determine the exact point at which the air-flow was great enough to start a note. The amount of air needed to sound a note changes with the register of the saxophone as well as with the saxophone used. The alto saxophone is a medium sized instrument that does not require too much air flow in order to sound a note. The pitch range that I had chosen for *Nano*, roughly between C♯5 and A♭4 (written pitches), is in the middle of the standard saxophone range. I generally find that this is the easiest part of the saxophone range in which to start notes, as not much air is required.

My technique of regulating the breath to play at lower-end dynamics on the saxophone gave me certain advantages over using subtone techniques. The most noticeable at first was that I retained stability of the instrument by keeping my upper teeth in contact with the mouthpiece. The second was that there was a slower, more normal, build-up of moisture on the reed as there was no longer prolonged contact with it. The third advantage was the ability to play quietly for the extended period that the composition required. [Recording 21/1.]

3.2.1.1 Articulation

For *Nano* I experimented with using air only to start the first note of a phrase. Whilst this worked following the longer five second pauses, I found this was not suitable following the shorter one second pauses, as the start of the note was too slow to arrive. I therefore had to try to develop a method which used the tongue to start the note. This would be the first time that I had combined my technique for playing at lower-end dynamics on the saxophone with any form of articulation.

I began by returning to Bumcke’s advice about articulation when playing quietly: a “note must not be articulated with the hard sound of ‘t’, but with the soft sound of ‘d’, the player thinking of such words as ‘day’, ‘do’, ‘dee’” (Bumcke, 1926, p.39). Similar advice has been given by Londeix, who uses the syllable ‘Taa’ for “émission ‘simple’” [normal articulation], and ‘Daa’ for legato tonguing (1989, p.95), and Weiss and Netti, who describe the consonants ‘d’ and ‘t’, as relating to “soft and hard tonguing” respectively (2010, p.141). Horch appears to freely interchange the syllables ‘Dah’ and ‘Tah’, but describes the part of the tongue used for ‘Dah’ as: “a spot very close to, but not absolutely on, the tip of the tongue (the same spot used when pronouncing the syllable DAH against the roof of the mouth)”, which he says “touches the tip of the reed” (Horch, 1998, p.82).

As I was actively limiting the amount of air going through the saxophone in order to play quietly the danger was that any form of articulation, contact between the tongue and the reed, would stop the reed from vibrating and therefore stop the sound.

Whilst the use of either the consonants ‘t’ or ‘d’ varies the part of the tongue that has contact with the reed, the amount of force that the tongue uses to pronounce each letter will also affect the strength of the articulation. When I tried to articulate using the consonant ‘t’ and the same amount of force as I would for a louder note, the reed stopped vibrating. [Recording 22/1.] I then tried the same exercise with the consonant ‘d’, but this also stopped the reed from vibrating. [Recording 23/1.] I now believe that this is because more tongue comes into contact with the reed when pronouncing ‘d’ than ‘t’. The placement of the tongue when using these two consonants can be tested by comparing how the word ‘day’ is said, as suggested by Bumcke, with ‘tay’. Or alternatively ‘dee’ and ‘tea’.

Bumcke’s advice about articulation was of no help to me when playing *Nano*. Therefore, the method that I have developed for tonguing when playing quietly is simply an adaptation of my existing method. I use the consonant ‘t’, but by further lightening the action, it has become so delicate that at only even slightly louder dynamics it does not stop the note. [Recording 24/1.]

Delangle and Michat say that sometimes composers “demand silent production” of a note, something which they call a “clarinet attack” (1998, p.179). There are alternative methods for starting notes, which do not use the tongue, and one of these is to use only breath to start the note. Weiss and Netti further define this method of starting the note, which Horch describes as “quite rare” (1998, p.81), as using the consonants ‘g’ and ‘k’ (2010, p.141). Using only air to start the note can also be done without clearly defining the starting point of the note, for example a ***crescendo*** from nothing, a technique for which Londeix provides no phonetic equivalent for the starting point of the note (1989, p.95). Players will also sometimes use air only to start a note and then also click a key shut whilst continuing to blow. This rapid closing of a key is then seen as the starting point of the note.

These alternative methods for starting a note can be especially useful at quieter dynamic levels, where an attack from the tongue can be too harsh, but they do also have disadvantages. In *Nano* I have experimented with articulation, and have sometimes started each phrase using air only. As the piece is so quiet I have not clicked a key at the same time as starting a note. I found that closing a key to provide a ‘start’ to a note could affect the pitch of the note and also that the movement of a key can be easily heard at quieter dynamic levels. [Recording 25/1.]

I have also not used ‘g’ or ‘k’ sounds to start a note, as my experiments with this technique always meant that the articulated note was always louder than the others. The use of the consonants ‘g’ or ‘k’, to give a precise starting point to a note without using the tongue, can cause a ‘surge’ of air down the instrument. The throat attack also lacks the clarity of a tongue articulation, and Wiedoeft called it “one of the worst faults one can develop” (1927, p.10). [Recording 26/1.]

The use of air only to start a note can be inexact and slow. It takes time to build up the air pressure needed to play a note, and there is not a precise starting point for a note played in this manner. Whilst this makes it more difficult to incorporate the technique into ensemble playing, when a clear start to a note may be required, this is an aspect I did not have to worry about in *Nano*. [Recording 27/1.]

I have not tongued each microtonal pitch in a phrase, but I have varied between using air to start the note, and tonguing the first note of a phrase and then slurring the remainder of each phrase, thereby limiting the number of notes that I would have to articulate. [Recording 28/1.] I have found that once a note has been started, it is easier to continue playing quietly. As each articulation came at the start of a new phrase and therefore followed a break, I had time to concentrate on the articulation, but this will not always be possible in other compositions.

3.2.1.2 Getting quieter and a couple of problems

Since the start of my work on *Nano* my ability to play at lower-end dynamics on the saxophone has increased. My results are now more consistent, more stable, and yet also more quiet than when I first began this research. Whilst I am happy with my achievements, playing ever quieter pitches has also highlighted two issues which needed addressing.

The first of these is air noise. Due to the composer’s suggestion in the score that when playing as quietly as possible, the piece can be played with a sound that is “close to noise/air, but with a definite sense of pitch” (Mc Laughlin, 2007), this has not been a particular issue in *Nano*. Whilst it was not my particular aim to create air-noise when playing, as a wind instrument, there is inevitably some noise produced by blowing. At quieter dynamic levels the sound of the air can appear magnified and can over-power the sound of the pitch. I have since discovered that unfocussed air has less of a ‘woosh’ to it, than focussed, fast air. [Recording 29/1.] Nonetheless the movement of air is an integral part of playing the saxophone, and a sound which cannot be entirely avoided.

The second issue that I have come up against is the noise produced by the movement of the keys. This is also part of playing the saxophone, and there will always be some noise that arises from the mechanics of the instrument, although a well maintained instrument will help in this respect. I have found that it helps to think of slow movement of the keys. Rather than snapping them shut they must be closed very carefully, and muscle training exercises, such as those found in Londeix's *Exercices Mécaniques* (1961a, 1961b, 1965) can help. [Recording 30/1.]

The third and final issue that I have encountered when playing *Nano* is the disruption of the air stream when playing microtonally. My technique for playing at lower-end dynamic levels on the saxophone entails seriously limiting the amount of air that is blown into the instrument. I have discovered that shutting a key too violently, or shutting several keys at once, which was needed to achieve the microtonal pitches in later interpretations of *Nano*, would manage to disrupt the vibration of the air column in the saxophone. [Recording 31/1.] The interference of the movement of the keys could therefore result in the sound of the saxophone stopping very briefly. I have again found that moving the keys gently has been a help with this matter.

3.2.1.3 Reeds

The most recent step in my work on *Nano* was regarding the use of different reeds. In a distinct change from my usual set-up [Appendix B1] I have tried performing the work using synthetic reeds to see if I would be able to better control certain variables. These were: to reduce the buzz as moisture gathered on the reed, to reduce air noise, and to see if I could find a reed that would need even less air in order to work. It was with these aspects in mind that I tried the *Hahn* reed which is made from hollow fibre glass. [Recording 32/1.]

Whilst such a reed did mean that I no longer had to worry whether the reed would dry out whilst playing, I found that overall it did not improve my ability to play at lower-end dynamics. My preference therefore remains to be for reeds that are ever so slightly softer than my normal reeds, a soft strength No.3 rather than a slightly harder strength No.3. The most important aspect that I have found is to have a well played-in reed, one that is stable and speaks easily, recalling Mayeur's claim: "Lorsqu'une anche est bien faite, elle produit le son avec peu de souffle; elle fait les ***pianissimo*** et les ***forte*** dans le grave et dans l'aigu" (1867, p.7).[48]

[48] "When a reed is well-made, it produces the sound with little air; it makes the ***pianissimos*** and the ***fortes*** in the low and in the high registers" (Mayeur, 1867, p.7).

3.2.2 The soprillo saxophone

As I developed my technique for playing lower-end dynamics I tried to transfer it to other members of the saxophone family. This was particularly difficult when I attempted to use it to play the soprillo saxophone. This instrument is a fairly new addition to the saxophone family, and has been developed by Benedict Eppelsheim. The instrument, which is pitched one octave above the soprano saxophone, is only 31.5 centimetres in length.

There are no reeds specifically manufactured for this saxophone, but the player can choose between sopranino saxophone reeds, E♭ or A♭ clarinet reeds, or German clarinet reeds, all of which require the base of the reed to be cut so that it does not interfere with the keywork.

Figure 2: Photograph of an alto saxophone reed (left) and the shortened German clarinet reed (right) which I use for the soprillo saxophone

Figure 3: Photograph of an alto saxophone mouthpiece (left) and a soprillo saxophone mouthpiece (right)

As the photos show, both the reeds and the mouthpieces for use on the soprillo, are considerably smaller than those for the alto saxophone. Such small reeds provide very little in the way of resistance compared to what I am usually able to feel when playing. Due to the size of the reed, I have found that playing with the tongue on the reed is not a suitable technique. The mouthpiece is so small that I have found it too small to grip properly/tightly using a double lip embouchure.

The embouchure that is required to play the soprillo saxophone is firm, and if the embouchure is relaxed, by re-placing the bottom teeth with the tongue, or by playing with a loose embouchure, then the notes which use the octave key will not sound correctly. [Recording 33/1.]

As a player I had already had to get used to breathing in less, to combat the problems I initially encountered: having and retaining too much stale air in my lungs. Whilst this has been a problem I have had on all the saxophones, it has been a particular issue on the soprillo saxophone. Transferring my technique for playing quietly to the soprillo saxophone was therefore a giant step. I have found that it is extremely easy to 'honk' a note out of this instrument if control is lost, as the mouthpiece which comes with the instrument has a relatively wide tip opening which gives little resistance when playing.[49]

Isaacs' composition *reflections, echoes and fugitive flickers which when traced evaporate* for solo soprillo saxophone has a range between D𝄳5 and A♭5 (written pitches), which means that most of the notes played require the air to travel further through the tube of the saxophone's body. This results in more resistance, which is an advantage on the smaller instrument. Due to the size of the instrument, mouthpiece, and reed, adapting my articulation for use on the soprillo saxophone has been difficult, and I have struggled with having too much 'stale' air that I am not able to blow into the instrument without making the sound considerably louder. Whilst this problem has gradually decreased as I have become more aware of the amount of air that I need to inhale in the first instance, unlike on the other, larger saxophones, it has remained an issue.

One of the problems that I had when performing *Nano* was the noise caused by the movement of the keys. As can be seen in the keywork charts in [Appendices C1-C4], the soprillo saxophone does not have all the keys that current models have for other members of the family. The instrument itself is so small that keywork mechanisms are light, and therefore make little noise. The pads on a soprillo saxophone are much smaller, and do not have resonators on them. The combination of these factors has meant that closing multiple keys does not have the same effect as discussed in section 3.2.1.2.

The combination of a small instrument, and a small reed, both of which require little air flow to sound a note, has meant that it has been difficult to limit my breath enough to play the soprillo saxophone at lower-end dynamics.

3.2.3 The tenor saxophone and playing at lower-end dynamics in an ensemble setting

Transferring my technique for playing at lower-end dynamics to a larger instrument posed different problems than using it on the soprillo saxophone. In general the hazards inherent to playing the soprillo, that a note accidentally sounds loudly, are not an issue on the larger instrument. I did find that the tenor saxophone was more difficult to 'get going' when blowing a limited amount of air through the instrument, and found it more difficult to judge how much air was needed for different notes compared to the alto saxophone.

49 The mouthpiece that came with the instrument was made by Hans Zinner. There is little choice in mouthpiece for the soprillo. Very few companies make soprillo mouthpieces, and the larger companies such as Selmer or Vandoren, do not manufacture mouthpieces for this instrument.

C. Fox's *Early one morning* was the first time I used my technique for playing quietly for the duration of an entire composition in an ensemble setting. The piece, which can be played by any two woodwind instruments, was premiered at the Muziekgebouw aan 't IJ in Amsterdam, together with Henri Bok on bass clarinet. C. Fox asks that any performance of the piece "should be consistently quiet" (C. Fox, 2014b), a dynamic level which he prescribes for both instruments. I therefore not only had to translate the technique that I had developed for very quiet playing from the alto saxophone to the larger tenor, which in itself posed some problems, but I also had to try to match the quiet dynamic level of the bass clarinet.

The choice of the pitch range in which the piece is played is left to the performers. The piece incorporates both microtonal tunings and multiphonics played in differing, interweaving rhythms. These aspects of the composition led us to choose to centre our first performance around B5 (written pitch), an area of both instruments which is rich in microtonal and multiphonic fingering patterns. This note is played with the index finger of the left hand, also using the thumb to operate the octave key, and is in a region of the tenor saxophone that is relatively high up on the body of the instrument, which makes it easier to sound with limited breath.

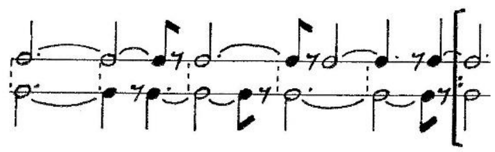

Figure 4: C. Fox, *Early one morning* (2014) rhythms at the start of the composition

The metronome mark for the piece is crotchet = 120. The fairly quick tempo, combined with a strict rhythm and the ensemble nature of the piece, meant that using air only to start a note was not successful. [Recording 34/1.]

Initial experiments were done with the consonants 'g' or 'k' as suggested by Weiss and Netti. As each new note followed a quaver rest, these methods of providing a clear start to the note, without using the tongue, were also found to be too slow and too inaccurate. They lacked clarity. [Recording 35/1.]

Following some experimentation, the notes were articulated using the consonant 't', and the tip of the tongue. Due to the speed of the piece, and the need to sound both microtonal and multiphonic notes without any delay, a slightly harsher articulation needed to be used. The larger reed on the tenor saxophone was found to be an advantage in this respect, as although a smaller reed would have needed less force to articulate, the larger reed allowed for a stronger articulation than would have been possible on a smaller saxophone. [Recording 36/1.]

3.3 Extending lower-end dynamics for extended techniques

Weiss and Netti pointed out the difficulty of moving to and from subtone playing, stating that it "requires an adjustment" and that it "cannot always be executed smoothly" (2010, p.162). This would make diminishing the sound to the point of silence, something which Londeix believes subtone can be used for, very difficult from anything but an already quiet dynamic. It appears that subtone techniques are therefore not a solution for playing quietly on the saxophone when it is necessary to come from or go to a louder dynamic. The adjustments to jaw position or the use of the tongue mean that subtone techniques can also impede upon extended techniques. Compositions though, can often have a large dynamic range and/or include extended techniques.

Since *Nano*, my work on the lower-end dynamic possibilities of the saxophone has also had to develop to incorporate a number of extended techniques. I will discuss four extended techniques: key percussion, the altissimo register, multiphonics, and articulation, with particular reference to slap-tonguing. Some extended techniques have lent themselves to lower-end dynamics, whilst I have had to adapt other techniques in order for them to work with a quiet dynamic. Some of these extended techniques were previously made difficult or impossible by using subtone techniques to play at lower-end dynamic levels. As you will see from the following work, some of these are now possible, through playing quietly by means of controlling the breath.

3.3.1 Slap-tonguing

In addition to developing a form of standard articulation to be used in combination with my technique of limiting the breath to play at lower-end dynamics, there are other extended techniques which involve the use of the tongue. Slap-tonguing is not only a means to start a note, but can also be used to produce a sound that is not linked to any blown note. As part of my work on the lower-end dynamics of the saxophone, I have also tried to expand the lower-end dynamic range of slap-tonguing, in order to be able to integrate it with the rest of my work.

Slap-tonguing can be seen as a percussive effect. One which Londeix has described as brutal, violent and hard (1989, p.97), and Kientzy has said is "l'attaque la plus tranchante possible" (2002, p.135).[50] As discussed in chapter 2, Weiss and Netti have defined three types of slap-tonguing and allocated

[50] "The most strident attack possible" (Kientzy, 2002, p.135).

each a dynamic range in which they are possible: 'standard slap' ***p*** – ***fff***, 'secco slap' ***pp*** – ***mf***, 'open slap' ***mf*** – ***fff*** (2010, pp.142-143). All three forms of slap-tonguing require the tongue to press the reed against the mouthpiece, and for the tongue to then be drawn away sharply from the reed. Therefore, to recapitulate, as the tongue is used for slap-tonguing, it would again not be possible to play a slap-tongue when the tongue is already occupied by subtone methods of playing quietly. Neither does the subtone technique where the tongue touches the reed, mean that the tongue is in the correct position to start playing a slap-tongue: preparation time is still required in order to push the reed towards the mouthpiece. [Recordings 37/1.-40/1.] show the results of playing secco slap-tonguing whilst playing using different subtone techniques.

Using the tongue to press the reed against the mouthpiece is the preparation point of playing a slap-tongue. Delangle and Michat have said that in order to play a slap-tongue on the saxophone, the player needs to use enough pressure in order to press the reed against the mouthpiece (1998, p.179). The tongue then pulls the reed away from the mouthpiece and, when the reed and the tongue part contact, the reed moves back towards the mouthpiece, and "hits it hard" (Delangle & Michat, 1998, p.179). A similar description is also found in Roach (1998, p.91). If a double lip embouchure is used, then the mouthpiece is not held stable enough for the player to use the tongue to press the reed against the mouthpiece. I was therefore aiming to be able to integrate slap-tonguing into my technique for playing lower-end dynamics by retaining a stable embouchure and keeping the tongue free for the articulation.

As Weiss and Netti have documented, the difference between standard or secco slap-tonguing is the inclusion, or not, of pitch (Weiss & Netti, 2010, p.143). The basic technique used is the same in each case. Standard slap-tonguing is a form of articulation which can be used at the start of a blown sound. Weiss and Netti have said that it is possible in the dynamic range between ***p*** – ***fff*** (2010, p.143). In secco slap-tonguing the same movement is made by the tongue, but the movement is not followed by air blown through the instrument. Weiss and Netti have said that secco slap-tonguing is possible in the dynamic range between ***pp*** – ***mf*** (2010, p.143).

Whilst the only difference between standard and secco slap-tonguing is the air blown through the saxophone, Weiss and Netti have said that secco slap-tonguing is possible at a lower dynamic level than standard slap-tonguing. At the start of my research I could not help but question why they had allocated different dynamic levels for these two forms of slap-tonguing as the only difference is the air blown into the saxophone following the actual slap-tongue. My aim was to adapt the one technique, which I could then apply to both standard and secco slap-tonguing, in the same dynamic range.

Kientzy has said that slap-tonguing is produced using the “dos de la langue”, the back of the tongue (2002, p.137). This is in contrast with standard articulation which uses either the tip, or a point just past the tip of the tongue. Kientzy’s explanation implies that more of the tongue is used for slap-tonguing than for stand articulation. Other authors, Londeix (1989), Delangle and Michat (1998), Weiss and Netti (2010), have not specified which part of the tongue should be used for slap-tonguing. As I began experimenting with which part of the tongue I could use for slap-tonguing, I discovered that the best point for slap-tonguing at lower-end dynamics was actually the tip of the tongue. Whilst ever so slightly more of the tongue had to come into contact with the reed than for standard articulation, I found that using a point further back on the tongue made the slap-tonguing louder. [Recording 41/1.]

Weiss and Netti suggest that the “slap should not be strenuous to produce” (2010, p.145), but Weber has said that to make a slap-tongue louder, it is necessary to “use more muscular effort” (H. Weber, 1926, p.14). I therefore felt that the use of less muscular effort could possibly lead to a quieter slap-tongue. I began by trying to find out how much effort was needed in order to sound a slap-tongue, and indeed, I found that whilst a loud slap-tongue does require a certain amount of effort, very little effort is needed to sound a quiet one. There is nevertheless a point at which too little force is used to make the slap-tongue sound. [Recording 42/1.]

Weiss and Netti suggest that the embouchure is kept very loose when playing a secco slap, in order to help mute the resonance of the instrument (2010, p.145). Their advice is contrary to the technique that I had used for developing lower-end dynamics on the saxophone, and I did not wish to have to change or relax the embouchure in order to incorporate slap-tonguing. My aim was to be able to play a quiet secco slap without disrupting the embouchure. I discovered, that as there is no air blown through the saxophone in secco slap-tonguing, the force with which the reed moves away from the tongue is relative to the dynamic level of the sound produced. Initially I believed that it was necessary to use enough force to push the reed against the mouthpiece, as the technique is described by Delangle and Michat (1998, p.179), but I have since discovered that the reed does not have to be pressed completely against the mouthpiece. Neither does it have to strike the mouthpiece ‘hard’ as stated in Roach (1998, p.91). As long as the movement is sufficient for the air within the tube of the saxophone to move, a sound will be produced. Therefore secco slap can be played extremely quietly. [Recording 43/1.]

By adding air to my technique for secco slap-tonguing I hoped to also be able to play a standard slap-tongue at lower-end dynamic levels. As using too much force to play normal articulation when using limited air to play quietly already interrupted the sound, my worry has remained finding the correct air flow needed to play a standard slap-tongue followed by a ‘played’ note. [Recording 44/1.]

In order to play an open slap-tongue the same basic actions of the tongue and the reed are maintained, but the technique for playing an open slap-tongue differs from that for standard or secco slap, as the embouchure is not preserved. At the point when the tongue is removed from the reed, the lower jaw is dropped and the mouth opened: due to opening the mouth, this form of articulation can only be played as a short sound.

Kientzy has said that the open slap-tongue is “le son le plus violent que l’on puisse obtenir sur un saxophone” (2002, p.142).[51] Weiss and Netti describe as open slap-tonguing as “strong” and “explosive”, and have given the dynamic range for this technique as ***mf*** – ***fff*** (2010, p.143). Adapting this technique, to allow it to be used at a very quiet dynamic, clearly posed more of a problem than either standard or secco slap-tonguing.

Weiss and Netti have suggested that the embouchure is opened abruptly for an open slap-tongue (2010, p.143), but investigation of this technique has revealed that if the movement is less brusque, and if the embouchure is not opened as wide, then the sound can be more contained. Kientzy has suggested that an open slap-tongue should be accompanied by a “sèche poussée du diaphragme”,[52] which is done at the same time as the tongue releases the reed and the mouth is opened (Kientzy, 2002, p.142). This additional movement is not mentioned in Weiss and Netti, and indeed is not needed. If an open slap-tongue is therefore played in the manner of a secco slap-tongue, but with a movement of the lower-jaw, then it is possible to play this extended technique relatively quietly. However, it does remain one of the more pronounced forms of articulation, and I have yet to master the technique for playing open slap-tonguing as quietly as that for secco slap-tonguing. [Recording 45/1.]

3.3.2 Multiphonics

Kientzy has described “sons multiples”, his term for multiphonics, as being formed by special fingerings which determine “pics d’impédance”[53] that do not correspond to the natural harmonics of the instrument (2002, p.377). In other words, they are a way of adapting which overtones can be heard for each fingering pattern used on the saxophone. Londeix has said that multiphonics require not only a special fingering pattern, but sometimes also require a change of embouchure, putting more, or less mouthpiece into the mouth (1989, p.31). Weiss and Netti believe that:

[51] “The most violent sound obtainable on the saxophone” (Kientzy, 2002, p.142).
[52] A “dry push of the diaphragm” (Kientzy, 2002, p.142).
[53] “Peaks of impedance” (Kientzy, 2002, p.377).

> How the embouchure functions can be very clearly observed when playing complex multiphonics with three to four tones…. The low partial tone is realized by relaxing both the embouchure and air pressure…. The high partial tone, conversely, will be produced by an increase in lip and air pressure (2010, p.155).

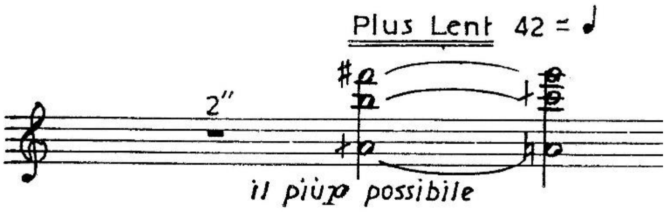

Figure 5: Voirpy, *Motum V* (1981) multiphonics taken from p.5, line 8

Using the first multiphonic in Figure 5, I will show the effect that any change in embouchure position or pressure has. Any change to the embouchure, such as using the double lip embouchure subtone technique in order to play at lower-end dynamic levels, will have a detrimental effect on the multiphonic. The result of a change to the embouchure by using double lip embouchure can be heard in [Recording 46/1.]. Using the tongue to support the bottom lip in place of the bottom teeth will also effect embouchure pressure. [Recording 47/1.] Playing with “little mouthpiece and loose embouchure” (Weiss and Netti, 2010, p.162) means that both the embouchure position and the embouchure pressure are determined by subtone technique. [Recording 48/1.] Weiss and Netti call the sound produced when using subtone techniques as “dull” (Weiss & Netti, 2010, p.162). If subtone is played by putting the tongue on the reed, then this is because the tongue partially prevents the reed from vibrating and subdues the upper partials (Delangle and Michat, 1998, p.175). If the upper partials are stopped from sounding, by placing the tongue on the reed, then either the multiphonic will not sound, or only part of it will sound. Multiphonics are therefore not suitable for being combined with a technique which aims to reduce the upper partials. [Recording 49/1.]

In contrast, adjusting the breath in order to play quietly allows any changes in embouchure position or embouchure pressure to be determined by the needs of the multiphonic. But, as Bartolozzi has written, multiphonics are also dependent on the correct air pressure (Bartolozzi, 1982, p.51). Therefore adjusting the amount of air going through the saxophone can have an effect on multiphonic sounds.

The following example [Figure 6] shows the different pitches that sound when the given fingering pattern is played ***pp*** and ***mp*** – ***ff***.[54] As can be seen, the notes which sound from the fingering pattern are different at different dynamics levels. [Recording 50/1.]

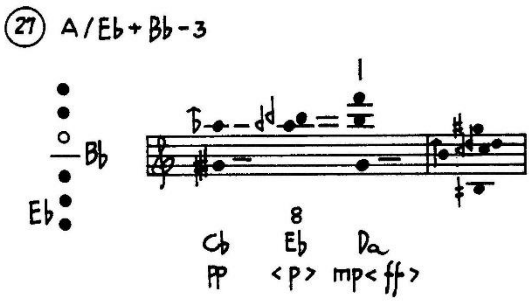

Figure 6: Weiss & Netti (2010, p.80) alto saxophone multiphonic number 27

If a multiphonic has been documented as only being playable at a middling dynamic level (***mp*** – ***mf***) as in Figure 7, is played at different dynamic levels, then the notes will change. [Recording 51/1.]
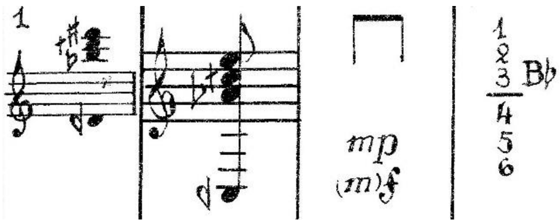
Figure 7: Kientzy (1982, p.49) tenor saxophone multiphonic number 1

Whilst Londeix has said that “the simultaneous sounds that have no distortion or interference can have, on the saxophone, great purity of timbre, particularly in the softer dynamic range” (1989, p.31), he has also stated that “multiphonics using non-tempered intervals are not stable, particularly when playing above or below their normal [dynamic] range” (1989, p.32). The books by Londeix (1989), Kientzy (1982), and Weiss and Netti (2010), all have clearly delineated the dynamic range in which each different multiphonic will sound. As part of my research I wanted to study what would happen to different multiphonics when I applied my technique, and limited the air put into the saxophone, in order to play them at lower-end dynamics. Applying my technique of limiting the air blown through the saxophone in order to play quietly could clearly also affect the pitches which sound from the fingering pattern.

[54] The second set of notes, with the number *8* underneath, is the result of adding the *octave* key to the fingering.

Unlike the above subtone techniques, playing quietly by limiting the air blown into the saxophone, does not have such a detrimental effect on the multiphonic. It does though change some of the pitches which sound most prominently. Therefore a change in air pressure, necessary to change the dynamic level, will also have an affect on many multiphonics, and the pitches which can be sounded, but instead of stopping them from sounding, it brings new possibilities. Work investigating multiphonics which can be played at lower-end dynamic levels, using air to achieve the quiet dynamic level, and the changes which occur when playing multiphonics extremely quietly was done for a performance of Mc Laughlin's *There are Neither Wholes nor Parts III* (2011). Some of the multiphonics that resulted from this research are documented in [Appendix E] and can be heard in [Recordings 52/1.-72/1.].

3.3.3 Altissimo/higher notes

Like multiphonics, playing notes in the higher register or the altissimo register depend upon embouchure position and pressure, which means that subtone techniques can interfere with these notes.

[Recordings 73/1.-76/1.] demonstrate the results of playing the pitches D6 and D7 using the four subtone techniques. [Recording 77/1.] shows that these notes are playable, and remain unchanged by applying my technique of limiting the air in order to play at lower-end dynamic levels.

The importance of embouchure position and pressure for notes in the altissimo register will be discussed further in section 3.4.1. Fingering patterns which have been discovered to work particularly well when controlling air flow to play at lower-end dynamic levels are documented in [Appendix F].

3.3.4 Key percussion

Key percussion is a technique which is not directly affected by the amount of air put into the saxophone, as it is a technique which is produced without blowing. It is not particularly disturbed by changes to the embouchure, and placing the tongue on the reed appears to improve the sound (Weiss and Netti, 2010, p.177). This is an extended technique that appears to lend itself to subtone techniques, and which I initially believed would not benefit from my technique for playing at lower-end dynamics. Whilst the microtonal aspects of key percussion will be discussed in chapter 5, this is nevertheless one area in which I have seen an extension of the range of possibilities due to my method of playing quietly.

Weiss and Netti say that “key slaps [percussion] are most audible in the lower register” (2010, p.177), and suggest that the lowest fifth of the instrument, notes between B♭3 and F4 (written pitches), have the most resonance (2010, p.176). These pitches are louder because they use the longest part of the instrument’s body and therefore have more tube in which to resonate, but when looking to integrate key percussion into lower-end dynamic playing on the saxophone, the quieter sonic result of key percussion sounded using the keys of the left hand and side keys becomes more relevant.

If key percussion is used at lower-end dynamic levels, then the microtonal differences become more apparent. This aspect will be further discussed in chapter 5, and the results documented in [Appendix G].

One aspect which can interfere with the sound produced by key percussion is the sound of the keywork mechanism. Both Weiss and Netti (2010), and Delangle and Michat (1998) have commented on this difficulty. When looking to integrate key percussion into lower-end dynamics, one of the biggest problems is that the sound which results from closing the key/pad, can be over-powered by the noise of the keywork mechanism of the saxophone. I have discovered that a very small amount of air can be blown into the saxophone whilst playing key percussion. This increases the resonance of the key percussion which can therefore be heard above the keywork mechanism. Therefore the issue identified by Delangle and Michat, that sometimes the “tone is so diminished [when playing key percussion] that only the key noise seems to be left” (1998, p.180) is controlled. [Recording 78/1.]

Blowing air through the instrument when playing key percussion additionally serves to lengthen the sound produced by closing the key.[55] This means that key percussion does not have to be used as “individual tones or isolated slaps” (Weiss and Netti, 2010, p.176), neither does there have to be the constant movement of keys in order to sustain a sound. [Recording 79/1.] Finally, blowing air into the saxophone to create key percussion at lower-end dynamics means that this extended technique can be integrated into a ***crescendo*** to, or a ***diminuendo*** from a note played using standard technique. Kientzy’s assertion, that key percussion has to be separated from the note which precedes it (2002, p.132), is no longer true. [Recording 80/1.]

[55] Blowing air through the saxophone for this technique is not the same as playing a standard note on the saxophone, and does not make the reed vibrate in the normal manner.

3.4 The application of extended techniques at lower-end dynamics

3.4.1 Pisaro - *breath*

The performance notes for Pisaro's *breath* state that "dynamics are ***as soft as possible*** throughout the piece. All gestures, no matter how demanding, should be gentle and restrained" (Pisaro, n.d., p.2). The composition includes articulated notes, an aspect of playing at lower-end dynamics which I have already discussed in relation to the compositions by Mc Laughlin, Isaacs, and C. Fox.

Pisaro's composition comprises 97 different "sound events", and "four pieces" (Pisaro, n.d., p.1). The sound events include techniques such as vibrato, glissando and trills. They also request changes in timbre, and "throbbing", an effect which can vary in speed. The sound events between numbers 65 and 97 are based entirely on different multiphonics. The study of this piece was therefore to see how far I was able to refine my technique for playing at lower-end dynamics, and how many different extended techniques I could integrate.

Sound event 1 is an A♯3. This, the lowest note on the alto saxophone, was a late addition, and did not feature in Sax's original patent, a matter I discussed in section 2.6. Pisaro writes the note with a slow, narrow vibrato, and also with 'throbbing', which he asks is regular and limited to very few in number. The instructions for the piece say that when throbbing, the breath should continue, but the sound should be intermittent (Pisaro, n.d., p.3). The note also has to be 14 cents lower than the equal-temperament pitch. As there are no keys which can change the pitch of this note, this change has to be made by dropping the lower-jaw and/or changing the position of the tongue inside the mouth. This would make it difficult to play quietly using any of the subtone techniques. I therefore felt that this sound event would be a test of my ability to limit and control my breath in order to play at lower-end dynamics. [Recording 81/1.]

Sound event 12 is an F♯5, which should be played by overblowing the fingering for B3. Pisaro requests that there is a timbral transition whilst playing this note. It should go from very bright, with lots of upper partials, to very dark, with no or few upper partials (Pisaro, n.d., p.3).[56] For this note I decided to apply one of the subtone techniques, not to play the note quietly, but in order to dampen some of the upper partials. My attempts at placing the tongue on the reed without disturbing the note were unsuccessful. Therefore, I went from a standard embouchure to a loose embouchure, where both top and bottom teeth were removed from the mouthpiece to change the timbre whilst still controlling my breath in order to play quietly. [Recording 82/1.]

[56] In the performance notes for the score Pisaro refers to the upper partials as overtones.

Sound event 67 calls for a timbral transition from normal to dark whilst trilling between type 1 multiphonics[57] based on C4 and C♯4. Type 1 multiphonics are based on the natural overtone scales of the saxophone. Pisaro requested that the trill also be played with a few, regular throbs and a wide, fast vibrato. As the lower jaw would already be used for the vibrato, on this occasion I removed the upper teeth from the mouthpiece in order to change the timbre. As I was effectively using subtone techniques to change the timbre, I again relied upon limiting the air going through the saxophone to play at a quiet dynamic level. [Recording 83/1.]

Sound events 61, 62, and 63 are all in the altissimo register. Whilst they each have a microtonal pitch change, they do not require any of the techniques which Pisaro applies to other sound events. When studying them I recalled Rascher's statement, that "to play ***pp*** in the higher register is not easy" (Patrick, 2014, p.247). Due to these notes being in the altissimo register they require a certain amount of embouchure pressure and a certain embouchure position in order to sound. [Recordings 84/1.-86/1.].

Through my work on this piece, using my technique of controlling the air flowing through the instrument to play at lower-end dynamic levels, I discovered that some altissimo fingering patterns worked better for me than others. These fingering patterns have been documented in [Appendix F].

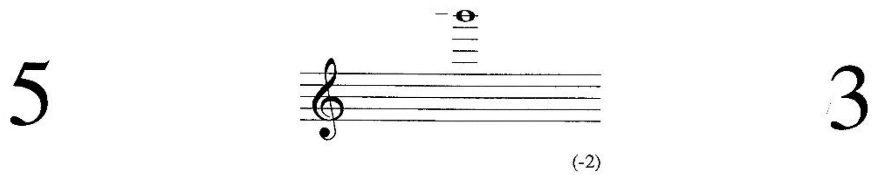

Figure 8: Pisaro, *breath* (n.d.) Sound event 61

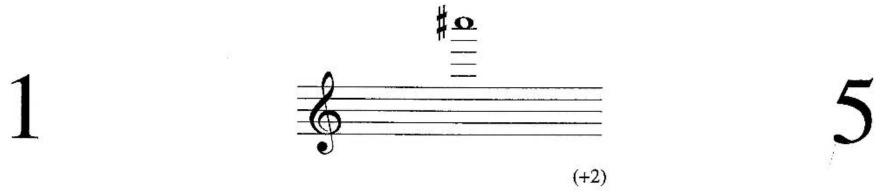

Figure 9: Pisaro, *breath* (n.d.) Sound event 62

[57] This classification of different multiphonics has been used by Bok (2011).

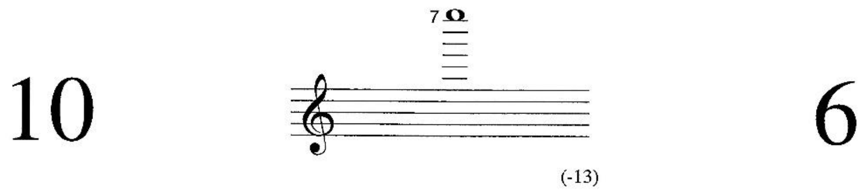

Figure 10: Pisaro, *breath* (n.d.) Sound event 63

As previously discussed, the dynamic level at which a multiphonic is played can change the pitches in it. This has implications for the multiphonics used in *breath*, as Pisaro has included some multiphonics that Kientzy et al., have documented as only being possible at louder dynamics, but Pisaro, as previously stated, wants quiet dynamics and all gestures to be quiet and restrained (n.d., p.2).

Londeix has said that "the most secure multiphonics are those which can be played within opposite dynamics (***pp*** < ***ff***)" (1989, p.31). Of the 45 "easily produced" multiphonics that require "no special preparation" that he has listed for the alto saxophone, only two have been allotted such a wide dynamic range (1989, pp.31-35). The fingering patterns for these multiphonics are both found as sound events in *breath*. One of these is sound event 72.

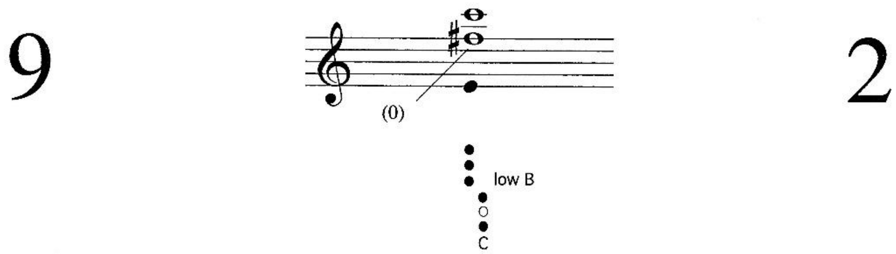

Figure 11: Pisaro, *breath* (n.d.) Sound event 72

Sound event 72 is comprised of three notes: E4, F♯4 and C6 (written pitches). Whilst Londeix has said that this is a multiphonic which is "easily produced" in a large dynamic range (1989, p.31), it has been credited with different qualities in other saxophone method books. Londeix (1989, p.34), Kientzy (1982, p.38), and Weiss and Netti (2010, p.78), have all documented the lowest note of sound event 72 as E♮4, not E4 (written pitches). Kientzy has given the multiphonic a smaller dynamic range, from ***p*** to ***mf***. Weiss and Netti (2010, p.78) have also given a smaller dynamic range. For the C6 to sound, they have said that the multiphonic should be played between ***mf*** and ***ff***. The lowest dynamic they give for a multiphonic to be played using this fingering is ***mp***, but then the multiphonic has only two notes, E♮4 and F♯5 [Figure 12].

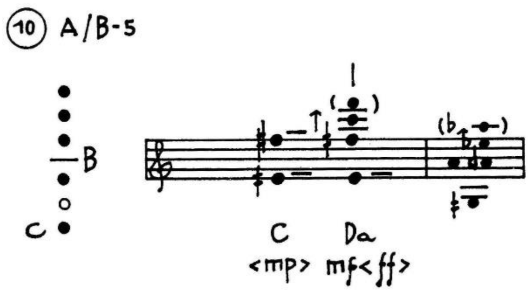

Figure 12: Weiss and Netti (2010, p.78) alto saxophone multiphonic number 10

I have found that I have been able to sound C6, at lower-end dynamics, by adapting my breath. The breath I use to do this is less focussed, and more diffuse than I would normally use. This can be heard in [Recording 87/1.].

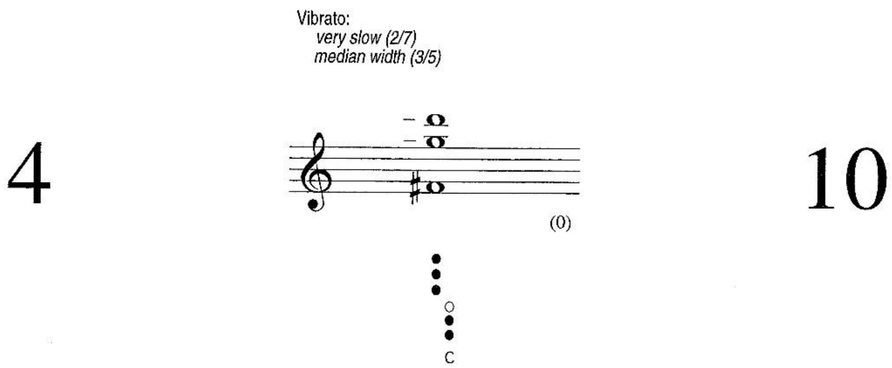

Figure 13: Pisaro, *breath* (n.d.) Sound event 93

Sound event 93 also contains three notes. Londeix, by contrast, states that only two notes, F♮4 and G5, sound using this fingering (1989, p.34), and that these notes sound for the dynamic range ***pp*** – ***ff***. Whilst Kientzy does state that it is a three note multiphonic, he gives a rather smaller dynamic range of ***mp*** – ***f*** (1982, p.40). Finally, Weiss and Netti (2010, p.79) give the dynamic range of it as ***mp*** – ***mf***, unless the octave key is added. It can then be played, as a three note multiphonic, at ***pp***. I have found that it is possible to sound all three notes in Figure 13 at a very quiet dynamic. [Recording 88/1.] Adding the *octave* key, as suggested by Weiss and Netti, does not aid production of the multiphonic, but rather raises the pitch of the lowest note.

These differences between the multiphonics documented in Londeix, Kientzy, and Weiss and Netti, and the results that I have found, highlight the disparity of results in an expanded dynamic range. This disparity points towards the need for further research about the effect dynamic levels, air pressure, and air flow have on saxophone multiphonics. [Appendix E] shows the results of initial research in this area.

3.4.2 Zych - *Kontr-atrofia/Contr-atrophy*

Kientzy has said that "sur un son ***ff*** ou même ***f***, l'attaque de tampon ne s'entend quasiment pas… Plus le son sur lequel elle est placée est doux, plus elle est efficace" (2002, p.132).[58] This was good news for playing Zych, as the key percussion in the composition is to be played at a very low dynamic level.

The noise that arises from moving the keys on the saxophone is an issue that I initially struggled with when attempting to master the key percussion in Zych's *Kontr-atrofia/Contr-atrophy*. The composer had used *Hello! Mr. Sax* (Londeix, 1989) as reference material when writing the piece and had integrated one of Londeix's ideas into the composition.

In *Hello! Mr. Sax* Londeix advocates the use of the *c5* key to sound key percussion. As can be seen in the tone hole placement and pad position diagram [Appendix H1], *c5* is a closed key, which opens when pressed. I was wary of using this key for two reasons. As the pad opens when the key is depressed, there is no way of changing or adjusting the force with which the key subsequently shuts. This instead depends upon the strength of the springs on the saxophone. Londeix does not warn composers thinking of using this technique that players have little to no control over the dynamic level of the key percussion produced using this key.

Before it can be closed, to create the sound, the *c5* key must also first be opened. To do this a key must be pressed by the right hand. Londeix's warning that players should "minimize the back-fire effect" by rapidly striking the *c5* key (1989, pp. 78-80)[59] does not clarify the noise that the movement of this keywork can cause. I felt that this was a difficult technique to include in very quiet key percussion.

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[58] Kientzy has said that "on an ***ff*** sound, or even ***f***, the key click is almost not heard… the softer the sound on which it is placed, the more effective it is" (Kientzy, 2002, p.132).

[59] Londeix also applies this warning to the *c3* key or the *Tc* key. These three keys are not normally used for key percussion, because as the chart in [Appendix H1] shows, they are all keys which open rather than close when pressed (1989, pp.76-80).

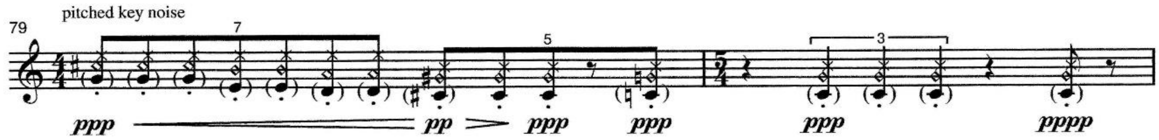

Figure 14: Zych, *Kontr-atrofia/Contr-atrophy* (2013) p.11, bars 79-80

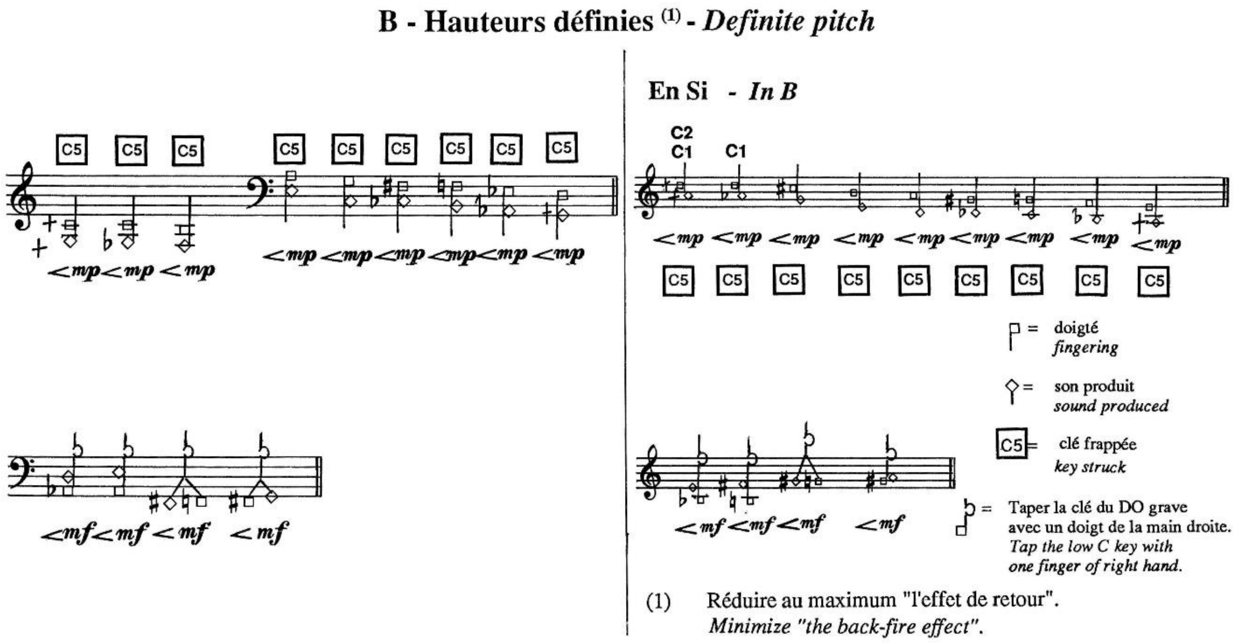

Figure 15: Londeix (1989, p.78) documentation of *c5* key percussion for the tenor saxophone

Zych had taken the pitches for his *c5* key percussion from Londeix (1989). My work on developing a suitably quiet technique for using the *c5* key to play key percussion was abandoned at an early juncture due to the inaccuracy of the resulting pitches documented in Londeix (1989). Despite this my work on using the *c5 key* to play key percussion continued for the microtonal aspects of it. These are discussed further in chapter 5.

As a lot of the key percussion in Zych was to be played at quiet dynamic levels, in finding a solution, I had to consider not only the pitch of the note but also the sound of the key movement. Weiss and Netti suggest using key *4* for playing key percussion on notes between B♭3 and E4 and key *1* for notes between F4 and B4 (2010, p.177). I initially followed the advice of Weiss and Netti, but found these keys too resonant for the extremely quiet staccato notes that the composer wants. [Recording 89/1.] Therefore, I have since tried other keys. My experiments with key *2* were unsuccessful.

[Recording 90/1.] Whilst this key gave a nice crisp staccato, I found that the pitch was lost. I have since begun using key *3* to play the key percussion on all the notes in Figure 14, as I have found that this gives a good balance between allowing the pitch to sound, and playing a quiet, crisp staccato. [Recording 91/1.]

The resonant quality of the note at lower-end dynamics was again an aspect of the music that I had to tackle in Zych. "Left hand against the right hand", which entails the independent movement of the hands when playing the saxophone, is a technique spoken about in Weiss and Netti (2010, p.168).

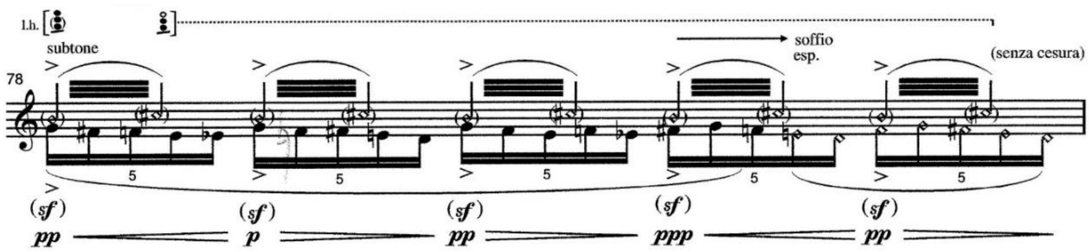

Figure 16: Zych, *Kontr-atrofia/Contr-atrophy* (2013) p.11, bar 78

In Figure 16 the player must play subtone whilst there is independent movement of the left and right hands. Different combinations of the same five pitches, G4, F♯4, F4, E4, and D4 (written pitches) are played with the right hand whilst *key 1* is constantly opened and closed in the left hand. This technique is used in combination with a move from subtone to air only exhalation (soffio espirare).[60] Zych described the separation of the hands as allowing the "perforation or distortion of a played phrase" (Zych, 2012, p.3). Subtle pitches created by this technique can sound when inhaling or exhaling through the saxophone. The air only exhalation can be seen as an extension of the use of key percussion: no pitch is actively played on the instrument, yet due to the saxophone's body acting as a resonator, the movement of keys changes the pitch that can be heard.

The subtone techniques that I discussed in chapter 2, all dampen the higher partials in the sound. I found that this is particularly so when playing very quietly. Playing at such low dynamic levels, the dampening effect of placing the tongue on the reed, or playing with a loose embouchure stopped the saxophone from sounding any resonant pitches. It was difficult to move from the subtone section to the air only exhalation, and I initially had a tendency to play the air only exhalation also using subtone.

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[60] In this composition the subtone marking refers to a change in timbre rather than a marking for playing quietly, as the entire section is at a quiet dynamic level.

This distinctly altered the sound and the effect became reduced to the sound of the key movement. [Recording 92/1.]

When I did move from subtone to non-subtone air only exhalation, this caused a distinct step, with a dry, dull sound when playing the start of the phrase using subtone, and a livelier sound once I changed to air only exhalation. [Recording 93/1.] Zych had continued the effect of both the pitches played by the right hand, and the key *1* movement up until the end of the bar, so for continuity, this phrase needed some upper partials to sound through-out, from lower-end dynamics through to the air only exhalation.

I eventually found that the best results came if I lifted my top teeth from the mouthpiece. This is not a double lip embouchure, and therefore not a subtone technique, but it allows the change in timbre that the composer has requested without stopping all the upper partials from sounding. The distortion of the sound caused by left hand against the right hand can be heard throughout the phrase. [Recording 94/1.]

The slap-tonguing in Zych is frequently at lower-end dynamic levels. To play this I used the technique that I had developed for secco slap-tonguing. With a point just back from the tip of the tongue I apply only a little pressure to the reed. It is not pushed up against the mouthpiece. To play the changes in dynamics in bar 137 [Figure 17] I regulate the force of the tongue, but do not change the position or the part of the tongue that I use. [Recording 95/1.]
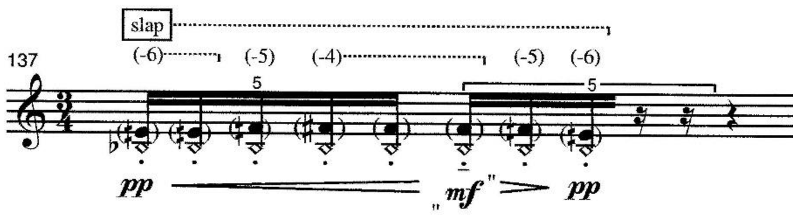
Figure 17: Zych, *Kontr-atrofia/Contr-atrophy* (2013) p.18, bar 137

3.5 Summary and conclusions

In this chapter I have shown how existing techniques for playing quietly on the saxophone, subtone techniques, cannot be applied to all music situations. I have shown that subtone techniques can potentially have an unwanted effect on other aspects of the music.

I have explained my technique for playing at lower-end dynamics on the saxophone. This technique achieves lower-end dynamics by controlling the amount of air blown into the saxophone and the way in which air is blown into the saxophone. I have explained the benefits of using this technique to play at lower-end dynamics on the saxophone and discussed its use in pieces by Mc Laughlin, Isaacs, and C. Fox.

I have explained why subtone techniques do not allow the integration of some extended techniques: slap-tonguing, multiphonics, the altissimo register. Unlike existing subtone techniques, I have discussed how my technique allows the integration of these techniques, and discussed specific cases in the compositions by Pisaro and Zych.

The numerous recordings which accompany this research serve to highlight the inability of subtone techniques to play successfully at lower-end dynamic levels and the failure of the integration of extended playing techniques when using subtone techniques.

The recordings also serve to show the advantages of using my technique, and how extended techniques can be integrated with it.

Despite the descriptions and dynamic ranges given in saxophone method books, I have shown that articulation, including slap-tonguing, multiphonics, and the altissimo register, can be integrated into lower-end dynamics. I have discussed any ways in which I adapted these extended techniques. Additionally, I have shown that when playing at lower-end dynamics, key percussion can be a valuable asset to a saxophone player.

The implications of my work on playing at lower-end dynamics, which initially began with *Nano*, have wider-reaching consequences than the compositions discussed as part of my research. Whilst my technique has here been applied to only a few works, it could equally be applied to any number of pre-existing compositions. My aim was to find a method of playing quietly which can truly become an integral part of playing the saxophone so that, in turn, playing at lower-end dynamics can become an integral part of playing the saxophone. The ease with which my technique can be applied makes its applicability far greater than existing techniques.

Chapter 4 Microtonality on the saxophone

Microtonality is a facet of music that has only been actively adopted into the saxophone's classical playing techniques and repertoire since the 1970s, whilst the use of microtonally altered pitches came much earlier in jazz. This was due to a technique called 'false fingerings' which was made popular by Lester Young. This technique was used to change the timbre of a note but also causes small changes to the pitch of a note.[61]

The discussion which follows details certain aspects of playing the saxophone which might, at first glance, not appear to have any direct link with microtonal saxophone playing, for example key-naming systems and fingering pattern notational systems, but both key-naming systems and fingering pattern notational systems affect the ease with which different information can be transmitted in either written or verbal form. These systems are therefore of relevance to general saxophone playing, and they are an area of particular relevance when large numbers of different fingering patterns are being used, as for microtonality.

In quarter-tone scales there are two extra notes between each tone, whilst in eighth-tone scales there are six extra notes between each tone. This leads to a substantially greater number of fingering patterns. These patterns need to be documented so they can be passed on, and used by, other saxophonists and composers. Therefore, whilst key-naming systems and fingering pattern notational systems are not only of use to microtonal saxophonists, because playing microtonality on the saxophone can be done by changing the fingering patterns for semitone pitches, this causes an increase in the number of fingering patterns available to the saxophonist. In order to pass on a large number of fingering patterns there needs to be an efficient way of both notating them, and speaking about them. The way in which the fingering patterns are written, and therefore also the key-naming systems used, is of great importance.

Following a discussion about how key-naming systems have developed, and the pros and cons of different fingering pattern notational systems, I will share the reasoning behind my choice of key-naming systems and fingering pattern notational systems. The key-naming systems found in [Appendices C1-C4] will be used for the remainder of the research documented here.

One of the earliest published saxophone method books, Kastner's *Méthode Complète de Saxophone*, claims that the saxophone was able to play perfectly in tune, and that changes to fingering patterns to aid tuning were not necessary (1846, p.22). Since then adjusted fingering patterns (adding or taking

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[61] Charlie Parker also used different fingerings to vary the timbre of a note in *Cherokee* (Woideck, 1996, pp.85-86).

away a key or keys, or using a different fingering to achieve the same pitch) have frequently been documented to aid the saxophonist perform in tune. Alternative fingering patterns are another way of altering the pitch of a note. These have been used to alter the timbre of a note, play a multiphonic, or play a note in the altissimo register. Whilst many of these different fingering patterns have been documented in saxophone method books, they have yet to be studied for their microtonal uses. I will discuss how I see these as potential sources of microtonality on the saxophone and how they can be harnessed for their contribution to the microtonal saxophone.

A number of quarter-tone fingering pattern charts for the saxophone have been published since the 1970s. The similarities and differences in fingering pattern choices between the different charts will be documented and discussed. How standard methods of playing the saxophone have affected the instrument's microtonal abilities will be considered. Hand and digit position, and jaw position will be studied to see how changes to the physical methods of playing the saxophone could contribute to the development of microtonality.

Early saxophones had fewer keys and fewer links between keys than most modern saxophones. Changes made to the keywork mechanisms of the saxophone since it was first invented have seriously altered the ways in which the saxophone is played. The changing saxophone has a link with the potential of the saxophone to be able to play microtonally. Some of these changes will be discussed for the benefit they bring to the microtonal saxophone, as well as some of the issues that have resulted from these changes.

4.1 Key-naming systems and fingering pattern notational systems

There is no evidence that Adolphe Sax, the inventor of the saxophone, wrote a manual or method book for the saxophone. Without such a document there was no precedent set for how to document or convey fingering patterns. The key-naming system that Sax used was documented in patent number 3226, but as a patent, this document was written in order to explain the instrument, rather than to show how it should be taught and how fingering patterns should be documented or passed on.

Levinsky believes that it is the first three method books, by Kastner, Cokken, and Hartmann, which form the basis for all future method books (Levinsky, 1997, p.8). They provide us with the first basic instruction on how the saxophone is intended to be played. It is therefore these three books, written in the 1840s, which provide us with the first known ways to name the keys on the saxophone and the first ways to document fingering patterns.

Kastner's *Méthode Complète et Raisonnée de Saxophone* and Hartmann's *Méthode élémentaire de saxophone* both used a system to document fingering patterns which was based upon a pad numbering system documented in Sax's patent, number 3226. This system, that shows which pads must be opened and which closed in order to sound a certain pitch, allocates the same numbers to each pad as Sax's diagram "No.1 Saxophone en mi♭ ténor" (Dullat, 1995, pp.192-196).[62] Such a system has two steps which must be taken before a note can be played; the pad chart must be read, and then interpreted. It relies upon the player knowing the effect of each key on the pads of the instrument, or having to find this out. It is therefore not a quick or instinctive way of notating fingerings. Despite this, it does have its benefits, and as the keywork mechanisms of the saxophone have become more complicated and interlinked, this manner of notation shows pad movement that could be otherwise missed.[63]

Cokken's *Tablature du Saxophone* in *Méthode complète de saxophone*, was the first to number the keys of the instrument and not the pads. It separates 'palettes', the six keys positioned under the index, middle and ring finger of each hand, from 'clés', the remainder of the keys. The palettes are numbered one to six consecutively, from the left hand index finger down to the right hand ring finger. In the tablature zeros indicate that a palette should remain open and black dots that it should be closed. Clés are labelled as *No.1*-*No.12*, and are written next to the open and closed dots on the tablature. The numbers for the clés ascend as the pitches do. For example Clé *No.1* is for the *B♮ key*, and Clé *No. 5* is for the *G♯ key*.

Whilst the distinction between palettes and clés is no longer made, and there are simply 'keys' on a saxophone, both the manner of numbering the palettes from one to six, and the use of open and black dots to notate their use in fingering patterns, can be found in later method books. For the remainder of my work, the terms palettes and clés will be used, where necessary, to differentiate between the different regions of saxophone keywork

Subsequent method books frequently based their key-naming and notational systems on pre-existing ones, but often changed part of the key-naming system. Mayeur's *Grande Méthode Complète de Saxophones* (1867, no page numbers) retained Cokken's key-naming system in its entirety, but in his drawing of the instrument, he labelled the numbers for the clés on the keys themselves rather than on the pads that the keys operates.

[62] The drawing shows an instrument that is currently known as the baritone saxophone, pitched in E♭ (Howe, 2003, p.121).
[63] This is a matter that will be discussed in further detail in chapter 5.

In Beeckman's *Méthode de Saxophone*[64] the aforementioned palettes are called 'plateaux' and labelled from *A* to *F* (n.d., pp.7, 10).

	8	
	x	c4
	1 A	c2 / c1
	p	
c3	2 B	G♯
Tc	3 C	B♮ / C♯
Ta	4 D	B♭
c5	5 E	
Tf	6 F	
	E♭ / 7	

Figure 18: Beeckman's key-naming system for the palettes (n.d., pp.7, 10) super-imposed (in red) on my key-naming system

This rather confusing system means the key-names and the pitches that the keys produce are reversed for palettes *D* and *F*.

For example, this means that to play F4 (written pitch) palettes *A*, *B*, *C*, and *D* have to be closed.

1 A
2 B
3 C
4 D

Figure 19: Fingering pattern for F4 (written pitch)

[64] These books were written for individual saxophones. The book for tenor saxophone was consulted for the information presented here.

If the player then wants to trill with D4 (written pitch) two more palettes have to be shut, *E* and *F*.

1 A

2 B

3 C

4 D

5 E

6 F

Figure 20: Fingering pattern for D4

In the left hand this form of key-naming also leads to confusion. In order to play B4 (written pitch) palette *A* has to be shut.

1 A

Figure 21: Fingering pattern for B4

To move from B4 to A4 (written pitches) palette *B* also has to be shut.

1 A

2 B

Figure 22: Fingering pattern for A4

To add to the confusion, in order to play C5 (written pitch), palette *B* has to be shut.

2 B

Figure 23: Fingering pattern for C5

Despite this being a rather confusing key-naming system, there is evidence which shows that Sax combined letters and numbers in his key-naming system,[65] and two later books, Briard's *Nouvelle Méthode pour l'étude de tous les Saxophones* (n.d., *Etendue Générale des Saxophones*), and Vereecken's *Complete Scale for all Saxophones* (dated 1916) in his *Foundation to Saxophone Playing* (1917) both use Beeckman's lettering system for the palettes.

Combelle's key-naming system appears to be loosely based upon that of Cokken, apart from three changes: the use of roman numerals to number the clés, the addition of "*I bis*" for the *B♭* key, and the reversal of the numbering for the *C♯* key and *C* key (1911/1934, *Tablature des Saxophones "Systèmes Perfectionnés"*).

Eby uses Beeckman's lettering *A-F* for the palettes, whilst reversing Cokken's numbering system for the clés: *No.1* is no longer the lowest pad on the instrument, but the highest, the *octave key* (1923, *Chart Showing Fingering for the Saxophone*).

Later into the 20th century the new edition of Klosé's *Méthode Complète pour tous les Saxophones*, edited by Gay, contained a fingering chart by Marcel Mule. The key-naming system used labelled the palettes (keys *1-6*), *A-F*, as Beeckman's system had. It labelled the clés starting with the lowest note, and the pads on the bell. Due to the extended range of the saxophone *No.1* now refers to *B♭* and not *B♮*. There are also more keys on the instruments and so keys are numbered up to *No.17* (1950, *Tableau de la Gamme Chromatique du Saxophone*). These books are evidence that aspects of the key-naming systems from the 19th century have continued into, and been further developed in the early 20th century.

Eby's *Complete Scientific Method for Saxophone* was published by Virtuoso Music School, Concord, Massachusetts, whilst Vereecken's book was published by Carl Fisher, New York, as was de Ville's *Universal Method for the Saxophone* (n.d.). De Ville's book included Vereecken's fingering chart (dated 1916). These books show that aspects of key-naming systems with European origins, such as Beeckman's system of labelling the palettes *A-F*, could be found in the saxophone method books intended for the North American market.

Despite many of the later key-naming systems retaining parts of the systems by Kastner, Cokken, Hartmann, and Mayeur, new key-naming systems continued to be developed and documented. Such

[65] There is some information in Sax's patent, number 139884 (Dullat, 1995, pp.200-204), that shows Sax combined letters and numbers to label keys *1-6*, starting from the bell and moving up the tube towards the mouthpiece. For example:
"Fa♯ . - *c* ouvert; appuyer sur *a* ou *b* et sur *d*, *e*, *f*."
"Sol. – Toute la main droite ouverte, la main gauche appuyant sur *d*, *e*, *f*" (Dullat, 1995, p.201).
"F♯. – *c* open [key *4*]; press on *a* [key *6*] or *b* [key *5*] and on *d* [key *3*], *e* [key *2*], *f* [key *1*]."
"G. – All the right open, the left hand pressing on *d* [key *3*], *e* [key *2*], *f* [key *1*]" (Dullat, 1995, p.201).

a new system can be found in Thiel's *Méthode pour tous les Saxophones*, which chooses to label all the keys (palettes and clés) with letters: *A* to *V*, and *X* to *Z* (1903, *Tablatures de Saxophones*, *Figure No.1* and *Tablature des Saxophones*, *Figure No.2*).[66] *A Tune a Day* by Herfurth separates the keys operated by the left and the right hands. Keys (palettes) *1-3* remain so numbered, but keys (palettes) *4-6* become keys *1-3* of the right hand. The *G♯* key is labelled *Left hand key 4*, but the remainder of the keys operated by the little fingers are allocated two numbers. Whilst this clarifies which finger should be used to operate each key, I find this a cumbersome method to write or relay verbally.

L-4-1 = C♯

L-4-2 = B♮

L-4-3 = B♭

R-4-1 = E♭

R-4-2 = C

Figure 24: Key-naming system from Herfurth (1945, pp. vi-vii). L is for left hand and R is for right hand

One more recent trend has been the diagrams which, rather than allocating names, letters or numbers to the different keys, use spatially positioned circles, oblongs and other shapes to represent them. Blackened shapes indicate that the key must be pressed, and clear/see-through shapes that they must remain as they are. This could be seen as an extension of the zeros and black dots used to indicate the palettes in Cokken's *Tablature*. Such diagrams can be found in Teal (1963), Paulson (1975), Gross (1998) and Lacy (2005).

Despite the clarity such diagrams may bring, they are bulky to notate. They are therefore not easy to use as a performing musician when notating a fingering pattern on a score. In the books by Gross (1998), and Lacy (1994), no names are allocated to the keys, which make it difficult to verbally transmit any fingerings via this method.[67]

Bumcke's key-naming system seemingly starts the trend of labelling the clés with either their function, or with the name of the (written) pitch they produce. For example, *octave key* or *high E♭ key* (1926, *Grifftabelle*). Labelling keys with the name of the pitch they produce is a particularly efficient method

[66] The letter W is the only one not used.

[67] Whether individuals find this method of notation easy or difficult to read and interpret may depend upon their learning styles: whether they relate to information either visually or logically/mathematically. I personally find it a slower process to interpret diagrams than to read numbers.

of transmitting key names in the Dutch and German languages for the notes that are either sharpened or flattened.[68] The note naming systems in these languages allow for sharpened or flattened notes to be conveyed with just one syllable. For example, *G♯* (spoken as G sharp in English), becomes *Gis* in Dutch or German, and *E♭* (E flat) becomes *Es*. Traces of Bumcke's key-naming system can be found in the later books by Sigurd Rascher (1941, p.19), Larry Teal (1963, p.67), and Eugene Rousseau (2002, p.vi).

In the books by Londeix (1989, p.8), Kientzy (1982, p.1), and Weiss and Netti (2010, p.10), a similar system has been adopted. *High D-F♯* are *c1-c5*,[69] with c standing for 'côté', or side. *Side C*, *side B♭* and *side F♯* have become *Tc*, *Ta* and *Tf,* with t standing for trill.

The key-naming systems by Kientzy (1982), Londeix (1989), and Weiss and Netti (2010) show that they have become pretty much standardized. There are only three points of difference between the three systems:

- The *octave key* becomes either *8* (Weiss and Netti), *c8* (Kientzy) or *8va* (Londeix).
- The *E♭ key*, *E♭* in Kientzy, and in Weiss and Netti, but *D♯* in Londeix.
- The *C key*, *C* in Londeix, and in Weiss and Netti, but *7* in Kientzy.

A combination of the zeros and dots system for the palettes, with labelling for the clés is common in recent saxophone fingering pattern notational systems. Londeix (1989), Weiss and Netti (2010), and Delangle and Michat (1998, p.178), all use it to document different fingerings. When transmitting such fingerings verbally though, one has to revert to the 'known' key names, which could lead to confusion. Kientzy is the only person who chooses to retain the numbers (*1-7*) in his written examples. He relies upon the person studying the fingering pattern knowing the names or numbers of the different keys.

This system of key-naming is quick to write - there are no circles to colour in - and quick to transmit verbally. Therefore, other than using *8* to denote the *octave key*, I will, for the remainder of this discussion retain Kientzy's key-naming system. The key-naming systems for the different saxophones used in this research can be found in [Appendices C1-C4].

Whilst Kientzy's pre-existing key-naming system will be used for the remainder of the research documented here, this system is not without its short-comings. Kientzy's system still labels five of the keys with the pitches they produce: *G♯*, *C♯*, *B♮*, *B♭* and *E♭*. This can lead to confusion when the keys are being used to produce pitches other than those originally intended.

To address this issue, more keys could be labelled with numbers, for example:

[68] Bumcke was of German origin (Jänecke, 2013).
[69] Weiss and Netti (2010), and Kientzy (1982) both include *c6, high G*.

	8	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮(9) / C♯(8)
Ta	4	B♭(10)
c5	5	
Tf	6	
	E♭ / 7	

Figure 25: Key-naming system. The numbers in red are proposed alternatives to their current names

The numbering system could logically be extended down past seven, to include the lower notes. This though, causes a ‘clash’ with the *octave key*, which will here be labelled *8*. Kientzy (1982), Londeix (1989), Delangle and Michat (1998), and Weiss and Netti (2010) have all used the number eight in their key-naming systems, as part of their label to refer to the *octave key*.

The extended numbering system [Figure 25] still leaves *G♯* and *E♭* un-accounted for. There is not a logical way to include these keys in the above key-naming system. One possibility might be to use a numbering system which is common to houses which have subsequently been converted to apartments, for example, if *G* is labelled *3*, then *G♯* could be labelled *3a*. Alternatively, the French word ‘bis’, which is sometimes already used for the *p key*, could be used. For example *3 bis*.

It has not proven possible to find a key-naming system which would provide solutions to the current weaknesses of the existing system or which noticeably improves the current system. It is for these reasons that, with the exception of the *octave key* which I label *8*, rather than *c8*, Kientzy’s key-naming system has been chosen for use here.

Whilst there are endless possibilities for key-naming systems and fingering-pattern notational systems, this discussion has covered the major trends. It has established that the development of these systems in relation to the saxophone have not been linear. Rather, it has uncovered a mix of ideas and systems. Through this study it has been possible to identify similarities between more recent key-naming and notational systems. This is therefore the reason behind largely retaining existing systems here, rather than provoking yet more, and un-necessary, change.

4.2 Alternative fingering patterns and alternative sources of microtonality on the saxophone

Now that a suitable key-naming system for method of documenting and transmitting the keywork of a saxophone has been identified, we can look at how, and why, the actual fingering patterns have developed.

The early saxophone method books, by Cokken, Hartmann, and Kastner all feature alternative fingerings for some pitches, but as Kastner believed the saxophone to be perfectly in-tune (1846, p.22)[70] these fingerings are seemingly not for adjusting the pitch, but are rather, alternatives which produce the same pitch.

In Kastner we can find alternative fingerings for five pitches: F♯4 (written pitch), C5, D♯5, F♯5, and C6 (1846, *Tablature du Saxophone*).[71] In Cokken alternative fingerings are also given for five pitches: F♯4, C5, C♯5, F♯5, and C6 (1846, *Tablature du Saxophone*). Mayeur's *Grande Méthode Complète de Saxophones* indicates a change of stance. Firstly, opposite to Kastner, and Cokken, who state that fingering patterns are the same for all saxophones, Mayeur's *Grande Méthode Complète de Saxophones*[72] indicates that whilst the fingerings up to C♯6 are the same for all saxophones, that D6 and E♭6 have two possible fingerings on the soprano saxophone, whilst only having one on the 'other' saxophones (1867, p.17).

A second difference between Mayeur earlier books, is that it is the first saxophone method book to specifically mention using additional keys to correct the pitch of certain notes on the saxophone.

> Pour faire le Re (*sic*) juste il faut prendre la Clé *No.3* ainsi que pour le Re♯ ou Mi♭
> Pour le Mi, Fa, Fa♯, Sol il faut prendre la Clé *No.4* (Mayeur, 1867, p.17).
>
> To play D4 in tune you must take the *C♯* key, equally for D♯4 or E♭4
> For E4, F4, F♯4, G you must take the *E♭* key (Mayeur, 1867, p.17).[73]

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[70] "L'instrument possède une grande étendue, il est d'une justesse et d'une égalité parfaite" (Kastner, 1846, p.22).
"The instrument possesses a grand expanse (range), it is of a perfect tuning and evenness" (Kastner, 1846, p.22).
[71] The same fingerings can be found in Hartmann (1846, *Tablature du Saxophone*)
[72] Mayeur's *Grande Méthode Complète de Saxophones* received an honourable mention in the 1867 Exposition (Hemke, 1975, p.269).
[73] For the ease of reading and understanding, the English translation uses my key-naming system [Appendix C1].

The later book, Mayeur's *Nouvelle et Grande Méthode de Saxophone*, retains the fingerings specific to the soprano saxophone, but no longer features the advice about correcting the intonation. The additional keys on the *Evette et Schaeffer* model provide new fingering possibilities for F♯4 and F♯5,[74] C5 and C6, and B♭4 and B♭5 (Mayeur, 1896a, *Tablature des Saxophones*). Mayeur's *Nouvelle et Grande Méthode de Saxophone* does not include the fingering pattern for F♯4 and F♯5 which uses key *6* in place of key *5* despite it being found in the earlier manuals by Kastner, Cokken, and Hartmann, and subsequent ones by Eby, and Mule.

Eby also lists 13 "special" fingering patterns for C♯5 (1923, *Chart Showing Fingering for the Saxophone*). Many of Eby's fingering patterns change which of the palettes (keys *4*, *5*, and *6*) are used, and the list does not include the alternative fingering pattern to C♯5 found in Cokken (1846, *Tablature du Saxophone*).

Alternative fingering patterns for the same note can be found in Eby (1923, *Chart Showing Fingering for the Saxophone*), Bumcke (1926, *Grifftabelle*), Mule (in Gay, 1950, *Tableau de la Gamme Chromatique du Saxophone*), Teal (1963, pp.68-69), whilst more recent books have included pitch correction fingering charts. These can be found in the saxophone method books by Teal (1963, p.66), Londeix (1989, p.43) and Buckland (2012, p.69).

There is already an extensive body of source material that lists alternative fingerings for the saxophone. These can be found listed not only under microtonal or quarter-tone fingerings, but also as bisbigliando fingerings, multiphonic fingerings, simplified fingerings to aid in the production of trills and tremolos, those used to adjust or correct the tuning of standard semitone pitches, or just alternative fingering patterns. For example Londeix has separate lists for microtones, multiphonics and tuning adjustments (1989, pp.24-43), and Delangle has proposed alternative fingerings in Berio's *Sequenza VIIb* for soprano saxophone (1995). Both Kientzy (1982) and Weiss and Netti (2010) have listed the pitches of each multiphonic which can be produced separately, and Netti's *necessità d'interrogare il cielo* (n.d.) also separates the notes of many different multiphonics in the course of the piece. There are additionally the false fingerings used by jazz saxophonists and the notes of the overtone series as documented by Rascher (1983).

There are, of course, other methods for microtonally changing the pitch of a note on the saxophone, other than using a different fingering pattern. Lower jaw movement is frequently used to play vibrato on the saxophone. Whilst this is done to change, or to enhance the sound, a small microtonal pitch change occurs with this movement. Lower jaw movement is also used to play some of the 'tricks'

[74] Mayeur's *Nouvelle et Grande Méthode de Saxophone* does not include the fingering pattern for F♯4 and F♯5 which uses key *6* in place of key *5* despite it being found in earlier manuals (Kastner, Cokken, and Hartmann) and subsequent ones (Eby, Mule).

detailed in H. Weber (1926). Kientzy has pointed out that many of the extended techniques on the saxophone are “non-tempéré”[75]: he calls both open slap-tonguing and key percussion microtonal (Kientzy, 2002, pp.60-61).

4.3 Hand and digit position when playing the saxophone

The earliest saxophone method books by Kastner, and Cokken, both address how the hands and fingers should be placed on the saxophone.

> L’index, le medium, et l’annulaire de le main gauche se placent sur les trois premières palettes et partant du haut de l’Instrument, les trois même doigts de la main droite se placent sur les trois dernières palettes: le pouce de la main gauche se place dessous l’Instrument à hauteur de la second phalange sur une petite plaque en saillie et de manière à conserver assez de liberté pour faire mouvoir les deux clefs *No.7* et *No.12*.
>
> Le petit doigt de la main gauche reste constamment tendu et prêt à faire mouvoir les deux clefs *No.1* et *No.3*. La main droite maintient l’Instrument de manière à le faire passer à droite du corps en longeant la hanche droite. Le coude du bras gauche devra être rapproché du corps et celui du bras droit porté en arrière.
>
> Le pouce de la main droite va se fixer sous le crochet ou support pour soutenir le poids de l’Instrument conjointement avec le secours de la courroie.
>
> Le petit doigt de la main droite tendu comme celui de la main gauche, met en movement les clefs *No.2* et *No.4* (Cokken, 1846, p.4).[76]

Each digit has been assigned a specific task, whether operating one or more keys, or supporting the instrument.

---

[75] “Non-tempered” (Kientzy, 2002, p.60).

[76] “The index, the middle finger, and the ring finger of the left hand are put on the first three palettes and starting from the top of the instrument, the same three fingers of the right hand are put on the last three palettes: the thumb of the left hand is put under the instrument at the location of the second phalanx on a small protruding plaque in such a way that you keep enough freedom to manipulate the two keys No.7 and No.12 [the two octave keys, *8¹* and *8²* respectively].
The little finger of the left hand stays constantly stretched and ready to manipulate the two keys No.1 [*B*] and No.3 [*C♯*]. The right hand holds the instrument in order to let it pass to the right hand side of the body by lengthening the right hip. The elbow of the left arm should be close to the body and the right elbow held backwards. The thumb of the right hand will be held under the hook or support to carry the weight of the instrument together with the strap.
The little finger of the right hand, stretched in the same way as the little finger of the left hand handles keys No.2 [E♭] and No.4 [*7*]” (Cokken, 1846, p.4).

Whilst the keywork on the saxophone has changed since its invention, advice about the position of the hands and fingers does not seem to have altered. For example: “Les doigts arqués se maintiendront toujours au dessus des palettes, même quand elles seront ouvertes” (Mayeur, 1896a, *Méthode de Saxophone*).[77] Some of the key-naming systems that have been studied supported these tasks by using terms such as “Left Side Key” and Right Side Key” (Rousseau, 2002, p.vi) or *L-4-2* (Herfurth, 1945).

In the list of modifications for the *Evette et Schaeffer* model saxophone (Mayeur, 1896a, *Avant-Propos*) discussed in section 4.6, each item includes the name of the finger with which the new key or new keywork mechanism should be played. Modification No.6, the *B♭* key, cannot easily be reached with all fingers of the left hand, and using a different finger may not allow other keys to be closed. This is therefore an area where little can be reasonably changed, but modifications No.1 (*Tc* key), No.3 (*Tf* key), No.5 (*p* key), and No.7 (*x* key), are all accessible by digits other than those allocated in Mayeur.

With the basic position of the hands and fingers remaining unchanged, and the keys which they operate being strictly allocated, it places limitations upon what is currently microtonally possible on the saxophone. The right hand thumb remaining in a supporting role, so that essentially only nine of ten digits are ever used to move keys, is also a limiting factor. Allowing, where possible, a new openness regarding hand and digit position would allow greater development of microtonality on the saxophone. In chapter 5 I will discuss how changes to hand and digit position have allowed me to develop microtonal fingering patterns.

4.4 Microtonal fingering pattern charts

Following the above discussion on hand and digit position this section examines which aspects of microtonal saxophone playing have already been documented and compares fingering patterns.

In the second World Saxophone Congress newsletter Thom David Mason wrote an article, ‘The Multiphonic Resources of the Saxophone’ (1970, pp.3-7). Part of his article was a ‘Multiphonic Fingering Chart’ which documented 76 fingering patterns which produce multiple sounds on the alto saxophone. In this chart Mason documented which notes of the different multiphonics were either a quarter-tone sharp or flat from the semitone pitches. At the second World Saxophone Congress, held December 14-15, 1970, Mason gave a lecture recital, ‘Multiphonics for the Saxophone’ (Liley, 2003, *World Saxophone Congress II*). Whilst Mason’s work does not specifically cover microtonality in

[77] “The hooked fingers always have to be held above the palettes, even when they are open” (Mayeur, 1896a, Méthode de Saxophone).

mono-phonic saxophone playing, it is the first example of the use of non-standard fingering patterns on the saxophone.

It was at the same congress that Londeix premiered Denisov's *Sonate* for alto saxophone and piano (Liley, n.d., 2003, *World Saxophone Congress II*). The saxophone part for the second movement of this work makes use of multiphonics, trills using alternative fingering patterns, and quarter-tones. The fingering patterns are included for the quarter-tones used in the piece.

A few years later, Hemke's article, 'New Directions in Saxophone Technique', mentions microtones as one of a number of extended techniques on the saxophone, but does not include fingering patterns (1973, pp.9-11).

The earliest documentation of complete fingering patterns specifically for playing quarter-tones on the saxophone, was Caravan's doctoral thesis (1974). It contains fingering patterns for quarter-tone pitches between D𝄲4 and F𝄳6 (1974, pp.139-141). The fingering patterns in Caravan are intended for use on the alto saxophone, with the exception of seven substitutes which are for the soprano saxophone (1974, p.141). The majority of documentation up to this point is for the alto saxophone.

The first large-scale documentation of quarter-tone fingering charts was done by Paulson (1975). This included fingering pattern charts for four different saxophones: soprano, alto, tenor, and baritone. The range studied is between D𝄲4 and F𝄳6 (1975, pp.17-36).

Caravan's fingering patterns were subsequently discussed, and further alternative quarter-tone fingering patterns were suggested in an article by Schwab (1976, pp.7-9). The fingering patterns in Schwab are non-specific, i.e. they are not intended for any one member of the saxophone family, but his article made suggestions for playing A𝄲3, A♯3, B𝄲3, and C𝄲4 on the saxophone, notes that prior quarter-tone fingering pattern charts had not covered.

Documentation of quarter-tone fingering patterns for six members of the saxophone family can be found in Londeix's *Hello! Mr. Sax* (1989).[78] In this book he documents pitches with a written range extending between C♯4 (for alto and sopranino this begins on E𝄲4), and F𝄲6 (E𝄳6 for the bass saxophone).

Thereafter Delangle and Michat published a non-specific saxophone quarter-tone fingering chart for the range D𝄳4 to G𝄳6 (1998, p.178), and most recently Weiss and Netti included eighth-tone fingerings charts for soprano, alto, tenor, and baritone saxophones with the range C𝄰4 to G𝄯6 (written pitches), (2010, pp.17-32).

[78] The saxophones are: bass, baritone, tenor, alto, soprano, and sopranino.

A comparison of the charts shows that Paulson gives the same fingering patterns as Caravan for 23 of the 27 different pitches, whilst Schwab gives only seven of the same fingering patterns. Londeix's alto saxophone chart gives the same fingering patterns for 17 of the 27 pitches, whilst the two most recent share only six (Delangle and Michat) and five (Weiss and Netti). Only two pitches, C𝄲6 and D𝄲4, have the same fingering patterns in all six sources, and the latter (D𝄲4), is in an area of the saxophone's range where there are few possibilities to change the fingering pattern.

1

2

3

4

5

6

E♭ / 7

Figure 26: Fingering pattern for D𝄲4 (written pitch)

This shows that there has not been a linear progression in the development of quarter-tone fingering patterns for the saxophone. Whilst this work was done over a span of forty years, and therefore most likely on different models of saxophone, the two solitary fingering patterns common to all six sources point towards a lack of standardization of fingering patterns for quarter-tones on the saxophone.

Closer study of these areas where there are differences in the fingering patterns may highlight an alternative reason for the differences. Some of the fingering patterns that differ between the two most recent charts, Weiss and Netti (2010), and Delangle and Michat (1998), are between C♯5 and E𝄲5. This is in the middle of the saxophone's standard range, an area where the change is made between not pressing the octave key and pressing it. It is an area where semitone pitches can either be played with a standard fingering or an alternative one. For example, E5 has this standard fingering:

8

1

2

3

4

5

Figure 27: Fingering pattern for E5 (written pitch)

It can also be played using either of the two following fingering patterns.

c3

c5

Figure 28: Alternative fingering pattern for E5 (written pitch)

1 c2

c3 2

3

c5

Figure 29: Alternative fingering pattern for E5 (written pitch)

Whilst there are many alternative fingering patterns and timbral change fingering patterns in Teal (1963, p.69), Londeix (1989, p.43, p.54), Weiss and Netti (2010, p.44), neither of the fingering patterns in Figures 28 and 29, can be found in them.

Weiss and Netti point out that "many corrective fingerings for standard, chromatic playing can also be derived" from their eighth-tone fingering pattern charts (2010, p.15). The fingering pattern they give for

E♮↓5 (1/8 tone flat) is similar to that in Figure 28 (*c3*/*c5*), but uses the *octave* key. The microtonal change that this produces can be heard in [Recording 96/1.].

Another range where there are differences between Delangle and Michat, and Weiss and Netti, is between D𝄲6 and F𝄲6 (written pitches). This is another area where there are standard and alternative fingering patterns for semitone pitches.

For example, the standard fingering for E6 is:

8

c2 / c1

c3

Figure 30: Fingering pattern for E6 (written pitch)

Teal writes that the same note can also be played using the following fingering pattern:

8

x

1

2

3

Figure 31: Alternative fingering pattern (Teal, 1963, p.69) for E6 (written pitch)

Whilst I occasionally use the following fingering pattern:

8

c4

Figure 32: Alternative fingering pattern for E6 (written pitch)

This is a fingering that Londeix uses to raise the pitch of E6 (1989, p.43). Londeix lists five alternative fingering patterns that raise or lower the pitch (1989, p.43). He also lists a further two fingering patterns which elicit timbral change (1989, p.55). Weiss and Netti have documented five fingering patterns which elicit timbral change on this note (2010, p.46). They have also given fingering patterns for the notes a quarter-tone and an eighth-tone above and below this pitch (2010, p.24). None of these are the same as the fingering patterns in Londeix.

The variation between the quarter-tone fingering patterns found in Delangle and Michat (1989), and Weiss and Netti (2010), may not be due to a lack of standardization, but rather to the large range of possible fingering patterns from which to choose.

When comparing the fingering patterns between different members of the saxophone family, there appears to be a difference between the higher and lower saxophones. In Weiss and Netti, nine and ten fingering patterns, for the alto and tenor saxophone respectively, varied from those they gave for the soprano saxophone. Whereas, 21 of the 29 patterns were different for the baritone saxophone (2010, pp.17-32). Such variations could be down to personal preference of fingering patterns on different instruments, which in turn could be influenced by ergonomics and the ease with which fingerings can be played on, for example, larger instruments or instruments which are held in front of the body.

Twelve of the fingering patterns for the 30 quarter-tone pitches, with a range between D𝄳4 and G𝄳6, documented in Delangle and Michat are identical to those in Weiss and Netti's alto saxophone chart , whilst two-thirds of the patterns were identical to Weiss and Netti's soprano saxophone chart (2010, pp.17-32).

4.5 Microtonal notation

C. Fox has said that the interpretation of a work may be "affected by the amount of notational information provided" (2014a, p.7), but Kanno has spoken about the inadequacy of music notation (2007, p.234), and Leech-Wilkinson has called it "a grossly imperfect form of communication" (1984, p.535). The extended techniques documented in Bartolozzi (1982) have meant that more forms and methods of music notation are now needed than ever before. Extended techniques on the saxophone have been documented in saxophone method books by Londeix, Kientzy, Weiss and Netti, et al. These books were not only an attempt by saxophonists to clarify the various playing techniques, but also provided suggested notations for the techniques they discussed.

The diversity used in the key-naming systems and the fingering pattern notational systems used for the saxophone has already been discussed in section 4.1, but the microtonal symbols used to label the different pitches also varies between different sources. Schwab highlighted the issues surrounding the notation and reading of microtonal music when he said that “one of the difficulties encountered in playing quarter tones (sic) is that there are almost as many ways of notating them as there are composers who write them” (Schwab, 1976, p.7). A study of some of the notations used shows that a total of eight different symbols have been used by Schwab, Kientzy and Londeix to indicate quarter-tone sharp, three-quarters of a tone sharp, quarter-tone flat and three-quarters of a tone flat (Kientzy, 1982, p.4; Londeix, 1989, p.24; Schwab, 1976, p.7). There is not one symbol common to all three of the different notational systems.

A survey of the microtonal symbols used in other saxophone literature show that not all sources have suggested symbols for all four of the quarter-tones that can be notated.

Source	¼ sharp	¾ sharp	¼ flat	¾ flat
Caravan (1974)	𝄲	♯	♭	♭♭
Delangle and Michat (1998)	𝄲		𝄳	
Kientzy (1982)	†	♯	𝄳	𝄬
Londeix (1989)	†	♯	𝄬	𝄭
Paulson (1975)	𝄲	♯	♭	♭♭
Schwab (1976)	𝄲	♯	𝄳	𝄳̸
Weiss and Netti (2010)	𝄲	♯	𝄳	

Figure 33: Chart showing the different microtonal symbols used in saxophone literature

Whilst Seeger warned against increasing the use of symbols used in music notation (1958, p.187) Figure 33 shows, not only that eleven different symbols have been used to represent four different levels of pitch change, but also that one symbol has been used to represent two different levels of microtonal pitch change: Kientzy has used the same symbol to represent three-quarters flat as Londeix has used to represent one quarter flat. Whilst symbols can be learned, this last aspect - symbols being used to mean different things - can be particularly confusing.

The disparity of microtonal symbols in saxophone books has added to the number of symbols that players must know and be able to interpret. Despite this Delangle and Michat have failed to explain the meaning of their symbols. The difference between the symbols used to represent microtonal pitch change shows the importance of explaining these symbols whether used in saxophone method books or in compositions.

4.6 The changing saxophone. New keys, new mechanisms: new possibilities, new difficulties

As can be seen in the patents filed for changes to saxophone keywork and keywork mechanisms (Dullat, 1995), the saxophone has been constantly developed since the 1840s. Adolphe Sax followed his initial patent of the saxophone (patent number 3226) with two more.[79] These subsequent patents made numerous changes and additions to the original instrument. These included changes to facilitate using the left hand keys (Dullat, 1995, p.198), the addition of a key operated by the left hand thumb to allow the note C5 to be played with better tone and intonation (Dullat, 1995, p.199), and lengthening the tube of the alto saxophone to accommodate two more semi-tone steps at the bottom of the range (Dullat, 1995, p.201). Whilst some of Sax's ideas can be seen to have found their way through to modern-day instruments, for example the ergonomic function of the keys has been improved, others, such as the extended alto saxophone, have been short-lived.[80] Both the extended range of the alto saxophone, and the thumb operated key to play C5 would have been potentially interesting, adding to the saxophone's ability to play microtonally.

Some of the changes that were made by Sax's rival manufacturers have influenced saxophone design up to the current-day saxophones (Liley, 1998, p.16). It is the changes to the saxophone for the *Evette et Schaeffer* model instrument which are of particular interest when looking at the microtonal possibilities of the instrument. These changes have been documented in Mayeur's saxophone method book, *Nouvelle et Grande Méthode de Saxophone* (1896a).

These changes, and this book, mark a turning point in the capabilities of the saxophone which is of specific interest when examining the microtonal possibilities of the instrument.

These changes are listed as:

1º Une cadence de *si* à *ut* pour l'index droit.

2º Un *si♭* se prenant avec les deux index droit et gauche, comme sur la clarinette Boehm.

3º Une clé de *fa♯* pour l'annulaire droit.

---

[79] Patent 70894 (granted May 31, 1866) and Patent 139884 (granted May 14, 1881), (Haine, 1980, pp.198-200).
[80] Selmer produced only a few hundred alto saxophones which had the keywork to play A3 (written pitch). They were made between 1960 and 1970 (van Oostrom, 2009, p.37).

4º Une clé de *sol♯* articulée, se refermant automatiquement par les plateaux de la main droite.

5º Une petit plateau de *si♭*, pour l'index gauche.

6º Une clé de *si♭* grave, pour le petit doigt gauche.

7º Une clé de *mi* et *fa* aigus, pour l'index gauche.

8º Un *mi♭* pour le medium droit (Mayeur, 1896a, *Avant-Propos*).[81],[82]

Seven of the eight changes made to the instrument for the *Evette et Schaeffer* model are commonly found on instruments in the 21st century.[83] Changes 1, 3, 5, 6, and 7, relate to additional keys that *Evette et Schaeffer* have included in the remodelling. In microtonal terms, more keys mean more possibilities to be able to change the pitch of a note. But changes 2 and 4 relate to the keywork links. The articulated *G♯* key, which closes automatically when pressing keys *4*, *5*, or *6* in the right hand, has left the saxophone with a 'difficult' microtonal area.[84] What are the microtonal possibilities in this area: Work around it, ignore it, or find another way?

4.6.1 Keywork mechanisms and problem notes: the difficulties of G𝄲

One microtonal pitch has garnered more convoluted fingering patterns than the others, G𝄲. Caravan writes "N/A", not applicable, for both G𝄲4 and G𝄲5 (written pitches) and does not provide a fingering pattern (1974, pp.139-141). Londeix does not give a fingering pattern for G𝄲4 on bass, baritone, tenor or soprano saxophones, whilst he documents G𝄲5 (written pitch) as having possible fingering patterns on all six saxophones.

[81] "1. A trill key for B to C for the right hand index finger. 2. A B♭ which can be taken with the two index fingers of the right and left, as on the Boehm clarinet. 3. A key for F♯ for the right ring finger. 4. An articulated G♯ key, which is closed automatically by the palettes of the right hand. 5. A little key for B♭, for the left index finger. 6. A key for low B♭, for the left little finger. 7. A key for high E and F, for the left index finger. 8. An E♭ for the right middle finger" (Mayeur, 1896a, *Avant-Propos*).

[82] These changes have been documented in three patents filed by *Evette et Schaeffer*, numbers 184066, 246847 part 1 and 246847 part 2 (Dullat, 1995, pp.110-120). One other change to the keywork mechanism, the addition of three keys to be played using the right hand middle finger to play B♭4, B4 and C♯4, is not included in the *Avant-Propos* despite exercises for these keys at the back of the book (1896a, pp.1-5). These changes were documented in their patent number 260754 part 1 (Dullat, 1995, pp.122-125).

[83] The eighth change listed in Mayeur (1896a, *Avant-Propos*) is an E♭ key for the right hand ring finger. This key is no longer found on modern instruments, but was also documented in Bumcke's *Saxophon-Schule* (1926, *Grifftabelle*), and therefore may have remained part saxophone keywork for a short while.

[84] The details of the new G♯ can be found in *Evette & Schaeffer's* patent, number 184066.

On soprano and tenor saxophones Londeix has given the following fingering pattern for playing G♯5 (written pitch):

8

1

2

4

Figure 34: Fingering pattern for G♯5 (written pitch) on soprano and tenor saxophones (Londeix, 1989, pp.28-29)

Whilst for the baritone saxophone a different fingering has been given:

8

1

2
3

Tf

Figure 35: Fingering pattern for G♯5 (written pitch) on baritone saxophone (Londeix, 1989, p.27)

This is the same fingering that Paulson gives for both G♯4 and G♯5 on the tenor saxophone (1975, pp.27-29), whilst not providing any fingering patterns for either note on other saxophones.

To play G♯5 on the bass saxophone, Londeix adds the *G♯* key to the above fingering pattern [Figure 35] for baritone saxophone (Londeix, 1989, p.27).

Having studied the fingering patterns the six sources give for other notes, many are the same in different octaves and on different saxophones. It makes sense that the above fingering patterns could therefore also work on different saxophones and in a different octave. To verify if this assertion was true, I tuned my alto saxophone to A=442Hz, and tried all three fingering patterns for G𝄲5 (written pitch). [Recordings 97/1.-99/1.] As the saxophone works using an octave key, it was questioned if these fingering patterns would then be suitable for playing G𝄲4 (written pitch). Again, all three fingering patterns were tried, this time without the octave key, on each saxophone. [Recording 1/2.-3/2.] It was discovered that none of these fingering patterns allowed me to play either G𝄲 (written pitch) in either octave.

Having failed to play a G𝄲5 successfully using any of these fingering patterns, it became relevant to ask why this note is poses such a problem? The modification made to the saxophone for the *Evette et Schaeffer* model, which means that the *G♯* key automatically shuts when any of keys 4, 5, or 6 are closed, was made in order to aid trilling.[85] This change to the key-work mechanism has meant that no keys are available to lower the pitch of this note and has made it a stumbling block for microtonality on the saxophone.

Londeix's final fingering pattern, given for both G𝄲4 (written pitch) and G𝄲5 (written pitch), on alto and sopranino saxophones, is to half press the *G♯* key. As the *G♯* key is operated by a sprung mechanism, rather than found directly under a fingertip, half opening this key is a precarious business, but can be used to play a G𝄲, even if it is not very stable. [Recording 4/2.] Alternatively, Weiss and Netti suggest pressing *G♯* and half shutting key *4*, a solution which they apply to both G𝄲4 (written pitch) and G𝄲5 (written pitch) on all four saxophones in their study (2010, pp.17-32). Despite being left handed, I find that I have more control in the index finger of my right hand, than in the little finger of my left hand. [Recording 5/2.]

"Lâcher les lèvres",[86] is advice Londeix gives on a number of fingering patterns for tenor, baritone and bass saxophones (1989, pp.25-26), but never for G𝄲. Having studied the difficulties that current keywork causes to playing this note, relaxing the lips or moving the jaw down could be a suitable solution, but Kientzy warns against the "glissement indésirable"[87] that could sound if there is not a short silence both before and after the note when using this method (2002, p.58). [Recording 6/2.]

There are, of course, other suggestions for playing G𝄲, for example a change to the keywork mechanism as documented in Harrison (2012, pp.90-91), but my aim here is to work on an un-modified saxophone. This means that half closing the *G♯* key, or adjusting the pitch by relaxing my embouchure/jaw, might be the best possible solution for this note. The difficulties of playing G𝄲 on the

[85] Mayeur gives an example trilling between G♯ and D5, D♯5, E5, F5, and F♯5 (1896a, *Tablature des Saxophones*).
[86] "Release/relax the lips" (Londeix, 1989, pp.25-26).
[87] "Undesirable sliding" (Kientzy, 2002, p.58).

saxophone are clearly going to be a reoccurring issue in any research into the microtonal possibilities of the saxophone.

4.7 Summary and conclusions

There has been little development in microtonal saxophone playing beyond the quarter-tone scale. This work was commenced in the 1970s, but there has been no clarification of this work, and the fingering pattern charts do not explain or show the differences between fingering patterns when they provide multiple options. These are both issues that will be discussed further in chapter 5.

Bartolozzi wrote that, the possibilities of woodwind instruments to play pitches less than a semitone apart are considerable, and that they are "now available for music using (such) micro-intervals" (1982, p.27). Whilst the saxophone was not included in his study, it is widely considered a woodwind instrument, and this notion seems in contrast to the following statement by Londeix:

> Because of the current state of instrumental manufacturing, 1/3, 1/4, and 1/5 tones and micro-intervals cannot be obtained on all saxophones.
>
> The fingerings which appear here are the only ones that can create intervals smaller than a semi-tone (sic) (Londeix, 1989, p.24).

This quote by Londeix chooses to look at the limitations of the saxophone, rather than the potential. Whilst not all notes might be possible, what can be done? Although Londeix then provides fingering pattern charts for quarter-tones, he does not attempt either third-tones or fifth-tones. He also seeks to put himself in a position of hegemony by saying that his fingering patterns are the only ones.

Delangle and Michat mirror Londeix's statement, and have said that "intervals less than a quarter-tone (third-tone, fifth-tone) are not all possible" but that "at a moderate tempo all the quarter-tones from c♯^{1} [C♯4] are playable, although the intonation of the quarter-tone above G (written) is approximate" (1998, p.177).[88]

Kientzy's view of microtonal saxophone playing is even more derogatory:

> Grâce à des doigtés appropriés, sur la majeure partie de leur étendue normale, les saxophones, du basse au sopranino, peuvent émettre des hauteurs 'entre' les demis tons de leur gamme plutôt 'bien tempérées', abusivement appelées quarts de ton. En effet, ce ne sont pas d'exacts quarts de ton; que ce soit la flûte, le hautbois, la clarinette, la flûte à bec, le

[88] There does appear to be some confusion in Delangle and Michat's understanding of different microtonal divisions of the tone. Contrary to their assertion, one-third of a tone is larger than one-quarter of a tone.

> basson ou le saxophone, aucun instrument à vent à trous latéraux ne peut exécuter de gamme en véritables quarts de ton (2002, p.58).[89]

In contrast Schwab believes that: "the fact that it is acoustically impossible to build saxophones precisely in tune is occasionally an asset" for playing quarter-tones (1976, p.7), but his statement is hardly cause for celebration. Instead it is a rather damning remark about the state of saxophone manufacture.

This research demonstrates that there are in fact many microtonal possibilities on the saxophone. These include playing exact pitches, rather than the inexact pitches which Kientzy speaks of, and the ability of the instrument to play steps smaller than a quarter-tone.

In contrast with Londeix, Kientzy, and Delangle and Michat, the most recent source of microtonal fingering pattern charts for the saxophone, by Weiss and Netti states that:

> With the exception of a few tones in the lower register (approximately the lowest fifth of the saxophone's range), as well as the microtones between G and G♯ (for purely mechanical reasons), quarter-tone as well as eighth-tone fingerings are possible on the saxophone (2010, p.15).

Whilst there are three documented quarter-tone scales, only Weiss and Netti (2010) have documented eighth-tone scales on the saxophone, and no saxophone method book has documented smaller or irregular divisions of the tone. Their work has therefore been the starting point for my research into microtonality, but I would like to go further than this and see what else is possible.

Other sources of microtonality that are open to be explored are the multiphonic fingering patterns documented in Londeix (1989, pp.31-39), Weiss and Netti (2010, pp.64-114) and Kientzy (1982), and the natural overtone scale as studied by Rascher (1983).[90] Both areas have been documented, extensively in the case of multiphonics, but the numerous fingering patterns, many of which sound non-tempered notes, have not yet been studied for how they could be utilised for microtonal playing.

[89] "Due to adapted fingerings, on a large part of the normal range, the saxophones, from bass to sopranino, are able to emit pitches 'between' the semitones of their scale mostly well-tempered, abusively called quarter-tones. In fact, they are not exact quarter-tones… no wind instrument with side holes can play scales of true quarter-tones" (Kientzy, 2002, p.58).

[90] At the first World Saxophone Congress, Mason presented a lecture recital on multiphonics, and Rascher gave a 'clinic' which included a demonstration of overtones (Liley, 2003, n.p). Therefore these techniques, which can sound microtonal pitches, were heard by many saxophonists in 1969.

Chapter 5 Extending microtonality on the saxophone

Chapter 4 discussed the work which has already been accomplished in documenting the fingering patterns for playing microtonal scales on the saxophone. The majority of this work has been done in documenting the quarter-tone scale, and more of these fingering pattern charts have been written for the alto saxophone than for the others members of the saxophone family.

Whilst the six sources (Caravan, Paulson, Londeix, Kientzy, Delangle and Michat, and Weiss and Netti) discussed in chapter 4 show that microtonal fingering pattern charts for the saxophone are available, they do not include information about how other aspects of saxophone playing technique need to be adapted in order to play microtonally. The next two sections examine two areas that have not been covered in detail by any of the previous six sources.

5.1 The embouchure and microtonality

Oboist Christopher Redgate states that “in order to get pitches in tune the performer will be making adjustments to the embouchure as a matter of course” (n.d., *Microtonal Oboe*). Kientzy extends the importance of the embouchure in playing different pitches to also include the oral cavity. He believes that it is these two elements, together with fingering patterns which are used to form the pitch of each note played on the saxophone (2002, p.58).

The embouchure is a part of playing the saxophone which is examined only superficially: the basic position is taught, but the constant minor changes and adaptations which are made to it when playing, are done largely instinctively. Once these subtle changes in position are learnt, they are rarely spoken about, unless they interfere with what is being played, as I have detailed regarding using subtone techniques for playing at lower-end dynamics. Weiss and Netti define the production of eighth-tones as the “border area where fingering is just as important as a clean intonation with the help of embouchure correction” (2010, p.14), and in their eighth-tone fingering pattern charts they use arrows pointing up or down next to some fingering patterns (Weiss & Netti, 2010, pp.17-32). Whilst the arrows are not explicitly explained, it is thought, from studying the fingering patterns and pitches, that they indicate the embouchure correction necessary in order to assist the fingering to reach the desired pitch.

Whilst Weiss and Netti point out the importance of the embouchure in playing microtonality on the saxophone using fingering patterns, changes to the embouchure position, without a corresponding change to the fingering pattern, can itself create microtonal pitches. As Bok has stated, “it should be remembered that it is possible to obtain microtones by modifying the pressure of the lips" (2011, p.33). This means that there are therefore two methods available for adjusting the pitches of notes. Whilst both methods are at our disposal there are certainly pros and cons to playing microtonality on the saxophone by using either embouchure adjustment or different fingering patterns.

Although Bok mentions the possibility of playing microtones by changing the embouchure (2011, p.33), he does not discuss this option further. Redgate has similarly noted both methods of microtonal note production on the oboe, but says that the "best results can be obtained by fingering rather than using the lip" (n.d., *Microtonal Oboe*). Bartolozzi documented quarter-tone fingering pattern for the flute, oboe, clarinet and bassoon, stating that they can be "obtained throughout the whole compass of instruments" (1982, p.27). He states that "they [quarter-tones] are not obtained through the approximate method of lip adjustment, but through a well-defined order of fingerings" (1982, pp.27-28). This brings up the issue of approximation when using changes to the embouchure to microtonally alter the pitch of a note. Whilst a fingering pattern can be notated, subtle movements to the lower jaw are hard to document, and harder to replicate perfectly on numerous occasions.

Redgate notes that:

> The advantage from the oboist's point of view of the lip technique is that standard fingerings are used and the pitch is altered simply by changing the embouchure pressure; which means that there are no fingerings to learn.[91] The disadvantage is that it can be a very approximate way of performing and will tend, obviously, to include slides from pitch to pitch as the embouchure is moved (n.d., *Microtonal Oboe*).

Clearly, using fingering patterns to play woodwind instruments microtonally, is the preferred method of Redgate, Bartolozzi, and Bok.

Schwab has said that it is possible "to bend almost any note on the instrument lower in pitch by at least a quarter tone (*sic*)"(1976, pp.7-9). Two words of his statement, "at least", are the reason why I do not see movement of the embouchure as a suitable method of microtonal note production on the saxophone. The movement that can be made when playing many notes on the saxophone can be considerable, [Recording 7/2.] and has been used in the works by Ryo Noda. Despite this, using changes to the embouchure to play microtonality on the saxophone does preclude the use of some other techniques: vibrato, subtone, or playing in the altissimo register, where change to the embouchure to microtonally adjust a note, may prevent the note from sounding.

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[91] The issue of learning such fingerings and performing them at speed will be discussed in relation to *Nano* section 5.4.3.1.2.

Relying primarily upon the embouchure to make the microtonal changes could impede the speed with which microtonality can be clearly played on the saxophone, therefore my research will rely upon using fingering patterns to play microtonal pitches on the saxophone.

The fingering patterns used to play microtonal pitches on the saxophone are often made by making changes to those for the semitone pitches the instrument was invented to sound. This can make microtonal notes difficult to sound. Despite this difficulty, advice on the role which the embouchure has is extremely limited. Londeix (1989), and Delangle and Michat (1998) do not make any mention of the role the embouchure plays in playing microtonal fingering patterns. Whilst two of the other sources acknowledge the importance of the embouchure, the information is limited to the aforementioned quotes by Weiss and Netti (2010, p.14), and Kientzy (2002, p.58).

The embouchure plays a vital role in allowing each fingering pattern to sound a microtonal note, and in relevant parts of my discussions about how I have developed microtonal saxophone playing, I will discuss the role that the embouchure has played.

5.2 Specifying unspecified microtonality

In *Ali* by Mincek (2010), the composer has not written the sonic results he wants, but instead the actions. In this composition, rather than changing the fingering patterns with each note, one key is closed and held shut for longer periods of time. This produces some rather unpredictable changes in pitch. Such a form of fingering patterns also means that each note in the phrase where a key is applied, will be microtonally altered in some way. This technique has parallels with the extended technique ‘left hand against the right hand’ which is found in Zych (2012).

The majority of the fingering patterns for the quarter-tone scale have been patterns which make small changes to those for the semitone pitch either side of the microtone. This has often been done by adding a key that is close to others that are used in the semitone pitch. For example, to play F𝄲5 (written pitch), key *6* is added to the fingering pattern for F♯5, which lowers the pitch.

8

1

2
3

5

Figure 36: Fingering pattern for F♯5 (written pitch)

8

1

2
3

5
6

Figure 37: Fingering pattern for F𝄲5 (written pitch) taken from Weiss and Netti (2010, p.19)

To raise the pitch of F♯5 and play G𝄳5 (written pitch), key *Tf* is added.

8

1

2
3

5

Figure 38: Fingering pattern for F♯5 (written pitch)

8

1

2
3

5

Tf

Figure 39: Fingering pattern for G𝄳5 (written pitch) taken from Weiss and Netti (2010, p.19)

Mincek works in a more extreme manner, using keys *c1*, *c2*, *c3*, and *c5*, which due to their position high on the body of the saxophone, will result in greater change to the pitches of the notes.

Some fingering patterns are not stable, and give the possibility for more than one note to sound. One of the recurring fingering patterns which can be found from the first line of the piece (keys *8, 1*, *2*, *3* and *c1)*, which is essentially the fingering pattern for G5 with added *key c1*, is also the fingering pattern given for a multiphonic later in the piece [Figure 40].

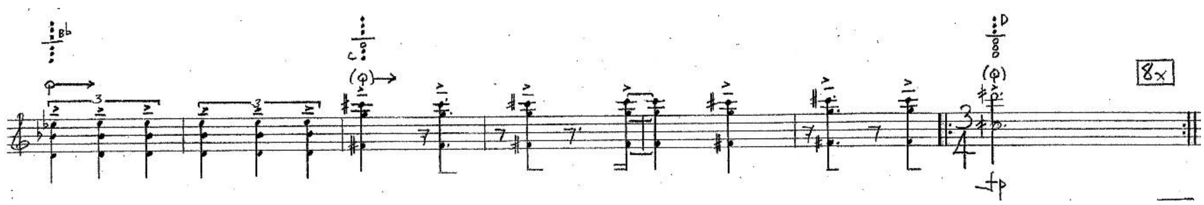

Figure 40: Mincek, *Ali* (2010, p.4, line 2) multiphonic in bar 7

Such 'extreme' fingering patterns are not found in the microtonal fingering charts, and so my first step in extending microtonality on the saxophone has been to document the pitch changes that are the result of adding each possible key (clé keys only) on each note of the saxophone. The results of this technique can be found in [Appendix I], and an example of extreme fingering patterns can be heard in [Recording 8/2.].

5.3 Issues affecting the development of microtonality on the saxophone

5.3.1 Understanding the keywork and keywork mechanisms of the saxophone

Early saxophone method books by Kastner (1846, pp.24-25), and Hartmann (1846, *Tablature du Saxophone*) showed which pads should be opened or closed in order to play a pitch, not which keys should be opened or closed, which is now the more common manner. Whilst, as shown in chapter 4, this was a long-winded way for transmitting fingering patterns, it did serve to allow players and composers to develop a greater understanding of the keywork on the saxophone. I believe that this is a necessary element in understanding how microtonality can be played on the saxophone.

Harrison has said that “the saxophone is capable of playing microtones by flattening the note above the desired microtone, thereby an F can become an F quarter-tone flat by the addition of a key lower than the pitch” (2012, p.39). This has already been discussed in section 5.2, but Harrison’s statement does not apply to all microtonal work on the saxophone. As shown in Figure 39, some microtonal pitches on the saxophone are played by raising the pitch. Londeix (1989), Paulson (1975), Delangle and Michat (1989), and Weiss and Netti (2010) have all used this fingering pattern in their microtonal fingering charts.

Another example shows that this is not a singular phenomenon: one of the possible fingering patterns to play B♭4, is key *1* and key *p*. By adding the *Ta* key it is possible to raise the pitch and arrive at the fingering that Caravan (1974), Paulson (1975), Londeix (1989), Delangle and Michat (1989), and Weiss and Netti (2010), suggest for playing B𝄳4 (2010, pp.17-32). These examples show that the saxophone is also capable of playing microtones by raising the pitch of the note below the desired microtone. This is done by depressing a key which opens a pad rather than shuts it. The mistake in the statement by Harrison shows what the importance is of understanding how the keywork mechanisms of the saxophone move/work.

In order to clarify the situation fingering pattern charts which give my suggested quarter-tone fingerings for alto saxophone, in combination with a chart showing which key and pads are open and shut for each note have been included in the appendices. [Appendices H2 and H3] Such an approach might aid in further developing the microtonal possibilities of the saxophone as it is possible to see which pads are available to change the pitch of any given note, something which is especially relevant when hand and digit position are no longer fixed and linked to specific keys as they currently are. Composers writing specific microtonal pitches are also able to see if the movement between any two notes would mean several pads either opening or closing, something that is not always seen from the fingering patterns.[92]

5.3.2 Problems as a result of the keywork mechanism: G𝄲

In his discussion of Roger Redgate's *Ausgangspunkte*, Christopher Redgate has mentioned the "creative solutions" that are required of the performer in order to play the piece (2007, p.141). On closed-pad instruments such as the saxophone or the bass clarinet, the solutions to such issues are perhaps required to be more creative than open-keyed instruments, where it is possible to half cover a tone hole.

The use of microtonal fingerings on the saxophone does leave the player with certain areas of the instrument's range where fingering patterns do not present a viable solution. One particular microtonal problem area on the saxophone is the apparent lack of microtonal possibilities between G and G♯ (written pitches, octaves 4 and 5). The meagre possibilities between G and G♯ on the saxophone are, as discussed in chapter 4, due to changes to the saxophone keywork mechanism. This makes it an area in which a creative solution is required.

Delangle and Michat also suggest half opening the *G♯ key* (1998, p.178), whilst Schwab's fingering charts advise opening the *G♯ key* a quarter of the way in order to play a written G𝄲4, and to barely open it in order to play G𝄲5 (1976, pp.8-9). Kientzy has said that written G quarter-sharps "sont impossibles dans un trait mélodique, mais pour une tenue, à partir du doigté de Sol ♯, le saxophoniste peut, en lâchant la pince, faire entendre un Sol 𝄲" (2002, p.58),[93] but he has warned about the danger of unintended glissandi that could be present when half opening keys in order to play microtonality (2002, p.58).

In *Hello! Mr Sax* Londeix provides two solutions, depending upon which saxophone is used and in which octave the G♯ is to be played. He suggests either half opening the *G♯ key* or provides a different fingering pattern which does not use the *G♯ key*, but he does not provide a solution for the written G𝄲4 on the tenor, baritone and bass saxophones (Londeix, 1989, pp.25-30).

The instruction for the saxophonist to "lâcher les lèvres"[94] in order to play a G𝄲4 (written pitch) in the second movement of Denisov's *Sonate* (1973, p.5) may be a stylistic choice, because the instruction

[92] The pitch change which resulted from several pads opening or closing at the same time was something remarked upon by Mc Laughlin in *Nano*.
[93] Kientzy has said that written G quarter-sharps "are impossible in a melodic line, but for a held note, from the fingering for G♯, the saxophonist can, by relaxing the little finger, produce a G𝄲" (2002, p.58).
[94] "Loosen the lips" (Denisov, 1973, p.5).

is also given for an F𝄲4, and in *Hello! Mr. Sax* the same instruction is applied to the notes for D𝄲4, E𝄳4 and B𝄳4 (1989, pp.25-27). To play a G𝄲 such a solution is a necessity.

Weiss and Netti provide three solutions for playing a G𝄲: embouchure correction, laying a finger nail on either key *4* or key *5* and then closing the key as far as possible, or a change to the mechanical keywork links of the instrument (2010, p.15). Such a change to the keywork mechanism for *key 6* has been detailed in Harrison (2012, p.91). This solution allows a player to play a G𝄲 by fingering a G♯ and shutting key *6*, which due to the altered mechanism, only half shuts the *G♯ key* (2012, pp.90-91). Whilst this adaptation of the keywork is a solution which allows a player to play G𝄲, issues might still arise due to the context the G𝄲 is in. Movement between F, E, E𝄳, or E♭ and G𝄲 is awkward. This difficulty of movement is exacerbated when the ring finger is also needed to close the *Tf key*, to play an F♯ using the alternative fingering pattern, or to play a G𝄳.[95] Therefore, whilst there are possible solutions for playing a G𝄲 on the saxophone, they are not always applicable.

There have of course been other creative solutions to aid microtonal playing on the saxophone. Sander Germanus has documented and discussed two ways in which he has rebuilt his soprano saxophone to facilitate microtonal playing on it. Germanus found it “Essentieel bij het ombouwen van de sopraansaxofoon was dat het een kwarttooninstrument zou worden dat makkelijk virtuoos in een verlaagde stemming zou kunnen spelen” (Germanus, n.d., p.104).[96] His first attempt at a quarter-tone saxophone was unsuccessful. Saxophone repairman Paul Feldman had the idea to put two necks of different lengths on the saxophone, but miscalculated the length needed to allow the saxophone to play a quarter-tone lower, and the new neck instead played a fourth lower (Germanus, n.d., p.103): Germanus called this instrument a “fiasco” (n.d., p.103).

Germanus’ own idea for a quarter-tone saxophone involved adding a key which would operate a lever which, in turn, would push the mouthpiece out, thereby adjusting the pitch. The work was done by two saxophone repairmen, Feldman and Nico Bodewes, and completed in 2004 (Germanus, n.d., p.103). The new key allows Germanus to play large sections of music a quarter-tone lower than the fingered pitch, but he still requires alternative fingerings patterns, as the instrument remains built with keywork for playing semitones not quarter-tones (Germanus, n.d., p.104).[97] The same problem remains for the

[95] The fingering solutions given by Londeix (1989, p.28), Delangle and Michat (1998, p.178) and Weiss and Netti (2010, p.23) for playing G𝄳5 on the alto saxophone all use the *Tf key*.
[96] “It was essential that in re-building the soprano saxophone, it would become a quarter-tone instrument that would be easy to play in a virtuoso manner at a lowered pitch” (Germanus, n.d., p.104).
[97] Specialized wind instruments that have been adapted or conceived to play microtonal music include the Bohlen-Pierce clarinet (S. Fox, n.d.), the 3D printed microtonal clarinet developed by Bailey et al. (2014), or Stephen Altoft’s microtonal trumpet (n.d.).

keywork mechanism between G and G♯, but by lowering the pitch of the entire instrument by a quarter-tone, it now means that there is no fingering pattern solution to play G.

Germanus' quarter-tone saxophone, which changes the mouthpiece position to allow it to play microtonally, is similar to composer Zabel's idea in *Sie sind zu lange im Wald geblieben IV* (2013). In this work for tenor saxophone, bass clarinet and live electronics, the bass clarinet remains tuned to A=442Hz, whilst the composer requests that the tenor saxophone re-tunes to A=428Hz. This work, written for duo hevans,[98] has yet to be played, because of an essential problem: it was not possible to re-tune my saxophone as low as A=428Hz before the mouthpiece came away from the neck. Pulling the mouthpiece out to such an extent also does not have the same effect on each note, as it changes the length of the tube which forms the body of the instrument. This means that the tone holes are no-longer in the correct place to play the semitone pitches at A=428Hz. The pitch changes are therefore different for each note. If my tenor saxophone is re-tuned as low as possible (concert pitch A=433Hz), then whilst the tuning note would be in tune, other notes of the instrument would not. The pitches which result from tuning A=433Hz (concert pitch) on my tenor saxophone has been documented in [Appendix J] and a semitone scale, which used B5 (written pitch) as the tuning note can be heard in [Recording 9/2.].

To return to the problem of the G𝄲 on the saxophone, my research has shown that solutions can be found for this note on other instruments. Whilst the extra keywork found on the Sistema Brevettato Delle Piane saxophone was originally intended to extend the normal range of the alto or tenor saxophone by one octave (Raganato, 2006, p.117), creative adaptation of the extra keywork could also provide more microtonal solutions. The keywork mechanisms of the Couesnon baritone saxophone allow this, and I have also found a solution on the soprillo saxophone. The microtonal possibilities of these instruments will be discussed further in sections 5.4.1.2, 5.4.2 and 5.4.2.1.

1

2 G♯
3
4
5

E♭

Figure 41: G𝄲4 (written pitch) fingering pattern for the Couesnon baritone saxophone [Recording 10/2.]

[98] This is an ensemble in which I play tenor saxophone and Henri Bok plays bass clarinet.

8^1

1

2 G♯

3

4

5

E♭

Figure 42: G♯5 (written pitch) fingering pattern for the Couesnon baritone saxophone [Recording 11/2.][99]

1

2

3

Ta 4

5

6

7

Figure 43: G♯4 (written pitch) fingering pattern for the soprillo saxophone [Recording 12/2.]

8

1

2 G♯

3

5

6

7

Figure 44: G♯5 (written pitch) fingering pattern for the soprillo saxophone [Recording 13/2.]

[99] [Appendix C2] explains the use of the two octave keys.

5.3.3 Hand and digit position

One issue which I feel has had a negative influence on the development of microtonality on the saxophone is the assumption that there is an optimum fixed position for the hands and the digits, and that this position must be maintained at all times. In chapter 4 the examination of different key-naming systems showed that early saxophone method books included information about which finger operated which key, and that Herfurth's key-naming system (1945, pp.vi-vii) was written in such a way as to make it clear which finger should be used to play different keys.

Oboist Christopher Redgate has said that "once you have decided that you can move your hands or use unorthodox fingerings, a wide range of options become available" (2007, p.143). His idea is equivalent to pianists crossing their hands whilst playing, or violinists who play pizzicato using their left hand, but such movements are not common in woodwind instrument performance. The shape of the instrument and the layout of saxophone keywork both suggest that the saxophone should be played with the left hand above the right hand. Whilst the keys normally operated by the left hand can be accessed by the right hand, the opposite is not possible. This is because on curved saxophone, the bell is fixed to the body of the saxophone, and the keys can only be accessed from one side, the right. The smaller saxophones (soprano, sopranino, soprillo) which are held out in front of the player, use the right hand thumb to support the instrument. Removing this support can lead to a lack of stability. On the curved instruments the right hand is capable of joining the left in the upper part of the instrument. The negative side of moving hand positions is the time needed to change back. Such movement has, for these reasons, not become part of my work. These reasons mean that crossing the hands when playing the saxophone is, whilst possible, not an option if the 'sets' of keys, those generally played by either the left or the right hand, are both required to be moved.

My work on extending the microtonal possibilities of the saxophone started from the standpoint, 'by any means possible'. This meant that rather than sticking to the hand and digit positions detailed in the early saxophone method books, if there is a key to be moved, and I have a digit that is able to move the key, then the fingering pattern is viable.

Using the right hand thumb as an active digit, rather than leaving it in its supporting role has opened up another layer of fingering patterns. This has allowed me access to the *c3*, *Tc*, *Ta* keys, usually operated by the right hand index finger, and *Tf* and *c5* keys, usually operated by the right hand ring finger, whilst still being able to move keys *4*, *5, 6, E♭* and *7*. Figures 45 and 46, show two of my fingering patterns where I have used the right hand thumb to move the *Tc* key.

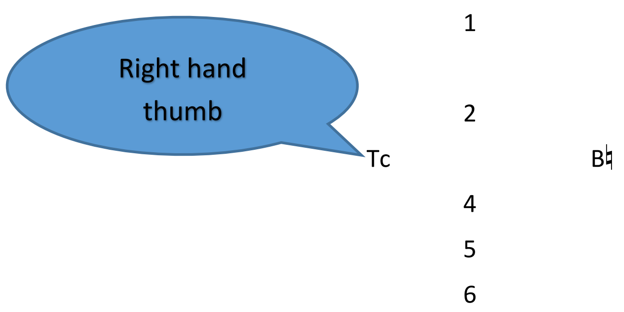

Figure 45: My fingering pattern for C𝄳5 (31-tone) on the tenor saxophone

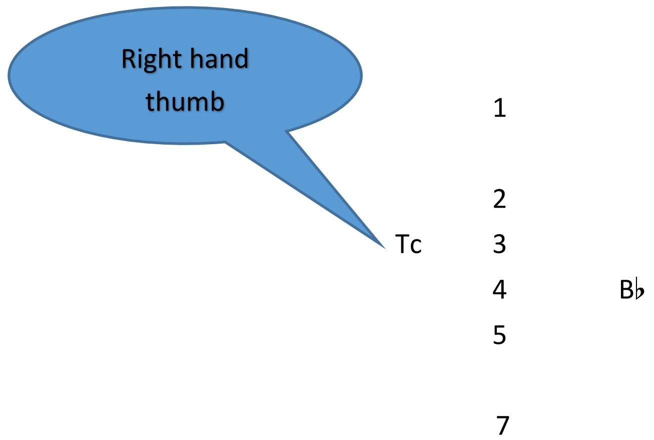

Figure 46: My fingering pattern for a flattened C5 on the alto saxophone

My work has also taken a position that has allowed each finger to press more than one key where this aids playing the fingering patterns, or allows more fingering patterns to be possible. Figures 47 and 48 are two examples of this.

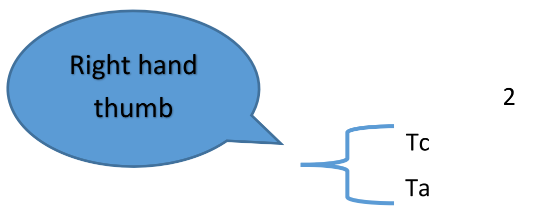

Figure 47: My fingering pattern for a flattened C♯5 on the alto saxophone

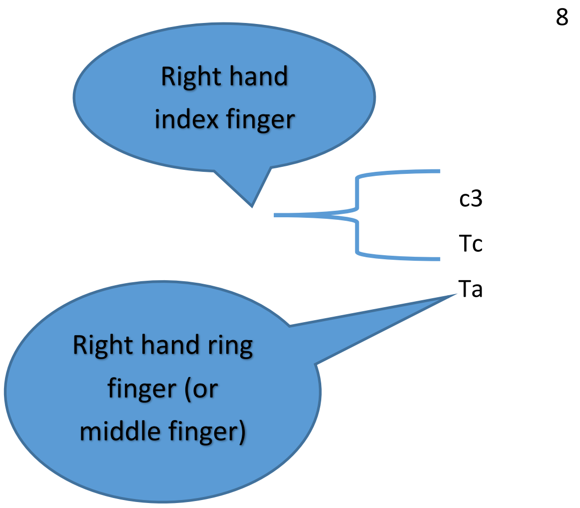

Figure 48: My fingering pattern for E6 (31-tone) on the tenor saxophone

The results of applying the free movement of digits and by using the right hand thumb as an active digit can be found in my work on the 31-tone scale, and the microtonal pitches I used for performing *Nano*. The free movement of individual digits has been a valuable asset in my work on extending what is microtonally possible on the saxophone.

5.3.4 Timbral change and dynamic range

Cottrell believes that microtones are “particularly effective on the saxophone, and can often be more readily perceived by an audience than when played on other instruments” (2012, p.272). Although he does not elaborate on this point, I speculate that the perceivability could be due to the change of timbre for each note, an aspect of microtonal playing on the saxophone that has been noted in Kientzy, and Schwab. They have said that quarter-tone pitches generally have a different timbre from semitone notes (Kientzy, 2002, p.59), and that “it should be remembered that it is almost impossible to coax these sounds from an instrument meant to play in half steps without obtaining some strange changes in timbre” (Schwab, 1976, p.7). Despite the change of timbre being the one issue which has effected all the microtonal work I have done on the saxophone, this point is missing from the microtonal discussions of Londeix (1989, pp.24-30), Delangle and Michat (1998, pp.177-178), and Weiss and Netti (2010, pp.14-32).

The numerous fingering patterns found in the appendices all have, to a varying degree, a different timbre from the ‘standard’ semitone pitches on the saxophone. Dealing with the change in sound from different fingering patterns can be difficult for both the performer and the composer to accept. When discussing what is microtonally possible on the oboe, Redgate has said that “there is going to be a certain amount of compromise in what can be done on the instrument [oboe]" (n.d., *Microtonal Oboe*). His statement is also relevant for the saxophone.

The effect of the timbral difference between notes has been found to be more apparent at louder dynamic levels, and the difference becomes more masked at lower-end dynamic levels. This has meant that microtonal playing on the saxophone has been particularly effective when used in combination with my technique for playing at lower-end dynamics.

Whilst Redgate has said that both "the timbre and the dynamics can vary from note to note" when talking about his work on the microtonal oboe (n.d., *Microtonal Oboe*), a change in dynamics between different microtonal notes, is not an aspect that has particularly affected my work on the microtonal saxophone. Neither has there been any particular difficulty in making the saxophone 'speak' when using the different fingering patterns. What I have found, is that the change in timbre can make some notes appear more prominent than others, although they are played at the same dynamic level. This is an issue which must be either embraced or tackled if choosing to play the saxophone microtonally.

5.3.5 Articulation

In general I have found the articulation of microtonal notes to be more difficult than that of semitonal notes, as the different fingering patterns produce notes that are less stable than semitone pitches. Some of the fingering patterns can be used to play several different pitches, and when articulating the notes, there has been a tendency for the pitch to change. Other fingering patterns can also be used to play a multiphonic, and I have found it more difficult to play an individual microtonal note accurately and consistently, using a multiphonic fingering for example, when the same note is articulated. In articulating microtonal notes on the saxophone I have had many of the same issues that affect the articulation of those played at lower-end dynamics, and found that the same methods of articulation can be applied. [Recording 14/2.]

5.4 Developing microtonality on the saxophone

5.4.1 Precision versus ease of playing

Comments such as those made by Kientzy (2002), and Londeix (1989), regarding the saxophone's ability to play notes between the semitones with any amount of accuracy calls into question the viability of any microtonal fingering pattern charts. The inaccuracy of microtonal saxophone playing has been stressed by Weiss and Netti, who say that their fingering pattern suggestions "can vary slightly in intonation according to the particular saxophone and its key arrangement" (2010, p.14).

There are many variables on the saxophone: the instrument, the mouthpiece, the reed, and the ligature. If these all affect the pitch of microtonal notes on the saxophone, then there are many good reasons to approach microtonality on the saxophone differently, by non-pitch specific means. This could be achieved either by using unspecified microtonality, such as the false fingerings used by jazz players, or by composers writing the desired action, as in Mincek, rather than the intended outcome.

To test the influence different saxophones, mouthpieces, and reeds have on the pitch of microtonal fingering patterns, an extract from Royé's work for solo alto saxophone has been studied. Royé has detailed the changes in pitch he wants from equal temperament in steps of five, ten, or fifteen cents. He has also included fingering patterns in his score. Figure 50 shows the results obtained using the fingering patterns in Figure 49 on my usual saxophone set-up.[100]

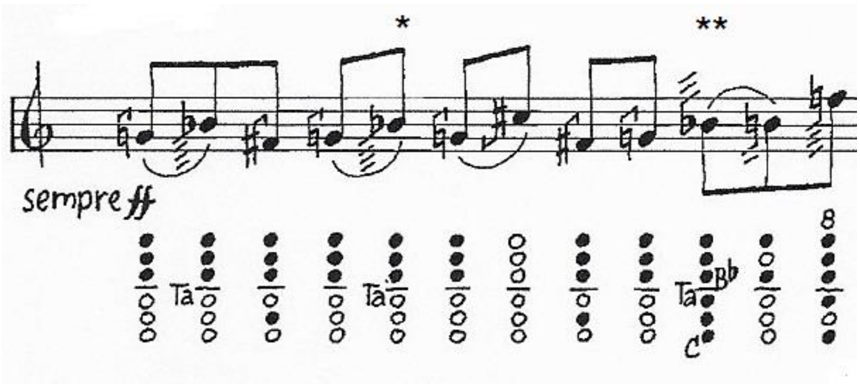

Figure 49: Royé, (*zonder titel*) - *for alto - saxophone* (n.d.) p.1, line 1

Note names	F♯4	G4	B♭4*	B♭4**	B4	C♯5	F5
Pitch change Royé	+5	+5	-40	+30	-20	-5	-40
Pitch change EAE	(+5)	-2	-31	+35	-3	-12	-21

Figure 50: Chart showing the microtonal pitch difference Royé wants and those I achieved using the fingering patterns marked in the score

[100] It is common to tune the saxophone using F♯4 and F♯5 (written pitches), the transposed notes for A3 and A4 in concert pitch. As the standard fingering pattern for this note is given in the score, but the note needed to be five cents sharp, the saxophone was tuned to A=442Hz using this note, but making sure that it was five cents sharp.

To further study the variation in pitch that results from using fingering patterns on different instruments the same extract of music was played on four different alto saxophones: Selmer series III, Selmer series II, Buffet Crampon Prestige, Yanagisawa 800. If microtonal pitches can differ slightly according to the instrument, as Weiss and Netti state, then using these fingering patterns on four different instruments would mean that the pitches are likely to change.

Note names	F♯4	G4	B♭4*	B♭4**	B4	C♯5	F5
Pitch change Royé	+5	+5	-40	+30	-20	-5	-40
Selmer III	(+5)	-2	-31	+35	-3	+12	-21
Selmer II	(+5)	-5	-43	+28	-16	-25	-32
Buffet Crampon	(+5)	+2	-37	+28	-12	-16	-45
Yanagisawa	(+5)	-4	-32	+43	-3	+1	-19

Figure 51: Chart showing the pitch change on four different saxophones

As can be seen in the chart, whilst my results are not the same as Royé on any of the saxophones tested, the difference in pitch was relatively small. To verify the extent to which other instrumental variables can affect the pitch of a note the same fingering patterns were played, using different mouthpieces on the same saxophone, the Selmer series III alto.

Note names	F♯4	G4	B♭4*	B♭4**	B4	C♯5	F5
Pitch change Royé	+5	+5	-40	+30	-20	-5	-40
Selmer S90/170	(+5)	-2	-31	+35	-3	+12	-21
Selmer D	(+5)	-3	-39	+35	-9	+5	-20
Vandoren A17	(+5)	-2	-36	+40	-6	+6	-22
Vandoren A25	(+5)	-3	-36	+38	-7	-1	-28

Figure 52: Chart showing the pitch change on four different mouthpieces

As can be seen from the Figure 52, the different mouthpieces caused next to no change in pitch. There are though yet more variables of saxophone playing, but these relate to the player: embouchure position, embouchure pressure, shape of the oral cavity,[101] breath-flow and breath pressure. These are variables which affect every single note played on the saxophone. One final experiment was done using the same extract of Royé's composition. This time, whilst playing my standard alto saxophone set-up [Appendix B1] I varied the position of my embouchure (standard, more or less mouthpiece), embouchure pressure (standard, biting or loose bottom teeth), focussed or non-focussed air, and a high or low tongue position in the oral cavity. The challenge was to see if by changing these player variables, I would be able to play the microtonal alterations to the notes that Royé wanted using the fingering patterns that he had provided.

Note names	F♯4	G4	B♭4*	B♭4**	B4	C♯5	F5
Pitch change Royé	+5	+5	-40	+30	-20	-5	-40
EAE	(+5)	+3	-40	+30	-20	-5	-40

Figure 53: Chart showing the pitch microtonal pitch difference achieved by adjusting player variables

[101] This aspect includes both tongue shape and length, and tongue position.

The results show that by adjusting player variables, I was able to achieve all but one of the pitch differences that Royé requested. This shows the great influence player variables have on the pitch produced by microtonal fingering patterns.

This experiment served to illustrate how the response of fingering patterns is not linked to different instruments, mouthpieces, or reeds, but rather to player variables. It explains how different players can play slightly different pitches using the same fingering patterns. Whilst this experiment has shown the highly personalized nature of microtonal fingering patterns, as this is due to player variables, aspects of playing which constantly change anyway, I believe that the player can then adapt and learn these variables for microtonal playing as they do for semitonal playing. This means that there is a level of transferability to microtonal fingering patterns that has been put to question by statements such as that by Royé on his score: “Different instruments (and players) will get different results. Changes will be necessary” (n.d., *(zonder titel)* – for alto saxophone).

5.4.1.1 Selecting fingering patterns

Now that the influence of different instrumental and player variables have been discussed, another matter arises which also has to do with the precision of microtonal pitches. Rather than the sometimes unintended influence of player variables, there is also the very much intended change in pitch produced by choosing different fingering patterns.

The microtonal fingering pattern charts by Caravan (1974), Paulson (1975), Schwab (1976), Londeix (1989), Delangle and Michat (1998), and Weiss and Netti (2010), each contain pitches which have been given more than one choice of fingering pattern.[102] Schwab has said that his quarter-tone fingerings were chosen “first for justness of intonation and second for ease of execution” (1976, p.7). By adding this second parameter Schwab implies that he has made ‘executive decisions’, which may or may not have derogatively affected the intonation of his chosen microtonal fingerings. Whilst there are microtonal pitches on the saxophone that have more than one fingering pattern which will sound the correct note, ‘bracketed’ keys can and do have an effect on the pitch of the note. Leaving these keys out for the ease of playing might therefore lead to a lack of precision in the pitch of the note.

To show how each change to the fingering pattern of a microtonal note can affect the pitch of it, I have collected the quarter-tone fingering patterns (for the notes between D𝄳4 and G𝄳6) from the six sources

[102] Some of these sources have written keys in brackets, and others have written two fingering patterns next to one another with and without the key(s) in question.

named above. The pitch difference between each different fingering pattern is noted in [Appendix K] and an example can be heard in [Recording 15/2.].

The charts in the [Appendix K] serve to illustrate the changes (in cents) that the different fingering patterns cause. By documenting supposed quarter-tone fingering patterns in a more exact way I hope to open up more microtonal possibilities on the saxophone.

The fingering pattern charts that use brackets to show the possible use of a key are insufficiently clear for composers. My work on comparing the fingering pattern charts in [Appendix K], has led me to develop two sorts of quarter-tone fingering pattern charts. One is for exactly pitched quarter-tones, but some notes use lots of keys to achieve this. [Appendix H2] [Recording 16/2.] The second contains easier fingering patterns that can be played faster, but the ease of playing can negatively affect the accuracy of the pitch of some notes. [Appendix H3] [Recording 17/2.]

Whilst in an ideal world fingering patterns would be both exact and easy, this is not the case for every quarter-tone note on the saxophone. It is believed that these two fingering pattern charts clarify the use of different fingering patterns to composers and other non-saxophonists.

5.4.1.2 Different keywork mechanisms and the Couesnon baritone saxophone

Working on different models of saxophone, including a Couesnon baritone from circa 1900, that does not have the keywork mechanisms of modern instruments has allow me to see how additions and changes to the keywork and its mechanisms have affected what is microtonally possible on the saxophone.

Whilst Sax's first patent for the saxophone spoke of instruments with either two or three octave keys (Dullat, 1995, pp.192-193), most subsequent early saxophones had two octave keys. The first (key *8¹*) was to be used for notes between D5 and G♯5 (written pitches) and the second octave key (key *8²*) was to be used for notes higher than this (Mayeur, 1867, pp.24-26). I have found that the second octave key makes small microtonal changes when used on other notes and thus provides yet more possibilities on this Couesnon saxophone.

Quarter-tone pitches in the lowest octave of the instrument are limited to only a few notes: D𝄲4, G𝄲4, A𝄳4 and A𝄲4. Whilst the different keywork mechanisms have opened up different possibilities to make small microtonal changes, they have also meant that many of the microtonal fingering patterns that I use on other saxophones are not possible, or do not produce the same results on the Couesnon. For example, whilst the different keywork and keywork mechanisms make G𝄲 possible, it also means that I have not been able to find any quarter-tones on notes between B♭4 and C5. Due to the two octave keys, more microtonal variations are possible in the higher register of the saxophone, but some of the fingering patterns are distinctly different from any I use to play the same pitch on other saxophones. For example, the fingering pattern for playing G𝄳5 on the alto saxophone [Appendix H2] has been given as:

8

1

2

3 C♯

5

Tf

E♭

Figure 54: Fingering pattern for G𝄳5 (written pitch)

The same note is played on the Couesnon baritone saxophone as:

8^{1}

1

2

3 B♮

6

7

Figure 55: Fingering pattern for G𝄳5 (written pitch) on the Couesnon baritone saxophone

One of the other microtonal pitches that it is possible to play on the Couesnon baritone, can be reached using two different fingering patterns. This pitch, A𝄲5, can be played using the fingering pattern for D5 with octave key *8²* [Figure 56], the resulting harmonic note that sounds is an ‘out of tune’ semitone pitch.

8²

1

2

3

4

5

6

Figure 56: Fingering pattern for A𝄲5 (written pitch) on the Couesnon baritone saxophone

As can be seen by comparing the fingering patterns in Figure 57 and Figure 58, the second fingering pattern for playing A𝄲5 has only one key different from the fingering pattern for A𝄳5.

8²

1

2

4

6

Figure 57: Alternative fingering pattern for A𝄲5 (written pitch) on the Couesnon baritone saxophone

8^{1}

1

2

4

6

Figure 58: Fingering pattern for A𝄳5 (written pitch) on the Couesnon baritone saxophone

The sole key changed between Figure 57 and Figure 58 is the octave key. The pitches A𝄳5 and A𝄲5 bracket the note (A5) at which the change between the different octave keys is made. These fingering patterns show the influence that the different octave keys have on the pitch of the notes. It is largely the microtonal pitch variations that result from using the different octave keys that have led to a Couesnon baritone saxophone version of *Nano*. This will be discussed in section 5.4.3.1.4.

5.4.2 Soprillo saxophone quarter-tone fingering pattern chart

Apart from studying how the different keywork mechanism on the Couesnon baritone saxophone has influenced its ability to play microtonally, my exploration of microtonality of other unusual saxophones has included that on the soprillo saxophone. This instrument is a relatively new addition to the saxophone family, developed by Benedict Eppelsheim.

The keywork of the soprillo has many of the mechanisms that the Couesnon baritone is missing, for example, the *p* key, the linked G♯ key, and the single octave key, but there are some essential differences between it and standard modern saxophone keywork. It does not have all the keys that these other instruments have. It has no *c3*, *c4* or *c5* keys. Neither does it have a *Tc* or an *x* key.

This has meant that I have had to come up with other solutions for the microtonal pitches when I would normally use these keys. For example, to play B𝄲4 and B𝄲5 on the alto saxophone I use fingering patterns with *Tc*, but on the soprillo I have to use entirely different fingering patterns.

2
3
4

Figure 59: Fingering pattern for B♮4 (written pitch) on the soprillo saxophone

8

1

G♯

Figure 60: Fingering pattern for B♮5 (written pitch) on the soprillo saxophone

I have found that it is possible to play C♮4 on the soprillo saxophone. This is a note that Caravan (1974), Paulson (1975), Londeix (1989), Delangle and Michat (1998), and Weiss and Netti (2010) have not included in their fingering pattern charts. On the soprillo saxophone it is done using a fingering pattern that I have not found to give successful results on other saxophones. This fingering pattern is also possible due to the small size of the instrument (spoken about in chapter 3) and I would find it difficult to use the fingering pattern on larger instruments due to the keys needed.

1

2
3 B♮ / C♯
4
5
6
7

Figure 61: Fingering pattern for C♮4 (written pitch) on the soprillo saxophone

The other note which I have been able to find a solution for is G𝄲. The difficulties of this note have already been discussed, but on the soprillo saxophone I have been able to find a fingering pattern for both G𝄲4 and G𝄲5 (the fingering patterns for these notes have been given in Figures 43 and 44).

Microtonal fingering pattern charts have not yet been documented for this relatively new addition to the saxophone family. My quarter-tone fingering pattern chart for the soprillo saxophone is in [Appendix L] and a recording of the quarter-tone scale can be heard in [Recording 18/2.]

5.4.2.1 Isaacs - *reflections, echoes and fugitive flickers which when traced evaporate*

This is a microtonal work for solo soprillo saxophone. The piece, like *Nano*, is based upon a small range of the instrument, using only the quarter-tone pitches between D𝄳5 and A♭5. This range allows me to vary the pitch using keys *4, 5* and *6*, and also the *G♯* key, *C♯* key, *B* key and *B♭* key. These last four keys are used to play the lowest notes of the instrument. Using them in *Nano* led to Mc Laughlin’s comment about key movement causing pitch changes on the alto saxophone. The soprillo, like the Couesnon baritone, does not have resonators on its pads. The keys are also much smaller on this instrument, which means that they are less difficult (take less force) to move, and are also less likely to cause changes in pitch.

One of the most interesting results of the keywork of the soprillo saxophone has been the instrument’s ability to play G𝄲, and Isaacs made use of this microtonal aspect of the instrument in his work. [Recording 19/2.]

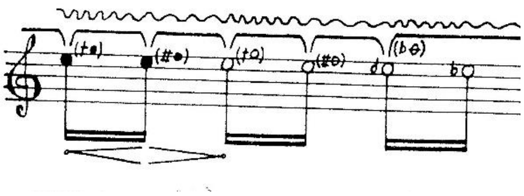

Figure 62: Isaacs, *reflections, echoes and fugitive flickers which when traced evaporate* (2011) p.1, line 4

5.4.3 Smaller and different steps

In my exploration of the microtonal possibilities of the saxophone I wanted to look beyond the quarter-tone scale, to find the outer limits of both the instrument and my own ability. I chose to do this in two ways, firstly to find out how many small microtonal steps it would be possible to find over a small range of the saxophone, and secondly by looking at a scale where the pitches are not divisions of the equal temperament tone/semitone. The first situation led to an exponential rise in the number of fingering patterns, whilst the second demanded fingering patterns that bear no relation to any used for semitone scales.

The steep increase in the number of possible fingerings on the saxophone that is a result of microtonal playing, places not only increased physical demands on the player, but also additional demands on the mental capacity of the player. This includes the need to retain all the fingerings, and also the ability to be able to use them as freely as one would the semitone fingering patterns.

Ninaus has said that because there are no open keys on the saxophone, as there are on the clarinet, it makes “playing the saxophone easier” (2011, p.135), but his study of the difficulty experienced by players of each instrument, related to standard fingering patterns. The range of the saxophone denoted by the keywork for most modern instruments is generally from B♭3 to F♯6. This gives saxophonists a basic group of 33 semitone notes for which they must learn the fingering patterns. Whilst there are some alternative fingering patterns for the semitone pitches, the fingering patterns for notes between D4 and C♯5 differ only from those between D5 and C♯6 by the addition of the octave key.

Playing quarter-tone scales as opposed to semitone scales already doubles the amount of fingering patterns that need to be learned. Redgate has spoken about the difficulties of playing quarter-tone fingering patterns.

> The advantage of fingering is that the performer can be much more precise in the production of pitches. The disadvantage is that the performer has to learn a significant number of new fingerings, some of which are very cumbersome, and require a great deal of practice to master. It has been said that a performer cannot play quarter-tone fingerings at any speed – this is nonsense – but it does take a great deal of dedication to learn fingerings sufficiently to be able to perform at speed (Redgate, n.d., *Microtonal Oboe*).

Redgate has said that the choice of quarter-tone fingering patterns that he makes, “can substantially change the performance… from one of extraordinary difficulty to one which is relatively comfortable” adding that “the psychological difference to the performer on the platform is very great indeed” (Redgate, 2007, pp.144-145). The idea of carefully picking fingering patterns, or adapting them in order to facilitate their ease of use was a matter spoken about in chapter 4, but Redgate is referring to the mental abilities of the player rather than the physical ones. If there is no choice in the available fingerings for desired pitches then additional pressure can be placed on the performer.

Bailey et al., have described the difficulties of performing in 19-tone as including not only the requirement to learn new fingerings, but also the need to inhibit existing score-reading skills, due to only one note in every octave of the scale correlating with semitonal pitches (2014, *19-EDO Playing with Conventional Clarinets*). Difficulties that they believe are “augmented still further… in higher prime-number temperaments” (2014, *19-EDO Playing with Conventional Clarinets*) such as the 31-tone scale in which I chose to work.

One answer that Bailey et al., have found to the difficulties of performing in 19-tone, is by working with a “re-tuned MIDI synthesizer”, a solution that they believe makes it “possible to articulate the notes of the pieces more readily and with less cognitive load on the clarinettist” (2014, *Augmenting MIDI Controllers for 19-EDO*). This method brings with it other issues, because as they point out, “the MIDI wind controller… can not approach the degree of subtlety available from the acoustic instrument’s century-or-two’s development” (Bailey et al., 2014, *Augmenting MIDI Controllers for 19-EDO*).

My work on extending the microtonal possibilities of the saxophone has been done on unmodified saxophones. In addressing the mental challenges that microtonal fingering patterns pose to the player my approach has been twofold. Firstly I have tried to increase my understanding of how the keywork mechanisms of the saxophone work, by studying them and documenting them in my charts. [Appendices H1, H2, and H3] Secondly, I have learnt to treat and study the microtonal fingering patterns in the same way that I would semitonal ones. This means that they are not ‘dreaded’ fingering patterns, which must be looked up in a book as they are rarely used, rather they are in constant use, and incorporated into exercises similar to those found in Londeix’s ‘Exercices Mécaniques’ (1961a, 1961b, 1965) as a regular part of my practice sessions.

5.4.3.1 The limitations of me/the player and of the instrument

5.4.3.1.1 Initial development - *Nano*

Nano by Mc Laughlin, a composition which was originally intended for performance on the clarinet (2008, p.95), is a text score which features a series of six instructions for the performer (Mc Laughlin, 2007). The directions in the text score are not specific to the clarinet and therefore allow it to be played on the saxophone.

The score asks for “a descending line in the smallest possible graduations of pitch” to be played (Mc Laughlin, 2007). This should be done within a “limited pitch range” and at lower-end dynamic levels (Mc Laughlin, 2007). I decided to use the alto saxophone, because this did not have the problems that the higher saxophones have if the hand position is altered.

The initial work done on this piece was to determine a possible pitch range in which it could be played: I wanted to find a range in which there would be a high number of microtonal pitches, and a range in which the dynamic level could be kept low. Due to the difficulties of playing microtonally between G and G♯ on the saxophone I chose to avoid a pitch range which included this area. There is also a lack of possible microtonal fingerings on the lowest fifth of the saxophone (Weiss and Netti, 2010, p.15). As discussed in chapters 2 and 3 the lower notes of the saxophone can be more difficult to play at lower-end dynamics. These were two good reasons for avoiding this range of the saxophone.

At first I believed that the pitch range between C♯5 and F♯5 would yield the highest number of microtonal fingering pattern possibilities. This is because it would be possible to use the *c1-c5 keys*, played without the *octave key*, to add to the number of pitches already available by adjusting standard fingerings for this pitch range. I was however, discouraged from using this range, due to the timbral changes which became apparent when moving between the notes playable using the *c1-c5 keys* and those played using the ‘normal’ keys. I also found it difficult to move between these two sets of fingerings quietly and quickly. Whilst this area has therefore not been my particular focus for performances of this work up until now, I intend to return to it in the future.

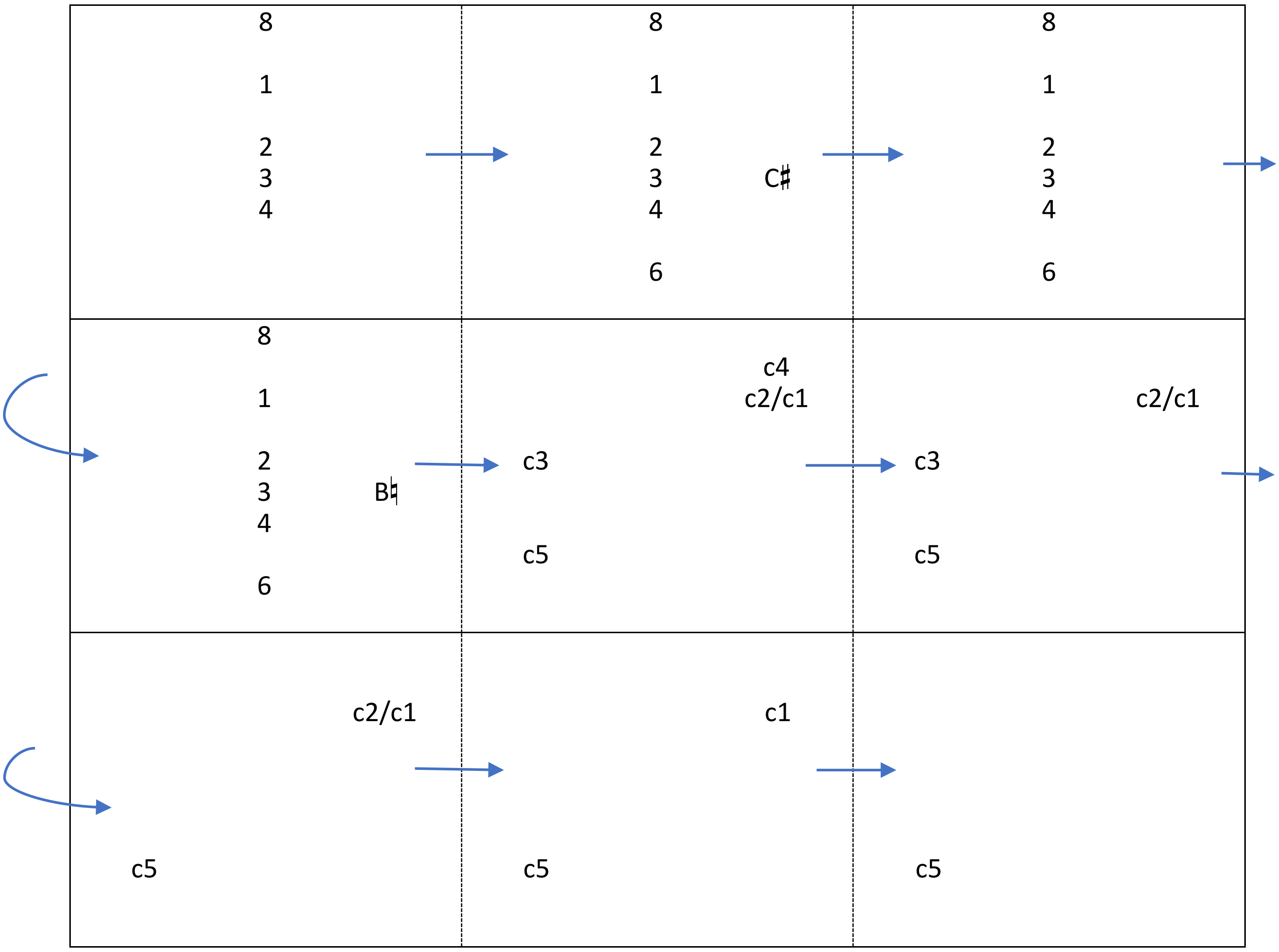

Figure 63: An example of the fingering patterns I used to play between C♯5 and F♯5 (written pitches) [Recording 20/2.]

Further research showed that the range between a slightly sharpened C5 and a slightly flattened A4 allowed for many microtonal possibilities. The ‘standard’ fingering patterns for these notes are all played using the keys operated by the left hand. Due to the changes made to the keywork mechanisms of the saxophone for the *Evette et Schaeffer* model, there are also alternative fingering patterns which can be used. These changes, which are listed in Mayeur (1896a, *Avant-Propos*), include two additional ways to play B♭4 and one new key which allowed C5 to be played using a different fingering pattern. As already discussed in chapter 4, the same changes to the saxophone for the *Evette et Schaeffer* model meant that if I included G♯4 in my pitch range, then the keys of the right hand would automatically close the G♯ key. As long as I stayed above this note it would not only be possible to use the fingering patterns for semitone pitches and their alternatives, but I would also have all the side keys, the left hand little finger keys, and keys *4,5,6,7,* and *E♭* (operated using the right hand) with which to manipulate the pitch. In this pitch range I was able to find a total of 140 different fingering patterns which allowed me to play different microtonal pitches. Of these, 26 were based around C♯5, 53 around C5, 22 around B4, 23 around B♭4 and 16 around an A4 (written pitches).

My fingering patterns made regular use of both the *Tc* and the *Ta* keys in combination with keys *4,5,6,7,* and *E♭*. In order to play all the fingering combinations that I had found, I had to use my right hand thumb to operate the *Tc* and the *Ta* keys. This digit, as previously discussed, is usually used for supporting the saxophone. Of the 140 different fingering patterns, 67 used either the *Tc* or *Ta* keys, or both. As just under half of the fingering patterns required me to use my thumb as an active digit, I decided that it would have to have a new position, hovering above these two keys. This left the saxophone without one of the two points at which it is normally held stable. The pressure from the top teeth on the mouthpiece also serves to hold the saxophone in position. I therefore applied more force than I would usually do from my top teeth to the top of the mouthpiece. In order to accommodate the use of the thumb as an active digit I also decided that sitting down would aid the stability of the saxophone. This meant that I would be able to keep the saxophone steady by holding it between my legs, and therefore the key changes would be less likely to cause the saxophone to move.

5.4.3.1.2 Learning the fingering patterns

Whilst the saxophone has the keys to play 33 different semitone pitches, and Rascher's work in the altissimo register enlarged this by an additional 18 pitches, the fingering patterns that I had developed as source material for use in *Nano* gave me a total of 140 notes for a range of around a minor third. This raised questions of both how it would be possible for me to notate the material and how freely I would be able to use it.

The text score for *Nano* means that there is no written score which shows me when to use a certain fingering pattern, therefore it is a composition which has an improvisational aspect to it. Nonetheless, the parameters imposed by the composer mean that it is not an actual improvisation. There are criteria which any performance has to strictly adhere to. Despite this, there is a certain freedom, an element of performative choice. As long as the notes played descended in pitch using steps of less than a semitone, I was free to choose where to start each phrase.

One of the main practical issues then, was how the source material I had discovered for this piece should be notated. I wanted to try to retain the aspect of performative choice in my playing, and felt that by working out specific phrases, notating, and studying them, this facet of the piece would be lost. I had documented all the fingering patterns on a large sheet of paper, going from the highest pitch to the lowest. This allowed me to have all the reference material constantly available, but did not restrict performative choice.

My first performance of *Nano* used this paper as the source material. With so many fingering patterns from which to choose I found that there was an element of dithering in my performance, and that the process of constantly moving one's focal point to find a new fingering pattern slowed the choices that I could make.

The way in which I had documented the fingering patterns meant that I only approximately knew where each semitone step began from the fingering patterns used. It also did not allow me to see what the pitch difference was between other fingering patterns. For example, if I started on the 15th fingering pattern down from C5, then at which point in the fingering patterns for B5, would the interval between these two notes reach a semitone. Due to this I decided to descend using only the smallest microtonal steps that I had found. An extract of this first version of *Nano* can be heard in [Recording 21/2.]

5.4.3.1.3 Different versions

The second version of *Nano* that I developed was a result of the composer's request that I try to play the piece using slightly larger microtonal intervals. I did this using the same basic material that I had used for the first version. This version meant that I would have to confront the issue of my notation. I would have to know at which point the interval between any two fingering patterns exceeded a semitone. This was not possible to determine from my existing documentation. I therefore decided to succumb to the enlarged pressure to make my performative decisions beforehand, rather than in the moment, and made a 'score' using my fingering patterns.

I had so many different fingering patterns at my disposal, that in the first version of *Nano* I had been able to play a complete phrase within the interval of a semitone. I then picked a different starting point and completed each subsequent phrase within a semitone. The extremely small microtonal pitch differences in the first version of *Nano* meant that I was mostly required to move only one or two keys for each note change. The larger microtonal intervals in the second version of *Nano* meant that I would have to move several keys with each step. Any mistake in the key movement could make the pitch of a note go up rather than go down. I did not want this to happen, it went against the composer's wishes and I felt that it would spoil the piece.

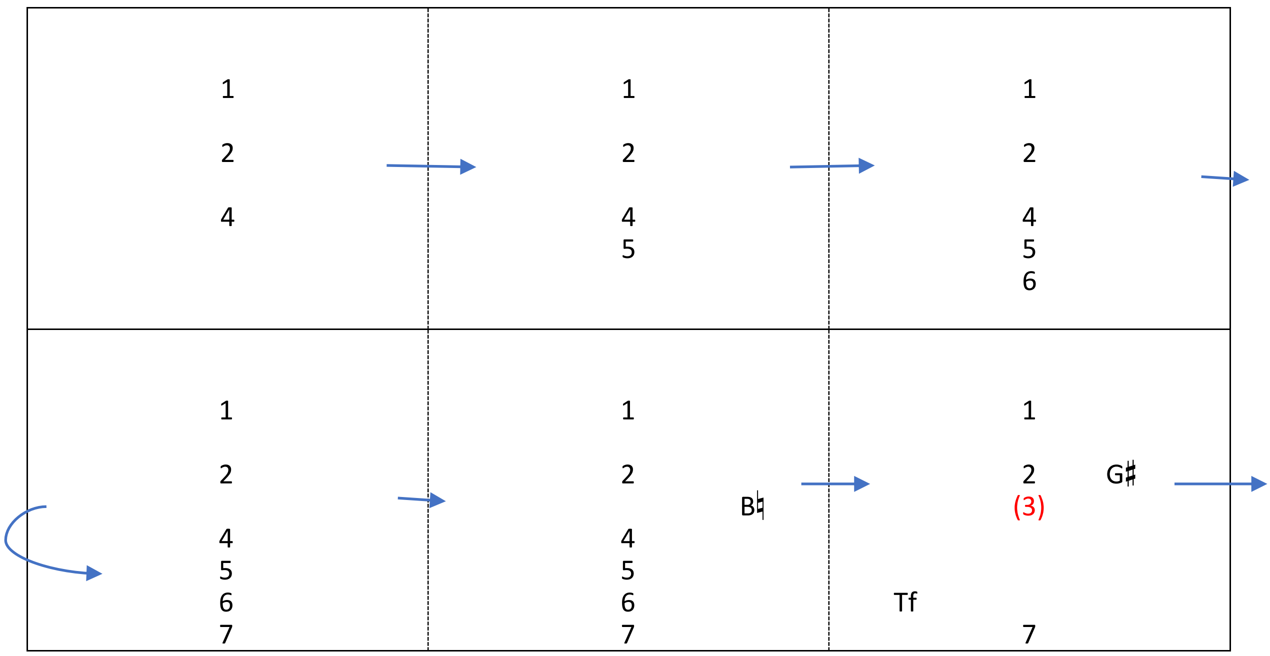

Figure 64: An example of an incorrect fingering pattern in a phrase from *Nano*. [Recording 22/2.]

The second version of *Nano* also meant that I would have to be able to move freely between the different 'groups' of fingerings that I had documented from each semitone step. By increasing the interval between each note I therefore had two choices, either make the phrases shorter, so that I could stay within the same group of microtonal variants, or be prepared to move between different groupings of notes. Each of these options would mean that I would have to move many more keys between each note than in the previous version.

The length of the phrase eventually determined that I would have to move between the different groups of microtonal fingering patterns that I had documented. I encountered great difficulty when initially trying to do this. There were some changes between different fingering patterns for these larger intervals that could not be played smoothly.

It became much more difficult for me to try to stay within the other parameters of the piece (constant pulse and dynamic level), when moving between sets of microtonal variations based upon slightly larger microtonal intervals. The difference in the level of difficulty that I encountered between the first and second versions of *Nano* surprised me. I felt as though I had found my microtonal breaking point.

I personally feel that this version of *Nano* has been my least successful to date. Mc Laughlin's programme notes for *Nano* explain his idea of inducing pareidolia through the work. The act of searching for the pattern in the music, even when there is not one, means that the listener must be able to relate to the musical material. I felt that the larger intervals in the second version of *Nano* meant that this aspect of the music was lacking as the listener lost their point of reference, and therefore had difficulty in relating each pitch to one another. A recording of the larger microtonal intervals used in version 2 of *Nano* can be heard in [Recording 23/2.].

In trying to achieve the composer's wishes for the piece, I therefore developed the third version of *Nano*. This was a mix of the smaller and larger intervals that I had used for the first and second versions respectively. The combination of both slightly larger and smaller intervals seemed, to my mind, to be more successful in generating the effect of pareidolia than just using larger steps.

As I had done for the second version, I predetermined the material to be used. I did this by notating 47 phrases of varying lengths using my fingering patterns. Rather than writing out complete phrases I used tree diagrams to notate the fingering patterns. An example of the fingering pattern tree diagrams can be found on the next page [Figure 65].

		2 Tc		
	2 Tc 3		2 Tc 3 4 5	
2 Ta	2		2 3 Ta	2 3 Ta 4 5 6
2 3 Ta	2 4 5 6		2 3 6	2 3
2 3	2 3		1 2 Tc 4 5	2 3 4 5
1 2 Tc	2 3 5		1 2 Tc 3 4 5 6	1
1 2 Tc 3	2 3 4 5			1 p Ta
				1 p

Figure 65: An example of my notation for *Nano*, version 3

This meant that I could choose to start from the top of each tree diagram, or from any point on it. This meant that I had gained back some level of performative choice. As I became better acquainted with the fingering patterns for the small microtonal steps I was able to make these decisions during a performance, but by making some of the choices beforehand I was able to avoid particularly tricky combinations of fingering patterns. [Recording 24/2.]

Redgate has spoken of the demands on “intellectual resources” when working with music which is “technically at the limits of performability” (Redgate, 2007, p.141). The difficulties I encountered when first performing *Nano* were largely due to the amount of concentration required in order to play a large combination of (relatively) new fingerings for an extended period of time without going wrong. The demand on my “intellectual resources” also meant that I ended up forgoing different levels of performative choice in versions 2 and 3 of the piece.

Kientzy touched on this problem when he said that:

> Les instruments à trous latéraux n’ont pas été conçus pour le jeu microtonique; c’est par ‘détournement’ qu’on peut le réaliser. Mais ce détournement se réalise par des doigtés qui n’ont absolument rien à voir avec les doigtés normaux, ce qui rend ce mode de jeu extrêmement difficile (c’est un peu comme si l’instrumentiste jouait d’un autre instrument) (2002, p.59).[103]

The difficulties I encountered in retaining all of the new information, and in making a choice of which fingering patterns to play, led to an extreme fatigue following each performance or practice session.

Redgate has spoken about the inadequacy of existing practice strategies when playing new music (Redgate, 2007, p.142). My study of existing material written to aid microtonal saxophone performance found a number of studies or etudes had been written: Caravan (1974), Paulson (1975), Bousted (n.d.), Murphy (2013). These all related to quarter-tone practise. Weiss and Netti’s microtonal practice tips provide methods to work on the tuning of the notes and how to deal with the change in timbre (2010, pp.15-16), but do not give advice about how to adjust the steep increase in the number of fingering patterns. As their eighth-tone scales produce fewer new fingerings, just over half as many over the entire range of the instrument, as I had found in the small range that I used for *Nano* (Weiss & Netti, 2010, pp.21-24), this is perhaps less problematic with their research.

It was when studying *Nano* that I began to develop my own practice strategies. My approach is similar to that found in Londeix’s *Exercices Mécaniques*. This is a method of study for developing finger

[103] “The instruments with holes on the side, were not conceived for playing microtonally; it is by misappropriation that we may realise it. But this misappropriation is accomplished through the use of fingerings which have absolutely nothing to do with the normal fingerings, which makes this mode of playing extremely difficult (it’s a bit as if the instrumentalist is playing a different instrument)” (Kientzy, 2002, p.59).

technique, which can be dated back to the *Exercices Indispensables* in Mayeur's *Grande Méthode Complète de Saxophones* (1867, pp.28-47). It has aided me, not only in becoming better acquainted with the different fingering patterns, but has also allowed me to try to change the muscle memory that has been formed and developed through the years of playing the semitone pitches.

Kientzy's statement, that playing microtonality on the saxophone is like playing a different instrument (2002, p.59) is, I believe, the result of a halted learning process. Since the majority of fingering patterns for the semitone pitches on the saxophone have often been learnt long before players make their first advances into microtonality, the process of learning new fingering patterns has largely stopped. This may inhibit players from easily learning microtonal fingerings. I therefore chose to treat the learning process the same as I would for any other tricky fingering pattern, and study them slowly, with a metronome, subsequently and systematically speeding up. As I have become more acquainted with the fingerings, the strain on my mental resources has decreased. This development has led to a fourth version of *Nano*.

The notation for the latest version of *Nano* has changed, and now allows the same level of performative choice as I feel that the first version did. All the 140 fingering patterns are again notated on a large sheet of paper.[104] The fingering patterns are vertically aligned in order to show me where the semitone intervals occur. This allows me to see precisely which fingering patterns I can use whilst remaining within the constraints of the piece laid out by the composer. As I have become better acquainted with the different fingering patterns, I have been able to remember which patterns are awkward. I now know which fingering patterns are difficult to combine, just as I know which of the different fingering patterns I can best use when moving to a B♭4 from any other note. The source material for *Nano* version 4 can be found in [Appendix M]. [Recording 25/2.]

5.4.3.1.4 Controlling the impact of key movement and resonators

Whilst working on *Nano*, I have encountered some issues surrounding the movement of keys. Whilst I have already discussed the problem this brings when playing at lower-end dynamics (chapter 3), there were additional problems in *Nano*, playing at lower-end dynamics whilst making small microtonal changes to pitch. In one of the first rehearsals together, Mc Laughlin noted that the movement of closing some of the keys caused a dip in the pitch of the note. The saxophone, like the bass clarinet, has closed keys (pads). Some of these, particularly for the lower notes, are quite large in size. Whilst this effect was minimized in the first version of *Nano*, it became more apparent in subsequent versions. This was due to the multiple key movement needed to play the slightly larger

[104] In [Appendix M] this has been split across eight pages, which can be placed next to one another.

microtonal intervals that the composer requested. Whilst I have considered moving to a different pitch range on the alto saxophone, the keys that I would use to microtonally adjust the pitch remain more or less the same. I have also considered performing *Nano* on a smaller saxophone, with smaller keys, in order to minimise the effect of key movement on pitch, but this change would bring with it another issue: the inability to free the right hand thumb from its supporting role to aid with complex fingering patterns.

In trying to address the dips in pitch in *Nano*, I began to question whether this phenomenon was made by the size of the keys, or by the resonators on them. I felt that due to their reflective nature, the resonators might enhance the movement of the keys and therefore also enhance the pitch change noticed by Mc Laughlin. I decided to experiment with playing *Nano* on the Couesnon baritone saxophone. As some of the now standard side keys are not on this instrument, it has not been a case of transferring the fingerings I found for playing *Nano* on my alto saxophone, to the baritone. What began as an experiment into the effect of resonators on the microtonal pitches, led into a study of the differing possibilities the instrument provides for microtonal work due to the different keywork on the baritone. The different keywork suggests that a new pitch range should be chosen when playing *Nano* on the Couesnon baritone saxophone. As the Couesnon baritone also lacks some of the side keys that I used to alter notes, the range that I used on the alto saxophone is no-longer possible. The new range which is suggested by the keywork on the Couesnon baritone saxophone is in the upper octave of the saxophone rather than in the lower octave. The new range ensures that the microtonal pitch variations that result from employing the two octave keys can be used. Finally, as the Couesnon baritone is able to make microtonal pitch changes between G and G♯, these notes can be included in the range. [Recording 26/2.]

5.4.3.1.5 Summary and conclusions

To conclude, I see the work which I commenced for *Nano* as the starting point for my development of microtonality on the saxophone. It has been this work which has allowed me to think outside the box about the way of playing the saxophone. It has also been very largely due to this piece that I have discovered the wide range of microtonal options available on the saxophone. *Nano* therefore allowed me to develop my microtonal work on the saxophone and still provides a basis for much further exploration of the microtonal saxophone.

5.4.3.2 31-tone

Referring back to Londeix's statement that it is not possible to play all third-tones, quarter-tones, and fifth-tones on the saxophone (1989, p.24), conclusions reiterated by Delangle and Michat (1998, p.177), I began to wonder what else was microtonally possible on the saxophone. The only microtonal scale that either source had documented was the quarter-tone scale. Neither Londeix, nor Delangle and Michat had shown any attempts at documenting third-tones or fifth-tones on the saxophone despite making such a sweeping statement. The results of my research into playing third-tones and fifth-tones on the saxophone can be found in [Appendix N].

Although Londeix, and Delangle and Michat have spoken about third-tones and fifth-tones, such divisions of the tone and octave are not common. They are, though, both close to two more commonly used equal temperament scales. The third-tone scale provides 18 steps in each octave, and is therefore close to the 19-tone equal temperament scale. The fifth-tone scale gives 30 steps in each octave, close to the 31-tone equal temperament scale.

In 2014, as part of the Huygens-Fokker concert series at the Muziekgebouw in Amsterdam, Henri Bok and I (duo hevans) presented a concert of microtonal music together with Ere Lievonen on the 31-tone equal temperament Fokker organ, which is housed in the building. None of the works documented by the Huygens-Fokker foundation use either bass clarinet or tenor saxophone (Stichting Huygens-Fokker, n.d.) and therefore this concert was, to our knowledge, the first in which our instruments used the 31-tone scale. Whilst some points of the 31-tone scale are close to twelve-tone equal temperament intervals, none is identical other than the unison.

Initially Bok and I used the Scala tuning programme to approximate which pitches of the 31-tone octave tuning we would be able to play on our respective instruments (Scala, n.d.). Following this initial investigation we decided upon a workable range for each of our instruments in which the majority of the 31-tone notes could be played. The range for the tenor saxophone was between D4 and F6 (written pitch). Due to the lack of suitable keys with which to microtonally vary the pitch I decided to exclude the lowest notes of the instrument, although this range is smaller than the fifth of the saxophone's range that Weiss and Netti state that microtones are not possible in (2010, p.15).

The smaller intervals of the 31-tone scale and the lack of meeting points between the 31-tone and the semitone scale of the saxophone meant that there was frequently only one fingering that would sound the exact required pitch, a problem that has also been documented by Bailey et al., when working in 19-tone equal temperament on the clarinet (2014, *19-EDO Playing with Conventional Clarinets*). As Bok and I were working with the 31-tone Fokker organ, there was no room for choosing inexact pitches due to their ease of execution. Both Bok and I had some notes that we were unable to resolve the tuning of through any combination of fingering patterns. For the tenor saxophone these notes were: D♯4, E𝄳4, G♭4 and F5.[105] Work by the Physics' department of Michigan Technological University has determined that the ear can hear pitch differences of less than one Hertz (Michigan Technological University, n.d.), therefore in our first rehearsal we confirmed the notes in this range with the organ and made any necessary changes. A 31-tone fingering pattern chart for the tenor saxophone can be found in [Appendix P] and the scale can be heard in [Recording 27/2.]

5.4.3.2.1 Notation

We were unable to find any suggestions for how transposing instruments should be treated when playing in 31-tone. Having studied the existing 31-tone methods of notation for the organ, we decided that given the limited rehearsal time, the simplest notation for both Bok and myself was one that was in some way familiar to us from our previous microtonal work. I therefore devised a system of notation that combined the sharp and flat signs with the well-known symbols for quarter-sharp, quarter-flat, three-quarter sharp and three-quarter flat. This provided us with a notation that was relatively simple to adjust to, as they were symbols that we recognised from semitone and quarter-tone music.[106] The chart which I made to help the composers with the transposition shows the pitch names for the organ and the transposed pitch names for B♭ instruments. [Appendix O]

5.4.3.2.2 Uijlenhoet - *Radio Istria*

Bok and I premiered seven new compositions in this concert, one of which was *Radio Istria* by Uijlenhoet. The piece is for a quartet comprising bass clarinet, tenor saxophone, Fokker organ and live electronics, which was performed by the composer.

As we were working with the 31-tone Fokker organ the fingering patterns that we had to choose in order to play exactly the right pitch negatively impacted upon the speed at which we could move between different notes. The fingering patterns, whilst producing the correct pitches, frequently involved moving several keys for each pitch change. In the process of working through the score we discovered that whilst individual notes were possible, some of the changes between notes were not practicable. Working together with Uijlenhoet we addressed these areas of the piece, and found that mostly, by simply swapping the bass clarinet and tenor saxophone parts we were able to resolve these issues.

[105] These pitches are given in my 31-tone notation, please refer to [Appendix O] for an explanation.
[106] My use of these standard symbols obviously makes this method of notation not suitable for use in a composition in which 31-tone is combined with semitone or quarter-tone pitches.

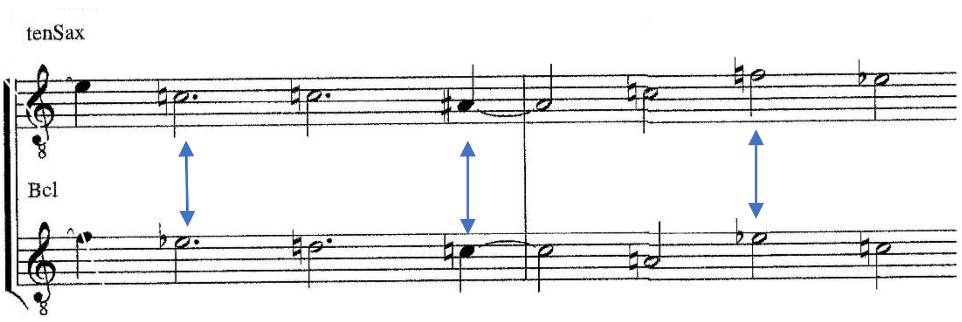

Figure 66: Uijlenhoet, *Radio Istria* (2014) bars 7-8, showing how notes in the tenor saxophone and bass clarinet parts were swapped

Weiss and Netti have said that “fingering combinations can be very difficult for microtones” (2010, p.14), but have not detailed why they are difficult. Both Bok and I came up against issues of physical and mental nature when performing this work. The mental issues posed were largely the ones that I had encountered when playing *Nano*: learning and using a new set of fingering patterns. There was even less room for dithering in an ensemble setting. Due to the short period of time between receiving the scores and the concert, and because I believe that it takes time to become truly familiar with such fingering patterns, some of the fingering patterns were written in the score.

The physical difficulties that I experienced playing Uijlenhoet’s composition were greater than I had for *Nano*. We performed Uijlenhoet’s piece seated so that I could use the right hand thumb as an active digit, but I found that there was a greater need for the right hand thumb to stabilize the instrument when playing tenor than when playing alto saxophone. I had played *Nano* on the alto saxophone, and held the instrument between my legs, but although I normally also play the tenor saxophone between my legs, I was unable to hold the instrument in the same way. The larger keys, and the greater distance between keys, meant that my ability to move between fingerings was impaired, when compared to my abilities on the alto saxophone, and that the key combinations that I was able to reach (with the size of my hand) was reduced.

The 31-tone pitches presented a particular difficulty, and in order to be able to play them I had to use a technique which I have previously discussed in relation to G♮. The problem was due to the need to half shut a key. I have previously discussed the difficulties of playing a G♮, which entails half opening the *G♯* key and half closing key *4* (chapter 4). Half closing a key was a technique that I had to further develop in order to play in 31-tone on the tenor saxophone. I effectively had to find the ‘biting point’ of the spring for this key. This technique was used for seven of the pitches in the range. On each occasion the key in question was key *6*. Despite this being operated by the ring finger of the right hand, which I feel is probably my weakest finger, I did eventually manage to control it with practise.

5.5 The microtonality of extended techniques

5.5.1 Key movement

5.5.1.1 Key percussion

My exploration of the microtonal aspects of extended techniques started when working with Zych on *Kontr-atrofia/Contr-atrophy* (2012). This was due to the incorrect information about the sonic results of *c5* key percussion documented in Londeix (1989, pp.75-80). Since then I have looked to document the microtonality that can result from using extended techniques.

The notation which Londeix used to document this technique includes both the fingering pattern used and the sound supposedly produced (1989, pp.76-80).

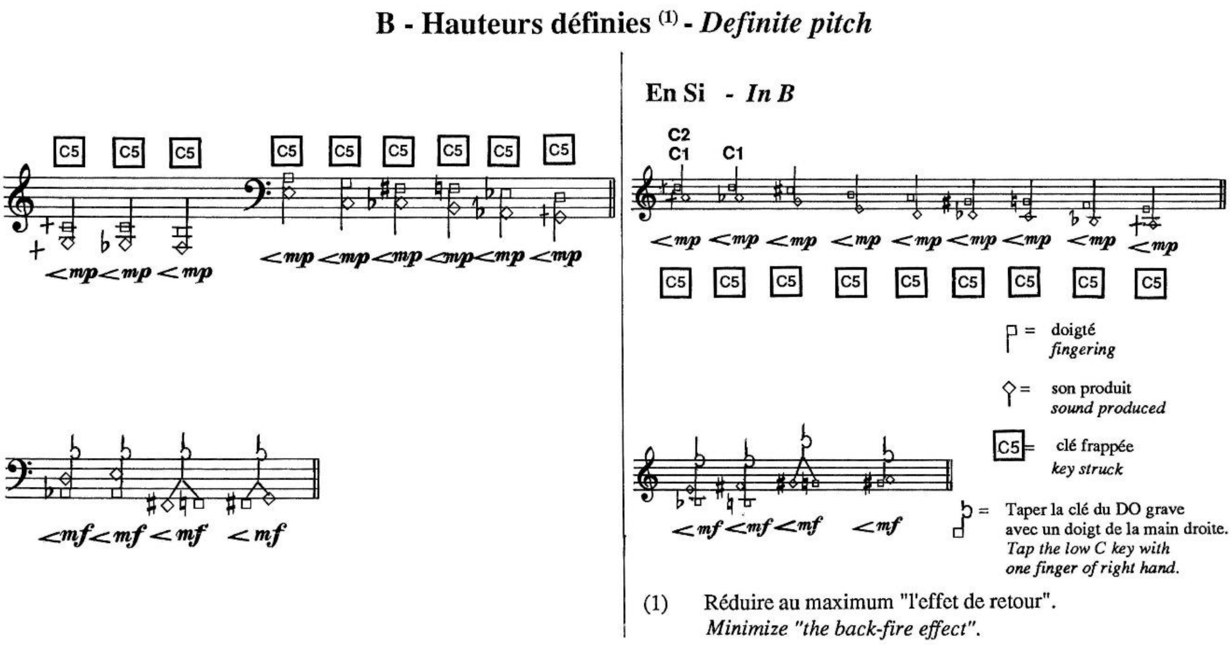

Figure 67: Londeix (1989, p.78) *c5* key percussion

As Figure 67 shows, Londeix thought that by using the *c5* key to play key percussion, different pitches would sound from the fingering pattern which was used. I have come to the conclusion that Londeix's pitches are incorrect, as I have not been able, with either a closed or open embouchure, to come anywhere near the pitches that he has associated with each fingering. When playing a key click using the *c5* key with a closed embouchure I have found that the result is only minimally, or microtonally, different from the fingered pitch. The sonic results using *c5* key percussion to play Figure 68 can be heard in [Recording 28/2.] (open embouchure) and [Recording 29/2.] (closed embouchure).

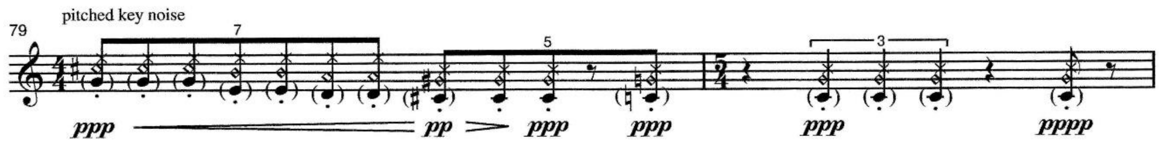

Figure 68: Zych - *Kontr-atrofia/Contr-atrophy* (2013) p.11, bars 79-80

Fingered pitch	C♯5	B4	A4	G♯4	G♮4
Londeix sounding pitch	G4	E4	D4	D♭4	C4
EAE closed embouchure	D♮↓5	B𝄲4	A♯↓4	G♯↑4	G♮↑4
EAE open embouchure	F♯↑4	E𝄳4	D𝄳4	C4	B3

Figure 69: Chart to show the pitches sounded by *c5* key percussion.

This meant that I had to ‘translate’ the *c5* key percussion to keys that actually produced the sonic results that the composer wanted. I initially looked at the possibilities of using a different side key, as I felt that this would best be in keeping with the technique that the composer had wanted. This was not possible, as I was not able to find a solution which would give the correct pitches. I therefore had to use the palettes, keys *1-6*. I have already discussed my choice of fingering patterns and keys used to play the key percussion with (section 3.4.2), but not the development of microtonality on the saxophone which came with this search for an alternative.

Weiss and Netti have said that there is a “clearly audible pitch content” to key percussion (2010, p.176). They have said that when playing key percussion with a closed embouchure the pitches of the lowest octave of the saxophone correspond to the fingered pitch, and that when playing key percussion with an open embouchure a similar shift in pitch occurs as when using open slap-tonguing (2010, p.177). What they have not mentioned is that the pitch of the note that sounds from each fingering pattern is also microtonally changed in pitch with each different key that is used to play the key percussion, whether the embouchure is open or closed. Weiss and Netti have also said that the octave key “produces no change in the result” (2010, p.176), but I have discovered that this is not true, as microtonal pitch changes occur on many of the notes when the octave key is also used.

This source of microtonal saxophone playing has never before been documented. The results of my search can be found in the appendix, where I have documented the sonic results of each finger pattern, played using keys *1-6* (clé) to sound the key percussion. This has been done with an open and a closed embouchure and with and without the octave key for each fingering pattern. [Appendix G] An example of the sonic results can be heard on [Recording 30/2.].

5.5.1.2 Independent hands and independent digits

"Left hand against the right hand", which entails the independent movement of the hands when playing the saxophone, is a technique spoken about in Weiss and Netti (2010, p.168).

In *Kontr-atrofia / Contr-atrophy* (2012) Zych uses the left hand against the right hand technique. To do this he has retained standard fingering patterns in one hand, whilst a finger from the other hand has been added and taken away. He has only applied this technique to the palettes (keys *1-6*).

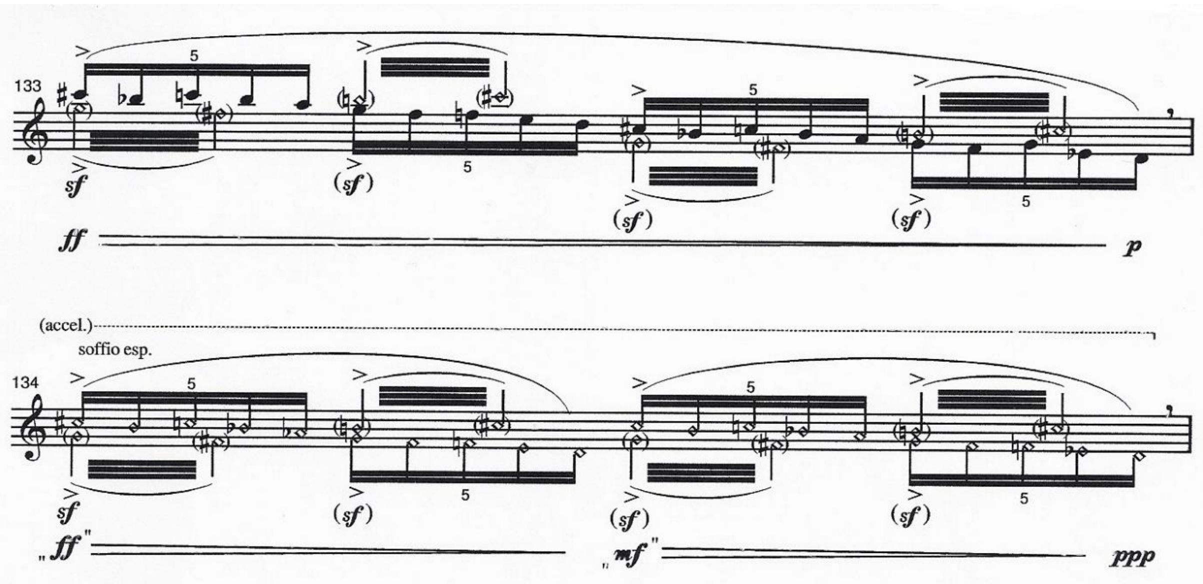

Figure 70: Zych, *Kontr-atrofia/Contr-atrophy* (2013) p.17, bars 133-134 [Recording 31/2.]

Mincek's work which adds additional keys to fingering patterns has been discussed in section 5.2, and the pitches which result from adding keys to standard fingering patterns have been documented in [Appendix I]. In *Kontr-atrofia/Contr-atrophy* Zych has chosen to add additional keys to fingering patterns both one at a time, and also two at a time. Rather than the keys remaining pressed down, as in Mincek, Zych trills using the additional keys.

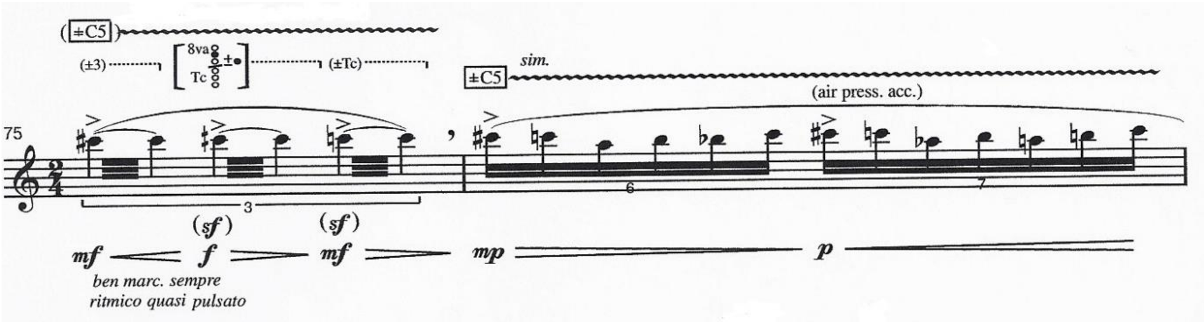

Figure 71: Zych, *Kontr-atrofia/Contr-atrophy* (2013) p.11, bars 75-76 [Recording 32/2.]

Zych has taken the idea of independent movement one step further, and applied this to individual digits. As the exact opposite of the work in Mincek, where keys are added to distort the notes played, Zych has extended his dissolution of normal fingering patterns into the use of fingering patterns where individual fingers/keys are removed.

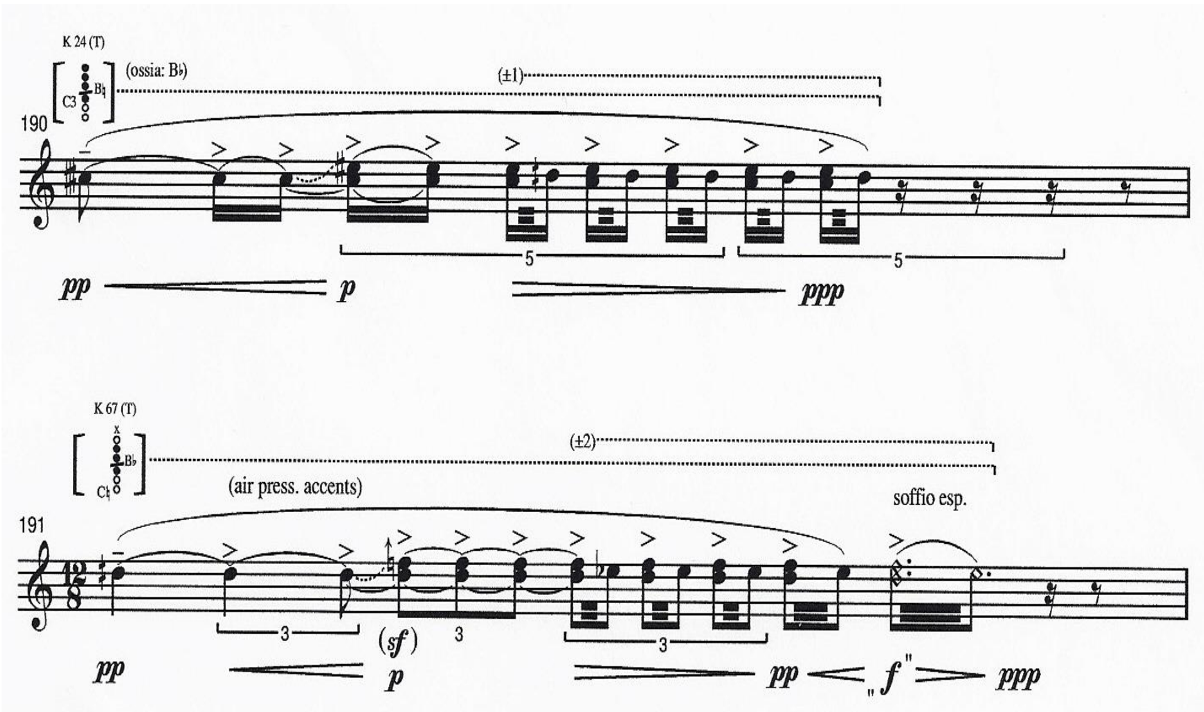

Figure 72: Zych, *Kontr-atrofia/Contr-atrophy* (2013) p.22, bars 190-191 [Recording 33/2.]

As can be heard, taking away a finger from an existing fingering pattern changes the pitch of the note. The sonic results of removing each possible finger (palette keys only) from the fingering pattern can be found in [Appendix Q] and an example can be heard in [Recording 34/2.].

5.5.2 Slap-tonguing

Weiss and Netti have said that slap-tonguing on the saxophone is “especially effective in the lower range” to approximately C♯5 (written pitch), and that “the octave key has only very limited effect on pitch” (2010, p.144). I have found that slap-tonguing can be successfully applied to notes higher than C♯5 (written pitch). Whilst the octave key does not work in the usual fashion, to raise the pitch of the note by one octave, for all fingering patterns, it does have an influence on the pitch of the note which is slap-tongued. The results of this can be found in [Appendix R] and heard in [Recording 35/2.].

Zych has also applied his technique of independent digits to the slap-tonguing in *Kontr-atrofia/Contr-atrophy*. The basic fingering pattern for bars 135-136 is a B♭3. By removing keys *4*, *5* and *6* in turn, the pitch of the notes that the slap-tonguing produces is microtonally changed.

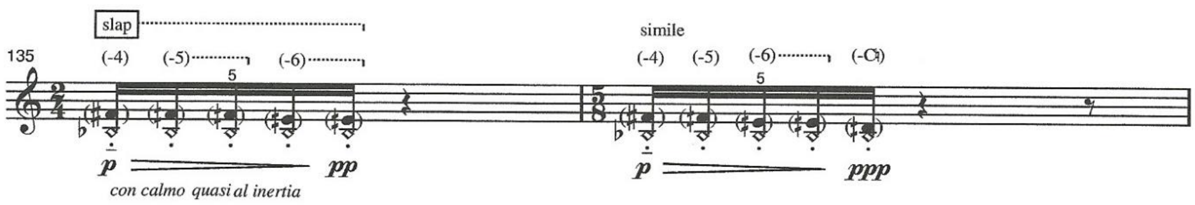

Figure 73: Zych, *Kontr-atrofia/Contr-atrophy* (2013) p.17, bars 135-136 [Recording 36/2.]

Because the B♭ key is constantly held shut by the little finger of the left hand, and because the little finger of the right hand at times also moves independently from the other fingers on the hand, the changes in the fingering pattern in the right hand, which roughly correlate to the semitone and quarter-tone pitches (F♯4, F𝄲4, E𝄲4 and D𝄲4 – written pitches), do not sound their exact pitches.

5.6 Summary and conclusions

Whilst previous literature has concentrated on documenting further microtonal divisions of the twelve-tone equal temperament scale, for example quarter-tones or eighth-tones, my work has expanded beyond these divisions of the scale. Pieces such as *Nano* and *Radio Istria* have illustrated my personal expansion of the microtonal possibilities on the saxophone beyond what was previously thought viable. This work has resulted in many hitherto undocumented microtonal fingering patterns for the saxophone which I have documented in the appendices.

Showing that closed-pad instruments such as the saxophone and the bass clarinet are able to adjust to play in different microtonal scales has opened up the way for further investigation of this music on these instruments. Future developments of this work could include the documentation of the possibilities for the saxophone to play in 19-tone or 41-tone. The alternative possibilities evidenced on saxophones which have different keywork mechanisms, such as the soprillo or Couesnon baritone, show a route to even greater expansion of the microtonal possibilities of the saxophone.

By adapting existing playing techniques, by using different members of the saxophone family, by documenting the microtonality in extended techniques and by finding the fingering patterns to allow the saxophone to play in different microtonal steps I have been able to propose new models and techniques for microtonal saxophone playing.

Chapter 6 Conclusion

My research has developed from real-world performing situations and a desire to extend the range and the precision of saxophone technique. It set out to discover if there were other methods for playing at lower-end dynamics on the saxophone and other models and techniques for playing microtonality on the saxophone.

Study of existing techniques for lower-end dynamics on the saxophone showed that they are not suitable for use in many common musical situations as they actively limit how else the saxophone can be played when using them. Previously used techniques also restrict other aspects of playing the saxophone when used in combination with extended techniques. After examining the saxophone and its component parts alongside existing techniques for playing quietly, and how these interact within normative and extended contexts, I propose that the one area for exploration of lower-end dynamics which is not detrimental to other aspects of playing, is breath control.

By learning to adjust the amount of air that I blow into the saxophone, I discovered that it is possible to play at lower-end dynamics on the saxophone, and that this technique does not have the same implications or unwanted influences on other basic aspects of playing or extended techniques.

The research presented here shows that I have been able to develop a new technique for playing at lower-end dynamics on the saxophone. This has allowed me to play quieter than I could before.

My technique allows me to play for lengthy periods of time without causing any unwanted side-effects such as fatiguing the embouchure muscles. It has meant that I am able to integrate lower-end dynamics into a much larger range of dynamics. Unlike the existing subtone techniques for playing quietly on the saxophone, it has also meant that I can continue articulation at this lower-end dynamic level. The integration of extended techniques is also possible: slap-tonguing, multiphonics, and altissimo and higher notes that were not able to be played using subtone techniques are now open for integration when playing at lower-end dynamics levels.

The case studies of compositions by Mc Laughlin, C. Fox, Isaacs, Pisaro, and Zych, have shown that my technique for playing at lower-end dynamics has allowed the saxophone to play in a manner in which it would not be possible if using the existing subtone techniques.

The results of my research and development of a new technique for playing at lower-end dynamics on the saxophone can be heard in the numerous recordings which accompany this thesis. By developing this technique I have shown that I have been able to reach a new level of extremely quiet playing on the saxophone.

The second part of this thesis examines microtonality and the varying degrees of specificity possible on the instrument. Londeix's *Hello! Mr. Sax* (1989), the saxophone method book which had first peaked my interest in playing intervals other than semitones appeared to actively discourage any microtonal steps other than the quarter-tone. The chapter heading in the contents page was "1/3, 1/4, 1/5 of a tone", but on turning to page 24 the reader is immediately confronted with a statement which says that these intervals are not all possible. It also says that the fingering patterns provided on the following pages of the book are the "only ones that can create intervals of smaller than a semi-tone (*sic*)" on the saxophone in the given range.[107] Why could the saxophone not play these other divisions of the scale? The later study of other documentation of microtonal saxophone playing showed that all but one of the existing methods had not taken any microtonal steps aside from the quarter-tone. Why was it not possible to develop this way of saxophone playing? What was stopping the development and what would be the results and the ramifications of playing smaller or different microtonal divisions of the scale?

In my microtonal, and perhaps also saxophonistic innocence, I may have circumvented some of the issues that had previously stopped this manner of saxophone playing from developing. In my work I have taken the attitude that if re-allocating a digit to a different use would mean that I would be able to play microtonally, then quite simply, that is what I felt should be done.

The different timbre that results from using microtonal fingering patterns is not that of standard classical saxophone playing, but neither do I choose to play with the constant vibrato that is used in this style of playing. Rather than saying that microtonal saxophone playing is not possible because it changes the instrument's timbre, I believe that this adds a new level of possibilities to the sound pallet of the saxophone.

My research on proposing new models and techniques for microtonal saxophone playing has shown that by changing current playing techniques and developing new fingering patterns, the saxophone is capable of playing in different microtonal steps. Rather than setting microtonal limitations, as Londeix has done in *Hello! Mr. Sax* (1989) it has shown that the saxophone has a great adaptability to microtonal playing.

My work on clarifying the accuracy of previous quarter-tone work on the saxophone will hopefully enlighten composers about the possibilities and potential difficulties of microtonal saxophone playing. My work on showing the transferability of microtonal fingering patterns has opened up the numerous fingering pattern charts found in the appendices for use by other players and on other instruments.

[107] The range which Londeix gives, A♯1 to F♯6 (concert pitch), is covered by six different saxophones (1989, p.24).

The accuracy of my work has shown, contrary to Kientzy's statement that the saxophone cannot play exact quarter-tones, that these, and other microtonal steps are possible, and with a level of accuracy that was previously not thought achievable.

By documenting the microtonal aspects of different extended techniques (slap-tonguing, key percussion and multiphonics), it is hoped that I have paved the way for these extended techniques to be integrated into microtonal playing. My work playing Zych's *Kontr-atrofia/Contr-atrophy* (2012) has shown that it is now possible to utilize these extended techniques for their microtonality rather than simply as an extended technique.

The pieces that I have played, and discussed here have shown that the saxophone can play in different microtonal settings, including with instruments built for microtonal playing.

It is hoped that the research I have presented here could lead to a new level of saxophone performance and, as saxophonists master my technique for playing at lower-end dynamics on the saxophone and learn the fingering patterns that I have documented in the appendices, to new compositions for the saxophone.

Whilst researching new methods for playing at lower-end dynamics on the saxophone and for new models and techniques for playing microtonally on the saxophone I have worked with a number of composers. The results of only some of the collaborations that I have worked on during the period of research have been discussed here. Other collaborations have led to the remaining works in the 31-tone concert given in May 2014, or the composition for soprano saxophone ensemble by Saunders. The former allowed me to show the microtonal capabilities of the saxophone to the audience and to the fellow microtonal musicians who performed in the concert, whilst Saunders' *eight panels* (2012) was performed at the 2012 World Saxophone Congress together with saxophonists from around the world. This permitted me to share my ideas for a new technique for playing lower-end dynamics on the saxophone with eight colleagues, and to allow many other saxophonists to hear the results of such a technique.

Whilst this research represents a clear step forward with regard to technical possibilities, there is still scope for further refining the techniques presented here, especially in relation to the soprillo saxophone. Microtonal fingering patterns and scales might be developed for different saxophones and which extend to a wider pitch range. However, it is hoped that the work achieved and presented here will benefit both performers and composers such that the saxophone will continue to be an instrument which is extended and which extends, and for which new repertoire will be championed which challenges perceived saxophone orthodoxy.

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Extending Techniques: Developing the saxophone's capacity for lower-end dynamics and microtonal playing.

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A thesis submitted to the University of Huddersfield
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Volume II of III

Volume II Page

Appendices

All the note names in the appendices are the written pitches for the specific saxophone referred to (soprillo, alto, or tenor). The exception to this is the 31-tone notation comparison chart in Appendix O, in which concert pitch note names are compared with a system for B♭ transposing instruments.

Some of the appendices have measured pitch in cents difference from equal temperament. The results documented in that way are the average measurements from ten repetitions. They have been measured using a Peterson strobe tuner. The scales allow for ten percent fluctuation, except for Appendix H3, the easy quarter-tone scale, which uses fingering patterns which are less precise in their pitch but easier to move between.

Greyed out fingering pattern tables indicate that no possible solution has yet been found for that pitch.

Appendix A: List of interviews

Marie-Bernadette Charrier (Bordeaux, France. June 23, 2010)

Claude Delangle (Paris, France. November 30, 2012)

Philippe Geiss (Tempe, United States. March 17, 2012)

John Harle (Kent, United Kingdom. October 11, 2012)

Frederick L. Hemke (Tempe, United States. March 17, 2012)

Michael Ibrahim (Tempe, United States. March 18, 2012)

Johan van der Linden (Utrecht, the Netherlands. April 18, 2011)

Jean-Marie Londeix (Bordeaux, France. June 24, 2010)

Timothy McAllister (Tempe, United States. March 19, 2012)

Leo van Oostrom (Amsterdam, the Netherlands. March 23, 2012)

Eugene Rousseau (Tempe, United States. March 18, 2012)

John Sampen (Tempe, United States. March 17, 2012)

Taimur Sullivan (Tempe, United States. March 18, 2012)

Marcus Weiss (Graz, Austria. February 7-13, 2011).

Appendix B1: List of equipment

Standard set-up

Alto: Selmer, Paris series III. Selmer S90 170 mouthpiece. BG Super Revelation ligature. D'Addario Grand Concert Select reeds, strength No.3.

Tenor: Selmer, Paris series III. Vandoren T20 mouthpiece. Vandoren Optimum ligature. D'Addario Grand Concert Select reeds, strength No.3.

Other equipment used

Saxophones:

- Benedict Eppelsheim soprillo saxophone
- Couesnon baritone saxophone
- Selmer, Paris series II alto saxophone
- Yanagisawa 800 alto saxophone
- Buffet Crampon Prestige alto saxophone

Mouthpieces:

- Selmer D (alto)
- Vandoren A17
- Vandoren A25
- Meyer 7 (alto)
- Lawton 6*B (alto)
- Hans Zinner (soprillo)
- Vandoren B25

Reeds:

- D'Addario Grand Concert Select reeds, strength No.2.5 and No.3.5 (alto)
- Vandoren Traditional (blue box), strength No.1.5 and No.4 (alto)
- Hahn reed, strength No.3 (alto)
- D'Addario Grand Concert Select reeds, strength No.3 (baritone)
- D'Addario Grand Concert Select reeds, strength No.3 German clarinet (soprillo)

Appendix B2: Details of recording

Microphone placement

The recordings were made sitting. The microphones were placed on a stand at a distance of 1.2 metres from the chair, and at a height of 1.4 metres. The distance between the microphones and the player stayed constant throughout the recording session.

No dynamic processing was used in the studio.

Microphones used

A pair of DPA 4090 microphones.

Test track

[Recording 1/1.] is a test track which should be used to determine an appropriate volume level to listen to the recordings. The track contains 5 notes played at different dynamic levels: ***mf***, ***ff***, ***mf***, ***mp*** and ***pp***. This allows the listener to find a suitable volume level, for the examples of playing at lower-end dynamics, and those of playing at louder dynamic levels. The volume level should be set so that the louder notes can be listened to without causing discomfort, whilst the ***pp*** note is just audible. The recordings should ideally be listened to in a low ambient noise environment.

Appendix C1: Keywork diagram for a Selmer, Paris series III alto saxophone

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix C2: Keywork diagram for a Couesnon baritone saxophone

	8^2 / 8^1	
	1	c2 / c1
	2	G♯
	3	B♮ / C♯
Ta	4	
	5	
	6	
	E♭ / 7	

Key *8^1* is to be used for notes between D5 and G♯5 (written pitches) and key *8^2* is to be used for notes A5 and higher.

Appendix C3: Keywork diagram for an Eppelsheim soprillo saxophone

	8	
	1	c2 / c1
	p	
	2	G♯
	3	B♮ / C♯
Ta	4	B♭
	5	
Tf	6	
	E♭ / 7	

Appendix C4: Keywork diagram for a Selmer, Paris series III tenor saxophone

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix D1: The player findings of an investigation into using different mouthpieces for playing at lower-end dynamics (alto)

The five ebonite mouthpieces used in Appendix D1 were played using my standard BG Super Revelation ligature. The Lawton mouthpiece was played using the ligature which is part of the design. Whilst the Lawton ligature is removable, the BG ligature is too large for use on the slimmer Lawton mouthpiece.

Mouthpiece facing curves were measured using the Reed Geek plaque and gauge set.

Name of mouthpiece	Material of mouthpiece	Style of mouthpiece (chamber shape/ mouthpiece facing curve in millimetres)	Recording No.	Findings/Comments
Selmer S90/170	Ebonite	Square/21	[Recording 7/1.]	Has a tendency to shut off/stop sound when played at lower-end dynamics.
Selmer S80/D	Ebonite	Square/20	[Recording 8/1.]	More air noise present than S90/170.
Vandoren A17	Ebonite	Round/15	[Recording 9/1.]	Has same tendency to stop sound when played at lower-end dynamics as S90/170.

Vandoren A25	Ebonite	Round/22	[Recording 10/1.]	Both Vandoren mouthpieces were found to be easier to play at lower-end dynamics than the Selmer mouthpieces. The easiest of the ebonite mouthpieces to play quietly.
Meyer 7	Ebonite	Elliptical/20	[Recording 11/1.]	Prominent air noise, stuffy, difficult to play quietly without changing embouchure position and pressure.
Lawton 6*B	Metal	Round/24	[Recording 12/1.]	This was the easiest of all the mouthpieces tried to play at lower-end dynamics. Less air noise than either the S80/D or A25, the two more open ebonite mouthpieces.

Appendix D2: The player findings of an investigation into using different strength reeds for playing at lower-end dynamics (alto)

These reeds were all tested on a Selmer S90/170 mouthpiece and using a BG Super Revelation ligature.

Reed type	Strength No.	Findings/Comments
D'Addario Grand Concert Select	2.5	Easier to start a note quietly.
	3	Standard reed used.
	3.5	More air noise present, difficult to play quietly.

The Grand Concert Select strength No. 2.5 reed was found to be slightly easier to play at lower-end dynamics than the strength No. 3 reed. As this is the softest strength reed available in this make, the investigation was run a second time, with Vandoren Traditional reeds.

Reed type	Strength No.	Recording No.	Findings/Comments
Vandoren Traditional (blue box)	1.5	[Recording 13/1.]	Next to no air noise, but easy to stop the sound unintentionally.
	2	-	Immediately more air noise, but also more resistance: less likely to stop the sound unintentionally.
	2.5	-	Very similar to strength 3, but greater difficulty in the upper octave.
	3	-	Good balance between air noise present and control of the note.
	3.5	-	Air noise present, more difficult to start a note.
	4	[Recording 14/1.]	Air noise present, difficult and unpredictable to start a note.

This test was done on a Selmer S90/170 mouthpiece and using D'Addario Grand Concert Select strength No. 3.0 reeds.

Ligature	Recording No.	Findings/Comments
Elastic band	[Recording 15/1.]	The sound is dampened. It is more difficult to start the reed vibrating.

Appendix E: Multiphonics played at lower-end dynamics (tenor)

Any fingering patterns which have been previously documented include the noted dynamic markings.

The two sources used have been referred to in the following charts by abbreviations:

K - Kientzy (1982)

WN - Weiss and Netti (2010)

The notes comprising each multiphonic have been documented, and if previously documented, the dynamic markings have been included.

Appendix E: Multiphonics played at lower-end dynamics (tenor)

Multiphonic 1 [Recording 52/1.]

8

1

2
3
4

6
7

Source	Dynamic	Notes Sounded
K	***mp***, ***f***	E𝄳5, A𝄳5, C𝄳6, G♯6
WN	***pp***	E𝄳5, C𝄲6
EAE		E𝄳5, C♯↓6

Multiphonic 2 [Recording 53/1.]

1

2
3 C♯

5
6
7

Source	Dynamic	Notes Sounded
K		
WN	***p-f***	F♯4, F♮↑5, C♯6, F♯6
EAE		F♯↓4, D𝄳6

Multiphonic 3 [Recording 54/1.]

1

2
3

6
7

Source	Dynamic	Notes Sounded
K	***mp***, ***(m)f***	F♯↓4, G𝄳5, D𝄳6, G♮↓6
WN		
EAE		F♯↑4, D𝄳6

Appendix E: Multiphonics played at lower-end dynamics (tenor)

Multiphonic 4 [Recording 55/1.]

1
2
3 B♮
5
7

Source	Dynamic	Notes Sounded
K	***p***, ***mp***	F♯↓4, F♯5, C♯6
WN		
EAE		F♯↑4, C♯↑6

Multiphonic 5 [Recording 56/1.]

1
2
3
4 B♭
c5
Tf 6
7

Source	Dynamic	Notes Sounded
K	***p***	D♯5, F♯5
WN	***mp***	C5, D♯5, F♯5
EAE		D♯5, F♯↑5, D♯↑7

Multiphonic 6 [Recording 57/1.]

1
2
3
4 B♭
5
Tf 6

Source	Dynamic	Notes Sounded
K	***mf***	F𝄲4, F5, C6, F6
WN		
EAE		F♯↓4, D♯↓6, F𝄳7

Appendix E: Multiphonics played at lower-end dynamics (tenor)

<u>Multiphonic 7</u> [Recording 58/1.]

1

2
3 B♮

5
6
7

Source	Dynamic	Notes Sounded
K	***p***	F♯4, F♯5, C♯6
WN		
EAE		F♯4, G𝄳5

<u>Multiphonic 8</u> [Recording 59/1.]

1

2
3

5
6
7

Source	Dynamic	Notes Sounded
K	***ppp***	F♯4, C♯6
WN	***p-f***	F4, G5, C♯6, F♯6, A♯6
EAE		F♯4, G𝄳5, D𝄳6

<u>Multiphonic 9</u> [Recording 60/1.]

8

1

2
3 B♮
4

6
7

Source	Dynamic	Notes Sounded
K		
WN	***pp***	D♯4, A4, F♯5, C6
EAE		F♯5, C♮6

Appendix E: Multiphonics played at lower-end dynamics (tenor)

Multiphonic 10 [Recording 61/1.]

8

1

2

Tc 3 B♮

5

6

7

Source	Dynamic	Notes Sounded
K	***mp***, ***f***	C𝄳5, C♯6, G♯6
WN		
EAE		C𝄳5, C♯↑6

Multiphonic 11 [Recording 62/1.]

2

3

6

7

Source	Dynamic	Notes Sounded
K	***p*** [***p***-***f***]	C5, D𝄳6 [C5, D𝄳6, A♭6]
WN		
EAE		C𝄳5, C♯↓6

Multiphonic 12 [Recording 63/1.]

1

2

3

B♭

c5 5

6

7

Source	Dynamic	Notes Sounded
K	***mp***, ***(m)f***	E♭5, E6, B6
WN		
EAE		E𝄳5, F♯6, D♯↑7

Appendix E: Multiphonics played at lower-end dynamics (tenor)

Multiphonic 13 [Recording 64/1.]

8

1

2
Tc 3

5
6
7

Source	Dynamic	Notes Sounded
K		
WN		
EAE		C𝄮5, D𝄳6

Multiphonic 14 [Recording 65/1.]

8

1

2
Tc 3
4

6
7

Source	Dynamic	Notes Sounded
K		
WN		
EAE		C𝄳5, C𝄱6

Multiphonic 15 [Recording 66/1.]

8

1

2
Tc 3 B♮

5
6

Source	Dynamic	Notes Sounded
K		
WN		
EAE		C5, C𝄰6, D♯7

Appendix E: Multiphonics played at lower-end dynamics (tenor)

Multiphonic 16 [Recording 67/1.]

8
1
2
Tc 3 B♮
5
7

Source	Dynamic	Notes Sounded
K		
WN		
EAE		C5, D𝄳6, E♮↓7

Multiphonic 17 [Recording 68/1.]

2
3
5
7

Source	Dynamic	Notes Sounded
K		
WN		
EAE		C5, D𝄳6

Multiphonic 18 [Recording 69/1.]

8
2
3 C♯
4
6
7

Source	Dynamic	Notes Sounded
K		
WN		
EAE		C♮↑5, C♯↑6

Appendix E: Multiphonics played at lower-end dynamics (tenor)

Multiphonic 19 [Recording 70/1.]

8

2
3
4

6
7

Source	Dynamic	Notes Sounded
K		
WN		
EAE		C𝄮5, C𝄱6

Multiphonic 20 [Recording 71/1.]

2
3
4
5

7

Source	Dynamic	Notes Sounded
K		
WN		
EAE		C𝄳5, C𝄮6

Multiphonic 21 [Recording 72/1.]

8

2
3
4
5

7

Source	Dynamic	Notes Sounded
K		
WN		
EAE		C𝄯5, C𝄲6

Appendix F: Altissimo fingering patterns for use with lower-end dynamics (alto)

F♯6	G𝄳6	G6	G♯6
8	8	8	8
1	1	1	1
p	p	p	
G♯	G♯		
3			Tc 3
		Ta	Ta 4 B♭
c5	c5	c5	
			7

Appendix F: Altissimo fingering patterns for use with lower-end dynamics (alto)

G♯6	A𝄳6	A6	A𝄲6
8	8	8	8
1	1		
2		2	2
Tc	Tc 3	3	Tc 3
4	4		

Appendix F: Altissimo fingering patterns for use with lower-end dynamics (alto)

8	8	8	8
	c1	c1	c2 / c1
	2		
Tc 3	3	3	3
Ta 4	4		
	5		
B♭6	B𝄳6	B6	B𝄲6

Appendix F: Altissimo fingering patterns for use with lower-end dynamics (alto)

8
c2 / c1

C7

8
c2 / c1
c3
3

C𝄲7

8
x
4
6
7

C♯7

8
x
6

D𝄳7

Appendix F: Altissimo fingering patterns for use with lower-end dynamics (alto)

D7	D𝄲7	E♭7	E𝄳7
8 x	8 x Tc	8 x c4 Tc c5	8 2 4 6 E♭

Appendix F: Altissimo fingering patterns for use with lower-end dynamics (alto)

E7	E𝄲7	F7	F𝄲7
8	8	8	8
c2 / c1	1	1	1 c1
2			
	3	3	3
4	4	4	Ta 4
5	5		
		6	6

Appendix G: Microtonal key percussion (tenor)

The charts here document the sounding pitches for key percussion on the notes between B♭3 and C♯6. This has been done for each key (clé) that it is possible to move to sound key percussion. It includes a number of alternative fingering patterns. For the notes with which it is possible to move keys *2* and *p* separately, they have also been documented. For C♯5 and C♯6 each key was used individually.

Where no discernible pitch could be heard it is indicated by ‘ndp’.

Appendix G: Microtonal key percussion (tenor)

B♭3

1

2

3

4 B♭

5

6

7

Key used	1	2	3	4	5	6
Closed	B𝄳3	F𝄲5	F♯↑5	B♭↑4	B♭↑3	B♭3
Open	C♯↓4	C♯↑4	G𝄲5	D♭↓5	C♮↑4	C𝄲4

Appendix G: Microtonal key percussion (tenor)

B3

1

2

3 B♮

4

5

6

7

Key used	1	2	3	4	5	6
Closed	C𝄮4	C5	G𝄮5	C4	C4	C4
Open	E𝄳4	E𝄭4	A𝄲4	E♭4	E♭4	E♭4

Appendix G: Microtonal key percussion (tenor)

C4

1

2

3

4

5

6

7

Key used	1	2	3	4	5	6
Closed	C𝄲4	D𝄳4	A𝄳5	C𝄮4	C𝄮4	C𝄮4
Open	E𝄮4	E4	B𝄳5	E4	E4	E4

Appendix G: Microtonal key percussion (tenor)

C♯4

1

2

3 C♯

4

5

6

7

Key used	1	2	3	4	5	6
Closed	C𝄰4	D𝄳4	A𝄳5	C♯4	C♯4	C♯4
Open	E𝄮4	E4	B𝄳5	E𝄯4	E𝄯4	E𝄯4

Appendix G: Microtonal key percussion (tenor)

D4

1

2

3

4

5

6

Key used	1	2	3	4	5	6
Closed	D𝄮4	D𝄲4	D5	D4	D4	D4
Open	F4	F𝄮4	D5	F𝄯4	F𝄯4	F𝄯4

E♭4

1

2

3

4

5

6

E♭

Key used	1	2	3	4	5	6
Closed	E𝄬4	E𝄳4	E𝄳5	E♭5	E♭4	E♭4
Open	F𝄮4	F𝄱4	F5	F𝄲4	F𝄲4	F𝄲4

Appendix G: Microtonal key percussion (tenor)

E4

1

2

3

4

5

Key used	1	2	3	4	5	6
Closed	E4	E5	E♮↑5	E𝄲4	E𝄲4	
Open	G4	G5	G♮↑5	G5	G♮↓5	

Appendix G: Microtonal key percussion (tenor)

F4

1

2

3

4

Key used	1	2	3	4	5	6
Closed	F♮↑4	F𝄲4	F5	F4		
Open	G♯↑4	A♮↓4	A𝄳5	G♯4		

Appendix G: Microtonal key percussion (tenor)

F♯4

1

2

3

5

Key used	1	2	3	4	5	6
Closed	F♯4	F♯↑4	F♯5		ndp	
Open	A♯↓4	A𝄲4	A♯↓5		A4	

Appendix G: Microtonal key percussion (tenor)

G4

1

2

3

Key used	1	2	2 + p	3	4	5	6
Closed	G4	G♮↑4	G𝄲4	G5			
Open	B4	B♮↓4	B𝄳4	A♯↑4			

G♯4

1

2 G♯

3

Key used	1	2	2 + p	3	4	5	6
Closed	G♯↑4	G𝄲4	G♯4	G♯↓4			
Open	C♮↑5	C5	C♮↓5	C6			

Appendix G: Microtonal key percussion (tenor)

A4

1

2

Key used	1	2	3	4	5	6
Closed	A𝄲4	A4				
Open	D𝄳5	C♯6				

Appendix G: Microtonal key percussion (tenor)

B♭4

1

p

Key used	1	p	2	3	4	5	6
Closed	B𝄳4	B♭4					
Open	D5	ndp					

Appendix G: Microtonal key percussion (tenor)

B♭4

1

2

Ta

Key used	1	2	2 + P	3	4	5	6
Closed	B♭4	ndp	B↑♭4				
Open	D5	D5	D6				

Appendix G: Microtonal key percussion (tenor)

B♭4

8

1

2

3

4 B♭

5

6

7

Key used	1	2	3	4	5	6
Closed	B𝄳4	F𝄲5	G𝄳5	B♭4	B♭4	B♭4
Open	C𝄱5	C𝄲4	G𝄲5	C𝄮4	C𝄮4	C𝄮4

Appendix G: Microtonal key percussion (tenor)

B4

1

Key used	1	2	3	4	5	6
Closed	B𝄮4					
Open	E𝄳5					

Appendix G: Microtonal key percussion (tenor)

B4

8

1

2

3 B♮

4

5

6

7

Key used	1	2	3	4	5	6
Closed	F♯↑5	G♭↑5	G𝄳5	B♮↑4	B♮↑4	B♮↑4
Open	D♮↓5	D5	A5	D𝄳5	D𝄳5	D𝄳5

Appendix G: Microtonal key percussion (tenor)

C5

2

Key used	1	2	3	4	5	6
Closed		F5				
Open		C♮5				

Appendix G: Microtonal key percussion (tenor)

C5

8

1

2

3

4

5

6

7

Key used	1	2	3	4	5	6
Closed	G𝄲5	C5	G5	C𝄲5	C𝄲5	C𝄲5
Open	B𝄳4	A𝄲5	B♭5	E𝄬5	E𝄬5	E𝄬5

Appendix G: Microtonal key percussion (tenor)

C♯5

No
Keys
Used
To
Play
This
Note

Key used	1	2	3	4	5	6
Closed	C𝄳5	C𝄲6	ndp	ndp	ndp	ndp
Open	E𝄲5	F♯5	F𝄰5	ndp	ndp	ndp

C♯5

8

1

2

3 C♯

4

5

6

7

Key used	1	2	3	4	5	6
Closed	G♯↑5	D5	A♮↓5	C♯↑5	C♯↑5	C♯↑5
Open	E5	F♯5	B♮↓5	E♮↑5	E♮↑5	E♮↑5

Appendix G: Microtonal key percussion (tenor)

D5

8

1

2

3

4

5

6

Key used	1	2	3	4	5	6
Closed	A♮↓5	D 5	A♮↑5	D♮↓5	D5	A5
Open	F♮↑4	F♮↓5	F♮↑5	F4	F4	F4

Appendix G: Microtonal key percussion (tenor)

E♭5

8

1

2
3
4
5
6
E♭

Key used	1	2	3	4	5	6
Closed	A♯5	E♮↓5	E♭↑5	A♯↓5	E♭5	E♭↓5
Open	F♯↑4	G𝄳5	F♯↑5	F♯5	F♯5	F♯5

Appendix G: Microtonal key percussion (tenor)

E5

8

1

2

3

4

5

Key used	1	2	3	4	5	6
Closed	E♮↑4	E♯↓5	E𝄲5	F𝄳5	E𝄲5	
Open	G𝄲4	G♮↑5	G♯↓5	G𝄲5	G♮↑5	

Appendix G: Microtonal key percussion (tenor)

F5

8

1

2

3

4

Key used	1	2	3	4	5	6
Closed	F𝄲5	F♯↓5	F♯↑5	F♮↓5		
Open	A♮↓4	A𝄳5	A5	A♮↓5		

Appendix G: Microtonal key percussion (tenor)

F♯5

8

1

2

3

5

Key used	1	2	3	4	5	6
Closed	G♮↓5	G𝄳5	G♭↑5		ndp	
Open	A♯↓4	A𝄲4	A♮↑5		A♮↑4	

G5

8

1

2
3

Key used	1	2	2 + p	3	4	5	6
Closed	G𝄱5	G𝄲5	G𝄮5	G𝄮4			
Open	B𝄮4	B𝄮5	B5	B𝄮5			

Appendix G: Microtonal key percussion (tenor)

G♯5

8

1

2 G♯

3

Key used	1	2	2 + p	3	4	5	6
Closed	G↑♯5	G↑♮5	A𝄳5	G♯5			
Open	C↓♯5	C↑♮6	C𝄲5	C↓♮5			

Appendix G: Microtonal key percussion (tenor)

A5

8

1

2

Key used	1	2	3	4	5	6
Closed	A♯↓5	A5				
Open	D𝄳5	D𝄳6				

Appendix G: Microtonal key percussion (tenor)

B♭5

8

1

p

Key used	1	2	3	4	5	6
Closed	A𝄲5	A♯5				
Open	D𝄲5	D𝄲6				

Appendix G: Microtonal key percussion (tenor)

B♭5

8

1

2

Ta

Key used	1	2	2 + p	3	4	5	6
Closed	B♭5	A𝄮5	A𝄲5				
Open	D𝄲5	D𝄮5	D6				

Appendix G: Microtonal key percussion (tenor)

B5

8

1

Key used	1	2	3	4	5	6
Closed	C♮↓5/C6					
Open	F♮↓5					

Appendix G: Microtonal key percussion (tenor)

C6

8

2

Key used	1	2	3	4	5	6
Closed		C♮↓6				
Open		F♯↓5				

C♯6

8

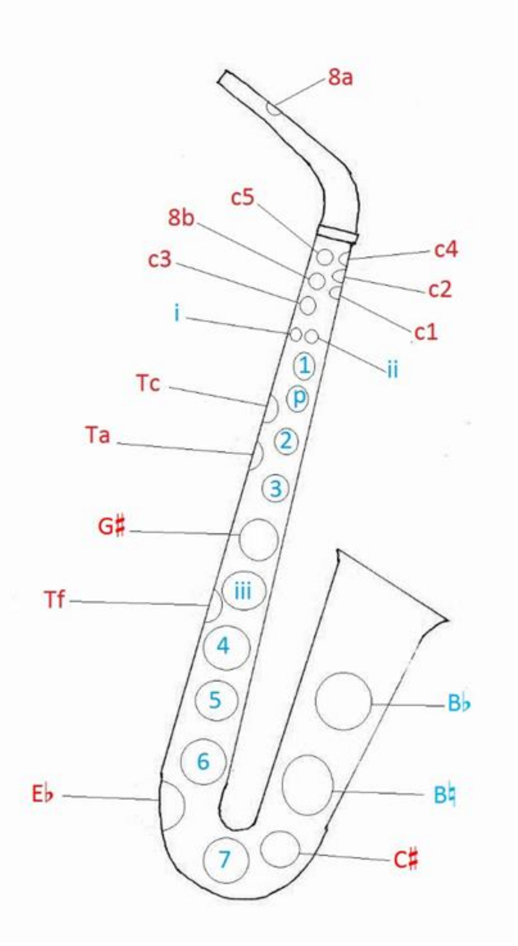
Key used	1	2	3	4	5	6
Closed	C𝄳5	C𝄲6	ndp			
Open	E𝄲5	F♯5	F♯↑5			

Appendix H1: Diagram of tone hole placement and pad position

A diagram which shows the placement of the tone holes and the position of the pads, either open or closed, when the keys are not pressed.

Red = pad shut

Blue = pad open



i - A pad shut by key *1*.

ii - A pad shut by key *1*.

iii - A pad shut by keys *4*, *5*, or *6*.

8a - A pad operated by the octave key, for notes A5 (written pitch) and higher.

8b - A pad operated by the octave key, for notes between D5 and G♯5 (written pitches).

The *x* key operates the same pad as *c4*.

The pad positions have been documented for each fingering pattern included in Appendices H2 and H3. This allows the study of which pads move between different notes.

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

	1	
	2	
	3	C♯
	4	
	5	
	6	
	7	

C♯4

	8a / 8b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Red = pad shut

Blue = pad open

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

D𝄳4

	8a / 8b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

	1	
	2	
	3	
	4	
	5	
	6	

D4

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

	1	
	2	
	3	B♮
	4	
	5	
	6	
	E♭/7	

D𝄲4

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

	1	
	2	
	3	
	4	
	5	
	6	
	E♭	

E♭4

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

		8	
		x	c4
		1	c2 / c1
	p		
c3		2	G♯
Tc		3	B♮ / C♯
Ta		4	B♭
c5		5	
Tf		6	
		E♭ / 7	

E𝄳4

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

	1	
	2	
	3	
	4	
	5	

E4

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

	1	
	2	
	3	B♮
	4	
	6	
	7	

E𝄲4

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

	1	
	2	
	3	
	4	

F4

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

	1	
	2	
	3	
		B♭
	5	
	6	
	7	

F𝄲4

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

	1	
	2	
	3	
	5	

F♯4

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

	1	
	2	
	3	
Tf	6	
	E♭	

G𝄳4

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

	1	
	2	
	3	

G4

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

	1	
	2	G♯
	3	
	(½)6	

G♯4

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	(½)iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	(½)6	
	E♭ / 7	

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

1

2 G♯

3

G♯4

8ᵃ / 8ᵇ

i / ii c4

1 c2 / c1

p

2

c3 3 G♯

Tc iii B♮ / C♯

Ta 4 B♭

c5 5

Tf 6

E♭ / 7

1

2

4

5

6

7

A𝄳4

8ᵃ / 8ᵇ

i / ii c4

1 c2 / c1

p

2

c3 3 G♯

Tc iii B♮ / C♯

Ta 4 B♭

c5 5

Tf 6

E♭ / 7

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

1

2

A4

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

1

2

3

Ta

5

6

A𝄲4

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

	1	
	2	
Ta		

B♭4

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

	1	
		C♯
Ta		
	6	

B𝄳4

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

	1	

B4

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

	1	
Tc	3	
	4	
Tf		

B𝄲4

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

	2	

C5

	8a / 8b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

	1	c1
	2	
	4	
	5	
	6	

C♯5

	8a / 8b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

(open)

C♯5

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

c1

3

5

6

D𝄳5

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

	8	
	1	
	2	
	3	
	4	
	5	
	6	

D5

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

		c1
c3	2	

D𝄲5

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

	8	
	1	
	2	
	3	
	4	
	5	
	6	
	E♭	

E♭5

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

	1	
Tc		
	4	
c5		

E𝄳5

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

8
1
2
3
4
5

E5

8ª / 8ᵇ
i / ii   c4
1   c2 / c1
p
2
c3   3   G♯
Tc   iii   B♮ / C♯
Ta   4   B♭
c5   5
Tf   6
E♭ / 7

8
1
2
3   B♮
4
c5
6

E𝄲5

8ª / 8ᵇ
i / ii   c4
1   c2 / c1
p
2
c3   3   G♯
Tc   iii   B♮ / C♯
Ta   4   B♭
c5   5
Tf   6
E♭ / 7

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

	8	
	1	
	2	
	3	
	4	

F5

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

	8	
	1	
	2	
	3	
	4	B♭
	7	

F𝄲5

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

	8	
	1	
	2	
	3	
	5	

F♯5

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

	8	
	1	
	2	
	3	C♯
	5	
Tf		
	E♭	

G𝄳5

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

	G5				G♯5	
	8				8	
	1				1	
	2				2	G♯
	3				3	
					(½)6	

G5

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

G♯5

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	(½)iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	(½)6	
	E♭ / 7	

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

	8	
	1	
	2	G♯
	3	

G♯5

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

	8	
	1	
	2	
		B♭
	4	
	5	
	6	
	E♭	

A𝄳5

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

8

1

2

A5

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

8

1

2

3

Ta

6

7

A𝄲5

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

8

1

p

B♭5

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

8

1

p

3

4 B♭

5

6

B𝄳5

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

8

1

B5

8^a / 8^b

i / ii   c4

1   c2 / c1

p

2

c3   3   G♯

Tc   iii   B♮ / C♯

Ta   4   B♭

c5   5

Tf   6

E♭ / 7

8

1

2

Tc

B♭

B𝄲5

8^a / 8^b

i / ii   c4

1   c2 / c1

p

2

c3   3   G♯

Tc   iii   B♮ / C♯

Ta   4   B♭

c5   5

Tf   6

E♭ / 7

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

8

2

C6

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

8

2

Tc

4

5

6

7

C𝄲6

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

	8	

C♯6

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

	8	
	1	c1
	2	
Tc		
Ta	4	

D𝄳6

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

	8	
		c1

D6

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

	8	
		c2
	1	
Tc		

D𝄲6

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

8

c2 / c1

E♭6

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

8

c1

c3 2

4

E𝄳6

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

8

c2 / c1

c3

E6

8ª / 8ᵇ
i / ii c4
1 c2 / c1
p
2
c3 3 G♯
Tc iii B♮ / C♯
Ta 4 B♭
c5 5
Tf 6
E♭ / 7

8
c4

c3 2

E𝄲6

8ª / 8ᵇ
i / ii c4
1 c2 / c1
p
2
c3 3 G♯
Tc iii B♮ / C♯
Ta 4 B♭
c5 5
Tf 6
E♭ / 7

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

	8	
		c4
		c2 / c1
c3		

F6

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

	8	
	x	
	2	
	3	
c5		

F♮6

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H2: Exact quarter-tone fingering pattern chart and pad movement chart (alto)

	8	
		c4
		c2 / c1
c3		
c5		

F♯6

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

	1	
	2	
	3	C♯
	4	
	5	
	6	
	7	

C♯4

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

	1	
	2	
	3	B♮
	4	
	5	
	6	

D𝄳4

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Red = pad shut

Blue = pad open

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

1

2
3
4
5
6

D4

	8ᵃ / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

1

2
3
4
5
6
E♭ / 7

D𝄲4

	8ᵃ / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

	1	
	2	
	3	
	4	
	5	
	6	
	E♭	

E♭4

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

	1	
	2	
	3	
	4	B♭
	5	
	7	

E𝄳4

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

1

2
3
4
5

E4

	8ᵃ / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

1

2
3
4

6

E𝄲4

	8ᵃ / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

1

2
3
4

F4

	8a / 8b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

1

2
3

5
6

F𝄲4

	8a / 8b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

1

2

3

5

F♯4

8ᵃ / 8ᵇ

i / ii c4

1 c2 / c1

p

2

c3 3 G♯

Tc iii B♮ / C♯

Ta 4 B♭

c5 5

Tf 6

E♭ / 7

1

2

3

5

Tf

G𝄳4

8ᵃ / 8ᵇ

i / ii c4

1 c2 / c1

p

2

c3 3 G♯

Tc iii B♮ / C♯

Ta 4 B♭

c5 5

Tf 6

E♭ / 7

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

	1	
	2	
	3	

G4

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

	1	
	2	(½)G♯
	3	

G𝄲4

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	(½)G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

	1	
	2	G♯
	3	

G♯4

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

	1	
	2	
	4	
	5	
	6	

A𝄳4

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

	1	
	2	

A4

	8ᵃ / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

	1	
	2	
	3	
Ta		

A𝄲4

	8ᵃ / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

	1	
	2	
Ta		

B♭4

	8a / 8b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

	1	
	p	
Ta		

B𝄳4

	8a / 8b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

	1	

B4

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

	1	
	2	
Tc	3	
Ta		

B𝄲4

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

	2	

C5

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

	2	
Tc		

C𝄲5

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

(open)

C♯5

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

c1

3

D𝄳5

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

8

1

2

3

4

5

6

c3

D5

D♮5

8a / 8b
i / ii c4
1 c2 / c1
p
2
c3 3 G♯
Tc iii B♮ / C♯
Ta 4 B♭
c5 5
Tf 6
E♭ / 7

8a / 8b
i / ii c4
1 c2 / c1
p
2
c3 3 G♯
Tc iii B♮ / C♯
Ta 4 B♭
c5 5
Tf 6
E♭ / 7

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

	8	
	1	
	2	
	3	
	4	
	5	
	6	
	E♭	

E♭5

	8a / 8b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

		c4
		c2
c3		

E𝄳5

	8a / 8b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

8

1

2
3
4
5

E5

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

8

1

2
3
4

6

E𝄲5

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

8

1

2
3
4

F5

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

8

1

2
3

5
6

F𝄲5

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

	8	
	1	
	2	
	3	
	5	

F♯5

	8a / 8b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

	8	
	1	
	2	
	3	C♯
	5	
Tf		

G𝄳5

	8a / 8b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

	8	
	1	
	2	
	3	

G5

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

	8	
	1	
	2	(½)G♯
	3	

G𝄲5

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	(½)G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

8	
1	
2	G♯
3	

G♯5

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

8
1
2
4
6

A𝄳5

	8ª / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

8

1

2

A5

	8ᵃ / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

8

1

2

3

Ta

A𝄲5

	8ᵃ / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

8

1

p

B♭5

	8ᵃ / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

8

1

p

Ta

B𝄳5

	8ᵃ / 8ᵇ	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

8

1

B5

8^a / 8^b

i / ii   c4

1   c2 / c1

p

2

c3   3   G♯

Tc   iii   B♮ / C♯

Ta   4   B♭

c5   5

Tf   6

E♭ / 7

8

1

2

Tc

B𝄲5

8^a / 8^b

i / ii   c4

1   c2 / c1

p

2

c3   3   G♯

Tc   iii   B♮ / C♯

Ta   4   B♭

c5   5

Tf   6

E♭ / 7

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

8

2

C6

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

8

2

Tc

C𝄲6

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

8

C♯6

	8a / 8b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

8

1 c1

D𝄳6

	8a / 8b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

8

c1

D6

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

8

c2

2

D𝄲6

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

8

c2 / c1

E♭6

	8a / 8b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

8

c3

E𝄳6

	8a / 8b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

	8	
		c2 / c1
c3		

E6

	8a / 8b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

	8	
		c4
		c1

E𝄲6

	8a / 8b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

	8	
		c4
		c2 / c1
c3		

F6

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

	8	
c3		
c5		

F𝄲6

	8^a / 8^b	
	i / ii	c4
	1	c2 / c1
	p	
	2	
c3	3	G♯
Tc	iii	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

Appendix H3: Easy quarter-tone fingering pattern chart and pad movement chart (alto)

8
c4
c2 / c1
c3
c5

F♯6

8a / 8b
i / ii c4
1 c2 / c1
p
2
c3 3 G♯
Tc iii B♮ / C♯
Ta 4 B♭
c5 5
Tf 6
E♭ / 7

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

For each semitone pitch the standard fingering pattern is given, followed by a table which shows the pitches which result from adding each key (clé) to the standard semitone fingering pattern. The resulting pitches are documented in cents difference from the closest equal temperament note.

‘0’ indicates that the pitch difference was less than one cent

‘n/a’ indicates a key that cannot be added

‘-‘ indicates that it was not possible to sound a pitch using the fingering pattern

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

B♭3

1

2
3
4 B♭
5
6
7

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	D5 +19	C♯5 +35	C♯5 +27	C♯5 -40	D5 -37	C5 -49	A♯4 +36	D♯5 -6	F♯5 -8	B5 -45	n/a	n/a	n/a	n/a	n/a

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

B3

1

2
3 B♮
4
5
6
7

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	D5 +42	D5 -34	D5 -48	C♯5 -12	D5 -12	C5 -25	B4 +13	D♯5 +14	F♯5 +35	D♯4 +47	n/a	n/a	n/a	n/a	n/a

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

C4

1

2
3
4
5
6
7

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	D♯5 -38	D♯5 -21	D5 -30	C♯5 +12	D5 +7	C5 +24	A4 -14	D♯5 +36	F4 +6	D4 +43	n/a	n/a	n/a	n/a	n/a

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

C♯4

1

2

3 C♯

4

5

6

7

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	D♯5 -17	D♯5 -3	D5 +12	D5 -40	D5 +33	B4 -34	A4 +13	D♯5 +48	F4 +24	D♯4 -33	n/a	n/a	n/a	n/a	n/a

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

D4

1

2

3

4

5

6

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	D♯5 +5	D♯5 +17	D5 +30	D5 +12	D♯5 -34	B4 -13	A4 +23	E5 -33	F4 +46	n/a	n/a	n/a	D4 +23	D4 -10	D4 -12

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

E♭4

1

2
3
4
5
6
E♭

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	E♭5 +36	E♭5 +40	E♭5 -5	B4 +40	E♭5 +12	B4 -3	A4 +28	E5 -21	F4 +48	n/a	E♭4 -38	n/a	E♭4 +3	E♭4 -4	E♭4 -10

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

E4

1

2

3

4

5

Key added	x	c4	c2	c1	c3[108]	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	E5 +8	E5 +6	C♯5 -35	C5 -11	E5 +10	B4 +12	A4 +38	E5 +18	F♯4 -25	E4 +14	E4 -11	n/a	E4 +8	E4 -4	E4 -7

[108] Also sounding C5 +36.

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

F4

1

2

3

4

Key added	x	c4	c2	c1	c3	Tc	Ta	c5[109]	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	D5 -25	D5 +14	C♯5 -2	C5 +13	C♯5 +20	B4 +18	A4 +46	F5 +5	n/a	F4 +3	F4 -4	n/a	F4 +3	F4 -2	F4 -4

[109] Also sounding D5 +24.

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

F♯4

1

2
3

5

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	D5 +22	D5 +45	C♯5 +24	C5 +30	D5 -50	B4 +26	A♯4 -47	D♯5 -11	F♯4 +33	F♯4 +2	F♯5 -6	n/a	F♯4 +2	F♯5 -2	F♯5 -3

G4

1

2

3

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	D5 +36	D♯5 -45	C♯5 +38	C♯5 -48	D5 -24	B4 +37	A♯4 -41	D♯5 +11	G4 +9	G4 +2	G4 -3	n/a	n/a	n/a	n/a

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

G♯4

1

2 G♯

3

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	D5 +40	D♯5 -39	C♯5 +42	C♯5 -38	D5 -18	B4 +38	A♯4 -25	D♯5 +23	G♯4 +1	G♯4 -2	G♯4 -1	n/a	G♯4 -1	G♯4 -4	G♯4 -6

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

A4

1

2

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	D♯5 -48	D♯5 -28	D5 -42	C♯5 -24	D5 -4	B4 +49	n/a	D♯5 +35	A4 +2	A4 -1	A4 -2	A4 +13	A4 +18	A4 +9	A4 +6

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

B♭4

1

p

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	D♯5 -30	D♯5 -11	D5 -30	C♯5 -5	D5 +15	C5 -30	B♭4 +42	D♯5 +48	B♭4 +3	B♭4 +1	B♭4 -4	B♭4 +5	A♯4 +1	A♯4 +6	A♯4 +3

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

B4

1

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	D♯5 -10	D♯5 +5	D5 -11	C♯5 +12	D5 +33	n/a	B4 +9	E5 -32	B4 +2	B4 +2	B4 -3	B4 +1	B4 +2	B4 -3	B4 -4

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

C5

2

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	D♯5 -42	D♯5 +12	D5 -6	C♯5 +34	D5 +37	C5 +36	C5 +6	E5 -36	C5 +1	C5 +2	C5 -2	C5 +2	C5 +3	C5 +2	C5 +1

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

C♯5

No
Keys
Used
To
Play
This
Note

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	D♯5 -20	D♯5 +18	D5 +14	D5 -44	D♯5 -41	C♯5 +8	C♯5 +2	E5 -25	C♯5 +2	C♯5 +1	C♯5 -2	0	0	0	0

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

D5

8

1

2

3

4

5

6

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	D♯5 +13	D♯5 +20	D5 -46	D5 +23	D♯5 -28	B4 +22	A♯4 -13	E5 -28	F5 +6	n/a	C5 +40	n/a	D5 +41	D5 -15	D5 -35

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

E♭5

8

1

2

3

4

5

6

E♭

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	D♯5 +32	D♯5 +36	D♯5 -5	C5 -34	D♯5 +4	B4 +26	A♯4 -14	E5 -23	F5 +20	n/a	D♯5 -40	n/a	D♯5 +6	D♯5 -6	D♯5 -13

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

E5

8

1

2

3

4

5

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	E5 -6	E5 -4	C♯5 -19	C5 +8	E5 +3	C5 -50	A♯4 +0	E5 +24	F♯5 -18	E5 +21	E5 -39	n/a	E5 +6	E5 -6	E5 -14

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

F5

8

1

2

3

4

Key added	x	c4	c2	c1	c3	Tc	Ta	c5[110]	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	D5 -13	D5 +16	C♯5 +13	C5 +34	C♯5 +19	C5 -47	A♯4 +8	D5 +44	n/a	F5 +3	F5 -13	n/a	F5 +3	F5 -1	F5 -6

[110] This fingering pattern produces two pitches, the second of which is F5 -2.

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

F♯5

8

1

2
3

5

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	D5 +26	D5 +45	C♯5 +36	C♯5 -44	D5 -41	C5 -36	A♯4 +15	D♯5 -6	G5 -47	F♯5 +4	F♯5 -10	n/a	F♯5 +1	F♯5 -1	F♯5 +10

G5

8

1

2

3

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	D5 +42	D♯5 -40	C♯5 +40	C♯5 -33	E6 -35	C5 -37	A♯5 -31	D♯5 +7	G5 +10	G5 +2	G5 -3	n/a	n/a	n/a	n/a

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

G♯5

8

1

2 G♯

3

Key added	x	c4	c2	c1	c3	Tc	Ta	c5[111]	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	D♯5 -50	D♯5 -27	D5 -46	C♯5 -24	D5 -16	C5 -32	A♯4 +19	D♯5 +20	G♯ +2	G♯ +2	G♯ -1	n/a	G♯ -1	G♯ +2	G♯ -3

[111] Also sounds F6 +23.

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

A5

8

1

2

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	F6 +10	F6 +20	C♯5 -45	C6 +32	F6 -17	C6 -36	n/a	F♯6 -18	A5 +2	A5 +2	A5 +3	A5 +15	A5 +13	A5 +19	A5 +10

B♭5

8

1

p

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	C♯7 +45	C♯7 +36	D6 -37	C♯5 -6	D6 -42	C6 -21	B♭5 +47	F♯6 +42	B♭5 +2	B♭5 +1	B♭5 -2	B♭5 +3	B♭5 +2	B♭5 +8	B♭5 +5

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

B5

8

1

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	D♯6 -8	D♯6 +32	D6 +10	C♯6 +32	D6 +44	n/a	B5 +23	D7 +16	B5 +1	B5 +2	B5 -3	B5 +1	B5 +2	B5 +1	B5 +2

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

C6

8

2

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	n/a	E6 -26	D6 +46	D6 -34	D♯5 -12	C♯6 -42	C6 +20	-	0	C6 +1	C6 -1	C6 +3	C6 +4	C6 +3	C6 +2

C♯6

8

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	D♯6 -23	E6 +29	D♯6 -12	n/a	D♯6 +33	C♯6 +23	C♯6 +4	F6 -12	0	C♯6 +1	0	0	0	0	0

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

D6

8

c1

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	E6 -6	E6 +47	n/a	n/a	E6 +36	D6 +6	D6 +2	F6 +17	D6 +1	D6 +2	D6 -2	0	D6 +2	D6 -2	D6 +3

E♭6

8

c2 / c1

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	E6 +40	F6 -31	n/a	n/a	n/a	F6 +3	F6 +1	F6 +48	0	0	0	0	F6 +1	F6 -6	F6 -3

E6

8

c2 / c1

c3

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	F6 -20	n/a	n/a	n/a	n/a	F6 +2	0	F♯6 -30	0	0	0	0	0	0	0

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

F6

8

c4

c2 / c1

c3

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	F6 -7	n/a	n/a	n/a	n/a	0	0	n/a	0	0	0	0	0	0	0

Appendix I: Extreme fingering patterns for microtonality. Part one – adding keys (alto)

F♯6

8

c4

c2 / c1

c3

c5

Key added	x	c4	c2	c1	c3	Tc	Ta	c5	Tf	E♭	7	G♯	C♯	B	B♭
Resulting Pitch	F♯6 -3	n/a	n/a	n/a	n/a	0	0	0	0	0	0	0	0	0	0

Appendix J: The resulting pitches if a tenor saxophone is tuned to A=433Hz

Pitch name (written pitches)	Difference from equal temperament (cents). Tuning note B5	Difference from equal temperament (cents). Tuning note F♯5
B♭3	+47	+37
B3	+36	+28
C4	+35	+25
C♯4	+34	+27
D4	+32	+15
E♭4	+25	+10
E4	+23	+1
F4	+20	-4
F♯4	+18	+14
G4	+27	+4
G♯4	-1	-12
A4	+9	-1
B♭4	-7	-16
B4	-9	-20
C5	+5	-15
C♯5	-10	-32
D5	+40	+25
E♭5	+28	+4
E5	+22	+11
F5	+14	-2

F♯5	+10	Tuning note (0)
G5	+13	+3
G♯5	+3	-21
A5	+13	-7
B♭5	-2	-20
B5	Tuning note (0)	-24
C6	-2	-22
C♯6	-7	-19
D6	-13	-29
E♭6	-17	-33
E6	-11	-23
F6	-19	-25
F♯6	-21	-29

The two notes which were used to tune the saxophone are at different points on the body of the saxophone. Whilst the number of cents each note differs from equal temperament changes with the tuning note used, the same general trend can be seen in both columns: the notes which require keys closer to the bell to be shut move further away from equal temperament pitch. This means that there is a noticeable step in the tuning between the notes D5 and C♯5.

[Recording 9/2.]

Extending Techniques: Developing the saxophone's capacity for lower-end dynamics and microtonal playing.

Eleri Ann Evans

A thesis submitted to the University of Huddersfield
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for the degree of Doctor of Philosophy

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Volume III of III

Volume III Page

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources (alto)

This appendix documents the exact pitch changes that occur when using the fingering patterns for the quarter-tone scales from six different sources. The sources will be referred to by abbreviations in the charts that follow. The fingering patterns which require a key to be partially closed have been documented, but the resulting pitches have not been measured in cents. Schwab is the only sources which provides solutions for microtonal pitches below D𝄳4. As these include half-closing keys and covering the bell they have not been included here.

Material referenced	Abbreviation
Caravan (1974)	C
Delangle and Michat (1998)	DM
Londeix (1989)	L
Paulson (1975)	P
Schwab (1976)	S
Weiss and Netti (2010)	WN

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources (alto)

1
2
3
4 B♭
5
6
E♭

Fingering pattern for	D𝄳4
Resulting pitch	D4 -12
Sources	DM, S, WN

1
2
3 B♮
4
5
6
E♭

Fingering pattern for	D𝄲4
Resulting pitch	D♯4 -4
Sources	L

1
2
3 C♯
4
5
6
E♭ / 7

Fingering pattern for	D𝄲4
Resulting pitch	D♯4 -23
Sources	DM

1
2
3
4
5
6
E♭ / 7

Fingering pattern for	D𝄲4
Resulting pitch	D♯4 -38
Sources	C, DM, L, P, S, WN

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

1
2 G♯
3
4
5
7

Fingering pattern for	E𝄳4
Resulting pitch	n/a
Sources	L

The pad operated by the *G♯* key cannot be opened when keys *4*, *5*, or *6* are closed.

1
2
3
4
5
7

Fingering pattern for	E𝄳4
Resulting pitch	E4 -21
Sources	C, L, P

1
2
3 B♮
4
5
7

Fingering pattern for	E𝄳4
Resulting pitch	E4 -23
Sources	DM, L, S, WN

1
2
3
4
6

Fingering pattern for	E𝄲4
Resulting pitch	F4 -28
Sources	DM, L

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

1

2

3 B♮

4

6

Fingering pattern for	E𝄲4
Resulting pitch	F4 -32
Sources	DM, WN

1

2

3

4 B♭

6

Fingering pattern for	E𝄲4
Resulting pitch	F4 -35
Sources	C, L, P, S

1

2

3

4

6

7

Fingering pattern for	E𝄲4
Resulting pitch	F4 -43
Sources	DM

1

2

3 B♮

4

6

7

Fingering pattern for	E𝄲4
Resulting pitch	F4 -48
Sources	DM

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

1

2
3

5
6

Fingering pattern for	F𝄲4
Resulting pitch	F♯ -17
Sources	DM

1

2
3 B♮

5
6

Fingering pattern for	F𝄲4
Resulting pitch	F♯ -20
Sources	C, L, P, S

1

2
3

5
6
7

Fingering pattern for	F𝄲4
Resulting pitch	F♯ -32
Sources	DM, WN

1

2
3

5
Tf

Fingering pattern for	G𝄳4
Resulting pitch	F♯ +33
Sources	DM, L, S

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

1

2

3

B♭

5

Tf

Fingering pattern for	G𝄳4
Resulting pitch	F♯ +35
Sources	S

1

2

3 C♯

5

Tf

Fingering pattern for	G𝄳4
Resulting pitch	F♯ +36
Sources	WN

1

2

3

5

Tf

E♭

Fingering pattern for	G𝄳4
Resulting pitch	F♯ +37
Sources	C, L, P

1

2 (½)G♯

3

Fingering pattern for	G𝄲4
Resulting pitch	-
Sources	DM, L

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

1

2 (¼)G♯

3

Fingering pattern for	G𝄲4
Resulting pitch	-
Sources	S

1

2 (¼)G♯

3

Tf

Fingering pattern for	G𝄲4
Resulting pitch	-
Sources	S

1

2 G♯

3

(½)4

Fingering pattern for	G𝄲4
Resulting pitch	-
Sources	WN

1

2

4

6

Fingering pattern for	A𝄳4
Resulting pitch	A4 -26
Sources	C, L, P

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

1
2
4 B♭
5
6
E♭

Fingering pattern for	A𝄳4
Resulting pitch	A4 -46
Sources	WN

1
2
4
5
6
7

Fingering pattern for	A𝄳4
Resulting pitch	G♯4 +46
Sources	DM, L, S

1
2
3
B♭
5
6

Fingering pattern for	A𝄲4
Resulting pitch	F♯4 -10
Sources	L

1
2
3
B♭
6

Fingering pattern for	A𝄲4
Resulting pitch	F♯4 +6
Sources	L

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

1
3
4
Tf

Fingering pattern for	A𝄲4
Resulting pitch	A♯4 -33
Sources	L, S

1
3
4

Fingering pattern for	A𝄲4
Resulting pitch	A♯4 -38
Sources	DM

1
p
3

Fingering pattern for	A𝄲4
Resulting pitch	A♯4 -39
Sources	WN

1
2
3
Ta

Fingering pattern for	A𝄲4
Resulting pitch	A♯4 -41
Sources	DM, L

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

1
2
3
Ta
6

Fingering pattern for	A𝄲4
Resulting pitch	A4 +41
Sources	C, P

1
2
3
Ta
5
6

Fingering pattern for	A𝄲4
Resulting pitch	A4 +47
Sources	C, P

1
p
B♭

Fingering pattern for	B𝄳4
Resulting pitch	A♯4 +3
Sources	L

1
p
Ta

Fingering pattern for	B𝄳4
Resulting pitch	A♯4 +42
Sources	DM, L, P, WN

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

1
p
G♯
Ta

Fingering pattern for	B𝄳4
Resulting pitch	A♯4 +34
Sources	C, P

1
Ta 4
5
6
E♭

Fingering pattern for	B𝄳4
Resulting pitch	A♯4 +38
Sources	S

1
2
Tf

Fingering pattern for	B𝄲4
Resulting pitch	A4 +2
Sources	L

1
2
Tc 3 B♮
4
5
6

Fingering pattern for	B𝄲4
Resulting pitch	B4 -20
Sources	DM

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

1
2
Tc
4
5

Fingering pattern for	B𝄲4
Resulting pitch	C5 -49
Sources	L

1
2
Tc

Fingering pattern for	B𝄲4
Resulting pitch	B4 +49
Sources	C, DM, P, S, WN

2
Tc
4

Fingering pattern for	C𝄲5
Resulting pitch	C5 +32
Sources	S

2
Tc
Tf

Fingering pattern for	C𝄲5
Resulting pitch	C5 +34
Sources	DM

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

2
Tc

Fingering pattern for	C𝄲5
Resulting pitch	C5 +36
Sources	C, DM, L, P, WN

2
7

Fingering pattern for	D𝄳5
Resulting pitch	C5 -2
Sources	L

c2
2

Fingering pattern for	D𝄳5
Resulting pitch	D5 -6
Sources	P

c1
Tc 3

Fingering pattern for	D𝄳5
Resulting pitch	D5 -27
Sources	WN

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

1 c1

2

Tc

Ta

Fingering pattern for	D𝄳5
Resulting pitch	C♯5 +29
Sources	S

c1

2

4

5

6

Fingering pattern for	D𝄳5
Resulting pitch	C♯5 +31
Sources	S

c1

2

Fingering pattern for	D𝄳5
Resulting pitch	C♯5 +34
Sources	DM

8

1

2

3

4 B♭

5

6

Fingering pattern for	D𝄳5
Resulting pitch	D5 -35
Sources	C, DM, L, P

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

c3 2

Fingering pattern for	D♯5
Resulting pitch	D5 +37
Sources	C, DM, L, P

8
1
2
3
4
5
6
E♭ / 7

Fingering pattern for	D♯5
Resulting pitch	D♯5 -40
Sources	C, DM, P, S

c3

Fingering pattern for	D♯5
Resulting pitch	D♯5 -41
Sources	DM, L

c3
Tc

Fingering pattern for	D♯5
Resulting pitch	D♯5 -48
Sources	WN

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

8

1

2
3 B♮
4
5
6
E♭ / 7

Fingering pattern for	D𝄲5
Resulting pitch	D5 +48
Sources	DM, L

8

1

2
3
4
5
6
7

Fingering pattern for	E𝄳5
Resulting pitch	C5 +32
Sources	DM

8

1

2
3 B♮
4
5
6
7

Fingering pattern for	E𝄳5
Resulting pitch	B4 +35
Sources	DM

c4
c2 / c1

Fingering pattern for	E𝄳5
Resulting pitch	D♯5 +24
Sources	C, P

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

c4
c1
c3

Fingering pattern for	E𝄳5
Resulting pitch	D♯5 +31
Sources	L

8
1
2
3
4
5
7

Fingering pattern for	E𝄳5
Resulting pitch	E5 -39
Sources	P, S

c4
c2
c3

Fingering pattern for	E𝄳5
Resulting pitch	D♯5 +34
Sources	L

8
1
2
3 B♮
4
5
7

Fingering pattern for	E𝄳5
Resulting pitch	D♯5 +35
Sources	C, L

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

2
c5

Fingering pattern for	E𝄳5
Resulting pitch	E5 -41
Sources	DM

c4
c2 / c1
c3

Fingering pattern for	E𝄳5
Resulting pitch	D♯5 +47
Sources	DM, WN

8
1
2
3
4
6

Fingering pattern for	E𝄲5
Resulting pitch	F5 -42
Sources	C, L, P

8
1
2
3 B♮
4
7

Fingering pattern for	E𝄲5
Resulting pitch	F5 -31
Sources	DM

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

8

1

2

3 B♮

4

6

Fingering pattern for	E𝄲5
Resulting pitch	F5 -36
Sources	DM, WN

8

1

2

3

4 B♭

6

Fingering pattern for	E𝄲5
Resulting pitch	E5 +36
Sources	C, DM, L, P, S

8

1

2

3

5

6

Fingering pattern for	F𝄲5
Resulting pitch	F♯5 -40
Sources	C, DM, L, P, WN

8

1

2

3 B♮

5

6

Fingering pattern for	F𝄲5
Resulting pitch	F5 +38
Sources	S

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

8

1

2

3

4 B♭

7

Fingering pattern for	F𝄲5
Resulting pitch	F♯5 -47
Sources	DM

8

1

2

3

5

Tf

Fingering pattern for	G𝄳5
Resulting pitch	G5 -47
Sources	C, DM, L, P, WN

8

1

2

3

5

Tf

E♭

Fingering pattern for	G𝄳5
Resulting pitch	G5 -48
Sources	C, P, S

8

1

2 (½)G♯

3

Fingering pattern for	G𝄲5
Resulting pitch	-
Sources	DM, L

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

8

1

2 G♯*

3

Tf

Fingering pattern for	G𝄲5
Resulting pitch	G5 +10
Sources	S

* “Barely opened”.

8

1

2 G♯

3

(½)4

Fingering pattern for	G𝄲5
Resulting pitch	-
Sources	WN

8

1

2

4

5

6

7

Fingering pattern for	A𝄳5
Resulting pitch	A5 -17
Sources	L

8

1

2

4

Fingering pattern for	A𝄳5
Resulting pitch	A5 -32
Sources	DM, WN

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

8
1
2
4
6

Fingering pattern for	A𝄳5
Resulting pitch	A5 -40
Sources	C, L, P

8
1
2
4
5

Fingering pattern for	A𝄳5
Resulting pitch	A5 -49
Sources	DM

8
1
2
4
5
E♭

Fingering pattern for	A𝄳5
Resulting pitch	A5 -50
Sources	S

8
1
3
5

Fingering pattern for	A𝄲5
Resulting pitch	A♯4 +44
Sources	WN

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

8

1

p

3

Fingering pattern for	A𝄲5
Resulting pitch	A♯5 -28
Sources	C, L, P

8

1

2

3

Ta

Fingering pattern for	A𝄲5
Resulting pitch	A♯5 -31
Sources	DM, L

8

1

2

4

5

6

Fingering pattern for	A𝄲5
Resulting pitch	A5 +40
Sources	C, L, P, S

8

1

2

3

Ta

6

Fingering pattern for	A𝄲5
Resulting pitch	A♯5 -48
Sources	C, L, P

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

8

1

G♯

Ta

5

Fingering pattern for	B𝄳5
Resulting pitch	B5 -29
Sources	L

8

1

Ta 4

5

6

Fingering pattern for	B𝄳5
Resulting pitch	B5 -37
Sources	S

8

1

p

Ta

Fingering pattern for	B𝄳5
Resulting pitch	B𝄳5 +47
Sources	C, DM, L, P, WN

8

1

p

G♯

Ta

Fingering pattern for	B𝄳5
Resulting pitch	B𝄳5 +48
Sources	C, L, P

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

8
1
2
3 B♮
5
6
7

Fingering pattern for	B𝄲5
Resulting pitch	G5 -39
Sources	DM

8
1
2
Tc
4
5

Fingering pattern for	B𝄲5
Resulting pitch	C5 -27
Sources	L

8
1
2 G♯
Tc

Fingering pattern for	B𝄲5
Resulting pitch	C5 -39
Sources	S

8
1
2
Tc

Fingering pattern for	B𝄲5
Resulting pitch	C5 -36
Sources	C, DM, L, P, WN

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

8
2
Tc
4
5

Fingering pattern for	C♯6
Resulting pitch	C♯6 -37
Sources	C, L, P

8
2
Tc
5

Fingering pattern for	C♯6
Resulting pitch	C♯6 -40
Sources	C, L

8
1
2
3 B♮
4
7

Fingering pattern for	C♯6
Resulting pitch	C♯6 -41
Sources	DM

8
2
Tc

Fingering pattern for	C♯6
Resulting pitch	C♯6 -42
Sources	C, DM, L, P, S, WN

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

8
2
Tc
4

Fingering pattern for	C𝄲6
Resulting pitch	C𝄲6 -44
Sources	C, L

8
1
P
Tc

Fingering pattern for	D𝄳6
Resulting pitch	C6 -21
Sources	L

8
c1
2

Fingering pattern for	D𝄳6
Resulting pitch	D6 -34
Sources	DM, L, WN

8
1 c1
2
Tc
Ta

Fingering pattern for	D𝄳6
Resulting pitch	D6 -38
Sources	S

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

8

1 c1

P

Tc

Fingering pattern for	D𝄳6
Resulting pitch	D6 -40
Sources	C, P

8

1 c1

2

Tc

Fingering pattern for	D𝄳6
Resulting pitch	D6 -47
Sources	S

8

1 c2 / c1

Fingering pattern for	D𝄲6
Resulting pitch	D♯6 -10
Sources	C

8

c2

Fingering pattern for	D𝄲6
Resulting pitch	D♯6 -12
Sources	WN

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

8
c2
2
Tc

Fingering pattern for	D𝄲6
Resulting pitch	D♯6 -21
Sources	DM, L

8
1 c2 / c1
p
Ta

Fingering pattern for	D𝄲6
Resulting pitch	D♯6 -23
Sources	S

8
1 c2 / c1
p

Fingering pattern for	D𝄲6
Resulting pitch	D♯6 -31
Sources	C, L, P

8
1 c2
2
Tc

Fingering pattern for	D𝄲6
Resulting pitch	D6 +35
Sources	L

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

8
1
c3 2
Tc

Fingering pattern for	D𝄲6
Resulting pitch	D♯6 -40
Sources	C, P

8
x
2
3
5
Tf

Fingering pattern for	E𝄳6
Resulting pitch	E6 -11
Sources	S

8
c1
c3

Fingering pattern for	E𝄳6
Resulting pitch	E6 -29
Sources	C, L, P

8
c3

Fingering pattern for	E𝄳6
Resulting pitch	D♯6 +33
Sources	L, WN

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

8
1 c1
c3

Fingering pattern for	E𝄳6
Resulting pitch	D♯6 +35
Sources	C, L, P

8
1
c3 2
3

Fingering pattern for	E𝄳6
Resulting pitch	E6 -35
Sources	DM

8
c1
c3 2

Fingering pattern for	E𝄳6
Resulting pitch	D♯6 +44
Sources	DM, L

8
c4
1 c2 / c1

Fingering pattern for	E𝄲6
Resulting pitch	F6 -20
Sources	C, L, P

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

8

c4

c2 / c1

Fingering pattern for	E♮6
Resulting pitch	F6 -6
Sources	DM

8

x

2 G♯

3

Fingering pattern for	E♮6
Resulting pitch	F6 -29
Sources	S

8

c4

c2

Fingering pattern for	E♮6
Resulting pitch	F6 -31
Sources	DM, L

8

x

c2 / c1

2

Fingering pattern for	E♮6
Resulting pitch	E6 +41
Sources	L

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

8
x
1 c2 / c1

Fingering pattern for	E𝄲6
Resulting pitch	F6 -45
Sources	C, P

8
c4
c1

Fingering pattern for	E𝄲6
Resulting pitch	F6 -46
Sources	WN

8
1 c1
c5

Fingering pattern for	F𝄲6
Resulting pitch	F6 -7
Sources	L

8
x
c5

Fingering pattern for	F𝄲6
Resulting pitch	F6 -1
Sources	L

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

8
x
2
4
5

Fingering pattern for	F𝄲6
Resulting pitch	F♯6 -35
Sources	S

8
c1
c3
c5

Fingering pattern for	F𝄲6
Resulting pitch	F♯6 -45
Sources	DM, L

8
c3
c5

Fingering pattern for	F𝄲6
Resulting pitch	F6 +46
Sources	DM, WN

8
1
2
3
Ta 4
c5

Fingering pattern for	G𝄳6
Resulting pitch	D♯5 +44
Sources	DM

Appendix K: Chart comparing the quarter-tone fingering patterns from six sources

8

1

2

Ta 4

c5

Fingering pattern for	G𝄳6
Resulting pitch	F♯6 +49
Sources	WN

Appendix L: Quarter-tone fingering pattern chart (soprillo)

1		1		1		1	
2		2		2		2	
3		3	B♮ / C♯	3	C♯	3	
4		4		4		4	B♭
5		5		5		5	
6		6		6		6	
7		7		7			
C4		**C𝄲4**		**C♯4**		**D𝄳4**	

Appendix L: Quarter-tone fingering pattern chart (soprillo)

D4	D𝄲4	E♭4	E𝄳4
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4 B♭
5	5	5	5
6	6	6	
	E♭ / 7	E♭	7

Appendix L: Quarter-tone fingering pattern chart (soprillo)

1	1		1	1
2	2		2	2
3	3	C♯	3	3
4	4		4	
5				5
	6			6
				7
E4	E𝄲4		F4	F𝄲4

Appendix L: Quarter-tone fingering pattern chart (soprillo)

1	1	1	1
2	2	2	2
3	3	3	3
5	5		
	Tf		Tf
F♯4	G𝄳4	G4	G𝄲4

Appendix L: Quarter-tone fingering pattern chart (soprillo)

1	1	1	1
			p
2 G♯	2	2	
3			3
	6		
	E♭		
G♯4	**A𝄳4**	**A4**	**A𝄲4**

Appendix L: Quarter-tone fingering pattern chart (soprillo)

B♭4	B𝄳4	B4	B𝄲4
1	1	1	
p			
			2
	3		3
			4

Appendix L: Quarter-tone fingering pattern chart (soprillo)

2

C5

3

C𝄲5

8
1
2
3 C♯
4
5
6
7

C♯5

8
1
2
3
4 B♭
5
6

D𝄳5

Appendix L: Quarter-tone fingering pattern chart (soprillo)

D5

8
1

2
3
4
5
6

D𝄲5

8
1

2
3
4 B♭
5
6
E♭

E♭5

8
1

2
3 C♯
4
5
6
E♭

E𝄳5

8
1

2
3 B♮
4

6

Appendix L: Quarter-tone fingering pattern chart (soprillo)

E5	E𝄲5	F5	F𝄲5
8	8	8	8
1	1	1	1
2	2	2	2
3	3 C♯	3	3 C♯
4	4	4	
			5
6	6		6
	E♭		E♭

Appendix L: Quarter-tone fingering pattern chart (soprillo)

8	8	8	8
1	1	1	1
2	2	2	2 G♯
3	3	3	3
	B♭		
5	5		5
			6
	7		7
F♯5	G𝄳5	G5	G𝄲5

Appendix L: Quarter-tone fingering pattern chart (soprillo)

8		8	8	8
1		1	1	1
2	G♯	2	2	2
3				
				4
		5		5
				6
G♯5		**A𝄳5**	**A5**	**A𝄲5**

Appendix L: Quarter-tone fingering pattern chart (soprillo)

8	8	8	8
1	1	1	1
p			
	2 G♯		G♯
	Ta		
	Tf		
B♭5	B𝄳5	B5	B𝄲5

Appendix M: Fingering pattern chart for *Nano* by Mc Laughlin, version 4 (alto)

In the following table each horizontal row refers to a different semitone pitch. From the top to the bottom these are: C♯5, C5, B4, B♭4, and A4 (written pitches).

Pitches descend moving from left to right across each page, and across pages 1-8 in order. When there are no more fingering patterns given on that line, the next closest pitch will be on the next line lower on page 1.

Black vertical lines indicate each eighth of a tone lower.

Blue vertical lines indicate groupings by the fingering patterns upon which these are based.

Appendix M: Fingering pattern chart for *Nano* by Mc Laughlin, version 4 (alto)

2	2 7	2 6	2 5	2 4	2 4 5 E♭	2 4 5
1	1 7					
1 p	1 p 7	1 p 6	1 p 5	1 p 4	1 p 4 5	1 p 4 5 E♭

Appendix M: Fingering pattern chart for *Nano* by Mc Laughlin, version 4 (alto)

2 4 5 6 E♭	2 4 5 6	2 B♮ 4 5 6 E♭	2 4 B♭ 5 6 E♭	2 G♯ 3	2 G♯ 3 E♭/7
			1 3 7		
1 p 4 5 6 E♭	1 p 4 5 6			1 p 4 5 6 7	1 p B♮ 4 5 6 7
		1 2 4 5	1 2 4 5 E♭	1 2 4 5 6 E♭	1 2 4 5 6

Appendix M: Fingering pattern chart for *Nano* by Mc Laughlin, version 4 (alto)

2 G♯ 3 7	2 3 B♮ 7	2 3 B♭ 7	2 3 B♭	2 3	2 3 7
1 2 Tc 3 4 5 6	1 2 Tc 3 B♮ 4 5 6 7		1 2 Tc 3 4 B♭ 5 6		
1 p 3	1 p 3 7	1 p 3 6	1 p 3 5	1 p 3 4	1 p 3 4 5
1 2 C♯ 4 5 6 7	1 2 4 5 6 7	1 2 B♮ 4 5 6 7			

Appendix M: Fingering pattern chart for *Nano* by Mc Laughlin, version 4 (alto)

				2 Tc Ta	2 Tc	2 Tc 5
2 3 6	2 3 5	2 3 4	2 3 4 6 E♭	2 3 4 6	2 3 4 5 E♭	2 3 4 5
1 3 Ta 4 B♭ 5 6 7	1 2 Ta 4 B♭ 5 6 7	1 2 3 Ta 4 B♭ 5 6 7	1 p Ta B♭	1 p Ta	1 p Ta 7	1 p Ta 6
1 p 3 4 5 E♭	1 p 3 4 5 6 E♭	1 p 3 4 5 6	1 p 3 B♮ 4 5 6 7	1 p 3 C♯ 4 5 6 7	1 p 3 4 5 6 7	

Appendix M: Fingering pattern chart for *Nano* by Mc Laughlin, version 4 (alto)

2 Tc 4	2 Tc 4 5	2 Tc 4 5 6	2 Tc 4 5 6 7	2 Tc 3	2 Tc 3 5	2 Tc 3 4
2 3 4 5 7	2 3 B♮ 4 5 7	2 3 4 B♭ 5 7	1 2 Tc	1 2 Tc 7	1 2 Tc 6	1 2 Tc 5
1 p Ta 5	1 p Ta 4	1 p Ta 4 5	1 p Ta 4 5 E♭	1 p Ta 4 5 6 E♭	1 p Ta 4 5 6	

Appendix M: Fingering pattern chart for *Nano* by Mc Laughlin, version 4 (alto)

2 Tc 3 4 5	2 Tc 3 4 5 6 E♭	2 Tc 3 4 5 6	2 Tc 3 B♮ 4 5 6	2 Tc 3 4 B♭ 5 6		2 Ta
1 2 Tc 4	1 2 Tc 4 5	1 2 Tc 4 5 E♭	1 2 Tc 4 5 6 E♭	1 2 Tc 4 5 6	1 2 Tc 4 5 6 7	1 2 Tc 3
		1 p Ta 4 5 6 7		1 p B♮ Ta 4 5 6 7		
						1 2 G♯ 3 Tf 7

Appendix M: Fingering pattern chart for *Nano* by Mc Laughlin, version 4 (alto)

2 Ta 5	2 Ta 4	2 Ta 4 5	2 Ta 4 5 6	2 Ta 4 5 6 7	2 3 Ta	2 3 Ta 5
1 2 Tc 3 7	1 2 Tc 3 6	1 2 Tc 3 5	1 2 Tc 3 4	1 2 Tc 3 4 5 E♭	1 2 Tc 3 4 5	1 2 Tc 3 4 5 7
1 2 3 B♮ Tf 7	1 2 3 C♯ Tf 7	1 2 3 B♭ Tf 7	1 2 G♯ 3 7	1 2 3 C♯ 7	1 2 3 B♮ 7	1 2 3 B♭ 7

Appendix M: Fingering pattern chart for *Nano* by Mc Laughlin, version 4 (alto)

2 3 Ta 4	2 3 Ta 4 5	2 3 Ta 4 5 6			
1 2 Tc 3 4 5 7	1 2 Tc 3 B♮ 4 5 7	1 2 Tc 3 4 B♭ 5 7	1 Ta	1 Ta 7	1 3 Ta 7
					1 p G♯
1 2 4 B♭ 5 6 7					

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Third-tone scale starting on D4

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

D4 +1/3

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

D4 +2/3

	1	
	2	
	3	B♮
	4	
	6	

E4 +1/3

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

E4 +2/3

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Third-tone scale starting on D4

	8			8			
	x	c4		x	c4		
	1	c2 / c1		1	c2 / c1	1	1
	p			p			
c3	2	G♯	c3	2	G♯	2	2
Tc	3	B♮ / C♯	Tc	3	B♮ / C♯		
Ta	4	B♭	Ta	4	B♭	4	4
c5	5		c5	5		5	5
Tf	6		Tf	6		6	
	E♭ / 7			E♭ / 7			
F♯4 +1/3			F♯4 +2/3			G♯4 +1/3	G♯4 +2/3

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Third-tone scale starting on D4

8		8	
x c4		x c4	
1 c2 / c1	1	1 c2 / c1	c1
p		p	
c3 2 G♯	2	c3 2 G♯	2
Tc 3 B♮ / C♯	Tc	Tc 3 B♮ / C♯	
Ta 4 B♭	4	Ta 4 B♭	
c5 5	5	c5 5	
Tf 6	6	Tf 6	
E♭ / 7	7	E♭ / 7	
A♯4 +1/3	A♯4 +2/3	C5 +1/3	C5 +2/3

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Third-tone scale starting on D4

1
c3 2
3
4
5
6

D5 +1/3

c4
c2
c3
6

D5 +2/3

8
1 c2
2
3 B♮
4
c5
6

E5 +1/3

8
1 c2
2
3
4 B♭
5
7

E5 +2/3

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Third-tone scale starting on D4

	8			8			8			8	
				x	c4						
	1			1	c2 / c1		1			1	
				p							
	2		c3	2	G♯		2			2	
	3	B♮	Tc	3	B♮ / C♯						
			Ta	4	B♭		4		Ta	4	B♭
			c5	5						5	
Tf	6		Tf	6						6	
	7			E♭ / 7						7	
F♯5 +1/3			F♯5 +2/3			G♯5 +1/3			G♯5 +2/3		

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Third-tone scale starting on D4

8	8	8	8
x c4			
1 c2 / c1	1		1 c1
p			
c3 2 G♯		2	
Tc 3 B♮ / C♯		Tc	
Ta 4 B♭	Ta	Ta 4	Ta
c5 5		5	
Tf 6		6	6
E♭ / 7	7	7	
A♯5 +1/3	A♯5 +2/3	C6 +1/3	C6 +2/3

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Third-tone scale starting on D4

8

c2

2

Ta

D6 +1/3

8

c2 / c1

p

D6 +2/3

8

c4

c2

E6 +1/3

8

c1

p

c5

E6 +2/3

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D4

	1	
	2	
	3	
	4	
	5	
	6	
	E♭ / 7	

D4 +1/5

	1	
	2	
	3	C♯
	4	
	5	
	6	
	E♭ / 7	

D4 +2/5

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

D4 +3/5

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

D4 +4/5

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D4

	1	
	2	
	3	
	4	B♭
	6	
	7	

E4 +1/5

	1	
	2	
	3	
	4	B♭
	6	

E4 +2/5

	1	
	2	
	3	C♯
	4	
	5	
Tf	6	
	7	

E4 +3/5

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

E4 +4/5

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D4

	1	
	2	
	3	C♯
	5	
Tf		
	7	

F♯4 +1/5

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

F♯4 +2/5

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

F♯4 +3/5

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

F♯4 +4/5

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D4

G♯4 +1/5	G♯4 +2/5	G♯4 +3/5	G♯4 +4/5
1	1	1	1
2	2	2	2
	B♮	3	3
4 B♭	4	Ta 4	Ta
5	5	5	
	Tf	6	
7			

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D4

1	1		
		2	2
	3	Tc 3	3
Ta 4		4	4
5			5
6			6
E♭			7
A♯4 +1/5	A♯4 +2/5	A♯4 +3/5	A♯4 +4/5

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D4

8			
1	1 c1	1	1 c1
2	2	c3 2	2
3		3	3 C♯
4		4	4
5			5
6			6
7			7
C5 +1/5	C5 +2/5	C5 +3/5	C5 +4/5

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D4

x	c4	c4	
1	1	1	
2	2	2	2
3 B♮	3	3	
4	4	4	
5	5	5	c5
6	6	6	
7	7		
D5 +1/5	**D5 +2/5**	**D5 +3/5**	**D5 +4/5**

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D4

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

E5 +1/5

	8	
	1	
	2	
	3	C♯
	4	
Tf	6	

E5 +2/5

	8	
	1	
	2	
	3	
	4	
	5	
Tf	6	
	E♭	

E5 +3/5

	8	
	1	
	2	
	3	
	4	B♭
c5		
	6	
	7	

E5 +4/5

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D4

	8	
	1	
	2	
	3	B♮ / C♯
	6	
	7	

F♯5 +1/5

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

F♯5 +2/5

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

F♯5 +3/5

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

F♯5 +4/5

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D4

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

G♯5 +1/5

	8	
	1	
	2	
	4	
	6	
	7	

G♯5 +2/5

	8	
	1	
	2	
		B♮

G♯5 +3/5

	8	
	1	
	2	
	3	B♮
Ta		
	6	

G♯5 +4/5

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D4

	8	
	1	
	p	
Ta	4	
	5	
	6	

A♯5 +1/5

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

A♯5 +2/5

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

A♯5 +3/5

	8	
	1	
	2	
Tc		

A♯5 +4/5

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D4

8
1
2
3 B♮
4
7

C6 +1/5

8
2
3 B♮
4
6
7

C6 +2/5

8
Tc

C6 +3/5

8
1 c1
p
Tc

C6 +4/5

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D4

D6 +1/5	D6 +2/5	D6 +3/5	D6 +4/5
8	8	8	8
			x
1 c2	c2	1 c2 / c1	
2	2	2	2
3	Tc	3	3
4			4 B♭
		6	6
7		7	7

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D4

E6 +1/5	E6 +2/5	E6 +3/5	E6 +4/5
8 x c2 / c1 2	8 c4 1 c2 / c1	8 c4 1 2	8 c4 2 4 c5 6 7

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Third-tone scale starting on D♯4

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

D♯4 +1/3

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

D♯4 +2/3

	1	
	2	
	3	
	5	
	6	
	7	

F4 +1/3

	1	
	2	
	3	
	5	
Tf		

F4 +2/3

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Third-tone scale starting on D♯4

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

G4 +1/3

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

G4 +2/3

	1	
	3	
	4	
Tf		

A4 +1/3

	1	
	p	
		G♯
Ta		

A4 +2/3

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Third-tone scale starting on D♯4

2
3

B4 +1/3

2
Tc
Tf

B4 +2/3

c4
1
2
3 B♮
4
5
6
7

C♯5 +1/3

c3 2
4

C♯5 +2/3

Third-tone scale starting on D♯4

							8			8	
							x	c4			
	1			1			1	c2 / c1		1	
							p				
	2					c3	2	G♯		2	
	3					Tc	3	B♮ / C♯		3	
	4					Ta	4	B♭			B♭
c5	5		c5			c5	5			5	
	6					Tf	6			6	
							E♭ / 7			7	
D♯5 +1/3			D♯5 +2/3			F5 +1/3			F5 +2/3		

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Third-tone scale starting on D♯4

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

G5 +1/3

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

G5 +2/3

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

A5 +1/3

8
1
3
4
5
6
E♭

A5 +2/3

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Third-tone scale starting on D♯4

8	8	8	8
1	1 c1	c1	1 c2
2	2	2	
Tc			
4			Ta
B5 +1/3	B5 +2/3	C♯6 +1/3	C♯6 +2/3

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Third-tone scale starting on D♯4

8
x
2
3
6

D♯6 +1/3

8
c1
c3

D♯6 +1/3

8
c2 / c1
c3
c5

F6 +1/3

8
x c4
1 c2 / c1
p
c3 2 G♯
Tc 3 B♮ / C♯
Ta 4 B♭
c5 5
Tf 6
E♭ / 7

F6 +2/3

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D♯4

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

D♯4 +1/5

	1	
	2	
	3	B♮
	4	
	5	
	7	

D♯4 +2/5

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

D♯4 +3/5

	1	
	2	
	3	
	4	
	6	
	7	

D♯4 +4/5

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D♯4

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

F4 +1/5

	1	
	2	
	3	B♮
	5	
	6	

F4 +2/5

	1	
	2	
	3	C♯
	5	
Tf	6	
	7	

F4 +3/5

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

F4 +4/5

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D♯4

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

G4 +1/5

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

G4 +2/5

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

G4 +3/5

	1	
	2	
		C♯
	4	
	5	
	6	
	7	

G4 +4/5

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D♯4

A4 +1/5	A4 +2/5	A4 +3/5	A4 +4/5
1	1 p	1	
2	2 G♯	2	2
3	3		3 C♯
Ta		4 B♭	4
		5	5
6		6	6
		7	7

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D♯4

8
1
2
3 B♮
4
5
6
7

B4 +1/5

1
p
Tc
Ta

B4 +2/5

2
Tc 3
4
5

B4 +3/5

1 c1
2
3
4 B♭
5
6
7

B4 +4/5

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D♯4

C♯5 +1/5	C♯5 +2/5	C♯5 +3/5	C♯5 +4/5
1 c2 2 3	x 2 3 5 6 7	x 1 2 3 5	8 1 2 3 4 5 6 E♭ / 7

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D♯4

D♯5 +1/5	D♯5 +2/5	D♯5 +3/5	D♯5 +4/5
8		8	8
1	1	1	1
2	2	2	2
3 B♮	3	3	3 B♮
4	4	4	4
5	c5 5	5	
	6		6
7	E♭	E♭	

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D♯4

	8	
	1	
	2	
	3	B♮
	5	
	6	

F5 +1/5

	8	
	1	
	2	
	3	
	4	
	5	
Tf		

F5 +2/5

	8	
	1	
	2	
	3	
	4	B♭
Tf	6	
	7	

F5 +3/5

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

F5 +4/5

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D♯4

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

G5 +1/5

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

G5 +2/5

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

G5 +3/5

8
1
2
4
6

G5 +4/5

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D♯4

A5 +1/5	A5 +2/5		A5 +3/5			A5 +4/5	
8		8		8			8
				x	c4		
1		1		1	c2 / c1		1
				p			
2		2	c3	2	G♯		
		3	Tc	3	B♮ / C♯		
4	Ta		Ta	4	B♭	Ta	4
5			c5	5			5
6			Tf	6			6
		7		E♭ / 7			

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D♯4

	8			8			8			8	
	x	c4									
	1	c2 / c1									
	p										
c3	2	G♯		2			2			2	
Tc	3	B♮ / C♯							Tc		B♮
Ta	4	B♭	Ta	4		Ta	4			4	
c5	5						5				
Tf	6			6			6				
	E♭ / 7						7				
B5 +1/5			B5 +2/5			B5 +3/5			B5 +4/5		

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D♯4

8
1 c1
2
Tc
4
6
7

C♯6 +1/5

8
1 c1
Tc
Ta

C♯6 +2/5

8
c1
p
Tc
Ta

C♯6 +3/5

8
1
c3 2
Tc

C♯6 +4/5

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D♯4

8
c3
4
5
6
7

D♯6 +1/5

8
c4
1
Tc
Ta 4
5

D♯6 +2/5

8
c4
p

D♯6 +3/5

8
x
c3 2
3

D♯6 +4/5

Appendix N: Third-tone and fifth-tone fingering pattern charts (alto)

Fifth-tone scale starting on D♯4

8	8	8	8
	1	1	1
c3 2	2	2 G♯	2
3		3	3
			4 B♭
c5	c5	c5	c5 5
			6
F6 +1/5	**F6 +2/5**	**F6 +3/5**	**F6 +4/5**

Appendix O: 31-tone notation comparison chart for concert pitch instruments and B♭ transposing instruments

Scala	C	C𝄲	C♯	D♭	D𝄳	D	D𝄲	D♯	E♭	E𝄳	E	F♭	E♯	F	F𝄲	F♯
duo hevans notation (written pitch)	D	D𝄲	D♯	E♭	E𝄳	E	E𝄲	F𝄳	F	F𝄲	F♯	G♭	G𝄳	G	G𝄲	G♯

Scala	G♭	G𝄳	G	G𝄲	G♯	A♭	A𝄳	A	A𝄲	A♯	B♭	B𝄳	B	C♭	B♯	C
duo hevans notation (written pitch)	A♭	A𝄳	A	A𝄲	A♯	B♭	B𝄳	B	B𝄲	C𝄳	C	C𝄲	C♯	D♭	D𝄳	D

Appendix P: 31-tone fingering pattern chart (tenor)

1	
2	
3	B♮
4	
5	
6	

D4

1	
2	
3	C♯
4	
5	
6	

D𝄲4

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

D♯4

1
2
3
4
5
6
E♭

E♭4

Appendix P: 31-tone fingering pattern chart (tenor)

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

E𝄳4

1	
2	
3	C♯
4	
5	
7	

E4

1	
2	
3	B♮
4	
5	
E♭	

E𝄲4

1	
2	
3	C♯
4	
6	

F𝄳4

Appendix P: 31-tone fingering pattern chart (tenor)

						8	
						x	c4
1		1	1			1	c2 / c1
						p	
2		2	2		c3	2	G♯
3	C♯	3	3	C♯	Tc	3	B♮ / C♯
4					Ta	4	B♭
		5	5		c5	5	
		6			Tf	6	
7		7	7			E♭ / 7	
F4		F♮4	F♯4		G♭4		

Appendix P: 31-tone fingering pattern chart (tenor)

1	1	1	1
2	2	2	2 G♯
3	3	3	3
		B♭	
(½)6		(½)6	(½)6
7	E♭	7	7
G𝄳4	G4	G𝄲4	G♯4

Appendix P: 31-tone fingering pattern chart (tenor)

A♭4	A𝄳4	A4	A𝄲4
1	1	1	1
2	2	2	2
			C♯
4 B♭	4		
5		5	
6	6	6	
		E♭	E♭ / 7

Appendix P: 31-tone fingering pattern chart (tenor)

1	1	1	1
		p	
2	2		
3			
Ta	Ta	Ta	
		6	(½)6
7	7		7
A♯4	B♭4	B𝄳4	B4

Appendix P: 31-tone fingering pattern chart (tenor)

B𝄲4	C𝄳5	C5	C𝄲5
1 C♯ Ta	1 2 Tc B♮ 4 5 6	1 2 Tc Ta	2 Ta

Appendix P: 31-tone fingering pattern chart (tenor)

1 c1
p
4
5
6
7

C♯5

1 c1
p
4
6
7

D♭5

1 c1
Ta

D𝄳5

c1
2
Tc

D5

Appendix P: 31-tone fingering pattern chart (tenor)

8	8	8	8
1	1	1	1
2	2	2	2
3 C♯	3	3	3
4	4	4	4
5	5	5	5
6	6	6	
	E♭ / 7	E♭	7
D𝄲5	D♯5	E♭5	E𝄳5

Appendix P: 31-tone fingering pattern chart (tenor)

	8	
	1	
	2	
	3	C♯
	4	
	5	
	7	

E5

	8	
	1	
	2	
	3	B♮
	4	
	7	

E𝄲5

	8	
	1	
	2	
	3	C♯
	4	
	6	

F𝄳5

	8	
	x	c4
	1	c2 / c1
	p	
c3	2	G♯
Tc	3	B♮ / C♯
Ta	4	B♭
c5	5	
Tf	6	
	E♭ / 7	

F5

Appendix P: 31-tone fingering pattern chart (tenor)

8	8	8	8
1	1	1	1
2	2	2	2
3 C♯	3 C♯	3 C♯	3 C♯
5		5	
6	6		Tf 6
7	7	7	
F𝄲5	F♯5	G♭5	G𝄳5

Appendix P: 31-tone fingering pattern chart (tenor)

8	8	8	8
1	1	1	1
2	2	2 G♯	2 G♯
3	3	3	3
	B♭		
	(½)6	(½)6	Tf
E♭ / 7	7	7	E♭
G5	G𝄲5	G♯5	A♭5

Appendix P: 31-tone fingering pattern chart (tenor)

A𝄳5	A5	A𝄲5	A♯5
8	8	8	8
1	1	1	1
2	2	2 G♯	2
			3
4 B♭			Ta
5	5		
6	6		
7	E♭		7

Appendix P: 31-tone fingering pattern chart (tenor)

B♭5	B𝄳5	B5	B𝄲5
8	8	8	8
1	1	1	1
	p		
2			
			C♯
Ta	Ta		Ta
	6	(½)6	
7		7	

Appendix P: 31-tone fingering pattern chart (tenor)

C𝄳6	C6	C𝄲6	C♯6
8	8	8	8
1	1		
2	2	2	
Tc	Tc	Tc	3 B♮
4	Ta	Ta	4

Appendix P: 31-tone fingering pattern chart (tenor)

D♭6	D𝄳6	D6	D𝄲6
8	8	8	8
1 c1	1 c1	c1	1 c2 / c1
		2	2
		Tc	
Ta 4	Ta		

Appendix P: 31-tone fingering pattern chart (tenor)

D♯6	E♭6	E𝄳6	E6
8	8	8	8
c2			
	c3 2	c3	c3
			Tc
4			Ta
5	5	5	
6			
		7	

Appendix P: 31-tone fingering pattern chart (tenor)

8

c2

c3

E𝄲6

8

c4

c2

2

4

F𝄳6

8

c4

c3

F6

Appendix Q: Extreme fingering patterns for microtonality. Part two – taking away keys (alto)

For each semitone pitch the standard fingering pattern is given, followed by a table which shows the pitches which result from taking away each key (palettes only) from the standard semitone fingering pattern. The resulting pitches are documented in cents difference from the closest note.

B♭3

1

2
3
4 B♭
5
6
7

Key removed	1	2	3[112]	4	5	6
Resulting pitch	C5 -15 cents	B♭4 +20	B♭4 +20	F♯4 -47	E4 +38	E4 -24

[112] Also sounds G4 +36.

Appendix Q: Extreme fingering patterns for microtonality. Part two – taking away keys (alto)

B3

1

2

3 B♮

4

5

6

7

Key removed	1	2	3	4	5	6
Resulting pitch	C5 +12	B4 +6	G♯4 +25	F♯4 -48	F4 -48	E4 -23

Appendix Q: Extreme fingering patterns for microtonality. Part two – taking away keys (alto)

C4

1

2

3

4

5

6

7

Key removed	1	2	3	4	5	6
Resulting pitch	C5 -41	A4 -12	G♯4 +46	F♯4 -32	F4 -43	E4 -21

Appendix Q: Extreme fingering patterns for microtonality. Part two – taking away keys (alto)

C♯4

1

2

3 C♯

4

5

6

7

Key removed	1	2	3	4	5	6
Resulting pitch	B4 -39	A4 +39	A4 -41	F♯4 -22	F4 -33	E4 -5

Appendix Q: Extreme fingering patterns for microtonality. Part two – taking away keys (alto)

D4

1

2

3

4

5

6

Key removed	1	2	3	4	5	6
Resulting pitch	B4 +13	A4 +37	A4 -34	F♯4 -17	F4 -28	n/a

Appendix Q: Extreme fingering patterns for microtonality. Part two – taking away keys (alto)

E♭4

1

2

3

4

5

6

E♭

Key removed	1	2	3	4	5	6
Resulting pitch	B4 +33	A♯4 +49	A4 -36	F♯4 -9	F4 -13	E4 +13

Appendix Q: Extreme fingering patterns for microtonality. Part two – taking away keys (alto)

E4

1

2

3

4

5

Key removed	1	2	3	4	5	6
Resulting pitch	C5 -46	A♯4 -46	A4 +34	n/a	n/a	n/a

Appendix Q: Extreme fingering patterns for microtonality. Part two – taking away keys (alto)

F4

1

2

3

4

Key removed	1	2	3	4	5	6
Resulting pitch	C5 -38	A♯4 -38	A4 -35	n/a	n/a	n/a

Appendix Q: Extreme fingering patterns for microtonality. Part two – taking away keys (alto)

F♯4

1

2
3

5

Key removed	1	2	3	4	5	6
Resulting pitch	C5 -25	A♯4 -32	A4 -16	n/a	n/a	n/a

Appendix Q: Extreme fingering patterns for microtonality. Part two – taking away keys (alto)

G4[113]

1
p
2
3

Key removed	1	2	2 + p	3	4	5	6
Resulting pitch	C5 -33	A♯4 -39	B4 -20	n/a	n/a	n/a	n/a

[113] The notes G4, G♯4, G5, and G♯5, are the only ones where it is possible to remove the *p* key independently of key *2*.

Appendix Q: Extreme fingering patterns for microtonality. Part two – taking away keys (alto)

G♯4

1
p
2 G♯
3

Key removed	1	2	2 + p	3	4	5	6
Resulting pitch	C5 -19	A♯4 -22	B4 -12	A4 +15	n/a	n/a	n/a

Appendix Q: Extreme fingering patterns for microtonality. Part two – taking away keys (alto)

A4[114]

1

2

Key removed	1	2	3	4	5	6
Resulting pitch	n/a	n/a	n/a	n/a	n/a	n/a

[114] There are no keys which can be taken away from this fingering pattern.

Appendix Q: Extreme fingering patterns for microtonality. Part two – taking away keys (alto)

B♭4

1

p

Key removed	1	2	3	4	5	6
Resulting pitch	C♯5 -3	n/a	n/a	n/a	n/a	n/a

Appendix Q: Extreme fingering patterns for microtonality. Part two – taking away keys (alto)

B♭4 (alternative fingering pattern)

1

2

Ta

Key removed	1	2	3	4	5	6
Resulting pitch	C5 +2	A♯4 +30	n/a	n/a	n/a	n/a

Appendix Q: Extreme fingering patterns for microtonality. Part two – taking away keys (alto)

B♭4 (alternative fingering pattern)[115]

8

1

2
3
4 B♭
5
6
7

Key removed	1	2	3	4	5	6
Resulting pitch	C5 +14	B4 -25	G♯5 +25	F♯5 +24	F♯5 -48	F5 +28

[115] The previous two fingering patterns for B♭4 use only two palette keys. This alternative, which uses the fingering patterns for B♭3 with the addition of the octave key, therefore provides more possibilities.

Appendix Q: Extreme fingering patterns for microtonality. Part two – taking away keys (alto)

B4 (alternative fingering pattern)[116]

8

1

2

3 B♮

4

5

6

7

Key removed	1	2	3	4	5	6
Resulting pitch	C5 +38	B4 +41	A5 -39	G5 -47	F♯5 +10	E♭5 +37

[116] The notes B4 and C5 are typically played using only one palette (key). Therefore, alternative fingering patterns, those for the notes one octave lower, with the addition of the octave key, have been studied here.

Appendix Q: Extreme fingering patterns for microtonality. Part two – taking away keys (alto)

C5 (alternative fingering pattern)

8

1

2

3

4

5

6

7

Key removed	1	2	3	4	5	6
Resulting pitch	C♯5 -35	A♯4 -9	A5 -15	G5 +12	E5 -3	E5 -31

Appendix Q: Extreme fingering patterns for microtonality. Part two – taking away keys (alto)

C♯5 (alternative fingering pattern)

8

1

2

3 C♯

4

5

6

7

Key removed	1	2	3	4	5	6
Resulting pitch	C♯5 +24	A♯4 +17	A5 +8	D6 -12	F5 -46	E5 -9

Appendix Q: Extreme fingering patterns for microtonality. Part two – taking away keys (alto)

D5

8

1

2

3

4

5

6

Key removed	1	2	3	4	5	6
Resulting pitch	C5 -48	A♯4 +12	A5 +40	F♯5 -40	F5 -42	n/a

Appendix Q: Extreme fingering patterns for microtonality. Part two – taking away keys (alto)

E♭5

8

1

2

3

4

5

6

E♭

Key removed	1	2	3	4	5	6
Resulting pitch	C5 -25	A♯4 +34	A♯5 -14	F♯5 -11	F5 -14	E5 +24

E5

8

1

2

3

4

5

Key removed	1	2	3	4	5	6
Resulting pitch	C5 -6	A♯4 +39	A5 -49	n/a	n/a	n/a

Appendix Q: Extreme fingering patterns for microtonality. Part two – taking away keys (alto)

F5

8

1

2

3

4

Key removed	1	2	3	4	5	6
Resulting pitch	C5 +5	A♯4 +24	A5 -32	n/a	n/a	n/a

Appendix Q: Extreme fingering patterns for microtonality. Part two – taking away keys (alto)

F♯5

8

1

2

3

5

Key removed	1	2	3	4	5	6
Resulting pitch	C5 +6	A♯4 +44	A5 -11	n/a	n/a	n/a

Appendix Q: Extreme fingering patterns for microtonality. Part two – taking away keys (alto)

G5

8

1
p
2
3

Key removed	1	2	2 + p	3	4	5	6
Resulting pitch	C5 +10	A♯5 -28	B4 +25	n/a	n/a	n/a	n/a

Appendix Q: Extreme fingering patterns for microtonality. Part two – taking away keys (alto)

G♯5

8

1
p
2 G♯
3

Key removed	1	2	2 + p	3	4	5	6
Resulting pitch	C5 +10	A♯4 +31	B4 +24	A5 +24	n/a	n/a	n/a

Appendix Q: Extreme fingering patterns for microtonality. Part two – taking away keys (alto)

A5[117]

8

1

2

Key removed	1	2	3	4	5	6
Resulting pitch	n/a	n/a	n/a	n/a	n/a	n/a

[117] There are no keys which can be taken away from this fingering pattern.

Appendix Q: Extreme fingering patterns for microtonality. Part two – taking away keys (alto)

B♭5

8

1

p

Key removed	1	2	3	4	5	6
Resulting pitch	C♯6 -9	n/a	n/a	n/a	n/a	n/a

Appendix R: Microtonal slap-tonguing (tenor)

The fingering patterns used for this appendix are those I use for playing a quarter-tone scale on the tenor saxophone. It starts on D𝄲4.

Semitone pitches for the notes lower than this have also been included, alongside a number of alternative fingering patterns.

The sounding pitches documented are those that result from slap-tonguing (secco or standard) the given fingering pattern.

Some of the fingering patterns can also be used to sound multiphonics. Where two notes have been given, both sound when playing a slap-tongue using the fingering pattern.

Appendix R: Microtonal slap-tonguing (tenor)

1

2

3

4 B♭

5

6

7

Fingering pattern for	B♭3
Sounding pitch	B↑♭3

1

2

3 B♮

4

5

6

7

Fingering pattern for	B3
Sounding pitch	B↑♮3

1

2

3

4

5

6

7

Fingering pattern for	C4
Sounding pitch	C↑♮4

1

2

3 C♯

4

5

6

7

Fingering pattern for	C♯4
Sounding pitch	C↑♯4

Appendix R: Microtonal slap-tonguing (tenor)

1
2
3
4 B♭
5
6

Fingering pattern for	D𝄳4
Sounding pitch	D𝄲4

1
2
3
4
5
6

Fingering pattern for	D4
Sounding pitch	D♮↑4

1
2
3
4
5
6
E♭ / 7

Fingering pattern for	D𝄲4
Sounding pitch	D♯↓4

1
2
3 C♯
4
5
6
E♭

Fingering pattern for	E♭4
Sounding pitch	E♭↓4

Appendix R: Microtonal slap-tonguing (tenor)

1

2

3

4 B♭

5

7

Fingering pattern for	E𝄳4
Sounding pitch	E♭4

1

2

3

4

5

Fingering pattern for	E4
Sounding pitch	E♮↑4

1

2

3 B♮

4

6

7

Fingering pattern for	E𝄲4
Sounding pitch	E𝄲4/F♯↓5/ C♮↑6

1

2

3

4

Fingering pattern for	F4
Sounding pitch	F♮↑4

Appendix R: Microtonal slap-tonguing (tenor)

1
2
3
B♭
5
6
7

Fingering pattern for	F𝄲4
Sounding pitch	G𝄳4

1
2
3
5

Fingering pattern for	F♯4
Sounding pitch	F♯↑4

1
2
3
Tf 6
E♭

Fingering pattern for	G𝄳4
Sounding pitch	G♮↓4

1
2
3

Fingering pattern for	G4
Sounding pitch	G♮↑4

Appendix R: Microtonal slap-tonguing (tenor)

1

2 G♯

3

(½)6

Fingering pattern for	G♯4
Sounding pitch	G♯4

1

2 G♯

3

Fingering pattern for	G♯4
Sounding pitch	G𝄰4

1

2

B♮

4

5

6

7

Fingering pattern for	A𝄳4
Sounding pitch	A𝄯4/A𝄯5

1

2

Fingering pattern for	A4
Sounding pitch	A𝄮4

Appendix R: Microtonal slap-tonguing (tenor)

1
2
3
Ta B♭
5
6
7

Fingering pattern for	A𝄲4
Sounding pitch	A♯5

1
2
Ta

Fingering pattern for	B♭4
Sounding pitch	B♭4

1
p

Fingering pattern for	B♭4 alternative
Sounding pitch	B♭4

8
1
2
3
4 B♭
5
6
7

Fingering pattern for	B♭4 alternative
Sounding pitch	B 𝄳4/F𝄲5

Appendix R: Microtonal slap-tonguing (tenor)

1
C♯
Ta
6

Fingering pattern for	B𝄳4
Sounding pitch	B♮↓4

1

Fingering pattern for	B4
Sounding pitch	B♮↑4

8
1
2
3 B♮
4
5
6
7

Fingering pattern for	B4 alternative
Sounding pitch	F♯↑5

1
2
Tc 3
4

Fingering pattern for	B𝄲4
Sounding pitch	C♮↓5

Appendix R: Microtonal slap-tonguing (tenor)

2

Fingering pattern for	C5
Sounding pitch	C♯↓5

8

1

2

3

4

5

6

7

Fingering pattern for	C5 alternative
Sounding pitch	C♮↑5/G5

1 c1

2

3

4

Fingering pattern for	C𝄲5
Sounding pitch	C♯↓5

1 c1

2

Fingering pattern for	C♯5
Sounding pitch	C♯↑5

Appendix R: Microtonal slap-tonguing (tenor)

8

1

2

3 C♯

4

5

6

7

Fingering pattern for	C♯5 alternative
Sounding pitch	D♮↓5

c1

2

3

4 B♭

5

Tf 6

Fingering pattern for	D𝄳5
Sounding pitch	D♮↓5

8

1

2

3

4

5

6

Fingering pattern for	D5
Sounding pitch	D♮↓5

c2 / c1

2

Tc

Ta 4

Fingering pattern for	D𝄲5
Sounding pitch	D5

Appendix R: Microtonal slap-tonguing (tenor)

8
1
2
3 B♮
4
5
6
E♭

Fingering pattern for	E♭5
Sounding pitch	E↑♭5

c2
2
3

Fingering pattern for	E𝄳5
Sounding pitch	E↓♮5

8
1
2
3
4
5

Fingering pattern for	E5
Sounding pitch	E↑♮5

8
1 c1
c3 2
4
c5 5

Fingering pattern for	E𝄲5
Sounding pitch	F↓♮5

Appendix R: Microtonal slap-tonguing (tenor)

8
1
2
3
4

Fingering pattern for	F5
Sounding pitch	F𝄲5

8
1
2
3
4 B♭
5
Tf

Fingering pattern for	F𝄲5
Sounding pitch	F𝄲5/C𝄰6

8
1
2
3
5

Fingering pattern for	F♯5
Sounding pitch	F𝄰5

8
1
2
3 C♯
Tf 6
E♭

Fingering pattern for	G𝄳5
Sounding pitch	G𝄭5

Appendix R: Microtonal slap-tonguing (tenor)

8

1

2

3

Fingering pattern for	G5
Sounding pitch	G♮↑5

8

1

2 G♯

3

(½)6

Fingering pattern for	G𝄲5
Sounding pitch	G♯↓5

8

1

2 G♯

3

Fingering pattern for	G♯5
Sounding pitch	G♯5

8

1

2

B♭

4

5

6

Fingering pattern for	A𝄳5
Sounding pitch	A♮↓5/B♮↓5

Appendix R: Microtonal slap-tonguing (tenor)

8

1

2

Fingering pattern for	A5
Sounding pitch	A♮↑5

8

1

3

4

5

7

Fingering pattern for	A♯5
Sounding pitch	B♮↓4/B♮↓5

8

1

p

Fingering pattern for	B♭5
Sounding pitch	B♭5

8

1

2

Ta

Fingering pattern for	B♭5 alternative
Sounding pitch	B♭↑5

Appendix R: Microtonal slap-tonguing (tenor)

8

1

2

3 C♯

Ta 4

5

6

7

Fingering pattern for	B𝄳5
Sounding pitch	B4

8

1

Fingering pattern for	B5
Sounding pitch	B𝄲5

8

1

2

Tc

4 B♭

6

Fingering pattern for	B𝄲5
Sounding pitch	B𝄲5

8

2

Fingering pattern for	C6
Sounding pitch	C♮↑6

Appendix R: Microtonal slap-tonguing (tenor)

8

1 c1

2

Fingering pattern for	C𝄲6
Sounding pitch	C♯6/E𝄮6

8

Fingering pattern for	C♯6
Sounding pitch	D𝄳6

8

1 c1

2

Tc

4

Fingering pattern for	D𝄳6
Sounding pitch	D6

8

c1

Fingering pattern for	D6
Sounding pitch	E♭6

Appendix R: Microtonal slap-tonguing (tenor)

8

c2

1

Tc

4

Fingering pattern for	D𝄲6
Sounding pitch	D♯↓6

8

c2 / c1

Fingering pattern for	E♭6
Sounding pitch	E♭↑6

8

c1

c3 2

4

Fingering pattern for	E𝄳6
Sounding pitch	E♮↓6

8

c2 / c1

c3

Fingering pattern for	E6
Sounding pitch	F6

Appendix R: Microtonal slap-tonguing (tenor)

8

c4

Tc

Fingering pattern for	E𝄲6
Sounding pitch	F♮↓6

8

c4

c2 / c1

c3

Fingering pattern for	F6
Sounding pitch	F6

8

c2 / c1

2

c5

Fingering pattern for	F𝄲6
Sounding pitch	F5

8

c4

c2 / c1

c3

c5

Fingering pattern for	F♯6
Sounding pitch	F♮↑5