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Microtonality as an Expressive Device: an Approach for the Contemporary Saxophonist

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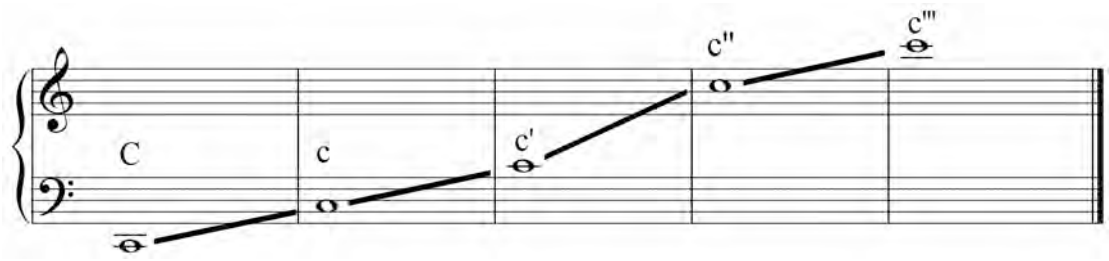
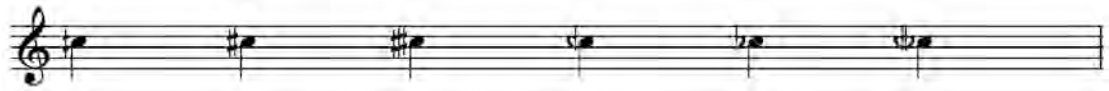
Terminology

When referring to pitch the dissertation will use the Helmholtz System.

- C two octaves below middle c is C
- Use capital letters up to B below tenor C
- Tenor C, the C below middle c is c (lower case)
- Lower case letters up to B below middle c
- Middle c is c'
- C above that is c"
- C above that is c"' et cetera



When referring to quarter tones this dissertation will use the following notation for quarter sharp, sharp, three-quarters sharp and quarter flat, flat, three-quarters flat.



Abstract

This dissertation provides a critical examination of the use of microtonality as an expressive tool for the improvising saxophonist and offers a new method for quarter-tone production drawing on cultural references from European art music, Arabic *Maqam* and Contemporary Jazz. The thesis is underpinned by an historical, musicological analysis of tuning systems and theory necessary for the performer of microtonal music. The dissertation is presented in three chapters. In Chapter One, a discussion of tuning theory and a history of temperament systems contextualises the current uses of equal temperament and extensions of it including the quarter-tone tempered system. Chapter Two introduces the breadth and influence of microtonal music from European art music, regional folk music and contemporary jazz while specifically analysing two exemplary case studies – the Arabic *Maqam* system and the music of the contemporary jazz saxophonist, Hayden Chisholm. Chapter Three presents the development of a new method, discussing microtonality as an expressive device for the contemporary saxophonist. This method demonstrates the use of the saxophone in microtonal music, looking at quarter-tone technical issues and the use of quarter tones in improvisation and composition within a jazz context. First, this research proves and demonstrates how the saxophone as an instrument of non-fixed intonation and therefore not confined to a fixed or single temperament system may, through a systemised method to mastering production of microtonal notes, be vastly increased in its expressive and melodic potential. Second, it demonstrates how an understanding of the history and nuance of tuning systems and alternative temperaments provides the required knowledge for effective communication and notation of the duality of contemporary intuitive, improvising performance / composition. Third, it establishes that cross-cultural studies most effectively provide the systematic, underpinning knowledge required to support the contemporary performer, drawing on ancient traditions of microtonality alongside recent innovations in contemporary music. Finally, the dissertation demonstrates that quarter-tone production is a proven viable addition to the contemporary saxophonist's toolkit, and that it has far reaching implications for the saxophonist leading him/her to a position of greater expressive potential.

Introduction

This dissertation provides a critical examination of the use of microtonality as an expressive tool for the improvising saxophonist.

The research investigates the history and development of tuning systems and alternative temperaments and illustrates how an understanding of these elements is essential for today's saxophonist. Acknowledging the saxophone as an instrument of non-fixed intonation and therefore not confined to a fixed or single temperament system, the acoustic properties of saxophone tone production, cross-fingerings and microtonal production are examined. With this knowledge at hand, the saxophonist will have a harmonic freedom, which is not bound by the pitch limitations of twelve-tone equal temperament and can utilise a more nuanced pitch-world, drawing on an infinite number of pitches as well as a developed approach to quarter-tone equal temperament production.

Chapter One presents a discussion of tuning theory and a history of temperament systems contextualising the current uses of equal temperament and extensions of it including the quarter-tone tempered system. An understanding of the history and nuance of tuning systems and alternative temperaments provides the required knowledge for effective pitch manipulation outside of the twelve-tone model.

In Chapter Two the use of microtonality is discussed with reference to contemporary classical, folk and jazz music. Two case studies are considered, where a systemised use of microtonality is examined. The first case study demonstrates a systemised approach to the use of microtonal intervals and embellishments in Arabic music, an approach which is hundreds of years old. The second case study explores jazz saxophonist Hayden Chisholm's approach to the twenty-four note (quarter-tone) equally tempered scale. Chisholm's work with quarter tones establishes a new paradigm for improvising saxophonists interested in microtonality.[1] Both of these case studies focus on musical practices

[1] A full transcript of an interview with Mr. Chisholm on these issues is included in Appendix C.

which use improvisation as a core value, yet which also rely on compositional structures to further shape the music.

Chapter Three argues that despite this extensive tradition of exploration into tuning systems and pitch experimentation outside the equal temperament system, the saxophonist, in the main, has not engaged with these developments. This is a new field both in terms of academic research and in the challenges it presents for contemporary saxophonists. This dissertation represents an important academic investigation into the issues surrounding microtonal music for the saxophone. Current developments in this field are discussed alongside performance considerations, quarter-tone fingering charts[2], exercises and a guide to the use of microtonality as an expressive tool in improvisation.

The term microtonality is used in this work to refer to any tuning system outside of twelve-tone equal temperament which consciously contains intervals smaller than the conventional equally tempered Western semitone (which is measured as 100 cent parts). There are arguments (outlined in Chapter One) which suggest Just Intonation does not fit this classification and that there is a case for describing equal temperament itself as a microtonal temperament due to its deviation from the consonant naturally occurring overtone series. However, for the sake of clarity and in accordance with today's convention these arguments will be set aside.

[2] New fingering charts for quarter tones are included in Appendix A.

CHAPTER ONE

1.1 Tuning Theory

Much has been written concerning the nature of overtone structures and temperament. In this dissertation brief outlines of some of the physical principles relevant to temperament will be discussed.

To simplify the explanation of complex ratios, cents are used to measure note frequencies. Alexander Ellis developed this term in the late Nineteenth Century. A cent represents a one hundredth part of a semitone, or 1200 cents per octave. For the purpose of explaining a Pythagorean comma, in 1.2 below, a pure[3] fifth is measured as 702 cents.

1.1.1 Tuning Discrepancies

When pure fifths are tuned from the note c': c'- g', g'- d'', d''-a'', a''-e''', e'''-b''', b'''-f♯'''', f♯''''-c♯'''''', c♯''''''-g♯'''''', g♯''''''-e♭'''''', e♭''''''-b♭'''''', b♭''''''-f'''''', f''''''-c''''''' - the note c''''''' is arrived at again twelve fifths or seven octaves higher from the starting point. When tuning seven consecutive pure octaves starting from the same note c', a similar higher note is reached. However the difference between the two methods is a larger interval of twenty-four cents when moving in fifths. The twenty-four cent discrepancy is known as the Pythagorean comma.[4]

[3] Pure or beatless intervals are those, which sound without any pulsating frequencies and can be considered the aesthetic ideal in Western music.

[4] Also known as the ditonic comma. Although its discovery is commonly attributed to the Greek philosopher Pythagoras its existence has been documented in Babylonian texts from 3500 B.C.

Ex. 1.1 Pythagorean comma: mathematical illustration

12 (fifths) x 702 (pure fifth) = 8424 cents
7 (octaves) x 1200 (pure octave) = 8400 cents

24 cent discrepancy

Alongside the Pythagorean comma there is another tuning discrepancy known as the syntonic comma. This is illustrated by tuning four pure fifths from the note c': c'-g', g'-d", d"-a", a"-e'" the note e'" is arrived at two octaves higher. When this e'" is lowered two octaves it forms a major third in relation to c'. However this third is not pure (a pure major third measures 386 cents), but rather is quite sharp or wide (larger), and measures 408 cents. This twenty-two cent discrepancy is known as the syntonic comma.

Ex. 1.2 Syntonic comma: mathematical illustration

4 (fifths) x 702 (pure fifth) = 2808 cents
2 (octaves) = 2400 cents

2808 – 2400 (two octaves) = 408 cents (wide major third)
386 cents (pure major third)

22 cent discrepancy

1.2 Temperament for Keyboard Instruments

Faced with these discrepancies it becomes clear that pure octaves and pure fifths cannot both be present on an instrument with fixed intonation. Either the octaves can be tuned pure or the fifths can be tuned pure but because of the Pythagorean and the syntonic commas it is impossible to tune both sets of intervals pure.[5]

[5] "On keyboard instruments, tuning pure fifth intervals causes octaves to be out of tune. A temperament is a system in which the tuning of the fifths is altered to keep the octaves in tune and allow the use of all notes of the musical scale." - Donahue, Thomas: *A Guide to Musical Temperament* (Lanham, Maryland: The Scarecrow Press, 2005), 9.

To accommodate the tuning of a fixed intonation instrument (piano, harpsichord, accordion, harp, guitar, etc.) some notes need to be adjusted or 'tempered' to make them fit within an octave. The most common approach has been to tune the octaves pure (1200 cents), as this is the interval where beating tones are most noticeable if not tuned pure and to flatten some or all of the fifths so that their total value is twenty-four cents less (Pythagorean comma) than twelve pure fifths. The tempered scale is compromised by these adjustments: how noticeable this is and which intervals are detuned from their ideal pure state depends on the temperament chosen. In general the tendency is for the fifths to be a little narrower than pure, while fourths and major thirds are wider.

The laws of physics and the pitches of just intonation provide a genuine problem for the keyboard builder, balancing the need for both pure octaves and a serviceable scale. There is a long history of development, popularity and subsequent abandoning of various temperament systems among musicians and theoreticians. One important, but now obsolete, development in keyboard design was the use of split keys: as far back as 1555, Nicola Vicentino built the Archicembalo, a harpsichord with thirty six keys to an octave. This radical invention allowed the performer to play notes between B and C, E and F, which allowed the player to perform in just intonation and to modulate to more remote key centres. However, developments of this sort never gained mainstream acceptance. The general attitude then, as now, is that pure intervals may sound well and possibly produce better music but for the performer and instrument builder alike a shift of this sort requires a huge amount of effort. As Donahue points out, "a just scale is an ideal for the sake of pure intervals, temperament is a compromise for the sake of practicality."[6]

Prominent tuning theorists such as Andreas Werckmeister (1645 - 1706), Johann Georg Neidhardt (1685 - 1739) and Georg Andreas Sorge (1703 – 1778) did much to develop new temperaments which could accommodate the evolution of the increasingly chromatic musical styles of their time. As the need for 'circulating temperaments', which could transpose freely between the twelve keys, became more pressing (due to the level of harmonic complexity of the

[6] Donahue, 36.

music being composed in this period), some theorists argued the case for an even distribution of intervals across the octave. Depending on styles of music, instrumentation, and even venues and audience considerations, an equal temperament was seen to have its advantages over other unequal temperaments and *vice versa*. This attitude of flexibility in relation to choice of temperament, proved to be a balanced approach to a complex problem, which was concerned with how, fundamentally, could a keyboard instrument produce melody and harmony full of rich and resonant overtones. As Johann Mattheson wrote in 1731: "That the twelve semitones should be equal in size is not the purpose and highest pleasure in music, but rather that all, each in its own way, should strike the ear pleasantly, expressively and sweetly."[7] Neidhardt writes of equal temperament that

> most people do not find in this tuning that which they seek. It lacks, they say, variety in the beating of its major 3rds and consequently a heightening of emotion. In the harmonic triad, everything sounds tolerable enough; but when the major or minor 3rds occur alone, the former sound all too high, the latter too low… Thus equal temperament brings with it its comfort and discomfort, like blessed matrimony.[8]

However, the co-existence of several temperaments proved to be an inconvenience, which many keyboard builders and theorists could not sustain. Equal temperament, with its regularity and uniformity between key centres and intervallic relationships became the increasingly common standard by the mid-Nineteenth Century.

Example 1.3 illustrates the discrepancies measured in cents between the just intervals and the equally tempered intervals.

[7] Quoted in Lindley, Mark: 'J.S. Bach's Tunings', *The Musical Times*, Vol.126 (1985), 726.
[8] Neidhardt, J.G.: *The Nature of the Diatonic-chromatic Octave, Derived From the Order of Natural Numbers*, trans Reussner (Königsberg, 1734), 40 – 41.

Ex. 1.3 Table of Intervals in Cents

Interval	Just Intonation	Equal Temperament
Minor semitone	92.2	100
Major semitone	111.7	100
Minor wholetone	182.4	200
Major wholetone	203.9	200
Minor third	315.6	300
Major third	386.3	400
Perfect fourth	498.04	500
Tritone	590.2	600
Perfect fifth	701.96	700
Minor sixth	813.7	800
Major sixth	884.4	900
Minor seventh	996.1	1000
Major seventh	1088.3	1100
Octave	1200	1200

1.3 Non-fixed Intonation Instruments

While these considerations occupied pianists, harpsichord players, guitarists and harpists, string players had the freedom, when not performing with a keyboard instrument, to use pure intervals whenever possible and generally to avail of a more fluid approach to intonation. The renowned cellist Pablo Casals was outspoken in his attitude to performing with the fixed intonation of the piano: "Do not be afraid to be out of tune with the piano. It is the piano that is out of tune. The piano with its tempered scale is a compromise in intonation." [9] Musicians educated in the use of just intonation understand the variation between a major semitone and a minor semitone. According to tuning theory a whole tone is made of nine commas.[10] A major semitone occupies five commas leaving four commas for a minor semitone. Leopold Mozart, the father of modern violin playing puts it clearly "…according to their proper ratios, notes with flat signs

[9] Quoted in Samuel and Sada Applebaum, *The Way They Play*, vol. 1 (Neptune City, Paganiniana, 1972), p. 272.

[10] It is important not to confuse these commas with either Pythagorean or syntonic commas (as explained in Chapters 1.2 and 1.3). The comma here measures one ninth of a semitone and is used to measure the difference between the major semi-tone and the minor semitone.

are a comma higher than those in the same position with a sharp sign. For example, D♭ is higher than C♯, A♭ higher than G♯, G♭ than F♯, and so on."[11]

The influential theorist and flute virtuoso Johann Joachim Quantz is also unambiguous in regard to the compromises of the piano's fixed intonation:

> A keyboard player who understands that D♯ and E♭ are differentiated by a comma, and therefore cause, because of its lack of split keys, some inequality of intonation upon this instrument [that is, the keyboard] as compared with other instruments on which these notes are produced in their true ratios.[12]

Quantz, as a flautist, felt he shouldn't be restricted by the intonational shortcomings of the keyboard. He took practical steps

> to mark this difference [between E♭ and D♯] and to stop the notes in their proper proportions, it was necessary to add another key to the flute… It is true that this distinction cannot be made on the keyboard where each pair of notes…is struck with a single key, and recourse must be made to tempering. Nevertheless, since the distinction is based on the nature of the notes, and since singers and string players can observe it without difficulty, it may be reasonably introduced on the flute.[13]

The prominent German music theorist Daniel Gottlob Türk wrote in his treatise of 1789 for keyboard players:

> Each tone consists of two semitones, of which one is large and the other small… The fact that these sizes of tones do not occur on the keyboard in their true proportions is due to the instrument's imperfection… and does not prove anything contrary to the actual differences of these tones. These tones can and should be produced on the violin, flute, oboe, and many other instruments, as well as in singing, as far as their higher or lower differentiation is concerned, according to their mathematical proportions.[14]

The American composer Henry Cowell, himself a pianist, is plain in his criticism of the necessary compromise: "on the keyboard of a piano the chords are approximations, as the equal temperament necessary in tuning keyboard

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[11] Mozart, Leopold. *Versuch einer gründlichen Violinschule.* Augsburg: J.J. Lotter, 1756; facsimile, Kassel: Bärenreiter, 1995; trans. Editha Knocker, *Treatise on the Fundamental Principles of Violin Playing.* London and New York: Oxford University Press, 1948, 47.

[12] Quantz, Johann Joachim: *Versuch einer Anweisung die Flöte traversiare zu spielen* (1792); facsimile, Kassel: Bärenreiter, 2000; trans. Edward R. Reilly, *On Playing the Flute.* 2nd ed. London: Faber and Faber, 1985; reprint Boston: Northeastern University Press, 2001, 94.

[13] *Ibid.*, 96.

[14] Türk, Daniel Gottlob. *Klavierschule.* Liebzig and Halle, 1789; facsimile, *Documenta Musicologica* 1:23. Kassel: Bärenreiter, 1962; trans. Raymond H. Haggh, *School of Clavier Playing.* Lincoln: University of Nebraska Press, 1982, 204.

instruments only gives the suggestion of the chord as it is in the overtones, which are the basis of measurement."[15]

Despite all these endorsements (many from keyboard educators and theorists) for non-keyboard musicians to produce pure, beatless intervals, the dominance of equal temperament seems to have swept aside these concepts for the majority of musicians (with the notable exception of string players particularly in chamber contexts).

1.4 Dominance of Equal Temperament

1917 is the most realistic date that true equal temperament became the standard in piano tuning. This surprisingly recent date is at odds with English tuning practice where equal temperament became standard practice by the 1850s. However it is clear now that piano tuners in the mid-Nineteenth Century interpreted the dictates of equal temperament with considerable leeway as tuning expert Jorgensen points out:

> Before 1917, tempering was an art based on a keen sense of color awareness for each individual interval or chord on the piano. This color sense that was developed through environmental conditioning by listening to tunings and piano music during the nineteenth century is now lost. Wise aesthetic decisions based on classical traditions are no longer being made. Indeed, such judgements are contrary to twentieth-century atonal philosophy.[16]

The 1917 date refers to the publication of William Braid White's seminal treatise *Modern Piano Tuning and Allied Arts.* White (1878-1959) was an English acoustical engineer who created the science of precise equal temperament tuning for pianos counting beats and testing with comparative intervals. An important figure in the tuning world, it is White's system, which is

[15] Cowell, Henry: *New Musical Resources* (London: Cambridge University Press, 1958), 82.
[16] Jorgensen, Owen: Tuning the Historical Temperaments by Ear: A Manual of Eighty-Nine Methods for Tuning Fifty-One Scales on the Harpsichord, Piano, and Other Keyboard Instruments (Marquette: Northern Michigan University Press, 1977), 103.

still in use today. This influential and rigorous scientific approach leads us to the situation where

> after 1917, tempering became a skilled science based on universally accepted mathematical principles, and professional tuners now temper with similar results. There is little individuality, and the temperament sections of pianos tuned by different tuners match note for note when compared.[17]

The dominance of equal temperament soon came to represent a monopoly over other temperaments which have become obsolete in the main for today's musical community. This situation has an often unrecognised influence in terms of composition, aesthetics and the direction of keyboard related music:

> Equal temperament […] is virtually considered an inherent characteristic of the modern concert piano. Indeed the ideals of sonority in the acoustic design of the modern piano and in all but the more radical forms of modern pianism are as intimately bound to the acoustic qualities of equal temperament as any previous keyboard style ever was to its contemporary style of intonation. The enharmonic facility of Brahms or Fauré, the hovering sonorities of Debussy, the timbral poise of Webern, the slickness of the most urbane jazz chord progressions, all rely implicitly on the hue of equal temperament as much as on the other normal characteristics of the instrument's tone.[18]

The developments of piano tuning, of course, had implications for all other instrument design as well as pedagogical attitudes. Ross W. Duffin argues that at this period of transition to equal temperament a wealth of positive values, in terms of pure intervals and richer harmony, was lost in favour of a temperament which compromised many intervals (particularly the major third) and was easier for beginning students and instrument builders to navigate:

> ET [equal temperament] thus appears as the sanctioned system by virtue of its simplicity, not because of its superiority to other systems and not because it's what professional players were using. And yet the simple message bequeathed to us from these treatises is that ET is the only system that exists. We, in effect, have been the heirs of this mid-nineteenth-century pedagogical impulse to spare students the subtleties of professional tuning practices.[19]

While this may be considered for keyboardists by and large a closed case, singers, string players, brass and woodwind players have an ability to modify their tuning which is always a consideration of the expert musician. However, by the time the saxophone had achieved a meaningful position in popular music in

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[17] *Ibid.*, 104.
[18] Lindley, Mark: 'Temperaments', *Grove Music Online*/*Oxford Music Online* (15 July 2009), http://www.oxfordmusiconline.com/subscriber/article/grove/music/27643#27643.P52
[19] Duffin, Ross W.: *How Equal Temperament Ruined Harmony (and Why You Should Care)* (W.W. Norton & Co., 2006), 47.

the early- to mid-Twentieth Century the majority of musicians were unaware of these nuances of intonation. Due to the design of the saxophone and the pedagogical tradition that surrounds it, there has been no systemised approach to tackling these issues of temperament, just intonation or microtonality. If the saxophone were an instrument of reliable pitching and inflexible intonation this situation would be the result of a logical evolution. However it will be seen that the current thinking in these matters is a progeny of the problems of keyboard design through the centuries and reluctance to take on the challenges that the alternative view offers.

1.5 The Evolution of Equal Temperament: Microtonality

Due to the firm establishment of equal temperament as the *de facto* standard, composers and musicians are faced with a situation where investigating alternative tunings presents

> a considerable logistical obstacle for most performers of Western music, who today are accustomed to playing diatonic music in equal temperament – and to having the "room" to make minute, coloristic inflections, and historically is one reason why just intonation never took hold.[20]

Some innovative composers, such as the American maverick Harry Partch (1901 – 1974), have overcome the fixed equal temperament instrument design issues by building their own sets of new instruments with customised tunings. While addressing the lack of available musicians schooled in alternative temperaments has encouraged some composers to educate musicians through workshops and scholarly articles.

The most common approach to exploring and sustaining investigation into alternative temperaments, however, has been through the addition of extra notes to the twelve-tone equally tempered scale. Within this field it is the further dividing of the twelve-tone equally tempered scale into an equally divided twenty-four note scale, which has most captured the imagination of composers

[20] Werntz, Julia: 'Adding Pitches: Some New Thoughts, Ten Years after Perspectives Of New Music's "Forum: Microtonality Today"', *Perspectives of New Music,* Vol. 39, (2001), 168.

and musicians since the turn of the Twentieth Century. There is an irony here that the musicians, who are trying to break out of the perceived confines of the twelve-tone system, are, in fact, developing it further by sub-dividing the octave into twenty-four equally spaced notes. This situation further illustrates the remarkable dominance of twelve-tone equal temperament over contemporary musicianship in a comparatively short timeframe.

The Twentieth Century was a period which saw much exploration throughout the arts in general. In music, European and American avant-garde composers did much to develop the fabric of their output investigating dissonance, rhythmic complexity and the use of non-pitched elements. Pitch manipulation and alternative temperaments also became fertile areas of experimentation within this surge of seeking new sounds and approaches to structure music.

CHAPTER TWO

2.1 Twentieth Century Tradition of Microtonality

Experimentation with equal temperament began as early as the late Nineteenth Century and gained a limited momentum through the work of Mexican Julián Carrillo (1875-1965); the Russian Ivan Wyschnegradsky (1893-1979); and the Czech Alois Hába (1893-1973). These composers are regularly cited as the principle developers of microtonal experimentation, albeit that these "real pioneers of microtonal music are still fairly obscure figures, at least as far as performances and recordings are concerned."[21]

The American composer Charles Ives (1874-1954) had developed the use of a twenty-four note scale in compositions dating from the 1920s and is considered the first important figure to systematically use quarter tones. His Three Quarter-Tone Impressions for two pianos tuned a quarter-tone apart from 1923-24 "is the first genuinely microtonal work by any major composer."[22] Deeply drawn to the possibilities beyond twelve-tone equal temperament Ives stated, "I found I *could not* go on using the familiar chords only. I *heard* something else."[23] Ives wrote an important treatise concerning the use of quarter tones as a new tool for the composer and of how his inventive father, George Ives, cultivated his interest in these new sounds through his 'quarter-tone machine':

> My father had a weakness for quarter-tones […] One afternoon, in a pouring thunderstorm, we saw him standing without hat or coat in the back garden; the church bell next door was ringing. He would rush into the house to the piano, and then back again. "I've heard a chord I've never heard before-it comes over and over but I can't seem to catch it." He stayed up most of the night trying to find it on the piano. It was soon after this that he started his quarter-tone machine. […] He rigged up a contrivance to stretch 24 or more violin strings and tuned them up to suit the dictates of his own curiosity. He would pick out

[21] Gilmore, Bob: 'Microtonality: My Part in its Downfall', (key-note lecture at UK Microfest 1, October 15, 2005) http://homepages.inf.ed.ac.uk/stg/Bob_Gilmore/BGMicrofest05.pdf [Accessed 23 July 2009].
[22] *Ibid.*
[23] Bellamann, Henry: 'Charles Ives: The Man and His Music', *The Musical Quarterly*, Vol. 19, (1933), 49. Emphasis in original.

> quarter-tone tunes and try to get the family to sing them, but I remember he gave that up except as a means of punishment.[24]

Firmly established today as a seminal figure in twentieth-century composition, Ives anticipated many of the techniques central to the new musical modernism: polytonality, polyrhythms, atonality, quarter-tone composition and collage. Despite these achievements, Ives' music was rarely performed during his life and it took the championing of his work by established composers such as Mahler, Schoenberg, Henry Cowell and Aaron Copland for his music to gain recognition posthumously. It was not until another couple of decades later that the established avant-garde made use of these developments in microtonal exploration.[25]

> Even given the existence of a not inconsiderable body of microtonal music by, let's say, the end of the 1950s, Microtonality, as a movement, had not yet gotten going… Nonetheless, by the end of the 1960s microtones had entered the general vocabulary of the avant-garde, and almost all the leading figures in European new music were using them (Xenakis, Ligeti, Nono, Stockhausen et al) … For the most part the use of microtones made by the post-war avant-garde was of quartertones.[26]

Steps towards incorporating quarter-tone harmony into new music were certainly tentative overall. In 1944, Bela Bartók finished his Sonata for Solo Violin commissioned by violin virtuoso Yehudi Menuhin. Bartók included a quarter-tone passage in the forth movement, which Menuhin was reluctant to perform. In their correspondence Bartók makes it clear that the quarter-tones act as embellishments only and in fact can be omitted if necessary.

> The 1/4 tones in the 4th movement have only colour-giving character, i.e. they are not "structural" features, and-therefore-may be eliminated [...] if you don't feel inclined to worry about 1/4 tone playing. However, the best would be, if I

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[24] Ives, Charles: 'Some "Quarter-Tone" Impressions', *Franco-American Musical Society Bulletin*, (1925), 23.

[25] Microtonal composer Julia Werntz comments, "this path fell into disuse, with very few composers following in their [Carrillo, Wyschnegradsky, Hába] painstakingly-made footsteps. This is surely due largely to the bewildering challenge of making musical sense out of the added pitches, a challenge that largely was not met by these composers, who left no substantial repertoire of inspirational works to affirm the merits and artistic potential of this approach to future generations. Nonetheless, it is my belief that even in this nearly embryonic state expanded equal temperament is actually the most valuable form of microtonalsim, and that it carries the most potential for musical innovation." Werntz, 160.

[26] *Ibid.*

could hear played both versions, and then decide if it is worth while to use these 1/4 tones.[27]

Menuhin chose not to perform the piece with the quarter-tone embellishments and the work now exists in two separate editions – one of which has the quarter-tone passage intact.[28] See Examples 2.1 and 2.2 below.

Ex. 2.1 Bartók, Sonata for Solo Violin, IV, 38-40: Menuhin Edition

Ex. 2.2 Bartók, Sonata for Solo Violin, IV, 38-40: Original Version

Menuhin's reluctance to perform quarter-tone music is an example of the unwillingness of many musicians towards incorporating new techniques to their playing styles. Faced with these obstacles, instead of becoming part of the mainstream *lingua franca*, microtonality became adopted by a small group of specialists among twentieth-century composers. Contemporary composers Horaţiu Rădulescu (1942 - 2008), Krzysztof Penderecki (b. 1933) and Ryo Noda (b. 1948) have all contributed to the gradual integration of notated microtonality into the contemporary canon. The influence of folk music on these developments is an important one, with Noda, for instance, applying the microtonal

[27] Bartók, Bela:, "Letters to Yehudi Menuhin." (Peter Bartok, 1994); quoted in Bela Bartok, Sonata for Solo Violin, Urtext Edition (London: Hawkes & Son, 1994), viii.
[28] The 'Urtext Edition' of this piece was published in 1994 by Boosey & Hawkes who state that "this authentic edition restores to print many of the details from the composer's original manuscript, most significantly his famous passage in quarter-tones." - http://www.boosey.com/cr/sheet-music/Bela-Bartok-Violin-Sonata-Urtext/3078 [Retrieved 26 July 2009]

embellishments of Japanese shakuhachi music to a range of works for solo alto saxophone. See Example 2.3 below.

Ex. 2.3 Ryo Noda, Maï (pour Saxophone Alto seul), 3.

The integrated use of quarter-tones is still at an embryonic stage in Western art music.[29] Its development is hampered by a lack of education among instrumentalists, as well as insufficient innovation on behalf of commercial instrument designers. Charles Ives' prediction on the future of quarter-tones, dating from 1924, today reads as a prophetic challenge for the contemporary musical community:

> It will probably be centuries, at least generations, before man will discover all or even most of the value in a quarter-tone extension. And when he does, nature has plenty of other things up her sleeve. And it may be longer than we think before the ear will freely translate what it hears and instinctively arouse and amplify the spiritual consciousness. But that needn't keep anyone from trying to find out how to use a few more of the myriads of sound waves nature has put around in the air (immune from the radio) for man to catch if he can… Even in the limited and awkward way of working with quarter-tones at present, transcendent things may be felt ahead-glimpses into further fields of thought and beauty.[30]

However, many successful microtonal works have borrowed from developments in folk and jazz music where non-standard pitch fields have been in use and development by a wide range of musicians. Musicians working outside the realm of the European mainstream tradition using microtonality can be described in one of two ways: those who use microtonality unconsciously (as is the case in many folk traditions) or those who employ microtonality consciously as a tool of expression within a systematic framework. This later group is examined here through two case studies: one from the folk tradition and one from the jazz tradition.

[29] For a list of major works featuring the use of quarter tones see http://en.wikipedia.org/wiki/List_of_quarter_tone_pieces
[30] Ives, 2.

2.2 Use of Microtonality in Folk Music Traditions

Many musical cultures have cultivated a highly developed use of microtonality, largely as a tool of embellishment on a diatonic or twelve note system of temperament. In many instances, it is this use of microtonal inflection, which is recognised as the key component to creating an authentic musical experience specific to the idiom in question. In North American blues music the concept of the fluidly pitched 'blue note' is an expressive device vital to a meaningful performance:

> In fact every note of the twelve-tone chromatic scale may appear in a blues tune, possibly also as 'blue notes', because microtonality, attack, and timbre variation are such essential parts of blues expression.[31]

The Irish sean-nós tradition has a similar approach to microtonal inflexions, which imbue the singer's line with added expressivity: [32]

> Microtonal changes in pitch are a normal part of a good traditional singer's technique and one finds in particular a tendency to slide up to an important note through an interval which many be greater or less than a semitone. It is the author's experience that some of those who favor the [microtonal] slide have been influenced by traditional instrumentalists – particularly pipers.[33]

In contrast to the intuitive methods of blues music and sean-nós, a more systemised approach to microtonality has developed in a number of folk music systems, aided by the work of theorists and particular to certain species of instrumental design, such as non-fretted string instruments. Strong examples of this are seen in the musical cultures of India (Sarod[34] performance), Japan (Shakuhachi music), et cetera, and more broadly through the world of Arabic music.

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[31] Weisethaunet, Hans: 'Is There Such a Thing as the 'Blue Note'?', *Popular Music*, Vol. 20, (2001), 101.

[32] *Sean-nós* translates as old style. It is an ancient form of highly ornamented unaccompanied singing particular to certain regions in Ireland.

[33] Ó Canainn, Tomás: *Traditional music in Ireland* (London, Routledge, 1978), 74.

[34] The Sarod is a string instrument played in Hindustani music of northern India. It is fretless allowing glissandi and a flexible intonation, important characteristics of this music.

2.2.1 Case Study: The Arabic *Maqam* Tradition

Specialised tuning systems have formed an important part of the expressive nature of Arabic music for many centuries. Theorists such as Safi Al-Din (1252-1334), developed various tunings for different *maqamat*[35] (plural of *maqam*). These *maqamat* utilise microtonal shadings frequently and occupy a very different soundworld to the harmonic rules of Western music.

> The Arabic scales which maqamat are built from are not even-tempered, unlike the chromatic scale used in Western classical music. Instead, 5th notes are tuned based on the 3rd harmonic. The tuning of the remaining notes entirely depends on the maqam. The reasons for this tuning are probably historically based on string instruments like the oud. A side effect of not having even-tempered tuning is that the same note (by name) may have a slightly different pitch depending on which maqam it is played in.[36]

Theorists in Syria first began discussing, academically, a twenty-four note octave early in the Nineteenth Century. Their writings present the twenty-four notes as equally spaced quarter tones.[37] See Example 2.4 below.[38]

Ex. 2.4 The twenty-four note equally tempered scale

In practice, however, musicians performing this music do not use a twenty-four note equally tempered scale but rather use this quarter-tone system to reference approximately the necessary pitches for each *maqam*.

> The new [twenty-four note equally tempered] scale seems to have been the first major reconceptualization of the Arab scale since Safi al-Din's theories in the thirteenth century. Its development helped propel Arab music theory into a period of renewed vitality and prominence. The position of music theory grew throughout the nineteenth century and blossomed in the twentieth century,

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[35] "In Arabic music, a maqam (plural maqamat) is a set of notes with traditions that define relationships between them, habitual patterns, and their melodic development. Maqamat are best defined and understood in the context of the rich Arabic music repertoire. The nearest equivalent in Western classical music would be a mode (e.g. Major, Minor, etc.)." - http://www.maqamworld.com [Accessed 31 July 2009].

[36] *Ibid.*

[37] "Many considered the new scale to be composed of equal-tempered quarter tones. In an equal-tempered quarter-tone system, the notes occur at 50 cent intervals." - Marcus, Scott: 'The Interface Between Theory and Practise: Intonation in Arab Music', *Asian Music*, Vol. 24 (1993), 39.

[38] Track 2 in Appendix D is a recording of a saxophone playing this scale.

> aided by the growth of institutionalized music training from the first decades of the present century. Thus, we see a new scale of equal-tempered quarter tones, a revitalization of Arab music theory. Although the standard music theory presented the new scale as equal tempered, musicians – playing fretless instruments such as the oud and violin – were never confined to a single system of intonation.[39]

Despite the historical existence of a system to deal with the microtonal elements of Arab music, there still exists much disagreement among musicians concerning intonation issues. Ethnomusicologist Scott Marcus' fieldwork in Cairo led him to a discussion with a musician who "recognized four regional tunings for the note Sikah (i.e., E half-flat). 'The lowest Sikah is here in Egypt. You go to Lebanon and Palestine, the Sikah is a little higher. In Iraq, it is still higher, and in Istanbul, it is E natural.' However, this musician asserted, there is only one position for this note within each of these four areas."[40]

One explanation for these discrepancies is that the rules for intonation in Arabic music are passed on through an oral tradition. The equally tempered quarter-tone scale serves as a map (twice as detailed as the equally tempered twelve-tone scale) to relate the aurally learnt microtonal inflexions particular to each *maqam.*

A common feature of folk music throughout the world is the supreme importance of the vocalist and the expressive qualities of vocal technique. Naturally, singing is the most widespread and oldest form of musical expression and its flexibility in terms of pitch control and individuality has been a source of inspiration for instrumentalists and instrument builders for thousands of years.

In the Turkish classical music tradition vocal music is considered the pinnacle of expression, and instrumentalists are judged "according to the degree in which they imitate or partake of the qualities of vocal music."[41]

> Without pressing this point any further here, let it be said that the ability of the human voice to produce minute pitch differences or "shades" in intonation is a

[39] *Ibid.*, 39.
[40] *Ibid.*, 44.
[41] Zannos, Iannis: 'Intonation in Theory and Practise of Greek and Turkish Music', *Yearbook for Traditional Music*, Vol. 22, (1990), 43.

> sublimely expressive feature which Near Eastern instrumentalists strive to attain on most instruments.[42]

Turkish musicians commonly make use of a well-evolved system of tuning which uses twenty-four fixed degrees to an octave. However, these intervals are not spread evenly like the extended equal temperament quarter-tone model but instead are placed "at distances of commas (ca. 21 cents) and leimmas (ca. 90 cents) from each other."[43] In addition to these fixed pitches, musicians use defined microtonal embellishments for added expression.

> The expressive quality of Greek and Turkish music is not only due to the use of a great variety of fixed interval sizes. As noted above, these traditions make full use of the flexibility of the voice as a melodic instrument. Thus, the interval sizes identified by music theory are constantly varied in practice by small inflections that are conscious and refined means of expression. It is therefore necessary to take into account these fluctuations in the intonation of degrees and intervals. The interval sizes given by the different theorists are only of relative significance, and it is irrelevant to dispute over the exact size of an interval; whether for example a small wholetone is exactly 8/53 of the octave or 10/72 of the octave or has a string ratio of 10/9 or 12/11 etc. Intervals are identified and intoned not by their absolute size alone, but also by their function in a melodic context. Therefore, different sizes are acceptable or required in different contexts.[44]

Thus, it is seen that musicians working in Arabic music have a distinct and methodical approach to using microtones beyond the regular scale pitches as a means of infusing added expression to their compositions and performances.

2.3 Pitch Consideration in Jazz Saxophone Technique

In the jazz tradition the saxophone's potential freedom of pitching is a quality which many jazz musicians take full advantage of. As is the case in Turkish music (see Chapter 2.2.1 above), jazz saxophonists, in an extension of American blues music, seek to recreate the nuance and emotional range of jazz and blues vocalists.

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[42] *Ibid.*, 43.
[43] *Ibid.*, 52
[44] *Ibid.*, 54.

Ornette Coleman (b. 1931) is a jazz saxophonist who fully embraces the notion of playing with a vocalised approach. Drawing inspiration from the field hollers and early blues music of his native Texas, Coleman developed a microtonal aesthetic, "a fascinating and basically inimitable amalgam of blues and modal, atonal and microtonal music"[45], which he uses as a tool in improvisation.

> Coleman himself emphasized the importance of a vocal projection: "You can always reach into the human sound of a voice on your horn if you are actually hearing and trying to express the warmth of a human voice." The trick, he said, was playing in the right pitch… So acute is his ability to hear the continuity of alternative pitches that he stays in tune with himself even as he remains at odds with conventional tuning.[46]

John Coltrane (1926-1967), is another jazz saxophonist who had a very personal approach to intonation. Disparaged by critics in his early career for playing 'out of tune', Coltrane often chooses to play flatter than the equally tempered notes, heavily colouring his tone. Coltrane went on to explore the altissimo register of the instrument often producing notes of indistinguishable pitch outside the tempered system.

Regrettably, many improvisers who use intentional pitch manipulations outside of twelve-tone equal temperament are misunderstood as simply inadequately equipped to produce equally tempered notes. The reasons for this among the jazz music community are two-fold: the lack of an educational infrastructure regarding tuning theory, and the lack of a clear aesthetic framework for microtonal expression.

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[45] Schuller, Gunther: 'Coleman, Ornette', *Grove Music Online*/*Oxford Music Online* (15 July 2009), http://www.oxfordmusiconline.com/subscriber/article/grove/music/06079?q=saxophone+microtonal&search=quick&pos=1&_start=1#firsthit

[46] Giddins, Gary: *Visions of Jazz: The First Century* (New York and Oxford, Oxford University Press, 1998), 470.

2.3.1 Case Study: Hayden Chisholm - Quarter-Tone Jazz

Hayden Chisholm (b. 1975) is a New Zealand born saxophonist based in Europe. Chisholm is firmly established as a leading pioneer in regard to quarter-tone improvisation and composition in jazz saxophone. Educated in the jazz tradition he first came in contact with quarter-tone music through the work of his teacher Frank Gratkowski, although he also acknowledges earlier, less-organised microtonal influences.

> He [Frank Gratkowski] was the one who showed me a piece which had a couple of microtonal fingerings and at the same time he introduced me to the music of Giacinto Scelsi[47] – that was my first contact with microtonality as such. That was in about 1995, but if I was to look even earlier than that, the first music that really got under my skin was early blues music and obviously in the vocal part of blues music there is already a lot of microtonality going on. Or to take it a step further, Johnny Hodges[48] was a saxophone player who I really loved very early on. You could go as far as to say that he was in a sense microtonal, the way he used smudging and slurring and glissandi. But in an intellectual way as an extension to the saxophone's chromatic system, Frank's introduction in Cologne was the first one. He showed me a couple of fingerings and that sparked the whole thing off. Something attracted me to it straight away and I quickly developed more [microtonal] fingerings and tried to see how I could use it.[49]

Chisholm's intuititve interest in pitch bends and microtonality developed into a systemised approach of working with the twenty-four note quarter-tone scale, which he uses as a tool in both improvisation and composition.

> I first started using quarter tones because I found that these notes were feasible on the saxophone. I could have gone further and explored sixth- and eighth-tones but quarter tones were already quite a big step and I wanted to get the quarter tones down well. I was also quite interested in working on split scales, working on dividing intervals exactly in the middle and quarter tones were a good device for this. As far as symmetry goes, I was looking for new ways to divide up octaves and the quarter tones were a good tool for that. I think anything beyond that can get, let's say, less exact and I was looking to be as exact as I could.

The quarter-tone scale greatly increased Chisholm's melodic potential, giving him access to a range of new scales which hadn't been

[47] Giacinto Scelsi (1905-1988), Italian composer who produced microtonal work for orchestra, chamber and solo settings.
[48] Johnny Hodges (1906-1970), jazz saxophonist best known for his long tenure in Duke Ellington's big band.
[49] Interview with Hayden Chisholm, 28 July 2009.

used in the jazz saxophone lexicon. The mastery of quarter-tone harmony also suggested an aesthetic link to folk musics which employ microtonal structures. The Armenian duduk tradition[50] and Japanese shakuhachi[51] music are important aesthetic touchstones for him and he uses quarter tones to colour his saxophone approach in a manner similar to microtonal aspects of these traditions. Chisholm points to the saxophone's relatively young history and resultant lack of a restrictive tradition, which frees the musician from the need to adhere to rules or conventions, which might otherwise curtail a folk musician's means of creativity.

> In the shakuhachi tradition the use of microtonality, slurs, very modern techniques such as flutter tonguing is, of course, an integral sound of the actual instrument. It is sometimes difficult to separate an instrument from its tradition and shakuhachi is very closely connected to the ancient works that were written for it and continue to be performed on it, whereas the saxophone is, perhaps, more of a *tabula rasa* – something which you can write your own signature on. There are as many different saxophone sounds as there are players. The microtonal part of the saxophone is a way for me to broaden the tonal possibilities of the instrument, not just the harmonic possibilities but actually the timbre and the nuance.[52]

Chisholm believes that the malleable qualities of saxophone tone and tuning make it an ideal instrument for quarter-tone production. He points, also, to the mechanical design as an advantage in the development of a system of microtonal fingerings:

> I think [the saxophone] can adapt very, very well [to quarter-tone production]. I think it can adapt even better than other wind instruments. There are reasons for that: the tuning on a saxophone is difficult anyway, there are a lot compromises to make and these can vary depending on the instrument we play. For a start we have a lot of keys, so there are many possibilities with combinations of keys which gives us a very good start into microtonality. It seems that we are still at the start [of this investigation] and there is a lot of work yet to be done but I think there had already been a lot of progress made on our instrument in the last twenty years.[53]

[50] The duduk is a simple double-reed instrument without any keys. The traditional repertoire consists of slow instrumentals and songs often accompanied with a drone. Much of this music is improvised.
[51] Shakuhachi is a traditional flute which has ancient origins in medieval Japanese Zen practice. Shakuhachi music uses much microtonality and has very detailed embellishments.
[52] Chisholm interview.
[53] *Ibid.*

Working in a jazz context, the saxophonist must be able to apply these possibilities of increased pitch possibilities to an existing musical model. The function of these added pitches is an important consideration: do they serve as embellishments on the standard chromatic system or are the twenty-four notes per octave given equal weighting?

> I think the goal for me is give all twenty-four notes equal importance. I consider myself a long way off from that. I am still in a situation where a lot of the time they are used as embellishments. Also, a lot of the time the situations I am in are those in which the twelve tone chromatic system is what is called for. We are very heavily conditioned by that. For instance a 'too sharp F' is still an embellishment of an F. There's nothing wrong with that either, you can make very beautiful music by playing around these notes, colouring them differently and so on. It also has to do with ear-training which has to develop simultaneously with the fingers.[54]

As is common among jazz musicians, Chisholm sees a very close connection between his abilities as an improviser and a composer, and so sees the use of quarter tones extend into the both disciplines. The technical issues of saxophone quarter-tone production act as an inspiration of sorts when he states "there are certain quarter tones that are simply harder to play and to hear on the saxophone, I try to use these in the compositions simply because they *are* difficult."[55]

> My compositional approach and the way I think of improvisation are very closely related. A lot of the compositions I write for the saxophone are *etude* based. I use them to test out and increase my technical ability to play these microtones. I think of myself more as an improviser than a composer, although I try to use my compositions to benefit my improvisation and *vice versa* – I think they are very closely related. And I also try to think of my improvisation as a form of instant composition.[56]

In his work with the contemporary jazz group Root 70, Chisholm and his front line partner, trombonist Nils Wogram have recently applied their expertise in microtonality to the jazz standard repertoire. Using Broadway standards as a

[54] *Ibid.*
[55] *Ibid.*
[56] *Ibid.*

harmonic basis the group has composed new quarter-tone melodies, which combine the conventions of small group jazz music and microtonality.[57]

> The interesting thing about the trombone is that it proves itself to be a very accurate instrument for executing microtones and Nils [Wogram] has developed not just the intonation but also the timbre which makes it blend so well with the saxophone. So we spur each other on: a lot of the material that Nils writes is quite difficult for me to play on the saxophone and *vice versa*. So that has helped each of our microtonal techniques a lot. Compositionally how we have used microtonality has developed: we began to use it [quarter-tone harmony] with just the lead instruments in unison and this has developed to even writing microtonally for the bass, so that the chords themselves are slightly shifted.[58]

Chisholm has developed a systematic approach to incorporating quarter-tones into his saxophone playing style. His mastery of use of quarter-tones in improvisation and composition has resulted in a highly expressive and unique new approach to jazz saxophone. He is, today, acclaimed as an important stylist, having incorporated microtonality into the contemporary jazz lexicon. Hayden Chisholm's work with quarter tones presents the possibility of the saxophone as a fully workable and enormously expressive microtonal instrument.

Both the *maqam* tradition and Hayden Chisholm's advancements in contemporary jazz serve as examples for the microtonal saxophonist. The systemised approach to microtonality in the performance of *maqamat* acts as a blueprint for the development of a workable framework for microtonal saxophone performance. The Arabic concept of working from a twenty-four note scale and inflecting certain notes with the use of glissandi and bends translates into a new aesthetic model for contemporary saxophone. Chisholm's work in this area illustrates real developments and points to further potential for new expressive possibilities for the saxophone.

In order to understand how quarter tones relate to the saxophone, it is necessary to examine briefly the instrument itself and the technical issues surrounding the production of these new notes.

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[57] Nils Wogram & Root 70: *On 52nd 1/4 Street*, Intuition, INT 34232 (2008).
[58] Chisholm interview.

CHAPTER THREE

3.1 The Saxophone as a Microtonal Instrument

Invented in 1846 by Adolphe Sax, a Belgian instrument inventor working in Paris, the saxophone was a new composite of oboe, bass clarinet and ophicleide (a keyed member of the bugle family). Much has been written about the particular tonal qualities of the saxophone while the fact that the instrument became an important new voice in, both the then emerging jazz music in America as well as classical music in Europe points to its malleability in terms of tone, tuning and expression. The French composer Jean-Georges Kastner described the new invention as

> an instrument with an entirely new sound – powerful, far-reaching, expressive and beautiful. With its unique tonal quality, it offers the best imaginable link between the very high voices of the orchestra and the very weak ones or those with a very uneven timbre. […] Uniting strength and charm, it does not drown out the one kind and cannot be drowned out by the other – it is a perfect instrument.[59]

However this malleability brings challenges for the student saxophonist, who must conquer the technical issues concerning tuning and strive to play the saxophone according to the rules of equal temperament. Jazz musicians have made good use of the saxophone's timbral possibilities, celebrating it as the archetypal expressive jazz instrument. As Doug Miller writes, "unlike the clarinet, the saxophone is a hybrid instrument which does not have a fixed tonal range of its own. It is an imperfect piece of engineering and this gives it considerable scope for variation in timbre."[60] A thorough understanding of the mechanics of sound production in the saxophone is therefore crucial to success in this area.

> In reed-blown instruments the reed properties, such as size, shape, compliance and damping, are essential for proper tuning. The reed compliance causes a

[59] Kastner, J. G.: *A General Manual of Military Music*, trans Orilly, J. (Paris: 1848), 75.
[60] Miller, Doug: 'The Moan within the Tone: African Retentions in Rhythm and Blues Saxophone Style in Afro-American Popular Music", *Popular Music*, Vol. 14, No. 2, (1995), 155-174.

> lowering of the frequency. In conical instruments, the reed compliance has the same effect as a mouthpiece cavity and, therefore, it has an important function in keeping the upper register in tune with the lower one. […] The player can correct errors in the tuning within certain limits since […] in reed instruments the tone sharpens as the lips are tightened.[61]

Despite the flexibility of pitch possible with embouchure adjustments (lip pressure, widening of oral cavity) and reed properties, the saxophone has been designed to produce a twelve note equally tempered chromatic scale.[62] However with the use of cross-fingerings, many microtonal pitches outside the chromatic scale may be easily produced. Alternative fingerings are also used to create special effects such as multiphonics and microtonal trills. However, a system has been developed to manipulate the keys into new combinations of fingerings to produce quarter-tone scales.

3.2 Technical Considerations of Microtonal Production

Early woodwind instruments (the flute is the clearest example) have no keywork, relying on a simple system of holes which are covered by fingers to produce different pitches. The availability of between six to eight fingers to stop tone holes yields a limited melodic resource. Cross-fingerings: one or more closed holes below an open hole and then additional open holes below that – can be used to produce further note choice. The addition of keys further increases the range of the instrument.

The history of woodwind instrument design has evolved from use of cross-fingerings to a fully keyed chromatic system (perfected by Theobald Boehm in the 1840s), which has been a feature of saxophone design since its invention.

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[61] Nederveen, C.J.: *Acoustic Properties of Woodwind Instruments,* 2nd ed. (Illinois: Northern Illinois University Press, 1998), 97.

[62] There has been varying levels of success with creating an 'in-tune saxophone' among instrument designers. Many vintage (and some contemporary lower grade) saxophones have severe pitch deviances from equal temperament which must be compensated for by the musician. Due to the smaller bore and the call for precision engineering, these problems are particularly marked on many soprano saxophones.

The increasing use of microtones in contemporary music has necessitated re-introduction of cross-fingerings to further manipulate the sound waves in the bore of the instrument. This presents mechanical challenges to the performer as the smooth transition from one note to another enabled by the keywork becomes disrupted. A more pressing consideration is that the cross-fingerings result in an uneveness in tone production as they create a longer section of tube below the first hole:

> The effect of this greater length is to push the higher modes of the air column even further away from the harmonic frequencies than they are normally, so the harmonic content of the tone is further reduced; this results in a poorer quality.[63]

In practice, this results in a darker or duller sound, as there is a reduction in the tone's upper partials. So there is a tonal inconsistancy between the tempered semitones and some of the quarter-tone fingerings. This has varying implications as higher partials are less prevelant in saxophone tone at lower volume levels and also less prominent in the upper register of the saxophone. Notwithstanding these issues, fluid production of quarter-tones on any member of the saxophone family can be reasonably achieved through application of the diligent student.

3.2.1 Developments of Quarter-tone Instrumental Design

Although still a minority interest, there are a number of innovative instrument builders committed to developing new quarter-tone designs for existing Western instruments. The Dutch flute maker Eva Kingma is a leading pioneer in this field producing new flutes with quarter-tone key systems since the 1990s.[64]

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[63] Backus, John: *The Acoustical Foundations of Music* (New York: W.W. Norton and Company, 1909), 207.

[64] "The Kingmasystem® flute is, in all respects, a Boehm system flute with a C# trill. All of the normal touch pieces and fingerings are where you would expect them to be. What makes this flute so unique is that, in addition to the standard Boehm mechanism, there are six extra keys. This is made possible through the use of the patented key-on-key system… These keys are used to produce six of the seven quartertones and multiphonic vents which are "missing" on the normal French model flute. The seventh "missing" quartertone is achieved by using the C# trill

> This new design allows the Kingma System player to perform in remarkable new ways. The first and most obvious possibility for the flautist is to play accurate quartertone scales. While a French model flute can produce quarter steps by venting the open holes and shading certain notes with alternative fingerings, the Kingma System flute is able to play a complete chromatic quartertone scale through all the registers. It is possible to half-vent every key on the Kingma System, not just the open hole keys. This means that the flautist can now play accurately all of the quarter steps from e.g. F# to G# or from Bb to D. This aspect of the flute makes nonwestern types of music far more accessible to any player, and also provides some interesting special effects for the jazz player.[65]

A much earlier example of quarter-tone innovation is seen through the work of German clarinet builder Fritz Schüller (1883-1977). Schüller created a new clarinet consisting of two parallel bores and a modified key system which could accurately pitch quarter tones. Schüller's invention never gained mainstream acceptance and now exists only as a museum piece. The standard clarinet, unlike the saxophone, has hollow rings, which close over the tone holes. This fingering system allows a far greater degree of pitch flexibility, with the option for half covered holes.[66]

Other significant quarter-tone instruments include the quarter-tone marimba designed in 2007 by Norwegian musician Kjell Tore Innervik[67] and a patent for a quarter-tone oboe realised through the addition of extra venting holes[68]

3.3 The Quarter-Tone Saxophonist

With the addition of microtonality, an improvising musician has, on a very basic level, a widened harmonic palette. As musicologist Bob Gilmore states "the use of microtones is welcome as a way of increasing the general level

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key together with the normal C key. The other five quartertones are produced by using the normal, open hole keys." - http://www.kingmaflutes.com/mySite/Kingmasystem.html (7 August 2009)

[65] *Ibid.*

[66] Accordingly, quarter-tone fingering are more accurate and more widely played on the clarinet. See http://www.wfg.woodwind.org/clarinet/ocl_qt_1.html for a clarinet quarter-tone fingering chart.

[67] http://www.quartertonemarimba.com/index.html (7 August 2009)

[68] http://www.patentstorm.us/patents/4714001/description.html

of complexity of the pitch domain."[69] If the improvising musician seeks to expand his/her harmonic palette in a systemised manner, a particular tuning system must be chosen, mastered and assimilated into the aesthetic framework and personal playing style of the musician.

In developing a systemised approach to adopting microtonality for the saxophone, quarter-tone production is the choice (among the infinite varieties of just intonation, sixth-tone, eighth-tone, meantone temperaments, et cetera), which has a number of clear and practical advantages. The production of quarter-tones can be viewed as a simple extension of the twelve-tone equal temperament system. Quarter-tones are easily understood as the half-way point between two equally tempered semitones, which is immediately identifiable both in terms of tuning by ear and is also a workable interval in relation to the mechanics of the saxophone.

> Most "just intonation" microtonalists would likely argue that equal temperament is *counter-intuitive* because it denies the natural intervals sounding within every tone. I maintain that *that which has become second nature through habit* is what musicians can truly call intuitive. Therefore the process of simply adding pitches, in which one measures the new microintervals against the twelve traditional (habitual) intervals is more intuitive, more "natural," than that of just intonation because it demands, not that musicians embark on a fundamental re-training of their ears and re-invention of their vocabulary, but rather that they *expand from a familiar point of departure*.[70]

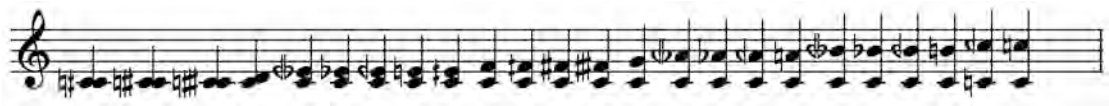
3.4 Quarter-Tone Technique

Mastery of quarter-tones on the saxophone mirrors the learning process for conventional equal temperament note production. Quarter-tone production for the saxophonist must start with the learning of new cross-fingerings to approximate the pitches in between the equally tempered semitones. (See Appendix A for fingering charts).

[69] Gilmore.
[70] Werntz, 204. Emphasis in original.

A period of ear-training must then be undertaken in order to fine-tune these pitches correctly as certain fingerings give merely an approximation of the correct pitch.[71] Ear-training exercises for quarter-tone recognition and production follow the same rules as those for the twelve-tone chromatic scale. The student must develop the ability to recognise and sing all intervals within the twenty-four note octave.

Ex. 3.2 Intervals within the twenty-four note octave



The advanced student will be familiar with all of the intervals from twelve-tone equal temperament, thereby halving the amount of new information to master. The remaining unfamiliar intervals are described (and heard) in relation to their twelve-tone equally tempered neighbouring intervals. For example, the third interval in Ex. 3.2 above is described as either a 'too sharp minor second' or a 'too flat whole tone'. An accurate tuner is an essential tool to monitor these unfamiliar intervals.[72]

Technical fluency with these fingerings and intonation issues is developed through exercises, études and scales. See Appendix B for quarter-tone erercises and études for the saxophone. It is interesting to note that this process greatly aids the saxophonist in intonation in general:

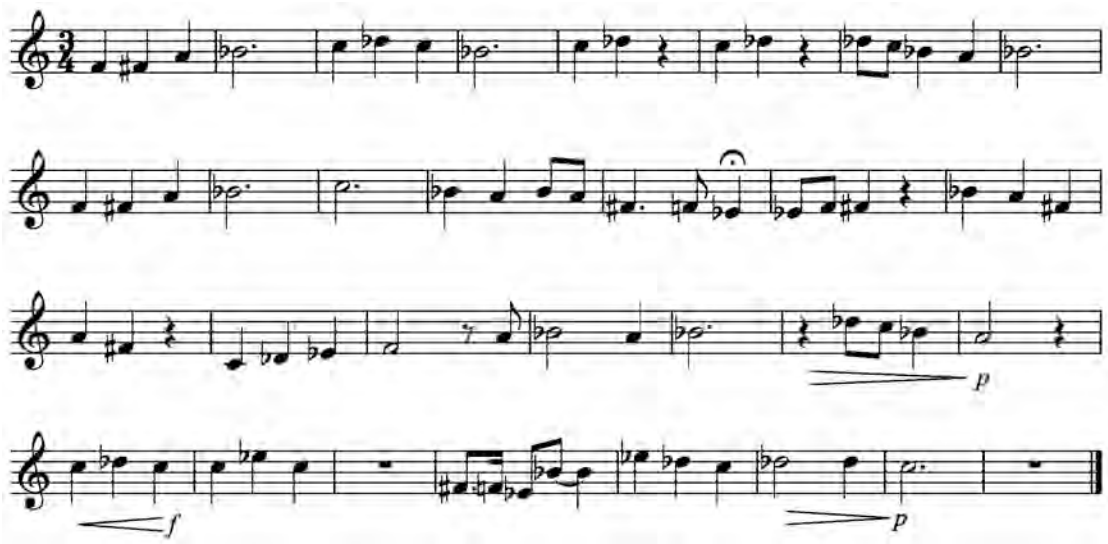
> Microtonality means increasing and fundamentally changing our patterns of hearing. Being raised in a diatonic musical world for 20 years and then trying to break out of it is a long road but one full of rewards. Once we move back in to our familiar chromatic musical world after playing micro intervals we find our hearing has become more exacting.[73]

[71] An exact measurement cannot be given, as the tuning varies between the different fingerings and also from instrument to instrument.
[72] Strobe tuners can measure within 0.1 cent. These are costly instruments but software versions are available. A free trial download is available from http://www.tbstrobetuner.com
[73] Softspeakers, Hayden Chisholm (2006): http://www.softspeakers.com/saxo/ars-microtonum [accessed 21 July 2009]

3.5 Quarter-tone Embellishment

Quarter tones serve as an extremely effective embellishment in a twelve-tone equally tempered situation. As a compositional device in an originally diatonic piece of music, quarter-tones can serve as additional sources of tension and release, providing an innovative alternative to the jazz procedure of chromatic sidestepping.[74] Example 3.3 below shows an traditional folk melody *Armenian Song* for alto saxophone and drone, arranged by the author.[75]

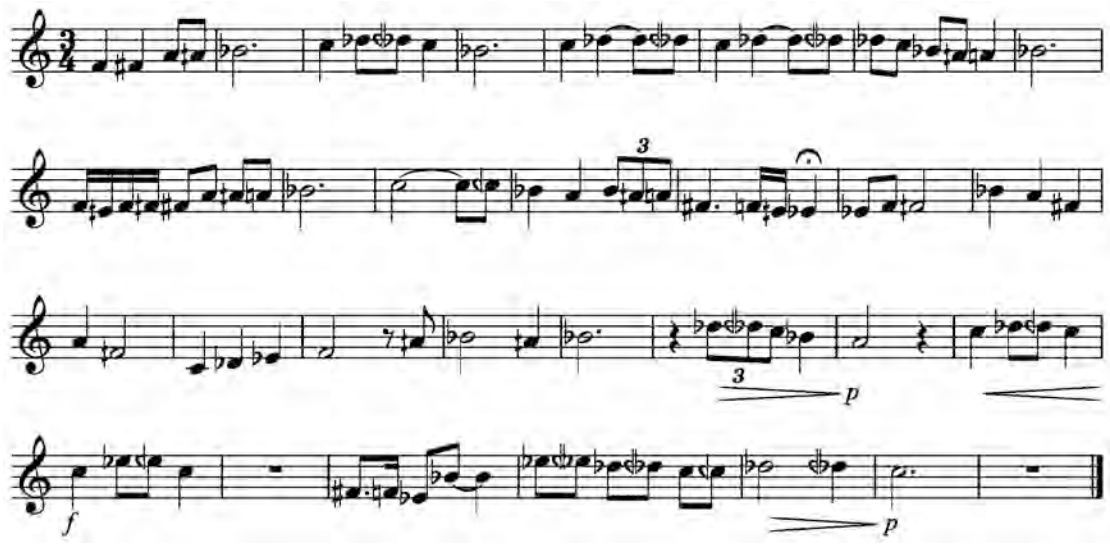
Ex. 3.3 *Armenian Song* – Original melody



Example 3.4 below shows the same melody, varied with the inclusion of quarter- tones. Each quarter-tone embellishment is placed a quarter-tone away from the original melody note (either it replaces the original note, or, more commonly the quarter-tone variant is fitted before or after the melody note, creating added rhythmic dynamic). This new composition retains the intrinsic qualities of the original composition, yet also gives the piece a more complex melodic contour. Thus, it is shown that quarter-tone embellishment functions as a useful compositional device.[76]

Ex. 3.4 *Armenian Song* – Variant melody

[74] Chromatic sidestepping, as a device to add chromatic tension notes, became a favourite cliché of be-bop musicians such as Charlie Parker and Dizzy Gillespie.
[75] A recording of this example can be heard on Track 3 in Appendix D
[76] A recording of this example can be heard on Track 4 in Appendix D

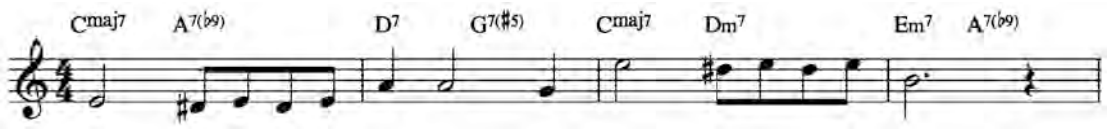


The variations between both examples above can be viewed as analogous to a jazz musician's reading of a lead sheet of a jazz standard. The traditional role of the jazz musician when faced with a score of a Broadway standard is to draw from a range of non-notated musical devices, which 'jazz up' the performance. These improvisational tools will typically include rhythmic displacement (increasing syncopation), melodic variation (substituting different scale tones) and chromatic ornamentation. The mastery of quarter-tone technique enables the improvising saxophonist to add microtonal embellishment to this list of tools. In this context, quarter-tone embellishment provides a new alternative to chromatic embellishment. The two systems may, of course, co-exist, further enrichening the melodic contour. See Example 3.5 – 3.8 below.

Example 3.5 below illustrates the original melody of the popular jazz standard Stars Fell on Alabama[77] composed in 1934. Jazz musicians rarely perform melodies strictly as written, preferring to improvise embellishments thereby creating a more personal interpretation.

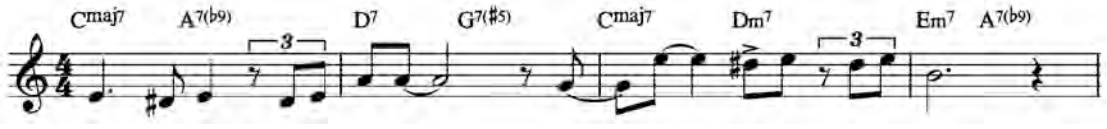
Ex. 3.5 Stars Fell On Alabama: Original Broadway version, 1-4

[77] Composed by Frank Perkins, lyrics by Mitchell Parish. 1934 (renewed 1962) EMI Mill, Inc., USA.



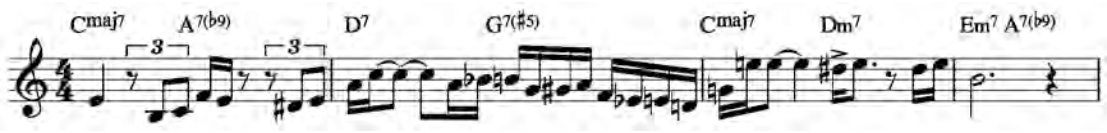
Example 3.6 is an example of a simple interpretation of the melody in Example 3.5 above. Note the rhythmic displacement and increased complexity featuring broken triplets. The quavers in this example (and the following two examples) are played with a swing feel. This example is idiomatic of jazz interpretation from the 1900s until the 1950s.

Ex. 3.6 Stars Fell On Alabama: Simple jazz interpretation, 1-4



Example 3.7 below displays a contemporary jazz interpretation of the melody from Example 3.5 above. Note the increased rhythmic complexity, mixing broken triplets and semi-quaver passages. This example features the use of chromatic passing notes. This example is idiomatic of jazz improvisation from the be-bop era of the 1950s and these techniques are also to be found in today's contemporary jazz.

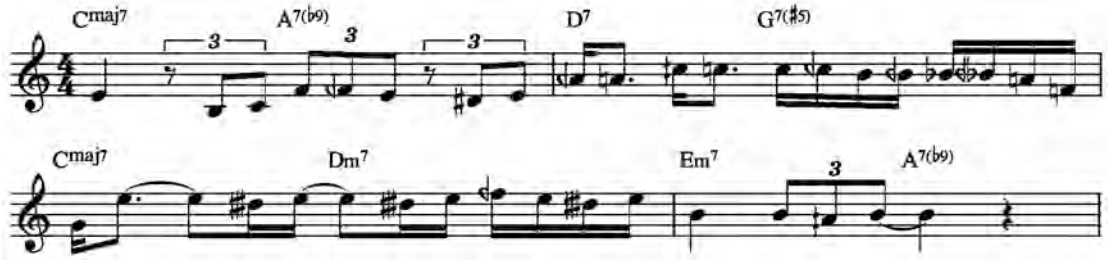
Ex. 3.7 Stars Fell On Alabama: Contemporary jazz interpretation, 1-4



Example 3.8 below shows an amalgamation of the three previous Examples with the addition of quarter-tone embellishment. The rhythmic complexities of Example 3.6 are still present. The chromatic notes from Example 3.6 are now interspersed with quarter tones. In bar 2, a micro-chromatic run is

used and in bar 3 a microtonal ornamental turn leads us to the melodic resolution on bar 4.

Ex. 3.8 Stars Fell On Alabama: Quarter-tone jazz interpretation, 1-4



From these examples, it is clearly displayed that quarter-tone embellishment is an effective tool in creating new harmonic possibilities for the saxophonist in both compositional approaches and as a tool in improvisation. This is an important innovation both in terms of an increased pitch field as well as offering new rhythmic opportunities. The addition of twelve extra notes per octave enables richer rhythmic nuance, where voice leading principles can be played with by substituting notes with their quarter-tone neighbour. Repeated notes can also be substituted with their quarter-tone neighbour as a colouring device or to increase rhythmic activity.[78]

3.6 Split Scales

The use of quarter tones presents many new harmonic possibilities, one of which is the formation of split scales. The term split scales refers to creating new divisions in the chromatic scale, resulting often in (although not exclusively) symmetrical scales which operate outside of the structures of twelve-tone music.

When a diatonic interval such as a major sixth in the key of D is split at the midway point, two new intervals are created. The midway point is thought of

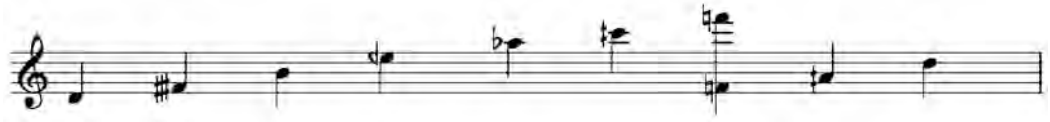
[78] This approach can be likened to Lester Young's use of repeating notes with 'false fingerings' which often were actually microtonal shadings (see Chapter 3.7).

as 4.5 semitones, in this example the note F three quarter sharp (enharmonically spelt G one quarter flat). The three quarter sharp F creates a wide major third between itself and the D below and another wide major third with the B above.[79]

Ex. 3.9 Split major sixth

Example 3.10 shows the full scale created using this quarter-tone interval of 4.5 semitones. This octatonic scale spans two octaves (the example shows the notes within the saxophone range).

Ex. 3.10 Split major sixth scale



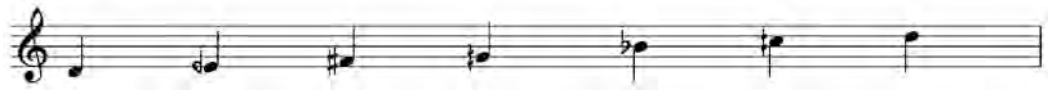
When the diatonic major third in the key of D is split at the midway point, two new intervals are created. The midway point is thought of as 1.5 semitones, in this example the note E quarter sharp (enharmonically spelt F three quarters flat). The E quarter sharp creates a wide wholetone between itself and the D below and another wide wholetone with the F♯ above.[80]

Ex. 3.11 Split major third

[79] This interval measures 450 cents and is exactly halfway between a major third and a perfect fourth in equal temperament.
[80] This interval measures 150 cents and is exactly halfway between a major second and a minor third in equal temperament.

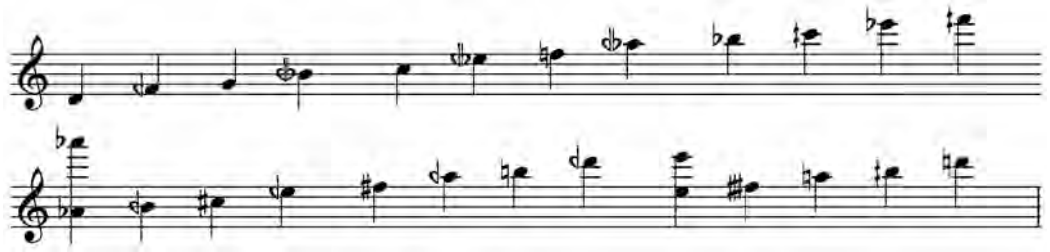
Example 3.12 below shows the full scale created using this quarter-tone interval of 1.5 semitones. This is a hexatonic scale spanning one octave and its harmonic composition is two augmented triads a semitone and a half away from each other.

Ex. 3.12 Split major third scale



Using the same system to split perfect fourths results in a scale which spans four octaves before resolution. The notated version here, starting on the note D, drops octaves three times in order to stay in the saxophone's range. This scale contains all twenty-four notes in the quarter-tone system.

Ex. 3.13 Split perfect fourth scale



There are multiple configurations of split scales available within the twenty-four note scale. These scales are a rich source of new melodic and harmonic potential. Appendix B contains three short études for saxophone using three different split scales.[81]

3.7 Expressive Intonation

In practice, the saxophonist, who is expert in advanced intonation, will sometimes choose to further colour notes beyond either equal temperament or quarter-tone intervals. Embouchure pressure alone, without the use of special

[81] A recording of these études is included in Appendix D.

fingerings, can comfortably modulate a pitch as much as a minor third or more. Within this range, the saxophonist chooses to play the equally tempered notes, the quarter-tone intervals, smaller non-notated intervals or glissandi. These microtonal deviations (often termed tonal shadings or colouring) are a common occurrence in much vocal and instrumental music outside the Western tradition. In terms of their expressive capabilities, saxophonist Hayden Chisholm sees these as embellishments "encasing a melody or a note within something beautiful. It feels like, instead of laying things out bare, you are presenting them with more subtlety; as something more fragile."[82] The Arabic *maqam* (discussed in Chapter 2.2.1 above) makes frequent use of changing intervallic relationships, as an expressive device:

> Because the Arab tone system is not tempered, the size of an interval can change during the presentation of a maqam, giving rise to a particular characteristic coloring of a tone level and simultaneously eliciting a specific emotional mood. […] It is the changeable size of certain intervals in this nontempered tone system that influences the emotional content of a maqam. Such an emotional content, however, becomes lost as soon as the tone system is artificially changed and organised into intervals of equal size.[83]

Glissandi have served the jazz saxophonist as a means to manipulate pitches. The technique can be further broken down into 'scoops' and 'smears' as Doug Miller elaborates:

> Techniques common in jazz playing to decorate the attack of a note […were] known as the 'scoop' or 'smear', these were glissando-type techniques which involved (respectively) starting the tone near its full pitch, going below it, then working back up to it before giving the tone its full duration; and approaching a tone from a pitch well below it.[84]

Microtonal trills are another well established intonational saxophone technique in the jazz tradition. One of the most influential jazz saxophonists

[82] Chisholm interview.
[83] Touma, Habib Hassan: *The Music of The Arabs*, trans. Schwartz L. (Portland and Cambridge, Amadeus Press: 2003), 45.
[84] Miller, 163.

Lester Young (1909 – 1959) popularised this device in the 1940s, using alternative fingerings to colour notes by microtonal intervals.[85]

> Young […] rapidly alternated the standard fingering of a note with its substitute fingering. This lent a subtle excitement to the simple device of pitch repetition. […] The alternate fingerings, however, produce different tone-colors and sometimes are slightly out of tune. […] Young relied increasingly on these expressive devices over the years… Beginning in the late 1940s, Young sometimes used alternative fingering techniques to produce a "wah-wah" sound leading into certain notes. Closing the keys below certain notes will muffle the tone (usually slightly lowering the pitch, too) and quickly releasing these keys will produce a "wah" sound as they open again.[86]

All of these techniques of pitch deviation add to the expressive nature of the instrument when used consciously and appropriately to the musical situation. They are further refinements to the quarter-tone fingerings illustrated in Appendix A, and are an important addition in expanding the expressive palette of the contemporary saxophonist.

[85] Examples of this use can be heard on many of Young's landmark recordings including *Jumpin' at the Woodside*, *Lester Leaps In* and *I Want to be Happy.* See Discography.
[86] Porter, Lewis: *Lester Young* (Ann Arbor, University of Michigan Press: 2005), 50.

CONCLUSION

A systemised method to mastering production of quarter-tone notes vastly increases new melodic and expressive possibilities for the contemporary saxophonist, offering a choice of twenty-four notes per octave. Quarter-tone production is an ancient and proven performance device and now a viable addition to the contemporary saxophonist's lexicon. This has far reaching implications for the saxophonist both as a composer and as an improviser.[87] Melodies containing far greater harmonic complexity can be realised with the twenty-four note scale. Even within a diatonic musical context, the improvising saxophonist can use quarter tones to embellish the scalar tones. This approach to microtonal embellishment is a powerfully expressive device, drawing on ancient techniques of many folk music traditions. The expressive powers of quarter tones lead the saxophonist closer to the development of a personal approach to intonation and also to approximating the nuance of vocalists (a long-standing aim of many musical traditions).[88]

The systemised method of quarter-tone production introduced herein, is an extension of the existing tradition of pitch manipulation within jazz music. This method marries the aesthetic framework of certain folk music (in this case, the Arabic *maqam* tradition), which has a clear and conscious methodology concerning microtonality, and the innovations of twentieth-century composers who investigated microtonality in their works (Ives, Bartók, Hába). This process is seen in the pioneering work of saxophonist Hayden Chisholm, who performs jazz with quarter tones and involves some of the concerns of the Armenian duduk tradition, Japanese shakuhachi music, twentieth-century Western music and contemporary jazz.[89]

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[87] The education of saxophonists in quarter-tone technique has enormous implications beyond the world of saxophone players and educators. For contemporary composers (and audiences) of saxophone music, the availability of quarter-tone instrumentalists will greatly aid the progression of new music.

[88] These expressive powers are manifested in many various ways depending on personal interpretation. The Spanish Catalan cellist Pablo Casals resolved cadences microtonally by tuning leading notes closer to their resolution point, increasing the sense of resolution. The American alto saxophonist Jackie McLean often pitched notes sharp to give his tone a cutting quality.

[89] A recent example of Chisholm's work can be heard with his group on the Nonplace release The Embassadors feat. Michel Ongaru, *Healing The Music* (2008).

The twenty-four note equally tempered scale is very well suited to the mechanics of the saxophone. New alternative fingerings facilitate these microtones. Mastery of quarter-tone technique mirrors the normal learning processes involved in saxophone playing, where études, scales and ear-training all form part of the practice schedule. This approach is an innovative development in terms of pitch consideration for saxophonists, where the pedagogical tradition has chosen to ignore or reject the microtonal possibilites which are intrinsic to the instrument.

Chapter One demonstrates how a basic knowledge of overtone structures and history of temperament is essential for the discerning saxophonist in order to navigate the challenges and nuances of tuning. The musicological study in Chapter Two of the identified case studies serves as an underpinning knowledge base for the microtonal approach of the contemporary saxophonist. This research acts to inform the methodology for saxophone microtonality outlined in Chapter Three.

To summerise, this research primarily proves and demonstrates how the saxophone, as an instrument of non-fixed intonation and therefore not confined to a fixed or single temperament system, may, through a systemised method to mastering production of microtonal notes, be vastly increased in its expressive and melodic potential. Second, it demonstrates how an understanding of the history and nuance of tuning systems and alternative temperaments provides the required knowledge for effective pitch manipulation outside of the twelve-tone model. Third, it establishes that cross-cultural studies most effectively provide the systematic, underpinning knowledge required to support the contemporary improvising performer, drawing on ancient traditions of microtonality alongside recent innovations in contemporary music. Finally, this research proves that quarter-tone production is a viable device for the contemporary saxophonist, and that it has far reaching implications for the saxophonist leading him/her to a position of greater expressive potential.

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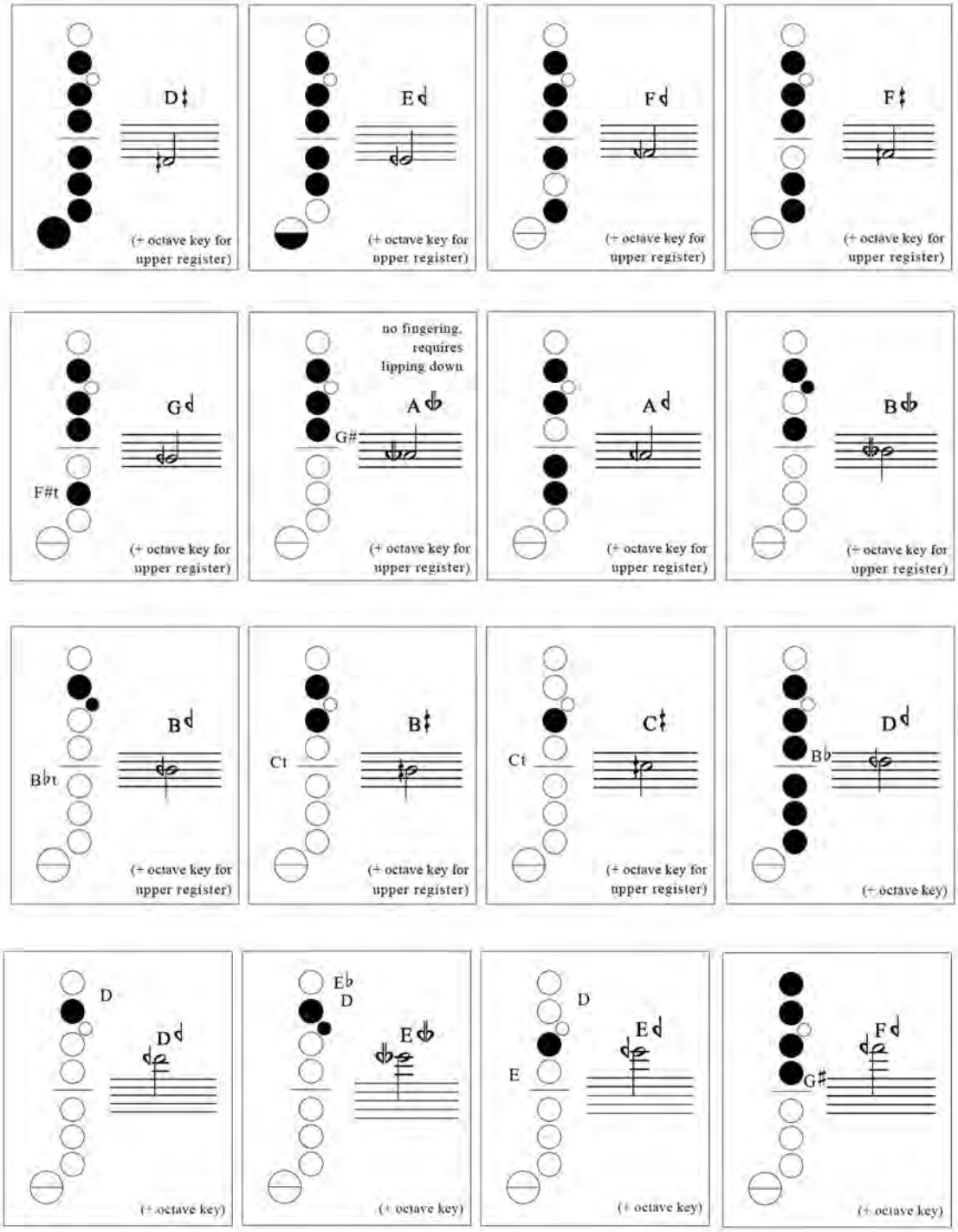
Appendix A Quarter-tone fingering chart

The following chart is a graphic representation of all the quarter-tone fingerings from low D to the top range of the saxophone. There are no practical fingerings for quarter tones below D. There is no fingering for the quarter-tone between G and G♯ (this note is attained by embouchure pressure alone).[90] Fingerings for quarter tones beyond the top range have not been included as these altissimo fingerings are often unstable and can vary substantially between different instruments.

While *any* saxophone fingering requires a careful understanding of intonation issues, these new quarter-tone fingering demand an increased awareness of pitch and experience with quarter-tone ear training. Inconsistencies in these fingerings are inevitable, due to the original design-purpose of the instrument. Further to this, there may be variances between different instrument brands as well as through the different members of the saxophone family (soprano, alto, tenor, baritone, et cetera).

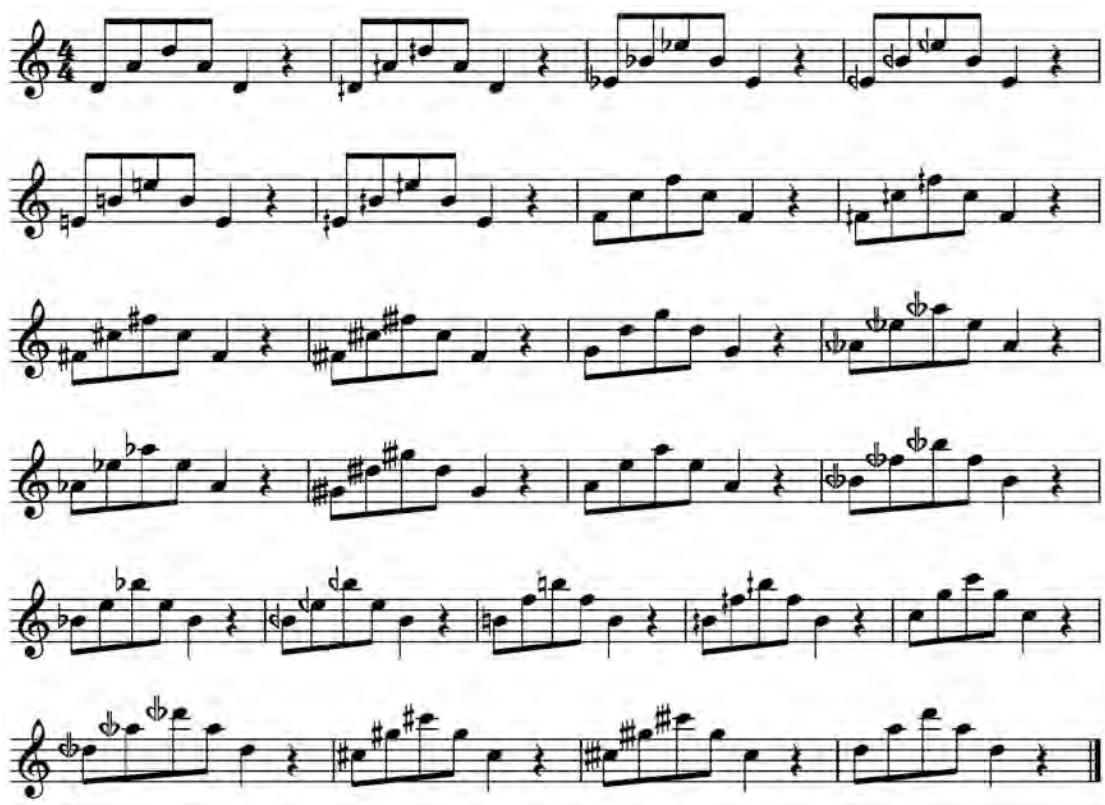
With practice these fingerings (in conjunction with the standard chromatic fingerings) will produce a twenty-four note equally tempered scale throughout the range of the saxophone.

[90] This quarter-tone fingering can, however, be achieved by a relatively simple instrumental modification by an experienced repair person.


D♯
(+ octave key for upper register)
E♮
(+ octave key for upper register)
F♮
(+ octave key for upper register)
F♯
(+ octave key for upper register)
G♮
F#t
(+ octave key for upper register)
no fingering, requires lipping down
A♭
G#
(+ octave key for upper register)
A♮
(+ octave key for upper register)
B♭
(+ octave key for upper register)
B♮
B♭t
(+ octave key for upper register)
B♯
Ct
(+ octave key for upper register)
C♯
Ct
(+ octave key for upper register)
D♮
B♭
(+ octave key)
D
D♮
(+ octave key)
E♭
D
E♭
(+ octave key)
D
E♮
E
(+ octave key)
F♮
G♯
(+ octave key)

Appendix B Quarter-tone exercises

Shown here is an example exercise which focuses on a root to fifth movement, which ascends micro-chromatically.[91] This exercise should be played slowly at first, in order to pitch the quarter-tone bars accurately.



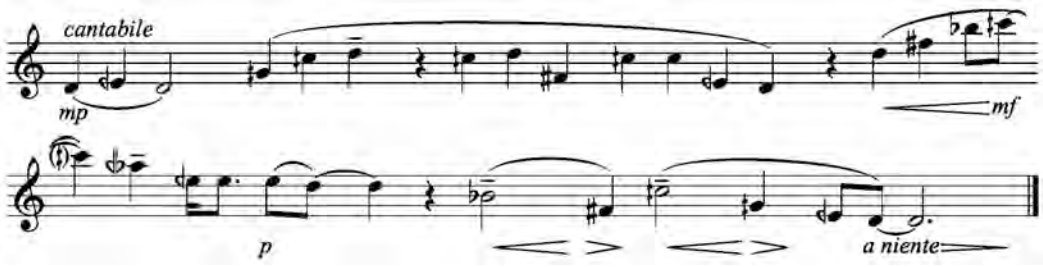
Split scales (see Chapter 3.6) are used here to familiarise the student with the use of quarter-tone fingerings, harmony and technique.[92] This Appendix shall use three distinct scales from the twenty-four note equally tempered system: the split major thirds scale, the split perfect fourths scale and the split major sixths scale. These scales should form the harmonic content of the student's practice regime, where he/she would have previously use scales/modes from twelve-tone harmony in exercises focusing on rhythmic and/or technical issues. Each scale should be transposed through all twenty-four keys. These musical examples are transposed for any member of the saxophone family.

[91] Micro-chromatic is a term used to describe modulation in quarter-tone steps.

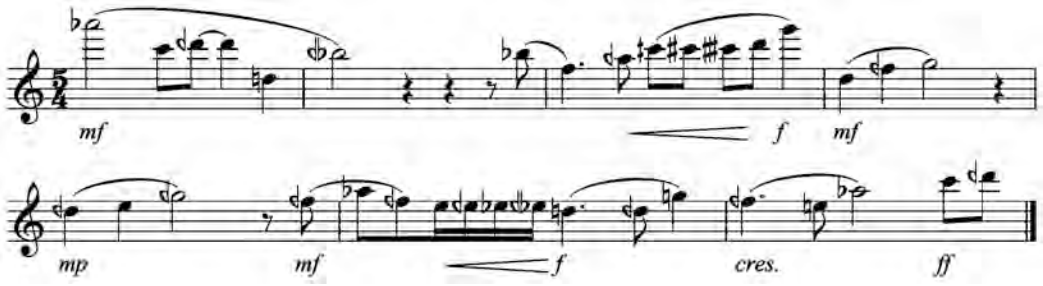
[92] Notes are spelt here in a mixture of sharps, flats and their quarter and three-quarter counterparts, this is in order to familiarise the student with the unfamiliar notation system.

The following miniature études each make use of the harmonic and aesthetic identity of the parent scales. These should be practiced slowly at first, paying attention to correct intonation.[93]

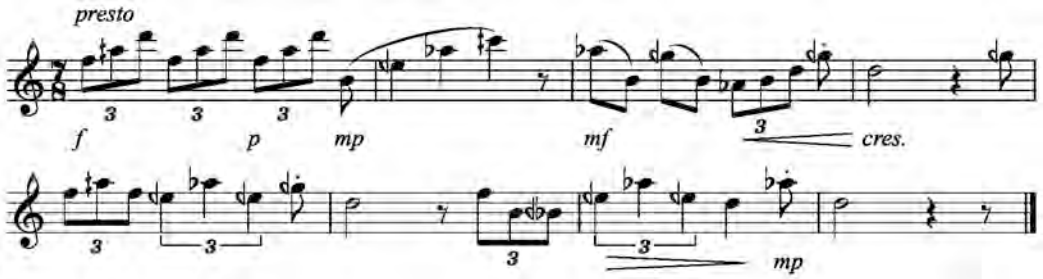
Étude #1: Split major third scale



Étude #2: Split perfect fourth scale



Étude #1: Split major sixth scale



[93] A recording of each of these études can be found in Appendix D. A synthesiser has been used to produce these recordings to unsure perfectly accurate intonation as a tool for the student. The CD tracks are pitched a major 6th down to facilitate sight-reading for alto saxophones.

Appendix C Interview with Hayden Chisholm

Q: When did you first start exploring microtonality – I am interested in whether you were drawn to it intuitively, was it the result of study, or was it something you heard and were curious about?

A: On the saxophone, I owe that step to Frank Gratkowski[94], who was my teacher in Cologne at the music school. He was the one who showed me a piece which had a couple of microtonal fingerings and at the same time he introduced me to the music of Giacinto Scelsi[95] – that was my first contact with Microtonality as such. That was in about 1995, but if I was to look even earlier than that, the first music that really got under my skin was early blues music and obviously in the vocal part of blues music there is already a lot of microtonality going on. Or to take it a step further, Johnny Hodges[96] was a saxophone player who I really loved very early on. You could go as far as to say that he was in a sense microtonal, the way he used smudging and slurring and glissandi. But in an intellectual way as an extension to the saxophone's chromatic system, Frank's introduction in Cologne was the first one. He showed me a couple of fingerings and that sparked the whole thing off. Something attracted me to it straight away and I quickly developed more [microtonal] fingerings and tried to see how I could use it.

Q: You have explored the twenty-four note equally tempered scale in both compositions and improvisation. From the infinity of choice what made you choose this scale system?

A: I first started using quarter tones because I found that these notes were feasible on the saxophone. I could have gone further and explored sixth- and eighth-tones but quarter tones were already quite a big step and I wanted to get the quarter tones down well. I was also quite interested in working on split scales, working on dividing intervals exactly in the middle and quarter tones

[94] Frank Gratkowski (b. 1963) is a prominent woodwind instrumentalist and educator in European jazz and avant-garde circles.
[95] Giacinto Scelsi (1905-1988), Italian composer who produced microtonal work for orchestra, chamber and solo settings.
[96] Johnny Hodges (1906-1970), jazz saxophonist best known for his long tenure in Duke Ellington's big band.

were a good device for this. As far as symmetry goes, I was looking for new ways to divide up octaves and the quarter tones were a good tool for that. I think anything beyond that can get, let's say, less exact and I was looking to be as exact as I could.

Q: Where do you stand on the argument of the twenty-four note scale is, in fact, even further 'out of tune' with the principles of the overtone series. Have you investigated Just Intonation or indeed any of the other temperament systems?

A: Sure, I have researched the pros and cons of different systems. It is an extremely subjective field … You chose the system that fits you best and the system which gives you the most expression and possibilities and that's why, in a sense, I chose this one. I also think it's the one best suited to the saxophone as far as an extension of the chromatic system goes.

Q: Your tonal approach seems to draw more from folk instruments (I am thinking of the Armenian Duduk tradition or Shakuhachi music) than the classical or even Jazz soundworld. Does your interest in quarter-tones stem from Western art music or is it related more to folk music influences? Do you consider the tuning part of the overall sound *per se*?

A: Yes, these instruments are important reference points for me. In the shakuhachi tradition the use of microtonality, slurs, very modern techniques such as flutter tonguing is, of course, an integral sound of the actual instrument. It is sometimes difficult to separate an instrument from its tradition and shakuhachi is very closely connected to the ancient works that were written for it and continue to be performed on it, whereas the saxophone is, perhaps, more of a *tabula rasa* – something which you can write your own signature on. There are as many different saxophone sounds as there are players. The microtonal part of the saxophone is a way for me to broaden the tonal possibilities of the instrument, not just the harmonic possibilities but actually the timbre and the nuance.

Q: Quarter-tone production goes against the twelve-tone chromatic design of the saxophone. As a saxophonist, how well do you think the instrument can adapt to microtonality?

A: I think it can adapt very, very well. I think it can adapt even better than other wind instruments. There are reasons for that: the tuning on a saxophone is difficult anyway, there are a lot compromises to make and these can vary depending on the instrument we play. For a start we have a lot of keys, so there are many possibilities with combinations of keys which gives us a very good start into microtonality. It seems that we are still at the start [of this investigation] and there is a lot of work yet to be done but I think there had already been a lot of progress made on our instrument in the last twenty years.

Q: Have you got a specific 'function' in mind with the quarter-tone notes? Do these notes serve as an embellishment to the chromatic scale or are all twenty-four tones given equal importance?

A: I think the goal for me is give all twenty-four notes equal importance. I consider myself a long way off from that. I am still in a situation where a lot of the time they are used as embellishments. Also, a lot of the time the situations I am in are those in which the twelve-tone chromatic system is what is called for. We are very heavily conditioned by that. For instance a 'too sharp F' is still an embellishment of an F. There's nothing wrong with that either, you can make very beautiful music by playing around these notes, colouring them differently and so on. It also has to do with ear-training which has to develop simultaneously with the fingers.

Q: How do you approach harmony in relation to quarter tones? And how does this change between performing with a group sympathetic to quarter-tone music as opposed to you as a soloist improvising with musicians who are inexperienced with the twenty-four note scale?

A: I have found that when playing with a piano I definitely have to use quarter tones with caution! Going back to playing music without quarter tones is also rewarding. Often with singers it is less of an issue. I have had very good experiences playing with blues musicians and using these microtones.

Q: What is your approach to quarter-tone composition - how does it differ technically from equal temperament?

A: My compositional approach and the way I think of improvisation are very closely related. A lot of the compositions I write for the saxophone are etude based. I use them to test out and increase my technical ability to play these microtones. On the other hand there is the jazz-based work with Root 70, where up to this point I have used quarter tones in compositions with a blues-type setting.

I think of myself more as an improviser than a composer, although I try to use my compositions to benefit my improvisation and vice versa – I think they are very closely related. And I also try to think of my improvisation as a form of instant composition. There are certain quarter tones that are simply harder to play and to hear on the saxophone, I try to use these in the compositions simply because they are difficult.

Q: I guess that really comes from the jazz tradition, where the composition is, at the end of the day, a vehicle to improvise with – it is not the piece itself.

A: Yes, exactly. I am coming very much from that tradition. Composition, for me, is really a sketchbook and a testing ground for ideas more than the composition being a 'finished work', especially in the microtonal area, as I think of that as really a research ground.

Q: Can you tell me about your work with the German trombonist Nils Wogram and contemporary jazz group Root 70. This group has done more than any other in jazz to introduce quarter-tone melody and harmony into the pre-existing model.

A: The interesting thing about the trombone is that it proves itself to be a very accurate instrument for executing microtones and Nils [Wogram] has developed not just the intonation but also the timbre which makes it blend so well with the saxophone. So we spur each other on: a lot of the material that Nils writes is quite difficult for me to play on the saxophone and vice versa. So that has helped each of our microtonal techniques a lot. Compositionally how we have used microtonality has developed: we began to use it [quarter-tone harmony] with just the lead instruments in unison and this has developed to even writing microtonally for the bass, so that the chords themselves are slightly shifted.

Q: Do you see microtonality on the saxophone as a device to closer replicate the nuance of vocal technique?

A: Yes I think it is. I have always aspired to getting closer to the nuance of the human voice and as instrumentalists I think we should all do that. That's one of the advantages we have as saxophonists.

Q: Do you feel that quarter-tones imbue your soundworld with a greater expressivity? And, if so, how do you account for this – what is it that is expressive about bending notes or playing notes outside of the chromatic scale – it is simply an extension beyond it to provide greater tension and subsequent release (much as the chromatic scale serves as an extension of the diatonic scale for modern jazz musicians)?

A: If you take, for instance, baroque music, there was a huge amount of embellishment with mordents and trills and so on. And in a sense it is just another form of that, of framing a melody or encasing a melody or a note within something beautiful. It feels like instead of laying things out bare you are presenting them with more subtlety; as something more fragile. It's a very interesting discussion why that is. As a player it gives me more possibilities to play around with the melodies.

It struck me from working on some shakuhachi pieces from the 13th and 14th centuries how incredibly modern they are, using techniques which we consider 20th century techniques like flutter-tongue, glissandi, multiphonics and so on. These were notated and used in the classical shakuhachi repertoire. These embellishments come in stylistic waves. So it comes down to stylistic issues of the time which is why it really has to up to the sense of the individual musician to make some choices with these issues.

Appendix D Audio samples

Please see Compact Disk attached.

Track One:

Twelve-tone chromatic scale
(alto saxophone)

Track Two:

Twenty-four note scale
(alto saxophone)

Track Three:

Armenian Song (original melody)
(alto saxophone & electronic drone)

Track Four:

Armenian Song (quarter-tone variant melody)
(alto saxophone & electronic drone)

Track Five:

Étude #1: Split major third scale

Track Six:

Étude #2: Split perfect fourth scale

Track Seven:

Étude #3: Split major sixth scale