Exploring the Waterfall

by

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M.Mus., New England Conservatory of Music, 1995

A THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

Doctor of Musical Arts

in

THE FACULTY OF GRADUATE STUDIES
(Composition)

THE UNIVERSITY OF BRITISH COLUMBIA
(Vancouver)
October 2010

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Abstract

*Exploring the Waterfall* is a 13-minute composition for 12 strings in 2 continuous movements. It realizes important aspects of a harmonic theory that I have been developing over the past 15 years. This theory is an attempt to recreate and expand tonal resources through a rational method based on acoustics. It focuses on the ability of one primary principle, the regulation of frequencies through number series, to generate the entire harmonic content of a piece of music. In the first movement, this is mainly accomplished through series selection, whereby many different series are grouped together according to the similarities and differences in their numeric and intervallic structure. In contrast, the second movement uses only a few different series, but attains harmonic variety through the Intervalic Design concept, in which a single series is segmented and recombined to produce a multitude of different intervallic structures. This harmonic theory illustrates how a wide spectrum of harmonic color can be achieved and united under one system. Finally, from an aesthetic viewpoint, *Exploring the Waterfall* defies some of the double standards that one often encounters in the realms of jazz and classical music composition.
# Table of Contents

Abstract ........................................................................................................................................... ii
Table of Contents ............................................................................................................................... iii
List of Figures ........................................................................................................................................ iv
List of Tables ......................................................................................................................................... v
Acknowledgements .......................................................................................................................... vi

CHAPTER 1: Introduction and Background ....................................................................................... 1
  1.1 Introduction ................................................................................................................................. 1
      1.1.1 Exoticism in Composition ............................................................................................... 3
      1.1.2 The Jazz Complex ............................................................................................................ 7
  1.2 Composition: Jazz or Classical? ............................................................................................... 15
  1.3 Music and Mathematics ............................................................................................................ 18

CHAPTER 2: Harmonic Theory ........................................................................................................... 21
  2.1 Issues .......................................................................................................................................... 21
  2.2 Objectives .................................................................................................................................... 23
  2.3 Functional Harmony ................................................................................................................... 24
  2.4 Tonal Shading ............................................................................................................................. 27
  2.5 Frequency Regulation ................................................................................................................. 30
      2.5.1 Introduction ....................................................................................................................... 30
      2.5.2 Equal Difference Series ................................................................................................. 32
      2.5.3 Intervallic Slope ............................................................................................................... 36
      2.5.4 A Sliding Scale of Values ............................................................................................... 41
      2.5.5 Sloped Difference Series ............................................................................................... 45
      2.5.6 Intervallic Design ............................................................................................................. 46

CHAPTER 3: Compositional Aspects of Exploring the Waterfall ......................................................... 50
  3.1 Form ........................................................................................................................................... 50
  3.2 Counterpoint and Motivic Relationships ................................................................................... 60
  3.3 Orchestration .............................................................................................................................. 70
  3.4 Rhythmic Procedures ............................................................................................................... 75
  3.5 Harmonic Theory Applications ............................................................................................... 82
  3.6 Aesthetic Value ......................................................................................................................... 102
      3.6.1 Style ............................................................................................................................... 102
      3.6.2 Rhythm ......................................................................................................................... 109
      3.6.3 Harmony ....................................................................................................................... 113

CHAPTER 4: Score of Exploring the Waterfall ..................................................................................... 117

Bibliography ...................................................................................................................................... 218

Appendix I: Intervallic Slope of the Harmonic Series ..................................................................... 222
Appendix II: Intervallic Sets from Selected Equal Difference Series ............................................. 223
List of Figures

Figure 1: (EDS) n+5 Group ................................................................. 34
Figure 2: Intervallic Slopes of S9, S12 and S15 .............................................. 40
Figure 3: Formal Plan of Exploring the Waterfall ........................................... 54
Figure 4: Phrase Level Pulsation in mm.241-274 ........................................... 78
Figure 5: Perfect-related Cadence on the 3rd Beat of m.18 .............................. 82
Figure 6: Tonal Shading in m.92 .................................................................. 84
Figure 7: The Reconciliation of Different Fundamentals within EDS Group n+11 ...... 87
Figure 8: Acoustical Expansion of mm.82-84 (Figure 7) .................................... 90
Figure 9: The Transition from (EDS)3+5 to (SDS)3+[(EDS)5+2] ......................... 91
Figure 10: Transitional Harmonies between (EDS)3+5 and (SDS)3+[(EDS)5+2] .......... 93
Figure 11: The Creation of a Lightning Chord .................................................... 94
Figure 12: The Painted Line and Other Concepts .............................................. 97
Figure 13: Maximum Tonal Shading, mm.318-321 .......................................... 100
Figure 14: Maximum Tonal Shading, mm.322-325 .......................................... 101
List of Tables

Table 1: Intervallic Slope of (EDS) 1+1, the Harmonic Series ........................................37
Table 2: Harmonic Series Intervallic Set Permutations for mm.334-335.........................67
Table 3: Harmonic Series Intervallic Set Permutations for mm.336-337.........................69
Acknowledgements

I have benefited greatly from all those with whom I have studied at the University of British Columbia and I am also grateful for their friendship.

In regard to this dissertation and the completion of this degree, it is my desire to mention here only two individuals by name in order to not diminish their outstanding contributions.

I would like to thank Dr. Keith Hamel for going above and beyond the call of duty during every step of this process.

I would like to thank my wife Esther, without whom none of this would have ever been possible.
CHAPTER 1: Introduction and Background

1.1 Introduction

If the spirit is not moved by the power of the expression, by the vivid colors of which the harmonist alone is capable, then it is not absolutely satisfied. (Jean Phillippe Rameau, 1734)

*Exploring the Waterfall* is a 13-minute music composition in 2 continuous movements, scored for 12 strings: 6 violins, 2 violas, 2 cellos and 2 double basses. The title itself is derived from Appendix II, which is a graphic representation of an important concept of my harmonic theory and happens to resemble a waterfall. The word *waterfall*, then, is emblematic of my harmonic theory and the word *exploring* represents the quest to find various applications of the theory in order to create the entire harmonic content of the work. The realization of this theory in a musical composition is an essential component of this thesis.

The theory of harmony, which I have been developing over the past 15 years, is an attempt to recreate and expand tonal resources through a rational method based on acoustics. It focuses on the ability of one primary principle, the regulation of frequencies through number series, to generate the entire harmonic content of a piece of music. The numbers in the series represent frequencies and frequency relationships (ratios). A chain of such relationships creates a number series. Different series create different intervallic sets, which are, in turn, used to create different sonorities. It is this aspect of the theory that is realized in the musical composition.

In the first movement, *Vengeance Is Mine, Sayeth the Groove*, harmonic content is generated primarily through series selection, whereby many different series are grouped together according to the similarities and differences in their numeric and intervallic structure. This means organizing a large number of different series into families. These families then have the capacity to produce a continuous and cohesive flow to the entire harmonic content in a given musical passage. Furthermore, families of
series themselves are subjected to operations which produce more families. Musical passages can be extended by using this process.

In contrast, the second movement, \textit{Precipitous Sanctuary}, uses only a few different series, but attains harmonic variety through the Intervallic Design concept, in which a single series can produce a multitude of different intervallic structures. Here, it is the order of the intervals as they occur in the series itself that is utilized to create sonorities. This order is subjected to a segmentation process and these segments can then be harmonically linked together in different combinations to produce a vast array of intervallic structures. As in the first movement, families can be created for the cohesion and continuity of a large number of structures in a given area. In this case, however, it is the similarities and differences in the order created by the Intervallic Designs that determine how these structures will be grouped together in families.

This harmonic theory illustrates how a wide spectrum of harmonic color can be achieved and united under one system. Generally speaking, most music falls within a given area of this spectrum. This piece, however, is able to smoothly integrate harmonies of both extreme consonance and extreme dissonance with relative ease. In addition, very simple harmonic movement can be easily integrated with more complex harmonic movement in a way which makes perfect harmonic sense. In this theory, all harmonic structures come from the same source and there is a clear and logical pathway connecting them. To me, this theory is able to convey the power and vivid colors that Rameau refers to in the quote above.

Finally, from an aesthetic viewpoint, \textit{Exploring the Waterfall} defies some of the double standards that one often encounters in the realms of jazz and contemporary classical music composition. The contemporary classical composition world has tended to treat jazz as an exoticism and the jazz world has usually done the same in return. Exoticism in this sense refers to the duality of the \textit{other} and how superficial and stereotypical musical aspects of that \textit{other} are applied in music composition. There is no such duality in the present composition. The underlying natural expressive language of this composition is founded on jazz and related types of music (what I refer to as the Jazz Complex) that were either subsequent offshoots of jazz or had a parallel development with it. This is the natural heritage of the composer, who is a jazz pianist, trumpeter and
vocalist. Based on its expressive language and feel, this piece could be considered to be within the realm of jazz, because the composition is an intrinsic development of that language and feel. Although the entire harmonic content is generated by my harmonic theory, this theory is in no way opposed to the type of polychordal harmony that is characteristic of jazz. Rather, the theory is able to recreate this language and expand on it through a rational method.

However, the jazz world has never fully embraced classical principles of composition. I know this though my own personal experience, because I originally sought compositional knowledge through a jazz program (at the Berklee College of Music). Unfortunately, my music, which even they acknowledged as a form of jazz, could not be accommodated or helped to develop on its own terms by their program. As a result, I ultimately sought to gain compositional knowledge through a classical composition program, although it has never been a perfect fit for me. Because jazz education has sought to define jazz as a music which is inextricably bound up with a standard form of performance practice, jazz has been kept in a box and its compositional potential has been artificially limited. There is no reason why jazz cannot be approached from a purely compositional standpoint and have at its disposal all of the compositional knowledge which is common currency for composers in general. To that extent, this piece is outside the realm of jazz. Compositionally speaking, this work belongs more to the contemporary classical world. It embodies rigorous standards of contemporary classical composition without, however, feeling a need to imitate or adopt a contemporary classical language. It does not dualistically disguise or distort its original identity, but is, rather, an intrinsic development of that identity. This partly explains the title of the first movement: Vengeance Is Mine, Sayeth the Groove. This movement has a very strong, authentic and undisguised funky groove. In contrast, the second movement, Precipitous Sanctuary, has a more lyrical Latin feel and is more coloristic.

1.1.1 Exoticism in Composition

In its basic manifestation, exoticism in composition comes in the form of the imitation of one musical culture from the perspective of another. This can happen even
within one given culture, where several different genres or styles are represented. For example, it has been very common for classical composers to borrow folk music from their own culture. Although they may be very familiar with this music, it usually does not reflect their primary musical identity and to that extent, it is foreign to them. Exoticism often deals with the charm of that which is foreign and the desire to evoke an atmosphere of this other culture. It is essentially an external approach of cultural borrowing, often without a deep experience and personal identification with that culture. In some instances there is an undervaluing of the other culture, resulting in superficial and/or stereotypical representations of it.

After studying with Nadia Boulanger in Paris, Aaron Copland was determined to create an American form of composition and his first approach in this endeavor was to “use” jazz in his own composition. An example of this undervaluing inherent in the exotic approach can be seen in Aaron Copland’s attitude toward jazz and his representation of it in his *Concerto for Piano and Orchestra* of 1926.

With the *Piano* Concerto I felt I had done all I could with the medium, considering its limited emotional scope. True, it was an easy way to be American in musical terms, but all American music could not possibly be confined to two dominant jazz modes – the blues and the snappy number (Pollack, 1999).

Copland’s motivation for writing this concerto was somewhat of a response to George Gershwin’s *Rhapsody in Blue* of 1924, which Copland did not consider to be a serious composition. This attitude was supported by the critic Paul Rosenfeld, who claimed that, unlike Gershwin, Copland had transformed jazz, a “product of second-rate feelings,” into real art (Crawford, 2001). But what did this “real art” amount to. Copland’s approach failed to develop jazz intrinsically, from an insider’s perspective, but only presented jazz superficially, as a flavor to be added to his inherently superior classical style. To me, his *Concerto* sounds dated and lacks the powerful personal expression and artistic statement of Gershwin’s *Rhapsody in Blue*. Gershwin’s jazz references are not borrowed: they are fundamental to his musical identity. Here is a composer who believed in the artistic worth of jazz and its potential as a form of pure
composition. While I would agree that Gershwin was less skilled than Copland as a composer, Copland only succeeded in creating a sophisticated parody of jazz, whereas Gershwin succeeded in creating a lasting monument. Schoenberg concurs with this statement and seems to be responding directly to composers like Copland who arbitrarily appropriate musical styles:

Many musicians do not consider George Gershwin a serious composer. But they should understand that, serious or not, he is a composer…. There are a number of composers, serious (as they believe) or not (as I know), who learned to add notes together. It seems to me beyond doubt that Gershwin was an innovator. What he has done with rhythm, harmony and melody is not merely style. It is fundamentally different from the mannerism of many a serious composer. Such mannerism is based on artificial presumptions, which are gained by speculation and are conclusions drawn from the fashions and aims current among contemporary composers at certain times. Such a style is a superficial union of devices applied to a minimum of ideas, without any inner reason or cause (Armitage, 1938).

Stravinsky was also a composer who adopted jazz as a stylistic overlay in compositions like the *Ebony Concerto* (1946). Although compositionally this is a successful piece, it can in no way be said to be an intrinsic development of jazz. In this work the expression of jazz has been weakened and dismembered, the result of which is a less convincing artistic statement overall. As to the possibility of transforming any style into real art, this seems to be a contradiction in terms, if in by doing so the style has been distorted or misrepresented. Like Schoenberg, Elliott Carter has also criticized composers who have had a tendency to employ styles without the full commitment that a musical style demands of a composer. In his view, a composer’s style ought to be grounded in a realm of irreducible artistic identity, beyond the reach of fashion or careerist aspiration (Crawford, 2001).

Jazz is still very much a musical style, but contemporary classical composition, although it can be represented by a number of styles, including jazz, does not in itself
indicate musical style. Contemporary classical composition is fully manifested when every aspect of a musical work embodies and demonstrates current standards of proficiency in the application of compositional knowledge and expertise. The integrity with which a composer expresses a style is an aspect of this, but the presence or absence of a particular style is irrelevant. It is a common misapprehension among jazz composers and contemporary classical composers alike that imitating styles or stylistic attributes associated with contemporary classical music or jazz constitutes successful composition. An additional twist in this misapprehension is how jazz composers have a tendency to imitate classical stylistic attributes that are centuries old. Many jazz musicians do not understand that contemporary classical composition is about composition itself and not about the imitation of “classical” styles. They tend not to realize that it is unnecessary for them to change their style the moment they put their hands to “classical” composition. What they do need to know are classical compositional techniques that are not generally taught in college jazz programs. Consequently, as in the classical world, exoticism has been a common route for jazz composers writing “classical” music.

A good example of this is a recent album by Dave Brubeck, entitled Classical Brubeck (2003), featuring his quartet alongside a chorus and symphony orchestra. A review of this music, by David Hart, is excerpted below:

"Generally there is just too much noise and bluster. Even the simplest sentiments are clothed in chunky orchestration that does little more than double the voice parts; and the choral writing itself is equally tiresome, consisting of either dull homophonic textures or grade one counterpoint. But why doesn’t he compose throughout in a jazz idiom? The various interludes from Brubeck and his quartet … are perfectly acceptable in themselves, but totally at odds with everything else. In a few places, like the gospelly He Is Risen, there is some attempt to fuse these styles, but elsewhere the jazz players sound as if they have wandered in from a totally different gig (Hart, 2003).

Another album from a jazz artist of a younger generation is Terence Blanchard’s A Tale of God’s Will (a requiem for katrina) (2007). In the piece Levees there is a
symphony orchestra employed along with Blanchard’s jazz combo. The orchestra’s music is orchestrated and conducted by Blanchard himself. When the orchestra plays by itself in the introduction we hear two and a half minutes of “classical” music, devoid of syncopation or any jazz inflection whatsoever. When Blanchard’s jazz combo comes in, they naturally play jazz, which goes on for another two and a half minutes. Then there is a reprise of the orchestra’s “classical” music for a minute until the jazz combo comes in again for the last two minutes. It is actually a well-proportioned piece and the transitions are done tastefully. But the question once again arises: why didn’t he compose throughout in a jazz idiom and why must the “classical” orchestra play “classical” music?

Finally, there tends to be an assumption among many jazz composers that they are automatically equally good at writing “classical composition.” I had heard an extraordinary piece of jazz composition for big band by Fred Stride in 2001 called Machina: A Concerto for Jazz Orchestra (2001). Hearing that he had also written several classical compositions, I acquired a CBC Orchestra recording of a piece called Fanfare and Scherzo – for Solo Horn, Strings and Timpani (1993/1996). In this piece, not only did he leave his jazz expression behind, but I found his imitation of “classical” music and his concept of what constituted contemporary classical composition to be undeveloped and uninformed. In the absence of his jazz expression, improvisational breaks and a rhythm section, this music paled in comparison to his jazz work. This shows how much he undervalued what it means to be a contemporary classical composer. Furthermore, on his website, it is lamentable that it was necessary for him to have two separate lists, one for his “jazz compositions” and another for his “classical compositions.”

1.1.2 The Jazz Complex

It is difficult to determine what enduring values, aesthetically, jazz has contributed, because jazz is a word which has been used for at least 5 or 6 different types of music. It is really a conglomeration of many things. It has a little bit of ragtime, the blues, classicism and spirituals. Basically, it is a matter of rhythm. In America, this preferred rhythm is called jazz (Armitage, 1938).
This quote by George Gershwin indicates that the Jazz Complex has existed from the early stages of jazz. What I call the Jazz Complex as it relates to my natural musical expression consists of jazz and related types of music such as the Blues, R&B, rock, funk and Latin music (primarily Latin-American). I consider jazz to be primarily a style and a type of expression rather than a genre. I identify a genre as a specific manifestation of a given type of music that can be classed with other such manifestations. A style, on the other hand, possesses stylistic attributes that can assume a wide variety of manifestations. Jazz as a style permeates many genres: the greater the permeation, the more jazz can be said to be present. When the permeation of jazz attributes in a particular work seems to be comprehensive to the one perceiving it, it is called jazz. This perceptive element or recognition is very important and can be more reliable than a definition, but its reliability requires informed perception. Definitions of jazz are problematic and tend to break down at some point, because they often also apply to many other types of music. Furthermore, such definitions are often nothing more than statements that limit jazz to the formulas and stereotypes established by jazz education. Getting a jazz degree and matching oneself up with a dictionary definition of jazz will not necessarily make one a true jazz musician and those who seek to put jazz into a box by such definitions go against the innate exploratory element of it. The musical style for *Exploring the Waterfall* is not about jazz canons, but jazz innovation. Gerald Early speaks of Keith Jarrett’s attitude on this issue:

For Jarrett, jazz is not simply a body of music or a set of techniques: it is a psychological stance toward music-making…to “learn” jazz is, in effect, to put the critics on the bandstand, to make the preoccupations of musicians identical with theirs: interpreting and protecting canons (Ward and Burns, 2000).

It is possible for a work to comprehensively manifest jazz attributes, but fail to be a convincing piece of jazz to those perceiving it. This means that, relatively speaking, there are authentic expressions of jazz and inauthentic ones: the real article versus the fake one. It is ultimately a judgment call, but usually the musically informed can instantly differentiate between the two.
Well, I don’t know what jazz is. And what most people think of as jazz I don’t think that’s what it is at all. As a matter of fact I don’t think the word has any meaning at all, but that’s another conversation… (Funkhauser, 1994).

The quote above by Cecil Taylor implies the problematic nature of trying to define jazz. Interestingly, even though he says that he doesn’t think the word has any meaning, he seems to know exactly what jazz is and is able to recognize the genuine article, whereas he implies that most people are not able to do so. This is likely because his perspective is that of a jazz insider who has been a part of that world for a long time and his opinions carry authority. This underlines the importance of reliable testimony as a form of evidence. The determination as to whether a piece of music is jazz or not is a matter of perception, dependent upon who perceives it and how authoritative or reliable that perception is. This evidence becomes reinforced when others whose perceptions are also authoritative or reliable make the same determination. For example, Robert Dudd, who is the Education Director for the Music Program at the Crooked Tree Arts Center in Petoskey, Michigan, commented to me after hearing my demo CD of Exploring the Waterfall, that he considered it to be a new development in jazz fusion.

This aspect of perception and recognition relates directly to jazz expression. In turn, the latter can be considered as a stylistic attribute of jazz. Whereas most stylistic attributes can be defined, jazz expression, like jazz, is problematic to define, although easy to recognize for those able to distinguish it. As such, the two are synonymous, since the presence of jazz expression necessarily means the presence of jazz. An analogy helps to illustrate this: a Southerner necessarily has a Southern accent and we can recognize a Southerner by the presence of this accent. This accent is immediately recognizable, but difficult to define. In the same way, an authentic jazz “accent” or “dialect” indicates a jazz expression, which in turn indicates the presence of jazz. Since jazz is the basis for my natural expression, the presence of this jazz expression in Exploring the Waterfall and how it is ultimately realized in performance will determine the degree to which the work is perceived as a manifestation of jazz.

That being said, a description of the stylistic attributes of jazz can be helpful in this discussion of the Jazz Complex. In 1998 I wrote a booklet for a jazz history course I
taught, entitled *The Elements of Jazz*. From this I shall summarize what I consider to be the most important stylistic attributes of jazz (bearing in mind that not every attribute will be present in every piece of jazz):

1. Improvisation – either in performance or as part of the compositional process
2. The rhythm section – usually consisting of bass, drums and piano (and sometimes guitar, but could potentially use any instruments)
3. Syncopation as a consistent rhythmic norm – often in the form of anticipations or delays of strong beat attacks and offbeat/weak beat accents in general
4. The groove – a consistent rhythmic “feel” that heightens the sense of a propulsive beat and forward momentum, whose foundation is often created by the composite rhythm of the rhythm section
5. Polyrhythm – the simultaneous existence of differently numbered rhythmic groupings, usually within a regular meter, adding to a sense of groove and syncopation, derived mainly from West African rhythm
6. Swing or groove as an expressive quality each individual part or performer has, irrespective of the rhythm section or the general groove of the music, in which there may be rhythmic inequalities of successive eighth notes, or a sense of “bounce” involving other parameters such as pitch-bending, grace-notes, dynamics and articulations
7. Timbral features and pitch-bending, somewhat imitative of the human voice (i.e. “oo-wah”), shaking, shouting, growling, scooping up or falling off notes and changes between a smooth and a rough sound
8. Blue notes – associated with the Blues, but also in most jazz: the flatted 3rd, 5th and 7th, often played simultaneously with their natural equivalents and/or in conjunction with pitch-bending
9. Blues in general as a form, a chord progression and a style have been absorbed into most of jazz
10. Song forms predominate in jazz, presenting a cycle or “chorus” that can be repeated, deconstructed and recombined to create a larger form involving improvisation(s)

11. Call and response, where one motif answers another by a different voice or instrument, often picking up in frequency as the music progresses

12. The use of riffs, or short, usually syncopated motives, which are often repeated over a changing harmonic background and varied over time

13. European-derived harmony, particularly influenced by French impressionism, pandiatonic and/or polychordal in nature, where each chord usually has a minimum of an added 7th

14. Jazz expression – an immediately recognizable presence of the jazz “feel,” “accent,” or “dialect” that links it and identifies it with the jazz tradition and its historically important artists

These are stylistic attributes that generally exist in jazz and related styles of music, or the Jazz Complex. The latter is a useful term because not everything that is labeled as jazz may be an authentic expression of jazz (as recognized by an informed insider of jazz). It is also true that other types of music in the Jazz Complex that are not labeled as jazz, may actually be forms of jazz. Labels have often been the result of how the recording industry has wanted to market the music so labeled. In turn, institutions have often appropriated these labels and compartmentalized the music accordingly.

I have learned as much from Marvin Gaye as I have from Thelonious Monk. James Brown is really a genius (Gottschalk, 2004).

The above quote by Cecil Taylor illustrates how jazz expression permeates other types of American music. Both Marvin Gaye and James Brown fall under the general category of R&B, with the additional and more specific categories of funk and soul music. Both of their musical styles have all of the stylistic attributes of jazz and there were times in the 70’s when their music sounded exactly like the jazz fusion of that era. It can be argued that R&B is a direct outgrowth and even a subgenre of jazz and that the
jazz style or feel has been preserved and developed over the decades through certain R&B artists. Indeed, the origins of R&B reveal the basic key to understanding the Jazz Complex. If there is a single genre that could bind the Jazz Complex together and a single artist who could be credited for doing so, that genre would be the *jump blues* and that artist would be Louis Jordan.

The *jump blues*, also called simply, *jump*, had already be a popular genre within the big band jazz of the 1930’s, with such hits as *One O’Clock Jump* and *Jumpin’ at the Woodside* by Count Basie. *Jump blues* was an up tempo style of jazz with a heavy beat and a more prominent bass line that used the blues progression and riffs, and was also closely related to *boogie woogie*. It was associated with a particularly wild and athletic style of dancing (lots of jumping). In the 1940’s, as the big bands started to decline, smaller combos came to the fore, as did the jazz soloist. In the jazz world and academia in general, bebop is considered by most to be the next step in the evolution of jazz at this time. But this ignores an incredible amount of musical activity that also came through smaller combos such as that by *Louis Jordan and His Tympany Five*. Jordan specialized in and perfected the *jump blues*. He was a prolific songwriter as well as a fantastic singer and saxophonist. In the 1940’s many jazz artists covered his songs (like *Is You Is or Is You Ain’t My Baby* [1944]) and in record sales he was second only to Bing Crosby (Carr, 1997).

Jordan, more than any other artist, is credited as being, if not the originator, the greatest innovator and most influential in the style of music that came to be known as *rhythm and blues* (R&B). But Louis Jordan and all of the members of his combo were jazz musicians and his music contained all of the stylistic attributes of jazz: it was jazz. It was also R&B. A labeling game has developed that has confused the issue. Charlie Parker said:

> Bop is no lovechild of jazz. Bop is something entirely separate and apart. It’s just music. It’s trying to play clean and looking for the pretty notes (Carr, 1997).

However, as we know, bop is called jazz, whereas R&B is not. It is true that many R&B artists developed a simpler style and got further away from its original “jazziness” over
the years, but this did not happen with all of them. It also led directly to rock and roll. *Shake, Rattle and Roll* (1954), originally done by the R&B/jump blues artist, Big Joe Turner, was also covered by the rock and roll artists Elvis Presley and Bill Haley. In their versions, the groove is the same as in Turner’s, the only significant difference being that in Turner’s band, as in Jordan’s, jazz musicians were used (resulting in more improvisational fills), whereas in Presley’s and Haley’s, they were not. However, there continued to be jazzy R&B that bore a strong resemblance to the music of Louis Jordan, such as Wilson Pickett’s *Baby Call on Me* (1962). It is also true that Blues artists recorded many songs in the *jump blues* genre and Rufus Thomas has claimed that R&B is nothing more than up tempo Blues (Dunas, 1998). Other contemporary Blues artists such as Gatemouth Brown and Buddy Guy have continued to record many of Louis Jordan’s songs over the years (like *Caledonia* [1945] and *Saturday Night Fish Fry* [1949]).

Gatemouth Brown’s music in particular is often indistinguishable from jazz, although he is labeled as a Blues artist. Louis Jordan’s songs are simultaneously jazz standards, R&B standards, and Blues standards. Since Louis Jordan’s music is called both R&B and jazz, just as Charlie Parker’s music is called both bop and jazz, it can be concluded that R&B that has continued in the tradition of the original R&B as exemplified by Louis Jordan and has preserved and/or developed this type of jazz feel, is a form of jazz. This is the case in the music of Marvin Gaye and James Brown. In light of this, Cecil Taylor’s comment makes perfect sense.

This also explains why jazz fusion emerged so effortlessly in the late 60’s and spread so quickly in the 70’s: the two streams of jazz that went there separate ways in the 40’s, bop and R&B, now converged. If one artist could be credited as being the catalyst for this convergence, that artist would be James Brown. In 1967, James Brown released *Cold Sweat*, a pivotal recording that brought the concept of groove to the forefront. Now the bass (amplified) and drums were no longer time-keepers, but dynamic motivic voices in the groove texture. Likewise, the brass, saxes, guitars and even the vocalist (James Brown), reacted to and became parts of this texture, heightening the sense of groove.

James Brown, who co-wrote *Cold Sweat* with his saxophonist and bandleader Pee Wee Ellis (a jazz musician), was to become the greatest innovator in R&B since Louis Jordan, so much so, that his music was no longer referred to as R&B, but as *funk.*
Atlantic Records’ producer Jerry Wexler later confessed that *Cold Sweat* was a record that deeply affected everyone who heard it, especially the likes of Aretha Franklin and other major soul stars: “For a time, no one could get a handle on what to do next.” There were few jazz groups around who could cook up such natural excitement and everyone from Miles Davis to his former cohort Herbie Hancock weren’t slow on the new groove uptake (Carr, 1997).

Miles Davis was essentially a bopper in his improvisational style and a leader in the jazz field. When he embraced this new groove, many others followed and the era of jazz fusion began. Being born in 1962, this is the music and the era that has affected my own style the most. Among Miles Davis’ recordings, the album *Miles Davis at Fillmore: Live at Fillmore East* (1970) was the most influential for me. Herbie Hancock’s album, *Manchild* (1975) and a piece therein called, *Hang Up Your Hangups*, I consider to be the definitive jazz fusion composition of that era. In this music can be heard a perfect balance of all the types of music of the Jazz Complex. In addition, we can hear a more pronounced and developed West African influenced polyrhythm, that has always been a feature of Afro-Cuban music, but remained somewhat buried beneath the surface of jazz. The Civil Rights movement of the 1960’s caused these African roots to come out strongly in the 70’s, which also created more of an interface with jazz and Latin music. Latin music has always had a parallel development to jazz. New Orleans, the birthplace of jazz, was a hub of French and Spanish culture in America. Jelly Roll Morton, who coined the phrase, the “Spanish tinge,” had many compositions that used Spanish influenced rhythms such as the habanera rhythm from Cuba. Afro-Cuban Music shares stylistic attributes with jazz, but it places greater emphasis on polyrhythm and has been able to remain more true to its West African roots than jazz. However, these polyrhythmic roots were brought out fully in Herbie Hancock’s jazz funk fusion of the 1970’s. Another type of Latin music even more closely tied to jazz is the *bossa nova* of Brazil. The simple evidence for this is that virtually all of Antonio Carlos Jobim’s songs have become jazz standards.
Jazz fusion in many ways is synonymous with the Jazz Complex. All of the types of music within this complex, such as the Blues, R&B, rock, funk and Latin, are related to jazz, and this came out to varying degrees during the era of jazz fusion. For example, the first album I owned at the age of 7 was *Get Ready* (1969), by the rock band *Rare Earth*. The title track was 21.5 minutes long, one side of an LP, consisting of the 4-minute R&B cover *Get Ready* surrounded by 17.5 minutes of improvisation: hardly a typical rock album. One reason this band drifted into obscurity was that Motown was at a loss as to how to market them. Were they rock or R&B, funk or blue-eyed soul? And what to make of all this improvisation? The 2.5 minute instrumental introduction sounds like soul jazz. Indeed, *Get Ready* manifests all of the important stylistic attributes of jazz. Even so, it is difficult to decide exactly what to call it, but it is without a doubt part of the Jazz Complex. Years later, I would wonder why I was immediately able to grasp the jazz style while many others around me had difficulty: the basic jazz feel of the Jazz Complex was imprinted on me from an early age.

1.2 Composition: Jazz or Classical?

The underlying natural expressive language of *Exploring the Waterfall* is founded on jazz and related types of music, or the Jazz Complex. By natural expressive language, I am referring to my primary mode of musical expression, which is innate, spontaneous, second nature and inseparable from my musical identity and style. Regardless of what compositional techniques or theoretical ideas I use, this natural expressive language comes through in every piece that I write. When I compose, this natural language is developed intrinsically, not exotically, as I transform it through theoretical and compositional concepts that serve to expand its expressive range without distorting its original identity.

The difference between my jazz world and that of most other jazz musicians is that mine is a private world. It informs my composition, but has no obligation to the world of jazz performance. I improvise jazz on a daily basis as an important part of my musical life and share this with family and friends. Occasionally, when I put on a recital of my works, I usually include some solo improvisations of my own. My private jazz
world pervades my composition, in which I have one basic style, as opposed to two segregated ones. I do not have two separate lists, one for jazz composition and one for classical composition.

Jazz music is based on strictly music. You have the finest ideas from the greatest operas, symphonies, and overtures in jazz music. There’s nothing finer than jazz music because it comes from everything of the finest class music. (Jelly Roll Morton, 1938)

In the quote above, Jelly Roll Morton acknowledges the intimate relationship between jazz and classical music. The latter plays a crucial role in the enrichment of the former. By stating that “there’s nothing finer than jazz music”, he seems to imply that what he was doing is serious and operates at the same level as classical composition. In fact, Morton wrote down many of his compositions note for note. However, he did not imitate classical music the way jazz composers often do today, but internalized it, learned from it, and created an authentic new American art form. I feel like I am bringing the art form of jazz forward into the future by helping it to realize its potential as serious composition. In the same way as Jelly Roll Morton, there is no duality in my music, but a mutual complementation and reinforcement between the jazz and classical worlds. From the jazz world comes the expressive base for my language and from the classical world, the formal and theoretical base. It should be noted that I am not using elements of jazz and other musics in an external sense, nor am I seeking to create a blend between jazz and classical music. I am simply expressing myself in the way that is most natural to me. Selective improvisation interfacing with my theoretical and compositional structures is my basic method for composition. Much like a jazz musician improvises on a chart, I build a composition through a constant internal dialogue between my improvisational language and my theoretical and compositional ideas. This approach can be described using the metaphor, “singing through my theory” -- I create compositional and theoretical structures that not only accommodate my natural expression, but it is quite literally my natural physical voice which flows continuously through these theoretical constructs.
In terms of the abstract influence of classical music on my compositional development, the first significant influence came from Schoenberg. Not only was I exposed to the 12-tone method as espoused by the Second Viennese school, I also learned harmony through Schoenberg’s *Theory of Harmony*. Harmony is what fascinates me most as a composer. I am very attracted to the German chromatic tradition and admire the music of Anton Bruckner. This tradition continued in the so-called free atonal period of Schoenberg, where his music, in reality, was not atonal at all, but merely a more complex manifestation of tonality. Dr. William Benjamin has analyzed many of Schoenberg’s works of this period in this regard. In an article that focuses on Schoenberg’s Op.16 no.5, he explains how Schoenberg was fascinated by the possibilities of putting two keys a semitone apart in the closest proximity. In the music he composed after 1908, Schoenberg radicalized this procedure, using one line of tonics to shadow another, slightly more prominent line, so as to interfere with it. The result is that there are separate tonal strands which nevertheless arrive at the same tonal goal (Benjamin, 2000). The theory underlying this late chromatic tonality has been explained well by Daniel Harrison and figures into my own harmonic theory (Harrison, 1994).

Two of my composition teachers were 12-tone composers. The first, John Ronsheim, was a student of Dallapiccola, who was noted for his segmentation of series and a more lyrical and even tonal approach to serialism. Dallapiccola was in turn influenced by Webern’s isomorphic treatment of 12-tone rows. Segmentation of series and isomorphism are both concepts that relate to my harmonic theory and compositional approach. The other teacher, Robert DiDomenica, studied with Josef Schmid, who in turn studied with Berg. My work does not relate specifically to the 12-tone system, but has a connection to serialism since I use ordered number series in a rigorous way.

In the music of Varèse, there is a much more direct influence. His primal rhythmic vitality, his control and subtle shading of dissonant harmonies, his concentration on sound as a sensual experience and his interest in science and acoustics all have a direct connection to my own work.

First, through the International Composers’ Guild, then even more so through the Pan-American Association of Composers, Varèse had a very close association with many Latin-American composers. I believe that this had an important influence on the rhythm
of his music (after he emigrated to America), which became more beat oriented, having somewhat regular rhythmic patterns, but with an asymmetrical treatment. This is what I call *the developmental groove*. This Latin influence reached its zenith with *Ionisation* (1931). Not only does this piece have an unmistakable Latin groove (established mainly by the rhythmic motives of the bongos and tambour militaire at rehearsal 1), but also suddenly he has added several Latin percussion instruments (such as the bongos, cencerros, guiro, claves, maracas and castanets) to his usual percussion battery. Varèse had a close association with the Cuban composer Amadeo Roldán, who had composed an Afro-Cuban-inspired percussion ensemble piece called *Ritmicas V-VI* in 1930. It seems more than just a coincidence that Varèse composed *Ionisation* just one year later. To me, this is an interesting connection between Varèse and Latin music, since I have a strong affinity for this kind of rhythmic vitality. In recent years, my interest in Latin music, both popular and classical, has equaled that of jazz. In the popular sphere, this influence comes mainly from the *timba* of Cuba and the *bossa nova* of Brazil and the classical influence from Spanish and French composers like Falla and Varèse. This Latin influence, while subtle, can be heard throughout *Exploring the Waterfall*, particularly in the form of the Phrygian inflection (both harmonically and melodically) and a consistent polyrhythmic approach.

1.3 Music and Mathematics

The relationship between music and mathematics has always fascinated me. A scientific basis for music necessarily means a mathematical basis and this comes through acoustics, the science of sound. For many, including Varèse, this science meant the liberation of sound in the form of new technology and/or instruments capable of utilizing the entire spectrum of sound. Varèse believed that the liberation of sound meant having the ability to use the entire registral space as well as the entire microtonal space of sound, and the ability to create new instruments and timbres via electronics. This has been easily accomplished in modern times, but sound still hasn’t been liberated because theories of harmony and pitch structure have not kept pace with technology. There has been a great deal of emphasis on creating and using devices and processes which
manipulate sound and very little on the understanding of frequency relationships and the development of harmonic structures based on these relationships. Properly speaking, this is the domain of harmony.

Mathematically based theories of harmony and/or pitch structure have had a significant impact on my thinking. The music of Harry Partch and his book, *Genesis of a Music* (1974), was my first influence in this regard. Based on the ratios of acoustics, he created a system of microtonal scales and tuning capable of producing a rich and expressive music. However, this system lacked a comprehensive harmonic theory and was inflexible. It lacked the ability to modulate freely and as a tuning system, could not be integrated into the musical world as a whole.

The music of Iannis Xenakis and his book, *Formalized Music* (2001) have had a general influence on my work with respect to the use of mathematics in composition. His ideas about organizing large numbers and large quantities of information into general tendencies and his use of the statistical mean and distribution have influenced my thinking. I am also interested in his systematic use of glissandi and the way he uses the interaction of waveforms as musical contours and textures in a musical score. Unlike Partch, Xenakis’ ideas can definitely be applied universally though many are not strictly acoustical. He imposes mathematical structures and processes on his music but these procedures often seem arbitrary and as a result some compositions are less successful than others.

Pozzi Escot is a mathematical composer whose compositions I admire. Although she never specifically reveals what mathematical processes she uses in her own work, I took courses from her in 1994-1995, which focused on the role of mathematics in music. Many of the ideas presented in those classes later appeared in the book, *The Poetics of Simple Mathematics in Music* (1999). One central idea she espoused was a general definition of harmony as a concept which dealt with everything being in proportion. This idea has played a central role in the development of my own theoretical ideas. I also took courses with Robert Cogan, which were based on the book *Sonic Design* (1984) that he co-authored with Escot. These courses provided many thought-provoking ideas in the realms of acoustics, color theory and rhythm.
Jean-Philippe Rameau’s book Traité de l’harmonie, written in 1722, is a landmark in harmonic thinking that continues to be thought provoking. Rameau is exhaustive in his attempt to create harmonic structures and to explain every detail of harmonic content through mathematical operations on the ratios of the harmonic series. He sought to justify tonality on scientific grounds and discusses the significance which specific numbers hold in this regard. Rameau’s ideas have much more depth on the fundamental nature of harmony than are represented by simple overviews of his important ideas. His theory is not a closed system, but contains within it the possibility of continuous expansion. I feel an affinity for Rameau’s approach. My harmonic theory seeks to justify tonality through acoustics and to generate all the harmonic structures necessary for composition using numbers derived from acoustics.
CHAPTER 2: Harmonic Theory

2.1 Issues

Tonality was never overthrown nor its potentials exhausted. The desire to break free from it was really a desire to break free from the constraints of common practice. Therefore, it was common practice tonality that was superseded by many of the composers writing in the early part of the 20th century. Tonality as a general concept is an ever-expanding universe that continues to offer new possibilities for growth and development. The harmonic theory that I have been working on for the past 15 years is part of that development.

The constraints of common practice tonality are manifold. The primary one is that common practice is based quite literally on common practice and not on science and/or reason. It contains a long list of ideas and practices which have been handed down from generation to generation, but does not present a unified theory which is able to stand the test of time or project itself into the future. My harmonic theory, which is based on the mathematics of acoustics, is able to explain and recreate the tonality of the past, consolidate its terminology and pave the way for future development. It presents a rational method for harmonic construction and function, which overcomes the constraints of common practice.

A further constraint of common practice tonality is the concept of key. Tonality does not need a key: it can function with or without one. I will present an abstract model of harmonic function based on acoustics that will show that simple ratios from the harmonic series determine tonal relationships and create harmonic functions depending on how they relate to one another. A network of such relationships creates tonality. Such a tonality can be manifested as a key or purely as a functional pathway that is independent of a particular key. Likewise, tonality is not dependent on any particular scale, although it can both utilize and generate a multitude of scales. It is only harmonic function which governs tonality and various pitch collections can be represented in the process. For example, focusing on harmonic function alone can give rise to what may be called a trans-key progression. Such a progression can appear to represent “free
atonality”, although the harmonic function may be clearly intended by the composer. This illusion can be magnified by the use of complex chords, which either have more than one fundamental bass and/or a composite harmonic function (a feature I refer to as tonal shading).

Another limitation of common practice is the concept of pitch class and pitch collection, which has continued into serialism and beyond. In my harmonic theory, pitch is the result of intervallic formation, which is in turn the result of acoustical proportions and frequency regulations. This is what governs the total selection of note content. Specific pitch choices are determined at a later stage and are usually made according to their tonality and their harmonic color rather than whether they belong to any particular pitch collection. As a result, there are many pitches that do not even need to be accounted for. This does not mean that anything is left to chance. It simply means that pitch class and pitch collections are usually not the most important considerations. The intervallic sets resulting from frequency regulation and the intervals therein have their own integrity and significance. This also means that they are not subject to octave reduction. Octave reduction is the result of pitch class thinking and introduces an element of arbitrariness. Along with octave reduction comes octave doubling, which is usually not necessary if the octaves occurring naturally (through acoustical proportions) were not destroyed in the first place. Even in more recent manifestations of tonality, such as the stacking of fourths in quartal harmony, we can see the influence and the limitations of the human senses and human habits imposing themselves on harmonic thinking. In response to this one may ask how it is possible to find the perfect chord for any given musical situation if one does not have the freedom to put one’s pitches where one wants. The answer is that through a rational method of building sonorities based on the regulation of frequencies, one can find thousands upon thousands of potentially perfect chords to choose from.

Probably the biggest issue in the overthrowing of common practice tonality is the emancipation of the dissonance. Dissonance handling is an important feature of common practice tonality: its formal justification, preparation and resolution. Schoenberg himself was unable to conceive of a functional tonality that was divorced from common practice considerations of dissonance handling. He viewed the freedom of the use of dissonance as synonymous with the breakdown of tonality (Schoenberg, 1984). In fact, harmony and
tonality can function perfectly well without dissonance handling. Emancipation means independence. Although dissonance handling can be combined with tonal function, it is ultimately independent of it. In the same way, tonal function itself is ultimately independent of form. It is only common practice syntax, which binds these parameters together. However, since consonance and dissonance are part of the same sound world, consonance must also be freed from its obligations. For example, there is no need for a phrase, section or piece of music to end on a consonance. In my harmonic theory, there is not even a need to distinguish between consonance and dissonance in any more than a subjective way. What matters is how notes are grouped together according to harmonic function. Consonance and dissonance are quite simply coloring agents that the composer uses in various ways and in various proportions to create harmonic colors.

2.2 Objectives

The positive aspect of this new harmonic theory is freedom. Consonance, dissonance and harmonic function are all freed. There is neither tonal avoidance nor tonal restriction. This destroys the duality between simple and complex harmonies, since they derive from the same source and are categorized in the same manner. For example, there is no reason why 5th motion needs to be separated from other kinds of motion or considered to be less sophisticated. They all derive from the same model. This model allows complete freedom of movement, while also giving the composer the ability to be conscious of how the resulting tonality is functioning. Any harmonic pathway or sonority can be utilized and analyzed. Although this theory has its basis in acoustics, there is no obligation to use pure intervals. It is all a matter of relative proportions and virtual tonalities (such as those which equal temperament produces). The theory is equally effective in semitonal equal temperament, microtonal equal temperament or pure microtonal frequencies. For performance reasons, I have written *Exploring the Waterfall* in semitonal equal temperament.

I will first explain the origins of my harmonic theory in the realm of functional harmony, such as the movements of fundamental basses and their tonal relationships to each other. This is relevant to *Exploring the Waterfall* and accounts for the functional
harmony used throughout the piece. However, this aspect, though it does exist, plays a comparatively minor role in the work. A greater role is played by sonority, harmonic color and the multitude and variety of their manifestations. Secondly, I will talk about tonal shading, which is essentially midway between the functional and the coloristic. Finally, I will arrive at the main topic of the thesis, which is the regulation of frequencies through number series and its ability to generate the entire harmonic content of a piece of music.

2.3 Functional Harmony

There is relatively simple mathematical model for functional harmony based on acoustics. In this model there are only 3 harmonic functions: tonic (T), dominant (D) and subdominant (S). Every harmony for which it is possible to ascribe a function can be categorized according to these three functions. These harmonic functions are cyclical. For example, in the key of C, not only is there subdominant function a 5th below the tonic (FM), it is also there a 5th above the dominant (dm). Using only 5th motion, the cyclical nature of these functions can account for the 12 semitones:

Gb  Db  Ab  Eb  Bb  F  C  G  D  A  E  B
T   D   S   T   D   S   T   D   S   T   D   S

This shows that there is an equivalence of harmonic function for harmonies whose fundamental basses are a minor 3rd apart. This is a well-known harmonic scheme, used by many composers, from Wagner to Schoenberg to Coltrane to myself, and well explained by the theorist Daniel Harrison (Harrison, 1994). In this theory there are three types of harmonic movement or direction. The first is a type of prolongation or parallel-related movement, where no change of harmonic function takes place. An example of this would be movement by minor 3rds in either direction or by tritone (any T-T, S-S, or D-D). The second is the tendency or the attraction of the dominant toward the tonic, or perfect-related movement. This would be descent by perfect 5th, descent by major third, or ascent by whole-step (any D-T, T-S, or S-D). The third is a plagal-related movement and gives a
feeling of tonal expansion, since the second harmony can be heard as a harmonic extension of the first. Examples of plagal-related movement would be ascent by perfect 5th, ascent by major 3rd and descent by whole-step (any S-T, T-D, or D-S).

The origin of tonality is the harmonic series. Simple ratios from the harmonic series determine tonal relationships and create harmonic functions depending on how they relate to one another: as integral multiples or divisions. A network of such relationships creates tonality. The center of a tonality and our point of tonal reference can be represented by the fundamental of the harmonic series, or the number 1. Above this fundamental are its overtones, which fuse with it and strengthen its identity as the tonic. When we focus on one or more of these overtones as fundamentals (or roots of chords) in their own right, they can be categorized as dominants in function. Likewise, when the tonic becomes an overtone of other fundamentals below it, those fundamentals can be classified as subdominants in function. Finally, since above these subdominant fundamentals, there are several overtones which can be tonicized, there are several possible tonal centers that are equivalent in function to the tonic. Any note which sounds and has overtones presents these functional potentialities at any given moment. Even if a sense of tonal center exists for only an instant, it exists at least for that instant.

By making an overtone into a root or fundamental, the tonic note necessarily disappears. This separation from the tonic creates an anticipation toward reunification upon its return. This is responsible for the power of attraction that the dominant has toward the tonic. The most prominent overtones which can then separate themselves from the fundamental are the harmonics 3, 5 and 7. The fundamental bass can be represented by its octaves as harmonics 2, 4 and 8. Therefore dominant to tonic movement can be determined by the ratios 3:2, 5:4 and 7:8 or: descent by 5th, descent by major 3rd and ascent by whole step. To this can be added descent by semitone since it is created as a result of these other movements. For example, the perfect-related movement of descent by a major 3rd (5:4) from the minor 7th (7) would result in the number 5.6, the tritone. Hence the tritone can be considered as another tonic. Since we know that the 5th represents the dominant, the 5th could also move to the tritone (as in G to F#). This movement would take the form of the ratio 6:5.6, which equals 15:14, roughly a semitone (119¢). This relationship exists in other places as well. Assuming a tonic of C, all of these
root motions added together would create a group of related tonics on C, Eb, F# and A and a group of related dominants on G, Bb, Db and E. We can therefore see that this acoustical model of tonal function validates the minor 3rd tonal equivalency model already presented.

The subdominant is mainly represented by the reciprocals of the harmonic numbers of the dominants: 1/3, 1/5 and 1/7 and its plagal-related movement is the inverse of the dominants’ perfect-related movement. Unlike the dominant, it does not cause the tonic note to disappear, since the tonic is an overtone of the subdominant. This means that the subdominant is like a second home to the tonic and explains why it is often used as a means of tonal contrast or prolongation to the tonic. Because of this lack of separation, the subdominant to tonic movement (plagal-related) has a gentler or more expansive feeling. It is also true that the tonic is the dominant of the subdominant and the subdominant is the dominant of the dominant. This explains the prevalence of the chord progression I IV V I, the repetition of which is a continuous cycle of dominant attraction. Tonal music in general often uses this perfect-related harmonic motion and secondarily the plagal-related motion for contrast. However, there is no law that says this must be so. In my opera, *Crimes Against the State* (1991), I almost exclusively used plagal-related movement, though it was usually veiled by the use of minor 3rd functional equivalents and complex chords.

One might question why the harmonic number 9, also being a prominent overtone, is not included with 3, 5 and 7 as a potential fundamental upon which a dominant harmony can be built. The reason is that once a number appears in the harmonic series, it sets up its own harmonic series. The closest harmonic relationship of 9 is 3, of whose harmonic series it is a part. It therefore presents another level of harmonic function, in which 9 is the dominant of 3. Due to the cyclic nature of harmonic function it is equivalent to the subdominant in its relationship to the tonic. Harmonic number 9 is then equivalent in function to the other dominants of the dominant harmonic number 3, which are based on 15 (3x5) and 21 (3x7).

Herein lies a simple pathway to functional microtonality. If we take the numbers 3, 5 and 7 and multiply each of them by 3, 5 and 7, we get the set of numbers: 9, 15, 21, 25, 35 and 49. Each of these harmonic numbers can be used as fundamentals for a
subdominant functioning harmony. 21, 25, 35 and 49 are all significantly microtonal. Of these, 35 is a quartertone below 36, which is equivalent to 9 (36/4=9). This means that we have two notes that are a quartertone apart but have an equivalent harmonic function. Therefore it is possible to go beyond the minor 3rd functional equivalency as previously noted. There are many other functional equivalencies, some of which only require the addition of quartertones. Furthermore, we can get another set of numbers that are the reciprocal of these: 1/9, 1/15, 1/21, 1/25, 1/35, 1/49. These being the next functional harmonic level below the subdominant would be functionally equivalent to the dominants based on 3, 5, and 7. I have used some of these relationships successfully. In a computer-generated composition using C-Sound, entitled *The Sine Wave Conspiracy* (2003), I used only the numbers of frequency and pure frequency ratios. This work contained some functional harmonic movement by quartertone, as well as other microtonal relationships.

2.4 Tonal Shading

Tonal shading is an area where the functional meets the coloristic. To the previous discussion on the functional relationships of fundamental basses is added another level of harmonic subtlety: the shading of harmonic function. It involves the final form which a harmony or sonority takes and a determination of its quality or relative value in terms of its harmonic function. It has three aspects and they are interrelated. The first is magnitude. This is a general determination of how much power a particular harmony possesses both by itself and in context. For example, a single note can have harmonic function, but if other notes which belong to its harmonic series support that note, it becomes more powerful. That power can be further manipulated depending on the relative registration of the notes involved. The next consideration is how much that power is realized in context. This is an aspect which already exists in common practice tonality and accounts for the many terms used to describe different types of cadences. Since in this theory, functional harmony is freed from the obligation of creating form, such terms are not necessary, but the general concept of magnitude remains important.

The second aspect is functional complexity. This is not to be confused with a complex sounding harmony, which could be many things. For example, a sonority
formed by the harmonics 1:6:11:16:21 (C2, G4, F#5, C6, F6) may sound complex, but functionally it is simple, because all of the notes are in harmonic position and relate to one fundamental. A functionally complex harmony is one which has more than one fundamental bass. The simplest example of this is the minor triad. Aside from the octave, tonality can be determined foremost by the presence of the ratio 3:2 (the perfect 5\textsuperscript{th}) and secondarily by the ratio of 5:4 (the major 3\textsuperscript{rd}). Both of these ratios exist in the minor triad, whose harmonic proportion is 10:12:15. 15:10 = 3:2 and 15:12 = 5:4. Therefore, the minor triad has 2 fundamental basses. Hermann Helmholtz recognizes this fact in his treatise On the Sensations of Tone and for this reason calls the minor triad tonally ambiguous (Helmholtz 1954). I would revise this conclusion to say that the minor triad is tonally and functionally complex, but not ambiguous. For example, the minor triad E,G,B would have fundamental basses on E and G (minor 3\textsuperscript{rd} equivalents). Assuming a tonic of C, both of these would be classified as dominant in function. Consequently, although there are two tonal centers, there is only one harmonic function. However, this does create a dispersion in tonal and functional focus, where the power of the harmony is divided between the two centers.

The third aspect of tonal shading is functional ambiguity. This necessarily requires that a harmony or sonority have more than one tonal center, but in addition, these tonal centers must have different harmonic functions. Such a harmony would be called functionally composite, or a composite function chord. The simplest example of this is the augmented triad. Since each note is a major 3\textsuperscript{rd} apart, each note is a tonal center and there is no commonality in harmonic function between them. Ambiguity could also result when there is no tonal center at all. This is only easily accomplished with sounds which have inharmonic partials and/or are unpitched (noises). Sometimes, when there are too many conflicting tonal centers, it can seem as if there is no tonal center at all, or atonality. Functional ambiguity, both within a sonority and in context, when taken to extremes can result in a de facto state of atonality. Consequently, atonality can be viewed as an extreme form of tonal shading. Therefore tonality and atonality can be understood as relative states that are part of the same continuum and are not necessarily opposed to each other.
Nor is 12-tone music necessarily atonal. George Perle is known for having developed 12-tone theory to a very sophisticated level. In *Twelve-Tone Tonality* (1977, 1996) and *The Listening Composer* (1990) Perle sets forth his own musical language and presents the view that the disparate styles of post-diatonic music share common structural elements that collectively imply a new tonality (Perle, 2007). Long before this, Schoenberg said:

The word ‘atonal’ could only signify something entirely inconsistent with the nature of tone. Even the word ‘tonal’ is incorrectly used if it is intended in an exclusive rather than inclusive sense. It can be valid only in the following sense: Everything implied by a series of tones (*Tonreihe*) constitutes tonality, whether it be brought together by means of direct reference to a single fundamental or by more complicated connections (Schoenberg, 1983).

“The nature of tone” is to have periodic vibrations and overtones. An octave, 5th or major third over a given note will tonicize it. Musical tones are self-tonicizing by virtue of their overtone structures. The only way to guarantee atonality is to not use musical tones. True atonality, strictly speaking, must lie outside the domain of the harmonic series. For example, the waves breaking on a beach are atonal and using them as a sound source would be an easy way to create atonal music. The effort to create atonality while using instruments which produce periodic vibrations is a contradiction in terms [which Webern pointed out in *The Path to the New Music* (Webern, 1975)] and compels the composer to go to extremes in order to achieve it. From a simpler standpoint, extremes in tonal shading, especially with respect to ambiguity, push the harmony out of the realm of functional tonality and into the realm of coloristic harmony. It is this latter aspect which often occurs in *Exploring the Waterfall*. 
2.5 Frequency Regulation

2.5.1 Introduction

When I first embarked upon this theoretical journey, my mindset was the same as most musicians: my thinking about musical and/or registral space began from the standpoint of pitch class and intervallic distance. Musical intervals were thought of in terms of how many semitones they encompassed: the octave = 12 semitones, the fifth = 7 semitones, the fourth = 5 semitones and scales were the result of different kinds of steps added together in different orders (whether tonal or in the manner of Xenakis’ Sieve Theory). Composers and theorists seemed preoccupied with such issues as how many tones should the octave be divided into: should it be 12, 19, 24, 72, or 43 as Partch suggested.

My first attempt at using mathematics to create intervallic structures centered around the logarithmic expansion and contraction of a given intervallic set. It had been my desire to use acoustical proportions to build harmonic structures. Since I considered the harmonic series to be an example of a perfectly proportioned intervallic set, I used segments of it as the basis for these expansions and contractions and used the resultant intervallic structures in my composition. This use of acoustical proportions was based on manipulating their intervallic distance values logarithmically. It created a wide variety of harmonic structures and colors to choose from and enabled me to compose what I considered to be successful music. However, in the end, this system did not appeal to my reasoning, because I was imposing my mathematical thinking on sound in a way that was external to the inherent nature of frequency. Although I was using segments of the harmonic series, I was using them indirectly. By logarithmically manipulating their proportional intervallic distances, I was imitating their spatial structure, but I was severing the link to their frequency ratios, which created that structure. There was no direct correspondence between the ratios with which I started and the ratios with which I ended. Even more important, there was nothing inherent in the resultant numbers which indicated a way to govern their large-scale harmonic organization.
The source of pitch is frequency and the source of intervalllic space is frequency ratios. I decided to return to these sources to uncover their inherent logic and to develop a conceptual model which was consistent with their mathematical tendencies. The harmonic series is a series of frequency ratios and also a source of frequency organization. From a purely mathematical viewpoint, it is also a number series of the simplest kind: the set of natural numbers. Its numbers not only represent frequencies, but, strictly speaking, they are frequencies. One need only multiply all of the numbers by a certain factor to make them audible frequencies. Therefore, I have found it more effective and logical to base my thinking of pitch and its organization on frequency and its organization, rather than on a priori considerations of pitch class, pitch collections and intervalllic distances. It is better to find out how frequency organizes itself and what it has to offer, than to impose concepts on it from the outside.

The logic that I found to be inherent in the harmonic series and related acoustical phenomena was that frequencies were being ordered by the concept of frequency itself. I determined that a unified proportional set of intervals resulted whenever any kind of regularity existed between the frequency numbers. This is frequency controlling frequency, or frequency regulation. This concept is able to account for all tonal sonorities, from the simplest to the very complex, but it does so through one rational principle, which is independent of common practice. In a sense, it is also independent of music. For example, the harmonic series can be categorized in a more general sense as a regulated number series. This is a liberating concept because it allows regulated number series to be thought of independently without any constraints. It also gives musical harmony a true mathematical basis, since every tonal harmony can be created directly from this one concept, with a one to one correspondence between the frequency numbers and the resultant pitches. Stated conversely, every musical tone can be represented by a frequency number. A combination of tones is then represented by a combination of numbers. This combination of numbers is a number series. If some kind of regulating principle between the numbers can be determined, then the ratios of these numbers form a unified or harmonic (proportional) set of intervals.
2.5.2 Equal Difference Series

The simplest way to regulate a set of frequencies in the form of a number series is through the differences between frequency numbers and within this, the simplest form of frequency regulation is by equal differences between frequency numbers. This gives rise to the term, Equal Difference Series (EDS), of which the harmonic series is the simplest form. It begins on 1 and has a difference of 1 between each successive number and can be labeled as (EDS) 1+1. Since the harmonic series is a series of ratios, if each number of the series is multiplied by the same factor, the resultant series would also be the harmonic series. For example, the number series of 1, 2, 3, 4, 5, 6, 7, 8...when multiplied by 3 would result in the number series of 3, 6, 9, 12, 15, 18, 21, 24..., or (EDS) 3+3, which is the harmonic series of the number 3. This shows that within the harmonic series, there are an infinite number of other harmonic series, each with the same regulating principle: equal differences between numbers with the difference being equal to the lowest number of that series (negative numbers and zero excluded).

The rationale behind Equal Difference Series as a general category originates with the fact that they are all chains of arithmetic means. The arithmetic mean of 2 numbers (otherwise known as the average) is expressed by the formula \((a+b)/2\). The resultant number will always be equidistant between the original two. It follows that by repeatedly adding the same value to a given number, a chain of arithmetic means will result. This leads to the next level of complexity involving the EDS, in which the difference is not equal to the lowest number of the series. For example, the electronically generated square wave has odd partials of 1, 3, 5, 7, 9, etc., in which the difference of 2 is not equal to 1 (the lowest number of the series), or (EDS) 1+2. This series is also a simplified model of the spectral profile of the clarinet timbre and shows another rationale behind the EDS in its relationship to one of the general tendencies of frequency in regard to the formation of timbres.

Probably the most significant rationale for the use of Equal Difference Series in a harmonic theory is that they are all related to the harmonic series and that they all create tonalities, whether real or virtual. Virtual tonalities are based on ratios which are close enough to pass for the simple ratios that determine tonality. For example, the tonalities
created through equal temperament are all virtual since, other than the octave, they are all approximations of simple ratios.

Figure 1 shows a group of Equal Difference Series, which as a whole can be expressed as (EDS) \( n+5 \). This means that each series is formed by successively adding 5 to the first number of the series (theoretically continuing on until infinity). Beginning with frequency number (FN) 1, (EDS) \( 1+5 \) contains the numbers: 1:6:11:16:21, etc. Continuing down the rows of frequency numbers in Figure 1, the first number of each series is increased by 1, until we reach (EDS) \( 5+5 \), which forms the series: 5:10:15:20: 25:30, etc. This is the harmonic series of the number 5 and is theoretically the last series of the EDS group (EDS) \( n+5 \). If we continue on to (EDS) \( 6+5 \), containing the numbers: 6:11:16:21, etc., we notice that these numbers already exist in (EDS) \( 1+5 \). Likewise, (EDS) \( 7+5 \) is already contained within (EDS) \( 2+5 \). Therefore, the entire EDS group of (EDS) \( n+5 \) is contained within the range of (EDS) \( 1+5 \) to (EDS) \( 5+5 \) and no other series beyond the latter are necessary in order for that group to be complete. This also means that the number of series in any EDS group is limited by the difference number of that group. For example, the EDS group (EDS) \( n+7 \) contains a total of 7 different series. Likewise, every EDS group will relate to the harmonic series, since the last series in that group (where the lowest number will equal the difference number) will always be the harmonic series.
In Figure 1, the underlined frequency numbers emphasize the exact correspondence between the ratios which exist in all of the series of the (EDS) n+5 group. This shows the main reason for organizing series into a group according to a common difference: the ratios created by every series in an EDS group are subdivisions of the ratios of the first series. The number of the subdivisions corresponds directly to the factor by which the numbers of the first series are multiplied. For example, the ratio of 1:6 from the first series appears as 2:12 in the second series. Since the latter has been multiplied by...
a factor of 2, the resultant difference of 10 is divided by 2 in order to maintain the
difference of 5, which is the common difference for every series in the (EDS) n+5 group.
This subdivides the original ratio of 1:6 into two parts, creating the compound ratio of
2:7:12. Likewise, the third series, (EDS) 3+5 divides this first ratio of 1:6 into 3 parts,

As in the harmonic series, if every frequency number is multiplied by the same
value, the ratios created by the resultant series will be exactly the same as the original.
Consequently, we can see that the first series, (EDS) 1+5 is replicated in every other
series in the (EDS) n+5 group. It is even replicated in its own series, which continues as
(EDS) 6+5. We can see that the ratio of 6:36 corresponds exactly with 1:6. But more than
this, it is possible to start from any number in the (EDS) n+5 group as a whole and to be
able to replicate the ratios of the first series (EDS) 1+5, using only the numbers contained
within the (EDS) n+5 group.

The fact that all of the subsequent series in the (EDS) n+5 group create
subdivisions of the ratios of the first series (EDS) 1+5 is verified by the intervallic
distance numbers (¢), which represent the intervals formed by these ratios. Below each
row of frequency numbers (FN) in Figure 1, there is a corresponding row of intervallic
distance numbers (¢), which expresses the number of cents that exists between each pair
of frequency numbers. The total number of cents created by each pair of underlined
frequency numbers is exactly the same in every series, since those ratios are exactly the
same. This total number of cents is then subdivided into more and more parts, depending
on the factor by which the frequency numbers of the first series have been multiplied in
each subsequent series. For example, the number of cents for the intervals between 1 and
6 of the first series and 3 and 18 of the third series both equal 3102 ¢. However, in the
latter case, this 3102 ¢ has been divided into 3 parts by the frequency numbers 3, 8, 13
and 18, creating intervals of 1698¢, 840¢ and 564¢ respectively.

It will be noticed that, whereas the resultant frequency numbers when subdivided
maintain equal frequency differences (3:8:13:18), the resultant intervallic distance
numbers do not remain equal (1698¢, 840¢, 564¢), but get progressively smaller. This is
natural, since the ratios (which determine intervallic distance) get progressively smaller
the higher one goes up in the series. However, an added dimension to this decrease is the
exponential nature of intervallic distance. Altogether, this creates a curve of comparative change between the intervals of all Equal Difference Series, which is called the intervallic slope.

2.5.3 Intervallic Slope

In our discussion of intervallic slope, it is first important to note that the hierarchy of the octave is present in all music, from the concept of pitch itself to the calibration of intervallic distance. The octave is only one specific intervallic distance. In the harmonic series, it is divided into different numbers of equal frequency parts, creating different sets of complementary intervals. Yet, it also can be a complementary interval: a resultant equal frequency part among others, which completes a larger interval (as in the ratio of 6:1 being divided by the series 1:2:3:4:5:6). Since it forms a part of the Equal Difference Series universe, among other complementary intervals, it points out the importance of that universe and the intervallic combinations that define it.

The octave is the interval whose distance is that upon which all other intervallic distances depend for their identity. It is purely a natural phenomenon, but it rules both our perception and our precise mathematical measurement of registral space. Table 1, which gives information about the intervallic slope of (EDS) 1+1, or the harmonic series, not only has its basis in the octave, but literally uses its ratio (2:1 or simply the number 2) as a base from which all other intervals are mathematically derived. Intervallic distance is determined logarithmically, that is, exponentially. This is easily demonstrated by looking at a series that continuously repeats the same ratio. This is called an Equal Ratio Series (ERS) and one such series for the octave would be 1:2:4:8:16:32, or (ERS) 2:1. This particular ERS shows 5 octaves and each octave corresponds to a specific power of 2. For example, the ratio of 1:1, the unison, has zero octaves, hence 2 to the power of zero. The ratio of 8:1 has 3 octaves, hence 2 to the power of 3. Looking below at Table 1, frequency number 8 (8:1) would be rendered thus: 3 is the logarithm of 8 to the base of 2. We can see from this that the logarithm is identical to the number of octaves each frequency number produces. For example, 1.585 is the logarithm of 3 to the base of 2, which means that the intervallic distance of the ratio 3:1 is 1.585 octaves. This is an
octave and a 5\textsuperscript{th}. To get the distance of the 5\textsuperscript{th} (3:2), we need only subtract 1.000, the previous logarithm of frequency number 2, from 1.585, which gives us .585. This means that the ratio of the 5\textsuperscript{th}, 3:2, is .585 octaves.

Table 1: Intervallic Slope of (EDS) 1+1, the Harmonic Series

<table>
<thead>
<tr>
<th>octave as base</th>
<th># of octaves and logarithm</th>
<th>frequency number</th>
<th>interval as octave difference from previous log.</th>
<th>slope (differences) between intervals</th>
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<td>.415</td>
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<td>32</td>
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<td>.0015</td>
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In this way, every frequency number from 1 to 32 has its intervallic distance expressed as a discreet number of octaves, which is identical to its logarithm to the base of 2. This gives us an accurate representation of how intervallic distances change over the course of the series. The fourth column (interval as octave difference from previous log.) gives the intervallic distances for each consecutive ratio from numbers 1 to 32. The fifth column shows the intervallic differences between these consecutive ratios. This is the intervallic slope of the harmonic series. For example, the first difference is between the ratios 2:1 and 3:2 (1.000 - .585), which is .415 octaves. The second is between the ratios 3:2 and 4:3 (.585 - .415), which is .170 octaves. We can already see that the slope (the decrease) in the size of the intervals does not decline at a constant rate. Indeed, the slope when graphed resembles a parabolic curve. To get a visual representation of the information in Table 1, turn to Appendix I. This shows the consecutive intervals of the harmonic series as different-sized steps. Below this is the curve of comparative change between intervals, which is basically the slope of the slope above it. Theoretically, the intervals continue to get infinitely smaller, but we can see that this curve begins to noticeably flatten out at frequency number 16 (the semitonal region). It is also interesting to note that the total amount of comparative change between the intervals of the harmonic series approaches, but never reaches the octave.

Consequently, there is a wide variation in the degrees to which intervals will differ from one another over the course of the intervallic slope of the harmonic series. This is true of every Equal Difference Series, where every intervallic slope will resemble the same general type of parabolic curve. The greatest change will be at the beginning, followed by moderate change and ending with virtually no change. It is common knowledge in acoustics, that equidistant frequencies do not create equal intervals. However, we can now see that this flattening out of the intervallic slope curve means that at that point, equal frequency differences do, for all intents and purposes, create equal intervals. As far as semitonal equal temperament is concerned, this relative flattening out of the intervallic slope begins even sooner, where the minor 3rd is the first interval to repeat itself (ratios 6:5 and 7:6). Then we have 4 consecutive whole-steps (harmonics 7-11), followed by about 15 consecutive half-steps (harmonics 12-27). Since I am primarily interested in utilizing the way intervals change over the course of a series, as opposed to
the way they stay the same, I often determine the minor 3rd to be the lower limit in the intervallic sets I use, when these have been derived from Equal Difference Series. Appendix II (Intervallic Sets from Selected Equal Difference Series) shows the basic range of choices that the EDS have to offer. The intervallic distances for each EDS are represented horizontally and allow one to visually compare the relative sizes of each intervallic set. These 13 different EDS, when represented graphically in this way resemble a waterfall, hence the title of this thesis, *Exploring the Waterfall*.

In Figure 2, three of these series have been extracted for a slope comparison: (EDS) 11+11, also designated as S12 (the harmonic series or Series 12), because its first interval is 12 semitones, (EDS) 16+11 accordingly designated as S9, and (EDS) 8+11 as S15. The first 5 intervals from these series yield the following intervallic sets:

(EDS) 16+11: S9 = \{9, 6, 4, 4, 3\}
(EDS) 11+11: S12 = \{12, 7, 5, 4, 3\}
(EDS) 8+11: S15 = \{15, 8, 6, 4, 3\}
Figure 2: Intervallc Slopes of S9, S12 and S15

These intervallic slopes are relatively close in range so we can compare their subtle differences. They all have the same basic type of curve in which the greatest intervallic difference is at the beginning. S12, the harmonic series, is the median slope. S9 is shallower and S15 is steeper. As their curves progress, the differences between their
slopes decrease, until at the end, all three slopes are the same (rounded off in semitones). This will hold true for every EDS, where the greatest variety in intervallic distances between them (and within them) exists at the beginning. As they decrease at different rates, they all reach a point where they are virtually the same. Consequently, in terms of intervallic sets, the EDS provide variety and similarity. Variety gives us more choices and similarity facilitates integration and consistency in harmonic language.

The EDS also provide an ordered set of different, yet complementary intervals. The nature of this complementation lies with the creation of tonality: whether simple, complex, single or multiple. Every EDS creates unequal, yet harmonically related intervals that have a definite order. This order can be utilized to organize and expand tonality and can be transformed in a general compositional way (as in a form of serialism).

Intervallic slopes that are the result of frequency regulation, such as the EDS, are called natural intervallic slopes. Those which have their origin purely by creating an ordered set of different-sized intervals are called artificial intervallic slopes. However, these categories are not mutually exclusive: an artificial slope could imitate a natural slope and a more complicated frequency regulation of a natural slope could resemble an artificial slope. However, the intervallic slope itself naturally occurs with the regulation of frequencies and the orderly presentation of intervals corresponds to the ordering of frequency numbers. No such correspondence inherently exists with an artificial slope: its frequency numbers will not present a discernable order. Consequently, the numbers which create the natural intervallic slope are more useful when it comes to controlling or modifying other groups of numbers.

2.5.4 A Sliding Scale of Values

A sliding scale of values is an inherent aspect of every EDS group. In Figure 1 (p.34), we can see that the third series, (EDS)₃+5, begins with FN₃:8:13:18. By subtracting 1 from each number, the result will be FN₂:7:12:17 or (EDS)₂+5. The act of going from (EDS)₃+5 to (EDS)₂+5 is called sliding down the scale of values and has the effect of acoustically expanding all of the intervals from the original set. For example, the
1698¢ between FN3 and 8 becomes the 2169¢ between FN2 and 7, an expansion of 471¢, about 5 semitones. This is called acoustical expansion because the change of the intervallic distances does not happen uniformly, but is modified according to the natural intervallic slope created by equal frequency differences. As was shown in Figure 2 (p.40), the differences between natural intervallic slopes were large at the beginning, but diminished as the series continued. In the above example from Figure 1, the 6th interval which results by sliding down the scale of values from (EDS)3+5 to (EDS)2+5 is only expanded by 10¢: the 284¢ between FN28 and 33 has become the 294¢ between FN27 and 32. Consequently, there is a distinction drawn between acoustical expansion and logarithmic expansion. In the latter, the intervallic distances would be uniformly affected throughout the series. Likewise, beginning with (EDS)3+5 and sliding up the scale of values to (EDS)4+5, all of the intervals would be acoustically contracted.

This expansion and contraction of intervallic sets within a particular EDS group is directly related to the expansion and contraction of intervals which happen within just one series. Sliding downward within a single EDS will increase intervallic distances and sliding upward will decrease them. In this sense, the EDS group as a whole behaves like one series. Conversely, the harmonic series, (EDS)1+1, which is considered to be just one series, is actually an EDS group unto itself. Since its difference is 1, the group is complete with only 1 series. However, it can still take the form of any number of distinct series and show different relationships through a sliding scale of values. For example, we could acoustically expand the set of intervals created by (EDS)2+1 by sliding downward to (EDS)1+1 and conversely contract this set by sliding upward to (EDS)3+1. Here are the resultant intervallic sets, with semitones in brackets:

(EDS)2+1 becomes (EDS)1+1 or (EDS)2+1 becomes (EDS)3+1
{7, 5, 4} expands to {12, 7, 5}      {7, 5, 4} contracts to {5, 4, 3}

If we would like to expand the intervallic set of (EDS)1+1 by sliding further downward, we can multiply all the numbers in the series by the same value. If the numbers in (EDS)1+1 were multiplied by 2, this would convert the ratios of 1:2:3:4 to
2:4:6:8, or (EDS)2+2. These new numbers could then be slid down the scale of values by subtracting 1 to get the ratios 1:3:5:7, or (EDS)1+2. This would expand the intervals accordingly:

\[(EDS)2+2 \text{ becomes } (EDS)1+2\]
\[FN2:4:6:8 \text{ sliding } – 1 = 1:3:5:7\]
\[{12, 7, 5} \text{ expands to } {19, 9, 6}\]

In addition, the magnitude and tonal specificity of the expansion can be adjusted by the choice of a specific factor, such as 5, which would convert the harmonic series, (EDS)1+1 to (EDS)5+5. In this case, we have also just linked the harmonic series to the (EDS)n+5 group and sliding down the scale of values fits the information of that group as displayed in Figure 1:

\[(EDS)5+5 \text{ becomes } (EDS)4+5\]
\[FN5:10:15:20 \text{ sliding } – 1 = 4:9:14:19\]
\[{12, 7, 5} \text{ expands to } {14, 8, 5}\]

Likewise, the additional series mentioned in connection with the (EDS)n+1 group (the harmonic series) of (EDS)2+1 and (EDS)3+1 become (EDS)10+5 and (EDS)15+5 as part of the (EDS)n+5 group.

An important property of Equal Difference Series is that every EDS can be acoustically expanded or contracted through a sliding scale of values to correspond exactly to every other EDS.

The use of the natural intervallic slope via a sliding scale of values continues beyond the EDS category. One such application is toward the Equal Ratio Series, or ERS. At first glance, it doesn’t seem like the ERS has much value, since it has the effect of stacking the same interval over and over again. Furthermore, it is not necessary to create an ERS, if all one wants to do is stack intervals. However, it is always valuable to understand the frequencies and frequency relationships which have created a given intervallic set. With the ERS, there is a complete absence of intervallic slope and hence,
intervallic variety. Its value lies in this very fact, because it is like a blank slate upon which an intervallic slope can be drawn, based on an average dimension. To this end, we can apply the natural intervallic slope attributes of the EDS to the ERS, by using the type of sliding scale of values that inherently exists in every EDS group.

In Figure 1 (p.34), within the harmonic series of the number 5, or (EDS)5+5, lies the octave series of (ERS)10:5, represented by FN5:10:20:40…etc. Between each of these frequency numbers there exists 1200¢. If we maintain the same differences, but slide downward to (EDS)4+5, the first interval between 4 and 9 will be larger than the octave, at 1404¢, and a downward intervallic slope will follow, with 1294¢ between 9 and 19 and 1245¢ between 19 and 39. As this slope flattens out, it will continue to approach, but never reach the octave. Conversely, if we slide upward to (EDS)6+5, the first interval between 6 and 11 will be smaller than the octave, at 1049¢, and an upward intervallic slope will follow, which again approaches, but never reaches the octave (but in reality, both these slopes will reach the octave when rounded off). This is shown below, but it is necessary to introduce the next general category of number series based on differences, which is the Sloped Difference Series, or SDS. Since the ERS does not remain an ERS when subjected to the natural intervallic slope of the EDS, it must be expressed as an SDS. Cents are expressed in brackets rounded off to the nearest quartertone:

\[
\begin{align*}
(ERS)_{10:5} & \quad \text{becomes} \quad (SDS)_{4+[(ERS)_{10:5}]} \\
FN5:10:20:40 & \quad \text{sliding} - 1 = \quad 4:9:19:39 \\
\{12,12,12\} & \quad \text{expands to} \quad \{14,13,12.5\} \\
(ERS)_{10:5} & \quad \text{becomes} \quad (SDS)_{6+[(ERS)_{10:5}]} \\
FN5:10:20:40 & \quad \text{sliding} + 1 = \quad 6:11:21:41 \\
\{12,12,12\} & \quad \text{contracts to} \quad \{10.5,11,11.5\}
\end{align*}
\]
2.5.5 Sloped Difference Series

The concept of slope plays an important role in this theory on many levels. Above, we saw that it was possible to precisely regulate intervallic slope. Now we will see that frequency regulation also involves regulating the slope of the differences between the numbers of a number series. This is called a Sloped Difference Series, or SDS.

The EDS and the SDS are closely related to each other. Indeed, the SDS are usually based on the EDS and therefore form the next layer of complexity in frequency regulation. Just as the ERS can be considered to be a blank slate upon which an intervallic slope could be drawn, the EDS can be viewed as a blank slate upon which a difference slope can be drawn. As an acoustical example, there is Helmholtz’ discussion of the metallic tone of the tuning fork in which “The pitch numbers of these high upper partial tones were to one another as the squares of the odd numbers” (Helmholtz, 1954). This series of numbers would result by taking (EDS)1+2 and squaring all of its numbers: \( 1^2 : 3^2 : 5^2 : 7^2 : 9^2 \ldots \) or 1:9:25:49:81, etc. This would have a very steep parabolic intervallic slope but a linear difference slope. This SDS shows a close relationship to the EDS. Since the differences are not equal, they are considered non-linear. However, they increase at a constant rate (8, 16, 24, 32), so their difference slope is linear. We can also see that these differences are integral multiples of each other (8x1, 8x2, 8x3, 8x4), just like the numbers of the harmonic series. A similar SDS is one that I use at the end of the score to Exploring the Waterfall, which is (SDS)3+[(EDS)5+2], resulting in the series of ratios: 3:8:15:24:35:48, etc. This means that the differences come from (EDS)5+2, [which is simply a continuation of (EDS)1+2] and they would be: 5, 7, 9, 11, 13, etc. These difference numbers also create a linear difference slope. However, these differences are not integral multiples of each other, so their acoustical relations are more complex.

Another closely related SDS results from the use of the EDS in reciprocal form. This creates a chain of harmonic means, as opposed to arithmetic means. The harmonic mean is the mean of the reciprocal, or \( \frac{2ac}{a+c} = b \) (Escot, 1999). This has the effect of simply reversing the order of all the ratios (intervals) of the original arithmetic mean series, or EDS. There has been considerable debate over the acoustical justification of the
harmonic mean series. This justification comes through its tonality: every tonal sonority when inverted invariably creates another tonal sonority, which is equal to the first, but oriented differently toward its fundamentals. The harmonic mean preserves the original ratios which created tonality, but reorders them and hence, refocuses them. Since every EDS creates some kind of tonality, the reciprocal to every EDS will always create a tonal equivalent. Whereas the harmonic series begins with 1:2:3:4:5:6:7:8, the reciprocal to it begins with 1/1:1/2:1/3:1/4:1/5:1/6:1/7:1/8, which creates a descending, rather than an ascending set of the same intervals. When multiplied by 840 (2x3x4x5x7), these reciprocals will result in the integral series of 840:420:210:168:140:120:105. The regulation of the differences between these numbers can be expressed as: 840/2, 840/6, 840/12, 840/20, 840/30, 840/42, 840/56. The respective divisors to each of these differences can be expressed by factors as: 1x2, 2x3, 3x4, 4x5, 5x6, 6x7 and 7x8. Consequently, there is a discernable order in the regulation of the difference slope regarding the reciprocals to the EDS. Although the above series is a Sloped Difference Series, it is more simply expressed as a reciprocal of Equal Difference Series 1+1, or R(EDS)1+1.

An SDS with a more acoustically distant relationship would be created using the EDS as a series of exponents. This is exactly what happens with the Equal Ratio Series, which is another type of SDS, whose difference slope is parabolic, rather than linear. If we take the harmonic series, (EDS)1+1 and use it as a logarithmic scale to the base of 2, we will get the octave series of 2:4:8:16, etc. as $2^1$, $2^2$, $2^3$, $2^4$, etc., or (ERS)4:2.

All of the above show that the SDS can be formed in many ways and has unlimited possibilities for ever more complex frequency regulations. While EDS provide a wealth of harmonic possibilities, using SDS dramatically increases the variety of intervallic content available to a composer.

2.5.6 Intervallic Design

Intervallic Design (ID) is a method for building intervallic structures, based on a series of ratios. The order of the ratios (intervals) in a given series is represented by ordinal numbers. Segments of this order are then joined together through a common ratio.
It can be described as a folding of the series in on itself, or a ratio reversal, which pivots on a common ratio. This means that the ratio that ends one series segment is the same as the beginning of another series segment in the opposite direction. There can be one fold or several folds, with the complexity of the tonality generally increasing with each additional fold. The main rationale for this method is that it reinforces and builds upon harmonic relationships by utilizing the order of the series and by harmonically linking different segments of that order. Intervals do not exist in isolation, but rather, they are complementary to other intervals in the series, and in particular, to those intervals to which they are adjacent. An interval’s value and identity is determined by its position in the order of a given series.

The justification for harmonically linking series segments comes through the relationship between the arithmetic mean and the harmonic mean. As stated above, the harmonic mean reproduces the tonality of the arithmetic mean in an inverted form. For example, the arithmetic mean proportion of 4:5:6 creates the major triad. Its tonality is supported by two different ratios, which are 5:4 and 6:4 (3:2). The inverse or reciprocal of this results in the harmonic mean proportion of 10:12:15, whose tonality is supported by the very same ratios: 12:10 = 5:4 and 15:10 = 3:2. In the latter case, the reversal of the order of the ratios that created these tonalities does not destroy them, but simply refocuses them. The only difference is that, whereas these two ratios are focused on the same fundamental in the arithmetic mean proportion (giving the fundamental more tonal support), they are focused on two different fundamentals in the harmonic mean proportion (dividing the tonal support between two fundamentals).

The Intervallic Design concept allows us to exploit the commonality of ratios between the arithmetic and harmonic means. By intersecting these two proportions through a common ratio, we are able to preserve and compound the tonalities of each of them. An example of this would be the major seventh chord, which results when we intersect the arithmetic mean proportion of 4:5:6 (or 8:10:12) with the harmonic mean proportion of 10:12:15. This results in the larger compound proportion of 8:10:12:15, which, in C, would be the notes c, e, g, b, or the major seventh chord. In this case, the ratio of 12:10, the minor third, is the harmonic link. However, we can also intersect these two proportions through the ratio of 5:4, or the major third. By multiplying 4:5:6 by 3, we
obtain 12:15:18. When we intersect the latter with 10:12:15, we get the larger compound proportion of 10:12:15:18, which in C would be the notes e, g, b, d, or the minor seventh chord.

The Intervallc Design (ID) concept affords us with a simpler way to represent the ratios of various series. To this end, each ratio is assigned an ordinal number, which represents its position in a given series. For example, the first 5 ratios of the harmonic series, or (EDS)1+1, are derived from the arithmetic mean series of 1:2:3:4:5:6 and are: 2:1, 3:2, 4:3, 5:4, 6:5. Represented in semitones, these would form the ordered intervallc set of: {12, 7, 5, 4, 3}. As an Intervallc Design of the simplest type, which illustrates the intervals of a given series in their original order, this would be labeled as (EDS) 1+1 (ID)12345. Broken down, the correspondence between the ID and the intervallc set would be: (ID)1 = {12}, (ID)2 = {7}, (ID)3 = {5}, (ID)4 = {4} and (ID)5 = {3}. The reciprocal to this, or the harmonic mean series of 10:12:15:20:30:60, which creates a retrograde to all of the above ratios, forming the ordered intervallc set of {3, 4, 5, 7, 12}, would simply be labeled as (EDS)1+1 (ID)54321. This same ID can then be applied to different series. For example, the ordered intervallc set of {21, 9, 6, 5, 3}, derived from the series of 8:27:26:65:84:103, would be labeled as (EDS)8+19 (ID)12345 and its reciprocal, or the ordered intervallc set of {3, 5, 6, 9, 21} as (EDS)8+19 (ID) 54321. Consequently, the same ID creates different intervallc structures when applied to different series.

After establishing this basic order of the ID, there comes the intersection or folding process. The following example consists of one fold. The arithmetic mean proportion of 4:5:6 exists as the 4th and 5th ratios in the harmonic series and would be labeled accordingly: (EDS)1+1 (ID)45. Since the harmonic mean proportion of 10:12:15 is simply a ratio reversal of this, it would be labeled as (EDS)1+1 (ID)54. The intersection of these two (ID)’s at interval #5(the minor third) would be expressed as: (EDS)1+1 (ID)45 ∩ (ID)54 @5 = (EDS)1+1 (ID)454, or more simply and graphically:

(ID)45 ∩

(ID) 54 =

(ID)454.
However, in practice, even the latter can be simplified. Essentially, we are dealing with permutations of a particular ordered intervallic set. These permutations are based on the joining of series segments through a common ratio. In this model, not all permutations are possible, but only those that fulfill certain criteria. One requirement is that the series segment must have at least 3 frequency numbers, which create 2 ratios. This minimum is necessary not only to show the context and the order of the intervals in a given series, but also to provide 1 interval which serves as a harmonic link between series segments and at least 1 more to complete the growth process. The above example of (ID)45 and (ID)54 being joined together to form (ID)454 illustrates this requirement.

As we can see, one result of this model is that all permutations must consist of adjacent numbers. Although this in itself is a limitation, it still allows for the repetition of a given interval, as long as there is an adjacent harmonic link in between it. It is possible to work out all of the permutations that conform to this growth process. For example, for an ordered intervallic set of 5 intervals, there are 14 permutations for intervallic structures consisting of 3 intervals based on this model. They are: (ID)’s 121, 123, 212, 232, 234, 321, 323, 343, 345, 432, 434, 454, 543 and 545. Using the same process, by the time we get to intervallic structures consisting of 11 intervals (producing a 12 note chord), there are 2,659 possible permutations. If we multiply this by the 13 selected EDS of Appendix II, this would give us 34,567 different intervallic structures, all of which are related to one another in some way. If we then turn our attention to the various types of SDS, the number of possible intervallic structures moves into the hundreds of thousands. Out of all these possibilities, I have chosen about 700 with which to compose the music for *Exploring the Waterfall*. 
3.1 Form

*Exploring the Waterfall* is one piece of continuous music united by the frequency regulation and Intervallc Design concepts presented in my harmonic theory; but it nominally has two movements: I. *Vengeance Is Mine, Sayeth the Groove* and II. *Precipitous Sanctuary*. The first is explosive, rhythmically charged and relatively linear in its development. The second is more lyrical, generally slower and characterized by contrasts in color, tempo and texture.

The first movement has a consistent rhythmic “feel” that results from building on the sense of pulse, the convergence of rhythmic elements and their interaction with all of the other elements in the music. This is “the groove” referred to in the title and this is developed through counterpoint, rhythmic procedures and selective improvisation as it weaves through a massive series of intervallic/harmonic structures. The groove gradually emerges in the Introduction and is then intensified through driving syncopated rhythms and huge dissonances. The rhythmic drive of the movement is eventually broken down by a series of interruptions, which returns us to the introductory material and a transition to the second movement. The second movement is more relaxed and lyrical in character and begins slowly and gently. However, this sense of sanctuary becomes unsettled in a series of colorful variations. After the midpoint of the movement, there is a return to the slower and more lyrical material, but again, the sense of sanctuary recedes into the shadows until the Coda, which ends the piece with a flourish in a faster tempo.

There are 4 essential elements in the form: the Introduction (I), the A material (first movement), the B material (second movement) and C, the Coda. Of these, the Introduction plays the biggest role in binding these elements together: it relates rhythmically to the A material and melodically to the B and C material. From a quiet and sparse beginning in the first movement, the Introduction gradually builds and develops the groove. When the intensity reaches its boiling point, the groove is unleashed with a vengeance (the A material). Three quarters of the way through the movement, a return to the introductory material suddenly interrupts this flow, functioning this time more as an
interlude. The A material then reappears, but soon breaks down and the introductory material returns. This return to the introductory material acts as an elision between the 2 movements. The Introduction is actually derived from the B material of the second movement. Despite a common connection to the Introduction in both movements, they are very different in character. In the first movement, the introductory material is developed into a funky groove with percussion-like dissonances, which the A material intensifies and freely develops. This free development causes a gradual movement away from the original material presented in the Introduction. By contrast, in the second movement, the introductory material is developed more lyrically and coloristically, with a consistent melodic development based on common motives that never departs from the original material. After the B material goes through its colorful variations, there is a sudden change in meter and tempo and the piece finishes with an energetic Coda. The Coda is also derived from the B material, but it merits a special designation in that it is set apart by a sudden change in tempo, meter and texture, as well as a radical increase in micro-harmonic rhythm.

The key to understanding the form in more depth lies in understanding how the form evolved. There is some source material for Exploring the Waterfall, which comes from a slow and lyrical section of my string quartet of 2006, entitled Crickets in Spring. I encapsulated this material in 16 bars and recomposed it for 12 strings. This musical passage can be considered the primary point of sanctuary in the second movement, Precipitous Sanctuary, and also the point of origin for the entire work. As such, it can be represented by the number zero. All passages and subsections to this work are related to this point of origin and can be represented by either positive or negative integers, helping to illuminate the form.

The B material of the second movement can be considered direct transformations of this source material and represented by positive numbers. The Introduction, which subtracts elements from the original source material and replaces them with others, can be represented by negative numbers. The A material of the first movement, which develops away from the source material and ultimately supplants it with different material, can be represented by negative integers higher than those of the Introduction. From a tonal perspective, the A material generally moves in the direction of the
subdominant, or flat side, in relation to the tonic and is aptly represented by negative numbers. Conversely, the second movement is characterized by a stronger presence of the tonic and a tendency to move toward the dominant, or sharp side, which can be considered a positive direction.

A deeper meaning to the word “sanctuary” is a spiritual one, being the ultimate source of all creation. This primary point of sanctuary is literally the point from which the creation of the entire work flows. It is also the point of greatest rest and the ultimate arrival point in the form. The driving rhythm of the first movement is relentlessly moving toward something and the second movement is that arrival point. The source, point of origin (0), or primary point of sanctuary, occurs slightly after the midpoint of the second movement in the penultimate section of the entire work (mm. 303-318). There is a secondary point of sanctuary at the beginning of the second movement (mm. 207-231). This passage is a continuation of the primary point of sanctuary and a development of the theme that begins to emerge in m. 315. This secondary point of sanctuary can accordingly be represented by the number, 1. Its theme, which opens the second movement, becomes the primary theme for the movement as a whole. The remaining sections of the second movement are then represented by positive integers greater than 1.

The next link in the evolution of the form is a passage of music that begins the Coda (mm.334-349) and occurs shortly after the point of origin (in the penultimate section). This passage is a direct transformation of the latter in that it preserves the basic motives, tonality and harmonic rhythm of this source material, or primary point of sanctuary. It is differentiated by a sudden increase in tempo, a fundamental change in meter (to compound time), a much denser rhythmic/contrapuntal texture and a much faster micro-harmonic rhythm. Micro-harmonic rhythm refers to a rate of change in sonority or intervalllic structure, which often does not result in any change in chord type. In the Coda, there is a very fast micro-harmonic rhythm, but a relatively slow harmonic rhythm. It is the methodical application of micro-harmony through intervalllic design, which forms this passage and is also responsible for the changes in tempo, meter and texture. This newly derived material is a fast, full-textured and rhythmically charged section of subtly changing colors, which stands out in bold contrast to the slow and lyrical source material which precedes it. These two qualities: slow and lyrical versus fast
and rhythmically charged, determined the basic polarity for the entire work, the culmination of which occurs in these last two sections. This concept is mapped onto the two movement structure of the work, the first being primarily fast and rhythmically charged (*Vengeance Is Mine, Sayeth the Groove*) and the second being primarily slow and lyrical (*Precipitous Sanctuary*). The Coda passage can be represented by the number 5, giving us a total of four different musical passages which have evolved out of the original source material: 0 = the *primary point of sanctuary*, 1 = the *secondary point of sanctuary*, -1 = the Introduction and interlude, and 5 = the Coda passage. They create a formal skeleton:

1\(^{st}\) movement \hspace{1cm} 2\(^{nd}\) movement

(flat side) \hspace{1cm} (sharp side)

(elision)

[-1 \hspace{2cm}, -1 - - [ -1,] 1 +++++++, 0 +++ , 5 + ]

The Introduction, as \(-1\), develops in the opposite direction of the source material, reappears as an interlude, then ends the first movement and is formally elided as an Introduction/transition to the second movement. The latter begins with 1, the secondary point of sanctuary, and continues to further develop the source material in a positive direction, ultimately leading back to 0, the primary point of sanctuary. A Coda ends the piece with a flourish. The complete formal plan is presented below.
In Figure 3, we can see that the Introduction (I) has 3 parts: (I1) coalescence of the groove, (I2) establishment of the groove and (I3) textural preview of the groove. The purpose of the Introduction is eightfold: (1) to slowly build the groove, (2) to introduce the basic motives of the piece, (3) to gradually increase the number of voices to a tutti, (4) to expand the total registral space, (5) to introduce orchestral textures to come, (6) to present a series of intervallic structures to be developed later, (7) to emphasize the dominant harmonic region of E, which will then cadence to the tonic of C with the arrival

<table>
<thead>
<tr>
<th>mm.#</th>
<th>integer</th>
<th>letter</th>
<th>subsection</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-32</td>
<td>-1</td>
<td>I</td>
<td>I1</td>
<td>Intro - coalescence of the groove</td>
</tr>
<tr>
<td>33-56</td>
<td>-2</td>
<td>I2</td>
<td>Intro - establishment of the groove</td>
<td></td>
</tr>
<tr>
<td>57-67</td>
<td>-3</td>
<td>I3</td>
<td>Intro - textural preview of the groove</td>
<td></td>
</tr>
<tr>
<td>68-90</td>
<td>-4</td>
<td>A</td>
<td>A1</td>
<td>vengeance of the groove (full strength and texture)</td>
</tr>
<tr>
<td>91-98</td>
<td>-2</td>
<td>A2</td>
<td>double bass solo (thinning of texture)</td>
<td></td>
</tr>
<tr>
<td>99-110</td>
<td>-4</td>
<td>A3</td>
<td>vengeance of the groove - variation</td>
<td></td>
</tr>
<tr>
<td>111-121</td>
<td>-5</td>
<td>A4</td>
<td>fragmentation of the groove</td>
<td></td>
</tr>
<tr>
<td>122-139</td>
<td>-6</td>
<td>A5</td>
<td>1/2 Golden Section - sliding scale - groove suspension</td>
<td></td>
</tr>
<tr>
<td>140-147</td>
<td>-4</td>
<td>A1</td>
<td>vengeance of the groove - recap</td>
<td></td>
</tr>
<tr>
<td>148-156</td>
<td>-5</td>
<td>A4</td>
<td>fragmentation of the groove</td>
<td></td>
</tr>
<tr>
<td>157-167</td>
<td>-1</td>
<td>I</td>
<td>II</td>
<td>Introduction inversion as interlude</td>
</tr>
<tr>
<td>168-174</td>
<td>-4</td>
<td>A</td>
<td>A3</td>
<td>vengeance of the groove – variation</td>
</tr>
<tr>
<td>175-185</td>
<td>-4</td>
<td>A1</td>
<td>vengeance of the groove – recap resumed</td>
<td></td>
</tr>
<tr>
<td>186-188</td>
<td>-4</td>
<td>A3</td>
<td>vengeance of the groove – variation resumed</td>
<td></td>
</tr>
<tr>
<td>189-194</td>
<td>-2</td>
<td>I</td>
<td>I2</td>
<td>Intro – establishment of the groove resumed</td>
</tr>
<tr>
<td>195-206</td>
<td>-1</td>
<td>I</td>
<td>I1</td>
<td>Intro to second movement</td>
</tr>
<tr>
<td>207-231</td>
<td>1</td>
<td>B</td>
<td>B1</td>
<td>lyric theme – secondary point of sanctuary</td>
</tr>
<tr>
<td>232-240</td>
<td>Ø</td>
<td>BØ</td>
<td>Golden Section – point of greatest stasis</td>
<td></td>
</tr>
<tr>
<td>241-247</td>
<td>3</td>
<td>B2/I2</td>
<td>lyric theme variation 1 - with groove</td>
<td></td>
</tr>
<tr>
<td>248-261</td>
<td>5</td>
<td>B3/I2</td>
<td>lyric theme variation 2 - in pastels and variable tempi</td>
<td></td>
</tr>
<tr>
<td>262-274</td>
<td>3</td>
<td>B2/I2</td>
<td>lyric theme variation 1 - with groove resumed</td>
<td></td>
</tr>
<tr>
<td>275-283</td>
<td>5</td>
<td>B4</td>
<td>lyric theme variation 3 - sturm und drang</td>
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<tr>
<td>284-296</td>
<td>4</td>
<td>B5</td>
<td>lyric theme variation 4 – birds in flight</td>
<td></td>
</tr>
<tr>
<td>297-302</td>
<td>2</td>
<td>B2</td>
<td>secondary point of sanctuary elaboration</td>
<td></td>
</tr>
<tr>
<td>303-318</td>
<td>0</td>
<td>B0</td>
<td>primary point of sanctuary</td>
<td></td>
</tr>
<tr>
<td>319-333</td>
<td>4</td>
<td>B3</td>
<td>lyric theme in shadow</td>
<td></td>
</tr>
<tr>
<td>334-349</td>
<td>5</td>
<td>C</td>
<td>C1</td>
<td>bright and spirited Coda in compound time</td>
</tr>
<tr>
<td>350-376</td>
<td>6</td>
<td>C2</td>
<td>final cadence – cliffhanger</td>
<td></td>
</tr>
</tbody>
</table>
of the A section and (8) to anticipate the transition from the A material of the first movement to the B material of the second movement.

*Coalescence of the groove* (I1) begins barrenly with a single motive in pizzicato, answered by its inversion. This motive begins in an elongated form that does not coincide to any sense of meter. Through progressive diminution, the durational space between attacks is gradually decreased and a sense of rhythmic regularity begins to coalesce. However, as soon as this occurs it is interrupted by a few irregularly placed block chords. The meter finally becomes stabilized at m. 21, where the groove is stated clearly for the first time. Toward the end of this phrase there is another interruption, longer in duration and with larger block chords.

Out of this texture a new motive is taken up by the double bass and the groove is firmly established at m. 33 (I2). This prominent bass line continues to be the backbone of the groove throughout the work. During I2, the number of voices and resultant registral space continue to increase as the block chords increase their registral span. But now, these block chords are integrated into the regular time flow and texture: they are no longer interruptions. Despite this, there still remain moments of sparseness and empty space, which create a sense of suspense.

This suspense ends abruptly with the arrival of I3 at m.57. What was up until this point a texture entirely composed of pizzicati, is suddenly contrasted by arco group glissandi. This new texture and orchestration is a preview of what is to come in the A section. During this passage, the dominant harmony of E (in various guises) is continually reinforced by the group glissandi to make way for the imminent arrival of the tonic harmony of C at m. 68.

*Vengeance of the groove* (A1) begins with a sudden and dramatic compression in texture and harmonic rhythm. A part of the sequence of the block chords presented in the Introduction is compressed into a very short time frame. At m. 68, the 6-measure phrase that begins the A section uses the intervallic structures that had occurred in the Introduction over 24 measures: an increase in harmonic rhythm by a factor of 4. As well, much of the intervening motivic material that existed between those block chords in the Introduction has been deleted. Although the Introduction is derived from the B material of the second movement, the superimposition of these block chords is an independent
development. Since the first movement A material is based upon the sequence of these block chords, it becomes completely independent of the B material and has its own development. Consequently, the A material is directly related to the Introduction, but not to the B material.

Having secured the basic formal outline and having built up the groove to critical mass, all that remains is to let it unfold: the purpose of the A section is to let the composer explore his favorite EDS groups in what amounts to a “jam session” within his own mind. Much of this section could be described using Stravinsky’s term: selective improvisation. The composer is singing through his theory. As such, the presence of the blues is apparent, but only because it is a natural part of the composer’s improvisational language. As this simple bluesy declamation weaves its way through the complex harmonic/intervalllic structures of the EDS group n+11, it is transformed into a chromatic modality that defies easy classification. Even so, it is clearly in the subdominant for the remainder of A1 and there is a general tonal trend in the direction of flats (the flat side) for the rest of the movement.

Since there is no further need to build up intensity, the A section explores a variety of textures. The best example of this is a sudden thinning of texture at the double bass solo (A2) in mm. 91-98. The full ensemble and wide registral span of the orchestra is still employed, but only as a sparse accompaniment in occasional short blasts. This temporary decrease in density allows the vengeance of the groove to return with renewed vigor at m.99 (A3). Subsections A3 – A5 see an increase in modulation, which culminate in a cadence back to A1 at m.140. This modulation is a direct result of the increasing application of a sliding scale of values, in which the original differences to the frequency numbers that created the harmonies are maintained, while the values of these numbers are uniformly increased or decreased. This is used in conjunction with fragmentation at A4. At the Golden Section to the first movement (.618 of its duration), this sliding scale of values goes into overdrive as it quickly goes up the scale of values of a single intervallic structure in A5 (mm.122-139). This serves as a type of dominant prolongation and there is a brief suspension of the groove, before the return of A1 at m. 140. The significance of A5 being at the Golden Section is that it is a completely unique event in the first
movement, not directly related to any other material, and it occurs dramatically right before the recapitulation of the *vengeance of the groove*.

This use of the sliding scale of values also causes acoustical expansion, whose byproduct is registral expansion. When A1 does return at m.140 (*vengeance of the groove recapitulation*), it returns in an acoustically and registrally expanded form. In this section the densest and most dissonant masses of sound of the entire work are presented. In this acoustically expanded form, A1’s original sense of tonal stability has become complex, ambiguous and destabilized. As a result it serves as a dominant to the subdominant section (I1) at m.157. Before this occurs, the music once again undergoes fragmentation (A4). This juxtaposition of quietness with I1 signals the ultimate breakdown of *vengeance of the groove*. This passage of music, which is in effect an interlude, is actually an inversion of an excerpt of the I1 part of the Introduction. This quiet interlude also bears some resemblance to the points of sanctuary of the second movement. Consequently, it can be viewed not only as a preview of the second movement, but also as an example of the general interpenetration of thematic elements throughout the work.

The interrupted recapitulation of A1 is resumed via a transition through A3, which suddenly interrupts the interlude of I1 shortly before it. In its acoustically expanded form, this resumption of the A1 recapitulation sees the piece’s largest sonorities (7 octaves) at m.176 and m.181. The dissolution of the recap through A3 and the resumption of *establishment of the groove* (I2) at m.189 signals the midpoint of the entire work, as a single double bass repeats a low F (F1) in m.190. This is an echo of the barrenness of the beginning and also a pinpointed focus on the lowest register of the orchestra (a unique moment that highlights the midpoint). Continuing from here, there is a sense of everything starting all over again as I1 returns as the Introduction and transition to the second movement.

Since I1 is based directly on B1, the transition between the two movements is a simple matter. But this time, instead of the Introduction steadily building energy, it relaxes into the sanctuary of B1, *secondary point of sanctuary*. However, this arrival at sanctuary is a qualified one: it is precipitous. What first appears as bright can suddenly have a shadow cast over it. *Precipitous Sanctuary* could be paraphrased as “sanctuary as viewed from the edge of a precipice.” Some of the rhythmic restlessness of the first
movement interpenetrates the second movement. Furthermore, the exhilaration of the Coda is brought to an abrupt end and does not allow a complete resolution: it is a cliffhanger.

Notwithstanding, Precipitous Sanctuary is still a form of sanctuary. It is in the second movement, for example, that we find the only stable expressions of the tonic (in C), a fact which in itself imparts a sense of groundedness and relaxation. These three tonic expressions can be found at the beginning with B1 (secondary point of sanctuary), after the midpoint in the penultimate section with B0 (primary point of sanctuary), and at the first half of the Coda with C1 (bright and spirited Coda in compound time).

All of the other passages of music in this movement lean toward various dominant harmonic regions and to the sharp side in general. However, these dominant regions are not clearly dominant, as they tend towards tonal complexity and ambiguity. This is unlike the first movement, which generally has strong and definite fundamental bass motion with strong perfect-related cadences, no matter how complex the harmonies may appear on the surface. In contrast, there are no particularly strong dominant to tonic cadences in the second movement. Whereas the dissonances of the first movement played a quasi-percussive role in intensifying the groove, in the second movement they are used more for the subtle shading of the various harmonies, be it tonal shading, coloristic shading, or both. As a result, the second movement is relatively nonlinear and more impressionistic than the first. We can see this just by comparing the integers that represent the subsections’ developmental distance from the point of origin (bearing in mind that a repetition of an integer does not in this case necessarily mean a repetition of a subsection):

<table>
<thead>
<tr>
<th>1st movement</th>
<th>2nd movement</th>
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<tbody>
<tr>
<td>[-1 -2 -3 -4 -2 -4 -5 -6 -4 -5 -1 -4 -4 -2 [-1]</td>
<td>1 Ø 3 5 3 5 4 2 0 4 5 6</td>
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</tbody>
</table>

We can see that the first movement contains many consecutive integers, which denotes linearity. This linearity, although it has several interruptions, basically goes up and comes back down, resembling an arch form. In the second movement, there are hardly any consecutive numbers (except at the very end), which means that contrast is
more the mode of operation in the form. One can detect a general pattern of rising, falling and rising again, but the manner in which this happens is somewhat irregular. It would be difficult to reorder the integers of the first movement and still have the music make sense, but in the second movement, this is not the case. Furthermore, the absence of consecutive numbers in the second movement does not necessarily denote interruption as it does in the first: generally speaking, the subsections of the second movement are self-contained. The cohesiveness of this movement relies more on a balance of contrasts between variations based on the same source material.

The second movement opens quietly with a lyrical theme stated clearly and simply by a solo violin (B1). This same theme was hinted at in the Introduction, but now it is presented in its complete form. After building up the texture around this theme, we reach BØ. It is given the null set number because it is the only place in the entire work that is devoid of any type of motivic material, but consists only of a repeated note with a harmonic background. This is the quietest passage in the piece (point of greatest stasis) and it is strategically placed at the Golden Section (.618) of the entire duration of the work. After all that has happened, a point of rest and reflection is needed before continuing on, especially since the rhythmic restlessness of the first movement is about to have a resurgence.

As the music picks back up, a series of contrasting variations of the lyrical theme ensues, in various rhythms, tempos, harmonic colors and textures (B2/I2 – B5). With B2/I2 and B3/I2, we can hear the groove of I2 temporarily making a reappearance, as it integrates into these new textures. By the time we get to B5, lyric theme variation 4 (birds in flight), there is a notable levity in harmonic color, texture and rhythmic character to the music, which is a preview of the Coda. This fades into B2, which can be considered as a continuation/elaboration of the textural buildup at the end of B1, the secondary point of sanctuary that began the movement.

Finally, after a brief silence, B0 (primary point of sanctuary) arrives and a soothing idyllic musical passage slowly unfolds. The source material continues at a relaxed pace, but as it starts to develop toward the lyric theme in secondary point of sanctuary, this theme, instead of continuing in the tonic with clear luminous sonorities, suddenly goes into shadow (B3). This passage (mm.319-333) is a good example of tonal
shading. From the simple bright tonality in *primary point of sanctuary* there suddenly emerges a very tonally complex music, in which each chord contains about 6 different fundamentals and is subtly different from every other chord. The result is a passage of music that approaches a de facto state of atonality.

Out of this eclipse rises the bright and vivacious Coda passage of C1. This Coda passage is formed by ordering the 120 permutations of the intervallic set \{12, 7, 5, 4, 3\}, which is the first 5 intervals of the harmonic series, in such a way that the basic motives and harmonies of the original source material can be reproduced, albeit transformed. Each permutation happens only once and lasts for only an eighth-note, resulting in 120 permutations occurring in 120 eighth notes. These 120 divide into 8 groups of 15, which in turn create the compound meter of 15/8 (subdivided in the score into 6/8 + 9/8). Consequently, the character of the music of the Coda is radically different from the source material, even though it is directly derived from it.

C1 is the final strong statement of the tonic, with alternations of subdominant regions for contrast. This ends when the 120 permutations end and proceeds to the second part of the Coda, C2, the final cadence – cliffhanger, which is in effect another dominant prolongation similar to the one that happened in the first movement at its *Golden Section*. It is also similar in shape and character, since it employs a rapid movement up and down a sliding scale of values. However, its rhythm is a continuation of the brisk compound time of C1, and as a result, the rhythmic flow of the Coda is unified to the very end, when the dominant suddenly resolves at a high point: the precipice.

### 3.2 Counterpoint and Motivic Relationships

Formally, I2 (mm.33-56), the *establishment of the groove*, is also the establishment of a specific contrapuntal texture. This texture is a culmination of the type of counterpoint that was established at the very beginning of the work in I1. Consequently, I1, the *coalescence of the groove*, can also be viewed as the coalescence of the contrapuntal texture. This also underlines the importance of realizing that the groove is not merely rhythmic patterning, but the interaction and development of different motives, resulting in a contrapuntal texture.
The jazz stylistic attribute of *call and response* is an important aspect of the counterpoint in this work. At the beginning of the work there are 4 motives involved in this, which can be subdivided into 2 groups of 2 related motives, the X group (X1 and X2) and the Y group (Y1 and Y2). In the opening measures of I1, only the X group is present. Motif X1 opens the piece, played by viola 1 and consists of three repeated notes followed by a fourth note a whole-step below (B, B, B, A). Motif X2, played by violin 2 in m.3, is a response to and also an inversion of X1. However, it starts out in a reduced form, which shows the whole-step movement in the opposite direction, but with no repeated notes (D, E). At its fifth occurrence in m. 15, the complete X2 motif finally appears (D, D, D, E). This was prepared by its fourth appearance in m.13, which added one note to the opening motif (D, D, E). In *call and response*, motives can either overlap or be completely separated. In the beginning of the piece the latter occurs, with X1 and X2 having no simultaneous attacks. As the music progresses, these motives get closer and closer together and the first simultaneous attack occurs in m.14.

Meanwhile, the gradual emergence of the first motif of the second group, Y1, began in m.7, where cello 1 played an E pedal below viola 1 in pizzicato tremolo. By m. 14, all the pitches of Y1 are introduced (E, G, A). Gradually these pitches become more rhythmically active and we see the first complete appearance of motif Y1, played by cello 1 at the pick-up to m.19, consisting of an ascending and descending minor 3\(^{rd}\) and perfect 4\(^{th}\) from the tonic of E (E, G, E, A, E).

It should also be mentioned that intervallic content, which plays a central role in the work, also determined the opening motives. For a “dry” beginning, I used only the intervals of the 5\(^{th}\), the whole-step and the 4\(^{th}\). In combination with the different parts, these also produced the octave, the minor 7\(^{th}\) and the minor 3\(^{rd}\). The main objective in doing this was to withhold the occurrence of the major third, which is then emphasized in mm. 16-18 as 4 accented block chords interrupt the flow. The introduction as a whole is mainly in a modal E minor (Phrygian), but these chords interject a glimpse of a later C Major tonality, with E being temporarily undermined by C. This also contributes to the suspense of the opening, which in turn contributes to the gathering momentum of the groove texture. Another pitch that is withheld is F, which provides the Phrygian inflection to the Phrygian mode and this doesn’t appear until m.28.
The fourth motif, Y2, finally makes its appearance at m.32 in double bass 1. This motif is an extension of Y1. Instead of returning to the first note of the motif as Y1 does (E, G, E, A, E), the double bass repeats the fourth note and extends the motif to become 2 measures long (B, D, B, E, E, E, E).

These are the notes of the 4 motives in their basic form:

\[
\begin{align*}
X1 &: B, B, B, A \\
X2 &: D, D, D, E \\
Y1 &: E, G, E, A, E \\
Y2 &: B, D, B, E, E, E, E
\end{align*}
\]

The rhythm of these motives varies, but this variance has different degrees for each motif, depending on their respective roles within the contrapuntal texture. The primary soloistic voice that others respond to (the caller) develops out of X1 and this is the motif that varies the most. In addition to changes in its rhythm, there are new pitches added to it as it develops into a theme and then a phrase. Beginning in m.37, in viola 1, we can see a phrase formed by three statements of the X1 motif, in which each successive statement undergoes greater elaboration. In mm. 38-39, the note C is interpolated between each B. After that in mm.41-42, the motif is further extended with a descending blues gesture added at the end. This process occurs again in mm.45-51, so that we have two statements of a complete phrase that has developed out of the X1 motif; this is the culmination of formal sections I1 and I2. A corresponding place where this theme occurs again is at the beginning of the second movement in mm.207-231 in the violin 1 part.

Comparing the notes of this theme with the earlier one, we can observe the differences between the basic forms of each:

\[
\begin{align*}
X1 \text{ theme in 2}^{\text{nd}} \text{ movement}: G, A, A\#, B, C, B, C, A \\
X1 \text{ theme in 1}^{\text{st}} \text{ movement}: B, C, B, C, A, B, Bb, A, G
\end{align*}
\]

We can see that the first half of the X1 theme in the second movement is a retrograde of the second half of the X1 theme in the first movement. In fact, the second movement
theme (lyric theme – secondary point of sanctuary) was written first and the X1 motif of the first movement is a deconstruction of it.

The X1 motif can also be compared to the tenor or reciting tone of a plainchant, which is often based on the 5th degree of the mode. X1 focuses on the repetition of the note B, the 5th degree in a Phrygian E minor. All of the other motives (X2, Y1, Y2) revolve around the tonic of the mode in E and as such play a supporting role to X1. The motif that is the most direct response to X1 is Y1. Although X1 begins on the 5th degree, it ends on the 4th degree, or A, the subdominant. This subdominant inflection is echoed by Y1 (E, G, E, A, E), but is approached from the tonic below rather than the 5th above.

Y1 is never stated the same way. Each time its rhythm is slightly varied. This is in response to X1, which is the caller and is never stated the same way twice. Consequently, Y1 is reacting to this. Y1 also imitates, to a degree, the manner in which the rhythm of X1 has been modified. The most obvious example is the triplets of X1 in m.39 (vla 1) which are echoed by Y1 in m.40 (vc 1). A more subtle example can be seen by comparing the 2 calls of X1 (vla 1) in mm.23 and 25 with the 2 responses of Y1 (vc1) in mm.24 and 26. In m.25, the 2nd call of X1, attacks 2, 3 and 4 occur sooner than in the first call in m.23. As a result, in m.26, the 2nd response of Y1, attacks 1, 2, 3 and 4 occur sooner than in the first response in m.24.

Motives Y1 and Y2 also have a call and response relationship, but theirs has a different function in the contrapuntal/groove texture. As an extension of Y1, Y2 is a direct imitation of it, with its first 4 notes being a transposition of Y1 a perfect 4th below. These 2 motives act in tandem and overlap, with Y1 beginning in the first half of the measure and Y2 answering it in the second half (as seen in m.38 in vc1 and db 1). By including measures 37 and 39, we can see a chain of call and response relationships from X1, to Y1, to Y2, with the most important notes in bold type:

<table>
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<tr>
<th>m.37</th>
<th>m.38</th>
<th>m.39</th>
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<tbody>
<tr>
<td>X1 (vla 1): B, (BB), (BB), A</td>
<td>B</td>
<td>C, B, C, B, C, A</td>
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<tr>
<td>Y1 (vc 1):</td>
<td>E, G, E, A, E</td>
<td>E</td>
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<tr>
<td>Y2 (db 1): E</td>
<td>E</td>
<td>E</td>
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</table>

| E            | E, B, D, B, E, E | E             |
However, Y2 does not respond to the changes of rhythm that occur in Y1, which is contrary to what we saw in the response of Y1 to X1. This is because Y2 occurs in the bass line and the bass line is responsible for the stability of the groove. This stability is also what allows the other motives to develop more freely during I2 (establishment of the groove). As such, Y2 does not respond to the rhythmic changes that occur in the other motives. Rather, the bass line is the part that effects more significant changes in the subsections of the form: when the bass line changes, the formal subsection changes. For example, A1, the vengeance of the groove, which is an intensification of the groove that had been building up in the introduction shows greater motion in the bass line, with the Y2 motif occurring twice as often, eliminating most of its repeating notes, as well as alternating itself with 2 slightly different versions. As the subsection continues, the change in the bass line gradually accelerates, which culminates in the double bass solo in subsection A2.

Just as Y1 is a direct response to X1, Y2 also has a relationship with X2. X2 and Y2 both emphasize the tonic of the mode and have a cadential function as their areas of greatest activity move toward the tonic at the beginning of each 2-measure period (X2: D, D, D, E and Y2: B, D, B, E). Although X2 is the first to respond to X1 and is a direct imitation of it, it can also be considered as coming before it, as it cadences toward and prepares for the beginning of X1’s call. This can be seen clearly in m.20, where X2 (in vln 2) precedes X1 (in vla 1) right before the beginning of a new phrase in m.21. Prior to this, the last call and response pair of X1 and X2 was in mm.14-15. In mm.31-32, X2 also precedes Y2, as it introduces the double bass line that establishes the stability of the groove. Consequently, although X2 is involved in call and response activity, it exerts a certain amount of independence like Y2 and serves to stabilize the mode and the groove. Its main purpose is to mark the beginning of the period for each recitation of the X1 motif. Eventually, this function is taken over by the Y2 motif as played by the double bass. The location of this transition or transfer of function occurs in m.36, where we can see both X2 and Y2 occurring simultaneously (in vln 3 and db 1). This is the last occurrence of X2 in its basic form.

X2 probably has the most interesting evolution of all the motives in the introduction. It starts out with only two notes in the beginning to show its whole-step
cadence to the tonic. As it proceeds its statement fluctuates between 2-5 notes and its rhythm is shifted to different locations within the measure as sometimes it seems like a response and sometimes like an introduction to the other motives. After its transfer of function with the Y2 motif, X2 becomes absorbed into the texture. Up until this point there have been occasional interruptions to the rhythmic flow by a series of irregularly placed block chords. This happens first in mm.16-18 and then again in mm.27-30. After the establishment of the groove beginning in m.33, these block chords are no longer interruptions, but become part of the rhythmic flow of the contrapuntal/groove texture. This is effected by having these chords occur where X2 would occur, beginning in m.38. After X2’s final solo statement in m.36, it becomes absorbed into the motivic activity of the block chords. These block chords continue to occur where X2 would normally respond to X1, such as in m.46 and m.48. In I3, at m.57 these chords become massive as a way of emphasizing a dominant harmony built on E that will then cadence to the tonic of C with the arrival of the A section in m.68.

The note content of the contrapuntal texture that emerges at m. 68 (subsection A1) is a direct result of taking the isolated occurrences of the block chords that began in m.38, where they took over X2’s response, and condensing all of these segments together in consecutive order. For example, the harmonic structures that occur in mm.38-40 form the basis of the harmonic structures in mm.68-70 and those that occurred in m.46 and m.48 form the basis for mm.71-72. These harmonic structures were all generated through Intervallic Designs applied to Equal Difference Series and were not chosen for their pitch content, but for their harmonic color. Therefore, the modal basis of the counterpoint that existed at the beginning of the work is replaced by a chromatic contrapuntal texture based on frequency regulation. However, the modality of the bass line remains and it is the application of these intervallic structures over a predetermined bass line that determines the note content of the entire texture. Additional textural features such as the snap pizzicato “hits” were created by additional frequency regulations applied to the existing harmonic structures.

The A1 vengeance of the groove contrapuntal texture that emerges at m.68 has 5 parts to it, but unlike the introduction, each part is now a group of voices, rather than a solo part. These 5 parts can further be reduced to two main parts: the rhythm section
(three parts) and the melodic line (two parts). The first part of the rhythm section is the bass line, played pizzicato by the two double basses an octave apart, with cello 2 doubling the upper octave in arco. The second part consists of rhythmic “hits” that punctuate the rhythmic flow in the form of syncopated 4-voiced chords played in snap pizzicato (vln 5, vla 1, vla 2, vc1). The third part is a rising chromatic line in 16\textsuperscript{th} notes at the very top of the register played by violin 1.

The two parts of the melodic line consist of a duo of soloists and a supporting thickened line. Violins 4 and 6 as a duo share the main melodic line, while violins 2 and 3 play a supporting melodic line that runs parallel to it. As a whole, the melody is a thickened line, which is a jazz term meaning a harmonically thickened melody. In classical music this is referred to as melodic planing. The difference here, however, is a heterophonic dimension to this line, or a bifurcation of the melody. Instead of the violins always playing parallel to each other, violins 4 and 6 split off into different directions, freely elaborating the main thickened line to create additional counterpoint.

Much of the counterpoint in the second movement is less freely created and more rationally controlled than in the first. In the first movement there tended to be harmonic structures put over a predetermined bass line that where chosen based on their tonality and harmonic color, with additional voices freely elaborated within the basic structure. In the second movement, there are areas where the contrapuntal texture is created entirely by ordered series of permutations of a given type of intervallic set. Since each harmonic structure is created by an Intervallic Design, it is possible to create a series of related Intervallic Designs, which when played in succession create adjacencies that sound like motives interacting within a contrapuntal texture. This is what I refer to as harmonic animation. These motives are brought out further by giving specific durations to each Intervallic Design and by shaping the musical passage with dynamics, articulations, rhythmic texturing and rests. A good example of this is subsection C1, the bright and spirited coda in compound time (mm.334-339), where each verticality is based on a specific permutation of the first 5 intervals of the harmonic series, whose ordered intervallic set in semitones is \{12, 7, 5, 4, 3\}. The intervals of this set can be represented by the numbers 1-5 and then reordered to create 120 permutations. The group of permutations used in mm.334-335 is shown below in Table 2.
Table 2: Harmonic Series Intervallic Set Permutations for mm.334-335

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67
The order of the numbers at the bottom of each column determines the order of the intervals in each intervallic structure. Since 1 = the octave, 4 = the major 3\textsuperscript{rd}, 2 = the 5\textsuperscript{th}, 5 = the minor third, and 3 = the 4\textsuperscript{th}, the permutation 1, 4, 2, 5, 3, creates the intervallic structure (in semitones) of \{12, 4, 7, 3, 5\}.

The 120 permutations were first grouped according to their respective tonalities and 8 groups of 15 permutations each created 8 different tonalities. To these 120, an additional 40 permutations, which were subsets of the basic 120, were selected to supplement each group as needed. Joined together, these eight 2-measure units, corresponding to 8 basic chord changes, formed the 16-measure passage. After the first group of permutations for mm.334-335 was determined, there needed to be subdivisions of this larger group for the internal organization of this 2-measure unit. These were determined by the placement of the octave, reasoning that this interval would stand out the most. Consequently, those permutations where the octave was in the same position were grouped together. In Figure 2 we can see that the octave (1) in the first group of 4 permutations occurs consistently as the first interval. Accordingly, the octave occurs in the same position for each successive group of 4 permutations. Each group of four was then ordered to create the same pattern of adjacencies, reproducing in different octaves the motives: D D E E, B B B C and E G G G. This created the basic structure upon which the final contrapuntal texture was created.

The 8 basic groups of permutations can further be reduced to 4, because each group has its inversion in another group and these two groups appear in succession in the musical flow. As a result, the contrapuntal texture of mm.336-337 is an inversion of mm.334-335 and this group of permutations can be seen below in Figure 3. However, if all of the permutations were based on C, this would create more than one key, since a major tonality when inverted creates a minor tonality. The objective was to create the smoothest transition possible and let the permutations create the interest. Since all of the permutations produced diatonic harmonic structures, it made sense to group these all together in one key. Accordingly it was necessary to transpose each inversion down a minor third, because the center of symmetry for a major scale is the second degree (the Dorian Mode). Since the first group of permutations is built upward from C and C is modally symmetrically to E, the second group must be built downward from E.
Table 3: Harmonic Series Intervallic Set Permutations for mm.336-337

| E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E |
| E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E |
| C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C |
| A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F |
| E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E |
| D | D | D | D | D | D | D | D | D | D | D | D | D | D | D | D | D | D | D | D | D |
| C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C |
| A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| 1 | 1 | 1 | 1 | 4 | 2 | 2 | 2 | 4 | 2 | 2 | 2 | 4 | 2 | 2 | 2 | 4 | 2 | 2 | 2 |
| 4 | 2 | 2 | 2 | 2 | 4 | 4 | 3 | 2 | 4 | 4 | 3 | 2 | 4 | 4 | 3 | 2 | 4 | 4 | 3 |
| 2 | 4 | 4 | 3 | 1 | 1 | 1 | 1 | 5 | 5 | 3 | 4 | 5 | 5 | 3 | 4 | 5 | 5 | 3 | 4 |
| 5 | 5 | 3 | 4 | 5 | 5 | 3 | 4 | 1 | 1 | 1 | 1 | 3 | 3 | 5 | 5 | 3 | 5 | 5 |
| 3 | 3 | 5 | 5 | 3 | 3 | 5 | 5 | 3 | 3 | 5 | 5 | 1 | 1 | 1 | 1 | 3 | 3 | 5 | 5 |

69
3.3 Orchestration

There are several reasons why I chose to compose this work for a large string ensemble. Firstly, it was a natural progression in my compositional output. I have written many works for solo strings, for strings in mixed ensembles and composed my first string quartet in 2006. It only seemed logical to follow this progression with a work for a larger group of strings. Secondly, a string ensemble of this type has the advantage of providing a homogenous sound that spans a wide range with more or less equal capabilities for different types of sound on each instrument. This is important for the passages in this composition where all instruments are required to play in the same manner, such as in the string glissandi sections. Lastly, because the focus of this piece is on creating a wide spectrum of color primarily through harmony in general and intervallic structures in particular, the homogeneity of the string sound allows the subtle effects of those harmonies to be highlighted.

One might argue that a string ensemble is not the most appropriate group for some of the music in the first movement. For example, the groove could be expressed more directly with a standard rhythm section, or by brass and percussion. However, the challenge of creating the groove using only strings is precisely the type of circumstance that can lead to innovative orchestration. For example, in jazz-fusion or funk, strong punctuating brass attacks are a trademark sound. The type of massive string attacks through huge intervallic structures with sharp dissonances that occur in *vengeance of the groove* are not necessarily a direct attempt to imitate brass, but they are meant to replace the role that the brass would usually fulfill in this type of music.

In terms of percussion, a strong presence of pizzicato attacks is essential for music with a groove. Fortunately, the pizzicato bass is a characteristic sound in funk and jazz-fusion music and is already a normal part of the string ensemble. In order to strengthen this sound, two double basses are used. The Introduction begins entirely in pizzicato in order to anticipate and emphasize the important role that the pizzicato attack will play in the work, especially in the first movement, where the groove emerges and is established by a single double bass in pizzicato at m.33. In the first movement, this prominent bass
line not only holds the rhythmic flow together, but also reinforces the tonality, as it cuts a clear pathway through what is, at times, a very dense harmonic environment.

With the arrival of the A section at m.68, both double basses are doubled at the octave in order to reinforce the bass line in a denser environment, with extra support from cello 2. To add percussive emphasis, a slash through an eighth or quarter rest indicates slapping the strings. To further highlight the pizzicato double bass’s role, it is the only instrument that has a featured solo passage in the first movement (mm. 91-98). Later, at the recapitulation beginning in m.175 the two double basses play the same pitches, but one plays arco and the other plays pizzicato. This gives the sound more body while still retaining the percussive pizzicato attack. It also helps to create a greater separation between the bass line and the other instruments. The removal of octave doubling also anticipates the return of the solo bass line at m.190, the midpoint of the entire work.

In traditional orchestration octave doubling is an important concept. However, in this work it is the exception rather than the rule. The bass line in the first movement is the only significant example of octave doubling and there are two basic reasons for this. One is that the bass line plays a crucial motivic role as the establisher and stabilizer of the groove texture. As this texture gets more dense, the bass line needs reinforcement in order to continue to be prominent within this denser texture. The thickened line mentioned above is an example of how the melodic line is strengthened by being part of a parallel harmonic texture. Because of the bass line’s low register, this kind of thickening would not work and would only obscure rather than strengthen. Therefore octaves are used. This exception is also permissible within my harmonic system because the bass line is at the outer extremity of the intervallic structure and if doubled below that structure, will not interfere with its integrity. The same rule will hold true for notes occurring above that intervallic structure, but usually that registral space is already taken up. As for the many instances in this work of doubling at pitch, these were done for their choral effect or as a composite timbre in order to thicken the tone.

As stated above on page 22, octave doubling is usually not necessary if the octaves occurring naturally (through acoustical proportions) were not destroyed in the first place. This accounts for the many instances in this work where it seems like octave doubling is taking place. The best example of this can be seen by again referring to
Tables 2 and 3 on pages 67 and 69, which form the basis for the counterpoint in mm.334-337. It appears that the motives created by the composite intervallic structure are being doubled at the octave in various ways. It would be more correct to say that the motives appear in various octaves as the result of the composite intervallic structure. Given that permutations of an intervallic set derived from the first 5 intervals of the harmonic series are being employed, there is no other possible outcome, since octaves abound in this intervallic set, both singly (the octave) and collectively ((5^{th} + 4^{th} = octave) and (4^{th} + M3^{rd} + m3^{rd} = octave)). There is a fundamental difference between taking a collection of pitch classes and doubling them at the octave and having a collection of acoustical proportions that naturally create octaves.

There is a wide variety of string techniques employed to create the orchestral texture in the A section (vengeance of the groove). Over the top of the continuously moving bass line, there are many massed syncopated accents performed in pizzicato, snap pizzicato, marcato, staccato, staccatissimo, staccatissimo battuto, staccatissimo battuto col mezzo legno and other types of accented attacks. Particularly noteworthy is the contrast between the staccatissimo battuto and tenuto accents, which are expressed in alternating groups of three short orchestral blasts, forming the accompaniment to the double bass solo in mm.91-98.

Another dimension to the use of the pizzicato sound involves the dichotomy between wet sound, which is characterized by prolonged resonance, and dry sound, which is shorter and more percussive. As a generalization, these two polarities can be represented respectively by arco and pizzicato. However, there is a range of gradations of both resonant (wet) sounds and non-resonant (dry) articulations. For example, staccatissimo battuto is very dry arco playing and pizzicato tremolo adds some wetness to the ordinarily dry pizzicato sound. In the Introduction, the objective was to start out as dry as possible in order to make the entrance of the arco sound as dramatic as possible. Consequently, the beginning is sparse, dry and barren, with no simultaneous attacks and very little resonance. Although the texture and registral span steadily builds, the texture remains entirely pizzicato until m. 56, where a deluge of arco group glissandi suddenly breaks the barrier. While the pizzicato tremolo could be considered an extended technique for most classical players, it is a well-known feature of classical guitar and
familiar to many jazz bassists. It is only used for a limited time since it is fatiguing for the players. Another means of adding more intensity and fullness (wetness) to the dry sound of pizzicato is the specification of vibrato, especially for the pizzicato block chords in the Introduction. In the second movement, pizzicato is used mainly as a different timbre to combine with other timbres, rather than for its specifically percussive attribute. This can be heard immediately at the beginning in B1, *secondary point of sanctuary*, where single instruments each contribute a different timbre, softly combining pizzicato, pizzicato in harmonics, arco, arco in harmonics and arco tremolo (mm.215-221).

Although pizzicato tremolo disappears after m.48, the use of arco tremolo replaces it and continues to be an important feature for the remainder of the work. In the A section, it is sometimes used along with vibrato to increase intensity. A good example of this is in mm.79-81. In conjunction with a crescendo, the sustained chord of m.79 has vibrato added to it in m.80, which then turns into a notated tremolo in m.81. This culminates in the massive fortississimo accented attacks in m.82.

In the second movement, tremolo is used more texturally and coloristically. A good example of this is in the 6-measure phrase from m.226 to m.231 at the end of B1, *secondary point of sanctuary*. Here, the music is quiet, serene and consonant and the bowed measured tremolo in 16th notes serves to add a shimmering quality to the sonorities, like the flickering reflections of light on the surface of a body of water. Another subtle feature is the use of tremolo at varying speeds and switching between bowed and fingered tremolo. Beginning in m.245 (B2/I2), we have bowed triplet tremolos, which are followed in the next section (B3/I2) by trilled chords of various speeds (starting with triplets and alternately speeding up and slowing back down in mm.248-252). A combination of bowed and fingered tremolo with variable speed exists in B4 (*sturm und drang lyric theme variation 3*) where each group of the 2 alternating pitches is done in one bow with a stress accent (tenuto) on the first pitch (mm.248-252). An additional subtlety involves the use of tremolo in combination with either a normal sustained note or other types of bowing, which occurs in various places. Finally, there is the use of bowed unmeasured tremolo (roughly equivalent to 32nd notes), which usually occurs with darker, more complex sonorities, as in *lyric theme in shadow* (mm.319-333). Here the tremolo serves to accentuate the darkness of the sonorities by adding a haze of
noise over the surface of the sound. This is subtly different from the shimmering quality imparted by the measured tremolo in 16\textsuperscript{th} notes at the end of B1 in mm. 226-231.

Glissandi are an important element of the work and occur regularly throughout. In some instances they are used to capture the microtonality that exists between the equal tempered pitches. This is explicit in the group glissandi, which effectively slide through an infinite number of different chords based on proportional series. Sometimes glissandi slide through single semitones in order to sound the quartetones or other fractional tones which should be there according to the frequency numbers that determine each pitch. At other times, glissandi are used to shape melodic and rhythmic gestures in a manner that recreates the declamation of the human voice -- this can be heard emphatically throughout the A section.

The use of saltando in a rhythmic texture imparts a light and lively quality to a passage of music and this is employed especially near the end of the work. It is first noticeable in B5 (birds in flight lyric variation 4), as 3 violins accompany a solo violin trilling flautando above (like a bird). The levity created by this technique is even stronger in the C1 Coda passage where a more rhythmically elaborate saltando texture in compound time is presented.

Harmonics also play an important role in this work. Sometimes they are used to produce the very high notes required by the harmonic structures. In other places, they are used as a means of contrasting the many complex sounds of the piece with a clearer, more transparent sound. This is noticeable in the first movement when a massive chord in harmonics suddenly appears in m.136, just before a return to a very dissonant sound, which begins the recapitulation of A1 at m.140. In the second movement, a similar spot occurs at the point of greatest stasis, the Golden Section of the entire work, where harmonics are used in conjunction with open strings and the specification of non vibrato.

There is often a deliberate shift between vibrato and non vibrato in the work. In the primary point of sanctuary (mm.303-318) this juxtaposition of vibrato and non vibrato is employed in conjunction with a variety of timbres: flautando, sustained open strings, arpeggiated pizzicato chords in open strings, arpeggiated sul ponticello in open strings and a solo pizzicato line. The intermittent, but deliberate appearance of vibrato within this serene, austere sound environment creates a significant effect.
3.4 Rhythmic Procedures

In this work there is a special distinction between beat and pulse. Beat is defined as a type of pulse in which there is a strong identification with the individual beats of a particular meter, evoking a strong visceral response. Pulse refers to a unit of time that is repeated and creates an awareness of tempo, but not a strong visceral response or identification with individual beats.

Music that has a strong groove also has a strong feeling of beat. There is usually a lot of stress put on the beat in general and on specific beats in particular. Firstly, this stress comes in the form of accents on attacks. Music with a groove is typically a highly accented music and the first movement, *Vengeance Is Mine, Sayeth the Groove*, fits this description. Secondly, this stress comes through different densities of attacks which occur on different beats. This not only relates to the comparative numbers of voices for each attack, which is a vertical consideration, but also how attacks cluster around a certain beat, which is a horizontal consideration. Another important consideration is how rests contrast these greater densities. Thirdly, the relative register of individual attacks has an effect on how different beats are stressed. For example, lower notes tend to fall on strong beats and higher notes on weak beats. A corollary of this deals with the total registral activation of individual attacks, which helps to determine (along with accents) how much power an attack has. Fourthly, the consistent use of syncopation within the meter in conjunction with a return to a normally stressed beat reinforces both the meter and the beat. Syncopation is not only an anticipation of an attack, but also a displacement of the expected location of an attack, or of an entire motive.

These characteristics can be easily seen in the first 4 measures of A3 (*vengeance of the groove variation*, mm.99-102). In m.99, 5 out of 8 of the attacks of the composite rhythm have accents. The presence of rests, which separates these clusters of attacks, brings into relief the beats around which these attacks cluster. The biggest stress is on the second beat for two reasons: (1) it has the greatest density, not only because it is a 10-note chord, but also because of the grace note preceding it, which is a clustering around it, compounding its density; (2) it has the greatest registral activation, not only because of its registral span, but because it is played arco, having more resonance than the other
attacks played pizzicato. This stress on the second beat is a syncopation at the beat level, but all of the other accents are at the subdivision level (off-the-beat), making the stressed second beat the most stable part of the measure. The downbeat is anticipated by the double basses in pizzicato: a syncopation. We can see that this strongest beat is emphasized by being in the lowest register and also as having the greatest amount of horizontal clustering of attacks in its vicinity, which increases its density. The fact that it is displaced (off-the-beat) not only draws attention to it, but also to the accent on the second beat, since the initial off-the-beat stress now occurs on the beat. The large pizzicato chord that follows in the second half of the third beat is like an echo of the arco chord of the second beat. This switches the stress again off-the-beat, which continues the push and pull between on-the-beat and off-the-beat accents. The displacement of normal stress and return to normal stress strengthen both the sense of syncopation and the meter.

Although this pattern continues, we can also see that it is varied. In m.100, the echoing pizzicato chord occurs on the 4th beat, which is effectively a displacement of the previous displacement. It returns to its “normal” syncopated position in the following measure. Although the large arco chord of the second beat remains in the same position in successive measures, it is given an increase in density by clustering more attacks around it in m.101. This is also an echo of the double bass’s rhythm. The third, penultimate measure of this 4-measure phrase has the greatest density, with the double basses also having more activity. The 4th and last measure is different again, introducing quarter note triplets, but also a greater degree of rhythmic regularity, which anticipates the primarily on-the-beat accents in the next phrase.

Whereas the first movement has a profusion of accents, the second movement has relatively few (aside from those subsections in which there is an interpenetration of the first movement). Precipitous Sanctuary deals more with contrasting a variety of tempos through different pulses. In this context, pulse is the unitary duration which is repeated to mark the time. The stated tempo stays the same for the entire work at 112 quarter notes per minute. In the first movement, one feels this quarter note very strongly and the beat is synonymous with the stated tempo. By contrast, in the second movement this stated tempo is only used as a frame of reference from which a variety of pulses and meters emerge. This variety of contrasting pulses coincides with the coloristic nature of the
second movement and is directly related to the use of a variety of tremolos. Both of these elements work together to create contrasting textures and tempos. Different subdivisions are employed to create tremolos and repeated notes of different durations to create a variety of pulses.

A good example of this contrast in pulse can be seen between B1 and BØ, the first and second subsections in the second movement. The pulse of B1 in 2/2 is twice as slow as that of the first movement, at 56 per minute. Here the emphasis on the beat of the first movement has vanished, but we can feel the slower rate of tempo subtly pulsating. When BØ begins at m.232, a completely new tempo of pulsation occurs at 74.67 per minute in the form of a dotted quarter note. This is at the Golden Section - point of greatest stasis in the work. It is easy to hear this stark contrast of pulse because there is little else to hear. There are no rhythmic shapes, beat patterns, accents or articulations, only a repeating note against a harmonic background that hypnotizes us into believing that the tempo has changed. At the end of this section, a further distortion of the pulse emerges between measures 238-240 as a repeated 16th note is quickly and progressively augmented until the attack occurs 10 times as slowly. In just three measures, the pulse goes from 448 per minute to 44.8 per minute. Simultaneous with this, the bass line of the first movement re-emerges to resurrect a sense of beat and groove (lyric theme variation 1 – with groove), but this cannot be felt until m.241, where B2/I2 begins.

After the resurgence of the groove in B2/I2 the sense of pulsation moves out of the beat level and into the measure level in subsection B3/I2 (lyric theme variation 2 – in pastels and variable tempi, mm.248-261). As the various speeds of the trilled chords increase and decrease, the lengths of the measures also expand and contract, creating a series of different meters: 3/4, 4/4, 3/4, 2/4, 3/4. The pulsating beat continues from the previous section, but now can only be felt at the beginning of each measure. Consequently, from the previous rate of 112 beats per minute, we go through the variable rates of 37.33, 28, 37.33, 56 and 37.33. This last rate continues as the trilling chords slow down over 3 measures, ending in one duration per measure, which then converts into one unmeasured tremolo chord per measure for the next 7 measures. The rate of 112 beats per minute re-emerges with B2/I2 (lyric theme variation 1 – with groove resumed) at m.262 for 6 measures in 4/4, after which the pulsation again moves back to the measure level,
but this time at the rate of 56 per minute for 7 measures in 2/4. This is a continued contraction of the previous group of 7 measures in 3/4. This subsection ends by resuming 4/4 for 2 measures, but with a contrasting and beat-obscuring subdivision in quarter note triplets.

The 34 measures that encompass the subsections of B2/I2, B3/I2 and B2/I2 again, (mm.241-274) can be grouped together to form a larger section of music. By looking at all of the metrical groupings in this larger span, we can observe a level of pulsation above that of the measure level to that of the phrase level. Here we see the reoccurrence of the number 7, as the number of measure level pulsations generally occurring in each phrase. 34 is 1 less than 35, which is $7 \times 5$. In order to create more interest through asymmetry, 34 is used and divided into 4 groups of 7 plus one group of 6. 3 of these groups of 7 are concurrent and the last one is broken up by an interpolation of 6, which is bisected into 2 groups of 4 and 2 respectively. The resultant pulsation pattern on the phrase level is $(7)$, $(7, 7)$, $(4, 7, 2)$. As well, these 3 subsections divide into 1, 2 and 3 phrases respectively. The proportion between subsections in real time is 2 to 3 to 2.7.

Figure 4: Phrase Level Pulsation in mm.241-274

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The interaction of different numbers on different levels of rhythm and pulse creates rhythmic interest. However, to do this effectively, there must be a balance between regularity and irregularity, stability and instability, symmetry and asymmetry, predictability and interruption, periodicity and a-periodicity, and simplicity and complexity. These aspects are all relative. For example, in music in general, it is hard to classify any rhythmic or durational formation as being entirely a-periodic, since music usually depends on the repetition of standardized units. At the very least, there is a gathering together of sound events that occur within a perceivable timeframe, which
would give them an average dimension of occurrence. It is more accurate and useful to qualify periodicity with adjectives, such as irregular periodicity, symmetrical periodicity, asymmetrical periodicity, sloped periodicity and permutated periodicity.

Simplicity and complexity in rhythm are easier to define. With respect to meter, these definitions already exist in the form of simple and compound time, where there is a basic dichotomy between 2 and 3. This indicates a fundamental hierarchy of numbers in terms of their simplicity and complexity, the simpler being subdivisions and multiples of 2 and the more complex being subdivisions and multiples of 3. This extends to higher numbers, which will be different combinations of 2 and 3 on different levels, such as 5 being 2+3, 6 as 2×3, 7 as 2+2+3 and 9 as 3×3. As different levels are built up, from the subdivision level, to the metric level, the phrase level, phrase group level, subsection level and beyond, a complex of numbers will interact to determine the relative simplicity and complexity of the rhythm in a given passage of music.

Of these numbers, 2, 3 and 5 are the most important in terms of how they are used in combination to create a basic range from the simple to the complex. Indeed, often there is a noticeable progression on the formal level, where the predominance of 2 gradually gives way 3 and then to 5. In this work, this can be seen on a metric level. In the first movement, there is a predominance of 4/4. In the second movement, there is an increasing presence of both 3/4 and 3/2. The combination of duple and triple leads to the introduction of 5/4, which ultimately leads to a combination of 5 and 3, when the meter progresses to 15/8 in the Coda.

This can also be seen within the first movement in terms of the interruption and breakdown of the groove. The predominant 4/4 meter is first given short breaks of 3/4 as a means of contrast. As the groove is broken down, there is an increased presence of 3/4, which then gives way to 5/8, as the groove is fragmented and then interrupted by the return of II. The idea of having a fundamental progression between the numbers of 2, 3 and 5 was inspired by Varèse, who uses this in his work *Ionisation* (1931), which I have analyzed. This piece begins with a marked rhythmic regularity and metric stability, moving gradually toward greater rhythmic irregularity and instability.

As was shown above, other numbers come into play, such as groups of 7, to create further variety. As well, number series can be used to create interesting rhythmic
structures. After the contrast created by a variety of metric and phrase level pulsations in the second movement, the arrival of B0 (primary point of sanctuary) presents an ambiguity of meter and pulse. On the one hand, we can feel that the pulsation of the tempo in 3/2 is the same as it was in B1, which was in 2/2, at 56 per minute. But the periodicity of the pulse is irregular. There are 3 phrases presented in B0, whose time lengths are at a ratio of 10: 9: 8. This utilizes a segment drawn from (EDS)10 – 1. However, there are series within this series, as each phrase has its own series of durations, which are respectively: \{16, 8, 10, 6\}, \{12, 10, 8, 6\} and \{11, 9, 7, 5\}. These series express in 8th notes how much time elapses between the entrances of the 4 different musical elements that make up each phrase. The first series is irregular and is a permutation of the second series, with the first number being augmented from 12 to 16. The second series is (EDS)12 – 2 and the third is (EDS)11 – 2. The second and third phrases are periodic, but asymmetric, presenting a sloped periodicity as do the phrases seen as a whole with ratios of 10: 9: 8. The effect is a balance between regularity and irregularity with respect to the feeling of pulse and this gives the music a feeling of stability with unpredictability.

In the Introduction, number series are also used, but in a different way. The object is to start out with a sense of no meter and have the music gradually coalesce into the stable 4/4 meter, which is the primary meter for the first movement. Here we see the dichotomy of synchronization versus displacement and un-synchronization. This is because one part of the music is un-synchronized and displaced according to the meter, while another part is synchronized. For this a Sloped Difference Series (SDS) is used to create an accelerated progressive diminution of durational values.

The opening pizzicato motif played by viola 1 does not correspond to the stated meter in 4/4. Since it recurs several times, it is in a sense periodic, but it does so at ever-diminishing time intervals determined by an SDS, which makes the periodicity asymmetrical and sloped on an accelerated curve. The slope of the differences is linear because the first difference is 5 and each successive difference is decreased by 1, resulting in differences of 5, 4, 3, 2, 1, 0. The opening period for the viola 1 statement equals 29 8th notes. The complete series in 8th notes for the first 6 statements is: 29, 24, 20, 17, 15 and 14. This series itself splits in half to create 2 related series: 13, 11, 9, 8, 7,
7 for the active part of the viola statement (the attacks) and 16, 13, 11, 9, 8, 7 for the passive part (the rests). Together, these create the compound series: 13+16, 11+13, 9+11, 8+9, 7+8 and 7+7. The object is to have the irregular number of 29 gradually resolve into the regular number of 16, which equals a period of 2 measures in 4/4. We can see that the number 16 is actually overshot, but that does not mean that synchronization with the 4/4 meter has not occurred. The first 3 numbers, 29, 24 and 20 = 73. The very first pizzicato attack is displaced one 8th note before the downbeat, which immediately disrupts a sense of metrical regularity. However, because of this, one 8th note can be subtracted from 73 to equal 72. Since 72 ÷ 8 = 9, after 9 measures, the next motivic statement with a period of 17 8th notes will land on the downbeat. Since the next statement of 15 8th notes, when averaged with 17, equals 16, the following statement of 14 8th notes will also land on a downbeat. As a result, the meter begins to coalesce at m.10.

Before this, however, there is a subliminal metrical regularity expressed in the other parts. Viola 1 makes 3 statements in 9 measures, which is an average of one statement every three measures. This average is expressed as cello 1 hits the downbeat at m.1, violin 2 hits the downbeat at m.4 and cello 1 again hits the downbeat at m.7. Still, this gives only a slight sense of periodicity with a small hint of meter when it is combined with the viola statements and the fact that 3 x 3 is an irregular grouping according to the duple nature of 4/4, not coinciding with its factors or multiples. It is in m.10 that a 2-measure period is established by the coordination between violin 2 and viola 1. However, this too, occurs 3 times, for a total of 6 measures, thereby retaining some asymmetry of the number 3 in relation to the number 4. So far, 15 measures have elapsed, which also introduces a factor of 5, reinforcing the metrical instability and irregularity on another level. But 5 itself is reinforced, as the next group of measures is a group of 5. However, this group of 5 measures (mm.16-20) is a complete disruption and interruption of the trend toward establishing a period of 16 8th notes, or 2 measures in 4/4. It also completely destroys any sense of 4/4, since it consists of group of accented block chords that not only do not fall on any downbeats, but occur in a completely irregular and unpredictable set of numbers: 3, 6, 5, 8, 6, 6, 8. These in turn can be grouped into 2 groups of 22 and 20 8th notes respectively. This distorts and negates the basic dimension of the 4/4 measure,
which has a period of 8 eighth notes. After this interruption, the meter in 4/4, with a period of 2 measures, is firmly established in m.21 and all parts are synchronized.

3.5 Harmonic Theory Applications

Tonal shading is an important aspect of my harmonic theory that affects both the function and the color of a sonority or group of sonorities. As a whole the Introduction has a tonal center of E, which then cadences to C at the A section (m.68). This macro-harmonic relationship makes E the dominant of C and this perfect-related harmonic motion can be represented by the harmonic 5 returning to fundamental basses at harmonics 4, 2, or 1. There is an internal cadence in the Introduction that hints at C being the tonic in measure 18, but this cadence is tonally shaded by functional dispersion, as illustrated by the two chords below (FN = frequency number).

Figure 5: Perfect-related Cadence on the 3rd Beat of m.18

<table>
<thead>
<tr>
<th>Dominant Chord 1</th>
<th>Tonic Chord 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note   FN</td>
<td>Note   FN</td>
</tr>
<tr>
<td>A#4 = 28</td>
<td>B4 = 30</td>
</tr>
<tr>
<td>E4    = 20</td>
<td>E4    = 20</td>
</tr>
<tr>
<td>C4    = 16</td>
<td>C4    = 16</td>
</tr>
<tr>
<td>G3    = 12</td>
<td>C3    = 8</td>
</tr>
<tr>
<td>E2    =  5</td>
<td>C1    =  2</td>
</tr>
</tbody>
</table>

At face value, this looks very simple: a C7 chord moves to a C major7 chord. However, what both looks and sounds simple actually has a degree of complexity to it. According to traditional tonal theory, C7 would not be considered a dominant of C major7, but this shows the limitations of purely thinking in terms of pitch class. In this case the first chord is not really a C7, but a collection of harmonics above a lower fundamental bass, which is the note C1. In the context of a tonal center of E in the
Introduction, the main thing happening is the bass note of E2 descending to C1, representing a perfect-related harmonic movement between harmonics (frequency numbers) 5 and 2. However, G3 descending to C3 is also a dominant to tonic relationship at a ratio of 3:2 (FN12 to FN8). Likewise, A#4 (FN28) is a dominant of either C4, C3, or C1, and although it voice leads to B4 (FN30), the latter has a simpler relation to the tonality of C, being at a 3:2 ratio to the E4 over C1. If a strong cadence between E2 and C1 were desired, then the tonal identity of E would have to be reinforced by its own harmonic series (as in e, g#, b, d). In this case, with the exception of E4, all of the other notes above E2 interfere with its harmonic series and also weaken its role as the sole dominant by acting as dominants themselves. This creates functional dispersion.

Conversely, in Figure 6, the three chords in m.92 that accompany the double bass solo both look and sound very complex and yet the harmonic movement is very simple. This is an example of tonal shading based not so much on function, but on the complexity of the sonorities, which in turn have an effect on human perception. Some listeners may even think that these chords are purely coloristic and without function due to their high degree of dissonance and internal complexity, but it all depends upon what part of the chord one focuses on the most. There are basically 3 levels of harmony to perceive in these three sonorities. Because these chords each represent a single series in its normal acoustical position, there is a clear separation between the bass and the rest of the chord, making the bass motion simple and clear. In the context of a modal G-minor, the first bass is in the dominant (F), the second the subdominant (C), and the third in the tonic (G). Above this in the mid-range, specific chord qualities are added: first a mixture of f minor and F augmented, second a mixture of c°7 and C7, and third a unified g minor 9. At the upper level each sonority is similar, due to the tendency of the natural intervallic slope to level out, as a Bb major7 11 is added for extra dissonances and/or color. This is actually an advantage, since the same upper structure causes different intervallic combinations and dissonances with the different lower structures.
Figure 6: Tonal Shading in m.92

However, this is all analysis after the fact: in a sense nothing is added. These sonorities already exist in their complete form within the EDS group n+11. It is a matter of selecting those series which will provide the appropriate harmonic content. This illustrates that a given EDS group not only provides a wide variety of harmonic content,
but that it is also conducive to tonal shading, because of the tendency for a given series to have a mixture of tonalities.

The chords in m.92 show the versatility of the EDS group in other ways. For example, no transposition was necessary to obtain all three harmonic functions. Just by sliding along the scale of values within the \((EDS)^{n+11}\) group and keeping the same fundamental, all the necessary harmonic content was produced. The fundamental is actually F, which is the tonal center of the previous musical passage. Frequency number 8 (F) moving to 9 (G) is a perfect-related movement. With 6 (C) in between, this altogether creates a plagal-related cycle. Using a sliding scale of values, the same difference of 11 is maintained between all the frequency numbers of each series. \((EDS)^{8+11}\) slides −2 to create \((EDS)^{6+11}\), which slides back up +3 to create \((EDS)^{9+11}\). This simple technique would not yield enough variety by sliding within the harmonic series alone. By creating the EDS group through an expansion of the implications and tendencies of the harmonic series, one is able to transcend its limitations. The harmonic series, as \((EDS)^{1+1}\), contains only 1 series in its group and one set of intervals and intervallic combinations. By contrast, \((EDS)^{n+11}\) contains 11 series, all of which contain different, yet related sets of complementary intervals.

In a lot of music based on acoustics and the harmonic series in particular, there tends to be a certain kind of sameness to the sound. This is an aspect that makes *Exploring the Waterfall* unique: it doesn’t have that stereotypical quality of sound, but rather a wide spectrum to its harmonic coloration. However, there still exists the problem of what to do once the intervals in any EDS get smaller and start repeating. In this respect, every EDS will resemble the harmonic series once its natural intervallic slope starts to level out (usually after the appearance of a minor third). The Intervallic Design concept was created to overcome this problem. With this, one can fold the series in on itself at any point, which essentially amounts to the intersection of series segments through a common interval. An example of one fold at the 5th interval would be \((ID)\) 123454321. This concept has variations, one of which is employed in the creation of the three chords in m.92. Here we have an SDS which is based on the EDS in operation and both are intersected at a common interval. Looking at the third chord in m.92, which is based on \((EDS)^{9+11}\), we can see that technically this series continues, but after the
interval of intersection (64:53), it skips an additional step in the series with each additional interval. In the upper half of this sonority, the differences are 11×1, 11×2, 11×3, 11×4 and 11×5 respectively. Beginning on frequency number 53 this is the Sloped Difference Series, (SDS) 53+[(EDS)11+11]. The complete ID for this sonority is (EDS) 9+11: (ID)12345 ∩ (SDS) 53+[(EDS)11+11]: (ID)12345.

Having established the rationale for the EDS group in CHAPTER 2, it only remains to illustrate its application. Figure 7 is an analyzed page of score showing how the EDS group is typically used in the A section. As in the previous example in Figure 6, large sections of different series are used. This results in complex and dissonant chords, which nonetheless have a relatively clear tonality. The EDS group n+11 is also used in this passage, but in a freer and more complex way. Here we see the use of several series in the n+11 group: (EDS)3+11, 4+11, 5+11, 6+11, 7+11 and 12+11 [with the addition of (EDS)2+3]. All frequency numbers that are part of these EDS are in bold type. The Intervallic Designs here are very simple, having either one fold or no folds. Harmonic variety is achieved by selecting several different series, which, in this case, are related by the EDS group n+11. The inversion line in Figure 7 (mm. 82-83) shows a series that is folded back on itself. For example, the first chord in m.82 is formed by (EDS)5+11, yielding the series of 5:16:27:38:60:71. This creates six intervals, which stated in order, have the simple Intervallic Design: (ID)123456. After the last ratio of 71:60 (the minor 3rd of G to Bb) the ratios reverse order, the three remaining intervals being formed by 60:49, 49:38 and 38:27, which are the 5th, 4th, and 3rd ratios of the series respectively. This ratio reversal only happens once, creating the following Intervallic Design of one fold: (EDS)5+11 (ID)123456543. The inversion line applies as well to the next two chords, also having one fold: (EDS)2+3 (ID)123454321 and (EDS)5+11 (ID)1234565432. It will be noticed that the first and third chords in this passage both use the same series of (EDS)5+11. However, unlike the previous example in m. 92, these two chords have different fundamentals, as determined by the number 16 (a power of 2). In the first chord, 16 is Ab3 and in the third chord it is B2. The second chord, which uses (EDS)2+3, also has a different fundamental, determined by 2 and 8, which are both at Eb. All of the remaining chords of this passage, beginning with (EDS)6+11, have the same fundamental -- F, which also happens to be the tonic of this section.
This is significant only because the exact same musical passage occurs again in an acoustically expanded form in Figure 8 (mm. 175-177). Acoustical expansion (or
contraction) via a sliding scale of values is an important compositional technique that is employed extensively throughout the first movement. Its effect is similar to that of the common techniques of inversion, retrograde and retrograde-inversion since it preserves the original structure of a musical passage. This technique is very easy to use if the musical passage being transformed is based on one fundamental. It should be noted that this fundamental doesn’t necessarily indicate the tonality. This technique can also be applied to any kind of music, regardless of the pitch content. In this case, having one fundamental only means that there is a consistent standard of pitch when it comes to assigning each note a frequency number. If this is not the case, then the transformation will be inconsistent. Since measures 82-84 have frequency numbers based on the different fundamentals of Ab, B, Eb and F, it is necessary to reconcile them all by multiplying each EDS (or frequency number) by the appropriate factor. This creates a new set of EDS that all have the same fundamental or standard of pitch. For example, we can see in Figure 7 that the two chords which both used (EDS)5+11 are now represented by two different series. The first, multiplied by 6, becomes (EDS)30+66 and the second, multiplied by 3.6, becomes (EDS) 18+39.6. Next, every frequency number of every note is multiplied by the appropriate factor, making all of the frequency numbers in this musical passage part of the same system.

Once this is done, the acoustical expansion can proceed with ease. First, the basis for the expansion is chosen, then the degree to which it will be expanded. In this case, the basis is the bass line and in particular the interval formed by the frequency numbers 40 and 30 (the ratio of a 4\text{th}). This 4\text{th} is expanded to an octave in the new passage. This is accomplished by subtracting 20 from both 40 and 30, resulting in the numbers 20 and 10, whose ratio of 2:1 equals an octave. To complete the process, every frequency number in mm. 82-84 is subtracted by 20 and this new series of numbers creates all of the pitches in the corresponding musical passage in Figure 8 (mm. 175-177). The entire recapitulation of the A section is an acoustically expanded version of the original, with the frequency value of each pitch subtracted by 20. This expands all of the intervals according to the natural intervallar slope and creates new tonalities in the process. This also results in additional tonal shading. Whereas the original passage was clearly in the tonality of F, the new passage is polytonal and has a more complex and ambiguous tonal structure. We can
also see that all of the EDS that existed in Figure 7 are transferred to Figure 8, but they now start with a number that is 20 less than the original. In the cases where this produced a negative number (which has no frequency) it was necessary to skip to the next number in the series. All EDS numbers are in bold print.
There are many different ways to use a sliding scale of values. Another approach is presented in Figure 9, where an EDS is gradually transformed into an SDS.
Figure 9: The Transition from (EDS)3+5 to (SDS)3+[(EDS)5+2]

<table>
<thead>
<tr>
<th>(EDS)3+5</th>
<th>(SDS)3+[(EDS)5+2]</th>
</tr>
</thead>
<tbody>
<tr>
<td>x 6</td>
<td>x 6</td>
</tr>
<tr>
<td>(EDS)18+30</td>
<td>(SDS)18+[(EDS)30+12]</td>
</tr>
<tr>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>63x6 = 378 444 510 576 642 708 774 840 906</td>
<td>972 1039 1104 1170</td>
</tr>
<tr>
<td>58x6 = 348 403 458 513 568 623 678 733 788</td>
<td>843 898 953 1008</td>
</tr>
<tr>
<td>-30 -40 -50 -60 -70 -80 -90 -100 -110</td>
<td>-120 -130 -140 -150</td>
</tr>
<tr>
<td>53x6 = 318 363 408 453 498 543 588 633 678</td>
<td>723 768 813 858</td>
</tr>
<tr>
<td>48x6 = 288 324 360 396 432 468 504 540 576</td>
<td>612 648 684 720</td>
</tr>
<tr>
<td>43x6 = 258 286 314 342 370 398 426 454 482</td>
<td>510 538 566 594</td>
</tr>
<tr>
<td>38x6 = 228 249 270 291 312 333 354 375 396</td>
<td>417 438 459 480</td>
</tr>
<tr>
<td>-30 -36 -42 -48 -54 -60 -66 -72 -78</td>
<td>-84 -90 -96 -102</td>
</tr>
<tr>
<td>33x6 = 198 213 228 243 258 273 288 303 318</td>
<td>333 348 363 378</td>
</tr>
<tr>
<td>28x6 = 168 178 188 198 208 218 228 238 248</td>
<td>258 268 278 288</td>
</tr>
<tr>
<td>23x6 = 138 144 150 156 162 168 174 180 186</td>
<td>192 198 204 210</td>
</tr>
<tr>
<td>18x6 = 108 111 114 117 120 123 126 129 132</td>
<td>135 138 141 144</td>
</tr>
<tr>
<td>13x6 = 78 79 80 81 82 83 84 85 86</td>
<td>87 88 89 90</td>
</tr>
<tr>
<td>8x6 = 48 48 48 48 48 48 48 48 48</td>
<td>48 48 48 48</td>
</tr>
<tr>
<td>-30 -30 -30 -30 -30 -30 -30 -30 -30</td>
<td>-30 -30 -30 -30</td>
</tr>
<tr>
<td>3x6 = 18 18 18 18 18 18 18 18 18</td>
<td>18 18 18 18</td>
</tr>
</tbody>
</table>

In order to obtain the desired number of transitional harmonies between the two series, both are multiplied by 6. As a result (EDS)3+5 becomes (EDS)18+30 and (SDS)3+[(EDS)5+2] becomes (SDS)18+[(EDS)30+12]. This allows us to have 12 transitional series that illustrate how an EDS with no slope to its differences can gradually increase its slope until the desired SDS is reached. Looking down the first column in Figure 9, we can see that all of the frequency numbers (in bold type) of (EDS) 18+30 have a difference of 30 between them. Starting at the bottom of the second column, the first difference remains at 30, but each successive difference is increased by
1, resulting in a slight gradient between them (30, 31, 32, 33, etc.). In the third column, each successive difference is increased by 2, in the fourth by 3 and the fifth by 4 until we reach the final Sloped Difference Series, where each successive difference is increased by 12. This illustrates how a linear pathway of transitional frequencies can be created between 2 different types of series, resulting in an array of subtly changing sonorities. The actual notes of these sonorities can be seen in Figure 10 (mm.367-369). We also notice here that the rate of change in pitch is different for each instrumental part. This results in a rich array of micro-harmonies and a series of specific textures due to the superimposition of different tempos. This page of the score presents the entirety of these harmonies as they appear in Figure 9, but they can also be extracted in order to compose different textures, as in measures 365 and 366 of the previous score page. In the context of the entire composition, this particular use of a sliding scale of values was chosen in order to enrich a dominant prolongation (which is something that also happened in the first movement before the recapitulation of the A section). The primary sonority for this dominant is created by (SDS)3+[(EDS)5+2]. By transitioning to a secondary sonority in the form of (EDS)3+5, a myriad of shimmering harmonic colors composed of micro-harmonic variations are created.
The other dominant prolongation applies a sliding scale of values to a single chord. I call this chord a Lightning Chord because it usually has a marked degree of consonance along with some very sharp dissonances; it is, at the same time, both
timbrally bright and harmonically dissonant. This special type of chord has many forms and is created by using the differences of the ERS, or Equal Ratio Series and sliding those values to create a myriad of related Lightning Chords. The dominant prolongation beginning in m. 122 uses Lightning Chords based on the ERS of the octave, whose series is 1:2:4:8:16:32:64:128. However, a 0 is added to the series to create this special chord. In the dominant of G we get the following series and its corresponding pitches.

Figure 11: The Creation of a Lightning Chord

<table>
<thead>
<tr>
<th>Octave ERS</th>
<th>Lightning Chord (downbeat of m.122)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FN note</td>
<td>interval</td>
</tr>
<tr>
<td>128 = G7</td>
<td>12</td>
</tr>
<tr>
<td>64 = G6</td>
<td>12</td>
</tr>
<tr>
<td>32 = G5</td>
<td>12</td>
</tr>
<tr>
<td>16 = G4</td>
<td>12</td>
</tr>
<tr>
<td>8 = G3</td>
<td>12</td>
</tr>
<tr>
<td>4 = G2</td>
<td>12</td>
</tr>
<tr>
<td>2 = G1</td>
<td>12</td>
</tr>
<tr>
<td>1 = G0</td>
<td></td>
</tr>
<tr>
<td>0 = ∅</td>
<td></td>
</tr>
</tbody>
</table>

Zero never represents any pitch in acoustics because it has no frequency. However, mathematically it creates a special formation of multiple arithmetic means, which in this case all relate to zero. By choosing any number in the series and averaging it with zero, we obtain all the other numbers. For example, \((0+128)÷2=64\), \((0+32)÷2=16\), \((0+8)÷2=4\) and \((0+2)÷2=1\). It is only when we slide up the scale of values that we can notice the significance of this. By sliding +1 we obtain the new series of 1:2:3:5:9:17:33:65:129. Now we have a fundamental with multiple arithmetic means which all relate to that fundamental. For example, 1:2:3, 1:3:5, 1:5:9, 1:9:17, 1:17:33, 1:33:65 and 1:65:129 all show an arithmetic mean relationship with the fundamental. This means that with every additional step in the series, the arithmetic mean relationship
is compounded with the first number. Musically speaking, this causes multiple reinforcement of the bass note and a very powerful chord. In Figure 11 this particular form of Lightning Chord was obtained by sliding the octave ERS with added 0 up the scale of values by 6.

The section that follows (mm.122-139) is a continuous increment of values based on this chord. As in the previous example, different rates of change occur in different parts and the intervening notes are determined by multiplying the whole series by various factors. However, in the previous example in mm.367-369, the rate of pitch change was faster at the top and slower at the bottom, whereas in this example the opposite is true. This illustrates how regulating frequency in slightly different ways produces a variety of harmonic results.

Figure 12 (mm.262-267) illustrates four important ideas concerning the compositional application of my harmonic theory: intervallic structural omission, the intersection of different series, the painted line and harmonic animation. The notes which appear in parentheses in the examples below are all omitted notes and the numbers that are circled show what the intervallic structure would be if those notes were there. We can see that the harmonies in the first and second measures of this phrase are virtually the same apart from omitted notes.

The creation of intervallic structures in this score example from the second movement is fundamentally different from those in the first movement. In the first movement, there are many different series employed, usually grouped together according to the EDS group, and the Intervallic Designs were simpler, with either one fold or no folds. In the second movement, we see only a few different series, but with much more elaborate Intervallic Designs, ranging from one fold to seven folds. This causes the analytical numbers in Figure 12 to be different. Here there are no frequency numbers at all, even though all the harmonies are formed by the EDS. For expedience a short-hand is used. S14 means Series 14, in which the first interval is 14 semitones. This is (EDS)4+5. The other numbers are the ID numbers, which specify which intervals are being used from the ordered intervallic set of that series. In semitones, S14={14, 8, 5, 4, 3}, hence the first intervallic structure is S14: (ID)(12345)4,-3. The numbers in parentheses signify that the first 5 intervals are compounded to make one large interval,
after which there is interval #4, and then #3 missing, being implied by its appearance in
the next measure. As for the other series in this passage, S12=\{12, 7, 5, 4, 3\} and
S19=\{19, 9, 6, 4, 4\}. Since they all have intervals in common, it is possible to intersect
them, which is what happens in mm.264 and 265. Here we can see one series forming
intervals from the top and another from the bottom.
In this work a particular phrase or passage tends to have a consistent harmonic coloration throughout. However, in this passage that is not the case. Here, the harmonic coloration changes midway through the phrase in what I call a *painted line*. Several
factors are involved. First is the omission of inner voices which gradually get filled in by the end of the third measure. Second is the intersection of two different series in one sonority, occurring in the third and fourth measures. Third is a busier rhythmic texture, mainly in the 4th measure. Lastly, and most significantly, is the different number of folds to the Intervallic Designs in a given measure. Generally, the more a series folds in on itself, the more complex the color and the tonality will be. In the first and second measures the Intervallic Designs have only one fold. The greatest change happens in the third measure which has the following range of ID’s:

(ID)12345432 – 1 fold
(ID)23234543 – 3 folds
(ID)234343 – 5 folds

Harmonic animation is also something that occurs primarily in the second movement. In the first movement, one can see that there are notes which are freely inserted between intervallic structures in an improvisatory manner to form melodies. In the second movement, however, Intervallic Designs have become all-pervasive; there is virtually no space that is not occupied by them. The melodies that do exist are the result of composite slices of Intervallic Designs laid out in a specific order. This is directly analogous to how motion pictures are created and cartoons are animated. Every simultaneity is accounted for: harmony is directly creating melody.

Figures 13 and 14 are two pages of score that also exhibit harmonic animation as well as micro-harmony and tonal shading. Measures 319-324 are based on the 9 permutations of (ID)43234343234. This is plugged into 2 different series: S12 and S14, for a total of 18 slightly different intervallic structures. The axis of symmetry for this passage is the perfect fourth between viola 1 and violin 6 (C6 to F4). In terms of intervallic content, there are only 2 different collections of intervals, because of the 2 different series, and these only differ in their second interval, which in S12 is a fifth, but in S14 is a minor 6th. The numbers in bold print represent those intervals which have changed according to the previous sonority. We can see by this that most intervals do not change. In fact, the 5 occurrences of interval #3, the perfect fourth, never change.
position. This is due to the method of intersecting series segments by a common interval, which puts greater limits on the number of possible permutations. Unlike the last example, this passage has only one harmonic coloration, which flickers in subtle shades of micro-harmonic variations. In a sense, there is just one large complex chord that is constantly undergoing slight alterations. This also causes a contrapuntal texture of numerous stepwise melodies, which again are the result of harmonic animation.
Figure 13: Maximum Tonal Shading, mm.318-321
This passage illustrates tonal shading to its maximum extent in this composition. This is due to two related factors: how many times a series folds in on itself and the location of those folds. Generally speaking, tonalities are compounded when a series
folds in on itself. A fold is defined as a reversal in the ordinal numbers that represent the ratios (intervals). The Intervallic Design upon which this passage is based is (ID)43234343234. With all of its permutations, the resultant intervallic structures will have either 5, 6, or 7 folds. This multiple compounding of tonalities, which are presented one after another, makes it impossible for the listener to focus on any one tonality. Neither are these sonorities ordered according to any kind of harmonic progression, but only in regard to voice-leading and contrapuntal texture. If the music were to continue in this manner for an extended period of time, there would exist a de facto state of atonality. However, this extreme degree of tonal shading only lasts for 6 measures (mm.319-324) and it is flanked by clearer tonalities in measures 318 and 325, whose Intervallic Designs both have only 3 folds. In addition, the voice-leading makes it easy for the ear to follow as it connects smoothly to what comes before and after.

The other factor that contributes to tonal shading is where the folds take place in the series. The significance here is that there are no large intervals involved, especially in the bass. Had there been a significant separation of the bass note, this alone would strengthen a sense of tonality (as was usually the case in the first movement). In addition, the degree of the tonal compounding depends upon the specific intervals involved. The major third (interval 4), when alternated with the perfect fourth (interval 3) will instantly effect a change of tonality, whereas other intervallic combinations may not.

3.6 Aesthetic Value

3.6.1 Style

In Exploring the Waterfall, abstract principles of classical composition and music theory (as opposed to classical language or style) are used to develop a language that grows naturally out of my jazz background without sacrificing its original identity. In this work the expression of jazz is merged with contemporary composition without the limitations imposed by genre or the dualities and double standards of exoticism. There is a tendency for composers to alter their original musical identity once they have begun studying composition. In some cases, they leave behind the natural expression of their
original culture and adopt a new musical language that is more representative of the contemporary composition subculture. However, it is a mistaken assumption that any musical style needs alterations in order to be considered as contemporary classical composition. Likewise, any style of music can be developed to become serious composition, based on its own native attributes.

There are isolated instances of the intrinsic development of jazz as a form of contemporary composition, such as Richard Peaslee’s *Stonehenge: A Jazz Symphony* (1963), which I consider to be a fine composition on a high level. Interestingly, Peaslee has a degree in Music Composition from Yale and also studied with Nadia Boulanger in Paris. This piece is probably the best example of third stream, since it does include improvisational breaks for performers and follows jazz common practice in respect to being within the format of a typical big band chart. However, Peaslee does have separate lists for “Jazz” and “Concert Orchestral” compositions. He has not fallen into the trap of exoticism like Fred Stride (see Introduction, p.7), but has felt a need to at least make some distinction between jazz and classical in his own compositions. He has two styles and his “Concert Orchestral” composition, *Arrows of Time* (1996) is a good example of third stream from the classical perspective. It is also a fine composition of a very high standard, but definitely sounds like a jazz-inflected classical composition and not a piece of jazz. He has probably taken a more sensible route than I have in that he is careful not to give the “classical” orchestra music that is outside of their experience. I essentially have only one style, which has grown directly out of my jazz background, but without conforming to jazz common practice and being more classically organized.

It would be tempting to classify *Exploring the Waterfall* as third stream, which is defined as a genre somewhere between classical and jazz. On the surface this seems plausible, but there is a subtle difference between my work and third stream. The latter is a conscious attempt to fuse the genres of classical and jazz. Writing third stream compositions requires a consciousness of the two genres and the subsequent designation of different attributes for each of them. There is always a sense of duality in third stream that does not exist in my work, because I do not necessarily view classical and jazz as genres to begin with. Consequently, I am not trying to fuse genres, but simply to develop my native language through greater knowledge. There was a time when classical and jazz
more clearly represented different genres, but this is now an artificial reality at best. Classical composition in the contemporary sense no longer indicates genre. It is a body of knowledge that facilitates composition and encompasses a plethora of different styles.

Jazz is a type of musical expression and is not limited by genre, nor is it intrinsically separated from classical ideas. It is essentially a feeling and a type of sound. For example, although improvisation in performance is an important feature of jazz expression, it is not mandatory that it be integrated into a jazz composition. There are many examples of jazz compositions that contain no improvisational breaks for the performers, such as Duke Ellington’s *Reminiscin’ in Tempo* (1935) and Stan Kenton’s *Opus in Pastels* (1940). Kenton in particular encouraged composition when in 1949 he assembled his *Innovations in Modern Music Orchestra*, a 43-piece ensemble that included woodwinds and 16 strings. Composers such as William Russo and Robert Graettinger are among those who wrote for this ensemble, though it did not last because of its economic infeasibility. The value of jazz improvisation is that it imparts a certain feel to the music and we associate this expression or feeling with jazz. As a jazz pianist, trumpeter and vocalist, this feel is part of my cultural inheritance and I can manifest it at any time and in any theoretical structure.Improvisation does exist in the present composition in the form of selective improvisation. The most obvious example is the double bass solo in mm. 91-98. This is a transcribed improvisation, of which I improvised and transcribed several versions before choosing the final version. There is no difference between this and the several takes that are done for jazz recordings, ending with a selection of the best take. Once an improvisation has been captured by a transcription or a recording, its value has been realized.

Due to the rigorous compositional structures and procedures used in *Exploring the Waterfall*, this particular manifestation of jazz can be considered to fall under the wider umbrella of contemporary classical composition. This jazz is a style of contemporary classical composition that I call *the developmental groove*. This is to distinguish it from other music that has a groove, but does not develop it using classical compositional ideas and procedures.

Jazz was a fusion of classical and popular elements from the beginning, but this was a natural cultural phenomenon. The place where jazz originated, New Orleans, was
musically unique because of its mixed French and Spanish heritage, a long-standing devotion to opera, the presence of many free blacks and the availability of education and musical training. Jelly Roll Morton was a French ancestry Creole who received just such classical music training. If Morton’s statement that there is “nothing finer than jazz music” were true (especially in his own case) and the equally high level of compositional potential for jazz was already there, then there is no reason why the compositional development of jazz could not have kept going, just as it did in the classical world. However, the formulation of jazz education and the subsequent musical segregation between the classical and jazz worlds hindered this development. Jazz education took it upon itself to consider individual improvisational performance virtuosity to be the main focus. The origin of this perception began with Louis Armstrong. Armstrong’s example had made solo improvisation increasingly important in jazz, whereas Jelly Roll Morton maintained composition as its vital force. “My theory,” Morton once said, “is to never discard the melody.” However, by 1930, more and more jazz musicians were following Armstrong’s example, basing their improvisations chiefly on harmony. After the opening melodic statement, the melody was discarded, making way for the performer’s show of virtuosity (Crawford, 2001).

This discarding of the melody after its initial statement inevitably led to a lack of thematic development and also counterpoint, both of which were conspicuous elements in the music of Jelly Roll Morton. It has also led to decreased opportunities for composition in other parameters. For example, the practice of all the soloists playing the melody or “head” in unison at the beginning and then everyone duly taking their “turn” at improvisation has eliminated opportunities for taking a compositional approach to form and orchestration. Unison playing of the melody in particular seems to contradict the individualism of performance that each player is supposed to have. In order to play a melody in unison, everyone must play it the same way.

The consciousness of jazz as a genre has caused jazz players to repeat the same type of forms over and over again. If this state of affairs existed in the classical world, it would mean that classical composers were still obligated to write in sonata form. If jazz were taught not as a genre, but as a style that could take any form, there would be no obligation to stereotypical forms or performance practices. Nor would there be an
obligation toward improvisational breaks, which in itself dictates a certain type of form. The composition of jazz would no longer be called “jazz composition,” but simply, composition. It should be enough to specify the type of ensemble (such as L’Attitudes for jazz orchestra) and to have the proper expressive directions in the score. For a composer to have a separate list of “jazz compositions” and “classical compositions” is not only redundant, but underscores the inherent segregation that still exists between these two worlds.

As jazz continued and it was increasingly considered to be a performers’ art, this in turn dictated and limited the ways in which jazz was to be composed. This has led to the expectation that jazz should be less composed than classical music, and to consternation when it becomes fully composed. Performers always outnumber composers, but this in itself is not sufficient reason to define jazz as a performers’ art. If that is the way most jazz musicians want to operate, there is nothing wrong with that. But when institutions, degree programs and dictionaries insist that jazz must be that way, that is a problem that not only limits the art, but threatens artistic autonomy and perpetuates musical segregation.

There are those who do not believe that musical segregation exists. However, as in other types of segregation, it often only exists for those who are negatively affected by it. When I first entered a jazz program, I was told that not everything in jazz was supposed to be composed and that I had to fit my composition into a certain type of format. I felt that my artistic autonomy was being threatened and so I did not continue. Unfortunately, when I started a composition degree in a classical composition program, I felt that my artistic autonomy was still being threatened, because I was told that I needed to abandon jazz, which was a performers’ art and embrace contemporary classical composition, which was a composers’ art. After completing my Bachelor of Music at New England Conservatory, I decided that I really wanted to go back to composing jazz my own way and I thought that the University of North Texas, where Stan Kenton bequeathed all of his scores, would be a good place to do a master’s degree in composition. I embarked upon writing a piece for jazz orchestra (but with no improvisation) called L’Attitudes. At the end of my first year the composition department informed me that unless I composed music that was more representative of contemporary
classical composition, I would not be promoted to the next year. Naturally I left that institution.

I returned to New England Conservatory, because I found a composition teacher (Robert DiDomenica) who understood my objective. He told me that when I first started studying with him that he had some reservations, because I was composing jazz. But as time went on he realized that I was approaching composition in a very pure way and that there was fundamentally no difference between what I was doing and what he was doing. I finished *L’Attitudes* in 1998 and then tried to get it performed. I was told by both jazz and classical people that I should have included improvisation and that I was “throwing out the baby with the bath water” by not doing so. However, I was not throwing out my own baby, because my own improvisational voice permeated the entire score. I was also told that I was not supposed to fully compose a detailed part for the drum-set, but only give indications. I found it curious that as long as my music sounded “classical” enough, I was supposed to write everything out in detail, but the moment it sounded too much like jazz, I was supposed to adopt a different policy. Although I have tried to get *L’Attitudes* performed, I have yet to succeed in even getting a reading of it. It is a large piece and requires a big band to be augmented by some classical players, much like Kenton’s *Innovations in Modern Music Orchestra*. I have found that big bands generally do not want to do this. On the surface, *L’Attitudes* sounds 100% like jazz and classical ensembles do not want to attempt it because of the rhythmic challenge and the feel. College jazz ensembles are also not interested because it does not fit into their format and provides no opportunities for improvisation.

Unlike *L’Attitudes*, *Exploring the Waterfall* does not sound 100% like jazz. I was not interested in inviting the same kind of trouble for myself by repeating the same debacle. If anything, I made sure that it sounded “classical” enough to pass inspection, since I am in a classical degree program and mindful of the trouble I have experienced in the past. It was never my intention to make *Exploring the Waterfall* sound like jazz, but only to explore compositional applications of my harmonic theory. However, neither did I want to bury my natural expression and since this expression is in evidence in the present composition, I am compelled to explain its presence. Now that I will soon be
completely free from academic scrutiny, I will once again go back to composing jazz my
own way.

One evolution in the jazz style that saw a greater degree of composition was jazz-
fusion, which saw its greatest development in the 1970’s. Much of the jazz-fusion of the
70’s was highly innovative and this is the style of music out of which my own
composition evolved. Exploring the Waterfall could be considered to be a more complex
development of jazz-fusion, but without the dualities that result from exoticism and
without the sacrifice of its basic musical identity. The basic underlying musical
expression of this work is a type of jazz-fusion, but this is infused and enriched on many
levels by more in-depth compositional thinking and by the influence of other types of
music.

This inherent jazz expression is more pronounced in the first movement,
_Vengeance Is Mine, Sayeth the Groove_, mainly because selective improvisation plays a
large role. No matter how involved the harmonic structures become, the improvisatory
voice of the composer can be heard weaving its way through them. In the second
movement, there is less space between intervallic structures so that by the time we get to
the end of the piece in mm.319-376 (B3, C1 and C2), the intervallic structures have
become all pervasive. In this span of music, every simultaneity is planned and part of a
vast sequence of intervallic designs. Consequently, any perceived motivic activity is the
result of composite vertical structures (harmonic animation). As such, there is no
movement of any kind which is unaccounted for within this rational structure and the
improvisatory voice of the composer has been eliminated. The absence of this
spontaneous personal voice decreases the presence of the jazz expression and as a result
the music sounds more “classical.”

The lyrical nature of _Precipitous Sanctuary_ reduces the emphasis on an overt
groove and this movement also has the influence of Latin music. Beginning in 1995, I
became more interested in Latin music, which was undergoing the same kind of
explosive development that jazz-fusion had in the 1970’s. I became particularly
immersed in Cuban _timba_, exemplified by such bands as Bamboleo, NG La Banda and
Cubanismo, who have a strong polyrhythmic groove, as well as being influenced by
American funk. This polyrhythmic attribute is expressed in the second movement of
Exploring the Waterfall as different pulsations on different levels. At this time I also became more interested in classical music from Latin countries. It is interesting to note that there is much less separation between popular Latin music and classical Latin music. This can be seen in the general interaction of flamenco guitar music with Spanish classical music (for example in the work of Manuel de Falla) and in the compositions of the Brazilian composer Antônio Carlos Jobim, whose work is a synthesis of popular and classical music. The interpenetration of these worlds has existed for a long time (beginning, for example, with Albéniz). This accounts for the greater “classical” feeling in Precipitous Sanctuary, as it has a much stronger Latin influence. The Phrygian Inflection is also in evidence. The melodic alternation of a semitone, often terminating with a lower neighbor note a whole step below is a typical gesture in all Latin music (as in the pitches b, c, b, c, a) and can be found repeated throughout the second movement. The coloristic nature of the harmony, while stemming mainly from jazz, also recognizes that jazz harmony was greatly influenced by the Latin classical world, notably through composers from France and Spain (who had an important cultural influence in New Orleans).

3.6.2 Rhythm

In Exploring the Waterfall there are clear metrical and beat structures, but this does not mean that the rhythm is simple or simplistic. The development of the beat, pulse, meter and groove is approached in a rigorous manner. The first movement of this work has a heavy groove and revolves around playing with the beat in the manner of jazz-fusion and funk, but with a higher degree of development. The second movement expresses the polyrhythmic nature of Latin music in a subtle way by contrasting a variety of pulses on different levels.

In the composition world, double standards continue in the area of rhythm, beginning with the beat. There is an attitude that if the beat is too strong, the music cannot possibly be serious composition, unless it is perhaps subjected to some kind of distortion, collage, or parody. John Zorn, for example, is considered to be a serious composer and a bona fide member of the avant-garde. He routinely uses styles that have a
heavy beat, but his aesthetic depends on the manner in which he juxtaposes, contrasts and relates these styles, often in the form of a collage. The beat as it exists within these styles is a given and would not be considered as a serious element in the absence of this manner of stylistic juxtaposition.

To actively engage in reinforcing the beat is counter to the 20th century dogma of the avant-garde: unless one treats it as an exoticism. In exoticism there is a consciousness of the other and usually this other is viewed as a lower or more primitive manifestation of culture. Often it is used to sprinkle a little “local color” into the music. There is also a tendency to view the other through stereotypical examples and without deep consideration, which results in a devaluing and undervaluing of the other. This accounts for the attitude that it is a simple matter to put these exotic elements of the other into a composition, because these elements are considered to be inherently simple. The beat is one such element. For example, in the music of Stravinsky the beat is very much in evidence, but it often comes in the form of merely adding a bass drum in a metronomic fashion. I would call this a “token beat,” where the beat is not taken seriously as a parameter in its own right, but is simply added. Many times have I seen in new music concerts where composers adopt a rhythmic pattern and simply let it run for the duration of the piece. We see this same kind of devaluing of the beat in popular music, where the beat is often looped by a machine, as if it neither needs nor deserves any further attention.

However, the beat is more profound than is generally supposed and it is possible to develop its presence in a variety of ways. Although the beat repeats, it doesn’t need to do so in the same way. The existence of strong beats and weak beats shows that beats are not equal in the way they make people feel. This inequality of feeling can also be manipulated by many factors. Theoretically, there can be an infinite gradation in the relative strengths of different beats. Through the application of different densities, rhythmic clustering, registral activation, orchestration and even silence, the beat can have a very dynamic presence and evolve over the course of a composition. The strength of the beat doesn’t even necessarily depend on making it loud. For example, in the Introduction after the establishment of the groove there is a spot where there are 6 beats of silence. During this pregnant silence (mm.43-44), the beat can be felt very strongly and with great suspense. This illustrates how the expression of the beat can take many forms.
In the next level of rhythm, meter and barlines, there are more double standards. Music that crosses the barline is often considered to be more serious than music that doesn’t, and music that obscures meter is often considered to be more sophisticated than music that upholds meter. A typical phrase in regard to the 20th century aesthetic is “the tyranny of the barline.” This need to avoid barlines is arbitrary. Rhythmic development can take many forms on many levels. Afro-Cuban music hits the barline every time and yet the rhythm is highly developed. When there is a fundamentally polyrhythmic approach, the barline issue becomes a non-issue. On the contrary, barline consciousness is very important in the development of the groove. It also follows that if the groove is developed effectively, this sense of tyranny will not exist, but rather a sense of excitement. The barline then becomes a source of great expressive power.

James Brown is a perfect example of this. He is well-known for the expression, “on the one.” As stated earlier, Cecil Taylor proclaimed James Brown to be a genius. The reason for this is that James Brown was able to create such a powerful and dynamic musical expression through what appeared to be on the surface the most limited and simplistic of means. How is it possible to be “on the one,” that is, emphasize the downbeat every single time and create so much musical excitement that everyone from Cecil Taylor, to Miles Davis, to Herbie Hancock and even to myself, are in total awe of the result. It is not the means, but what one does with them that makes the difference. James Brown had the authentic “feel” or “groove” and was able to build it, sustain it, develop it, and literally conduct it to the rest of his ensemble, with only a handful of variables. He was a unique artist and composers would benefit from analyzing his music. I feel that I have also succeeded in creating, building, sustaining and developing an authentic groove in the first movement of Exploring the Waterfall. This is an important contribution in the field of composition, where the groove tends to be devalued and treated exotically.

Relating to obscuring the barline is the issue of obscuring the meter and the employment of mixed meter. The obscuration of the meter has its value, but this is most effective when combined with upholding the meter. An important aspect of composition is the regulation of change. When there is too much change it becomes redundant and predictable, which defeats the whole purpose of it. It is more effective to change at the
right time in the right way, making the change significant and noticeable. A little over 20 years ago, I was interested in using prime numbers as a means to increase rhythmic unpredictability. However, I noticed that when prime numbers are added together, they often create very simple numbers. Furthermore, the differences between primes show a marked degree of regularity. I concluded that it was more effective to make occasional significant metrical changes than to change meter often (this also holds true for hypermeter).

In particular, the simplest and squarest of meters, 4/4, is often seen as an obstacle to complexity and subtlety. More than any other meter, 4/4 is the prime culprit that must be neutralized by obscuring it and crossing its barlines. This attitude lacks understanding of the bigger picture. Rhythm does not exist on the metric level only. There is fundamentally no difference between 1 beat divided into 4 sixteenth notes and 1 measure divided into 4 quarter notes and yet, composers do not seem bothered by using consecutive groups of 4 sixteenth notes. The interaction of different numbers on different levels of rhythm and pulse creates rhythmic interest. 4/4 is simply the number 4 operating on the measure level. If one does not like the number 4, one is not obliged to use it. But if one does use it, it should be used with an awareness of its numeric identity and its interactive role with other numbers. Subtlety in rhythm will be created by the intelligent use of all numbers.

The groove is an underestimated and misunderstood entity for most contemporary composers. Many equate it with rhythmic patterning or a layering of ostinati. The effort to try and define the groove in such simplistic terms illustrates the legacy of the European hegemony in classical composition and its accompanying cultural imperialism and ethnocentrism. Those who truly understand the groove are those who possess it. The groove is the captivating feeling that results from building on the sense of pulse, the convergence of rhythmic elements and their interaction with all of the other elements in the music. Every parameter of music contributes to its effect. It is ultimately indefinable and cannot be reduced to a formula. Creating and building on an effective groove cannot be taken for granted and it is difficult to maintain the kind of direct physical excitement that the groove can produce. The developmental groove is an important concept, because unless the groove develops, it will lose its intensity over time. In high quality popular
music, the groove does develop, but its development tends to be limited. It is possible to continue this development to a higher level of composition without sacrificing the original feeling and this is what I feel I have accomplished in the present work.

The title of the first movement, *Vengeance Is Mine, Sayeth the Groove*, was inspired by the 1997 funk album, *The Revenge of the Funky Drummer*, by Clyde Stubblefield (a former drummer for James Brown). Across the face of the Earth, human beings (myself included) will continue to desire to listen to music that has some kind of a groove. The vengeance of the groove lies in the fact that in the end the groove will continue to prevail. This work shows that it is possible for a serious composition to have a strong, authentic and undisguised groove that connects to the music of humanity without any compromise in either the groove or compositional integrity. If composers are able to develop the groove based on its intrinsic value rather than through the distortions of exoticism, then serious music will stop being merely a subculture and will enter the greater culture. This is not writing for a mass audience, but simply the end of musical segregation and double standards.

### 3.6.3 Harmony

The main aesthetic contribution of this work is in the area of harmony. The titles of the two movements convey the expressive qualities of the music, but the title of the entire work, *Exploring the Waterfall*, refers to what is constantly in the background. In this regard, the word *waterfall* represents my harmonic theory and *exploring* represents the quest to find various applications of the theory in order to create the entire harmonic content of the work. In this sense, the development of the theory as explained in Chapter 2 can be viewed as pre-compositional.

My harmonic theory is an effort to obtain tonality mathematically through the natural acoustical properties of sound. By doing so, the harmonic practices of the past can be explained under one system and at the same time a new way of creating tonality can project itself into the future. This is important, because tonality is generally regarded as regressive by those who consider themselves as progressive, and this has been the source of great division in the composition world for some time. This division has manifested
itself in a number of dualities, such as: tonality versus atonality, consonance versus dissonance, intellectualism versus natural expression and the new versus the old.

What is generally referred to as atonality is a phenomenon that came about for reasons which are largely historical and no longer apply. The conception of tonality as it existed in the early 20th century was limited in many ways, despite its complexity. There were many ways to use tonality, but all of these ways were still rooted in common practice. They addressed the how, but did not answer the question as to why tonality functions in the first place. It was unscientific. As a result, tonality felt confining and there was a desire to break free from it. This was a necessary step to take at that point in history, but it is no longer so and the continued avoidance of tonality, which is a legacy of the past, now seems outdated.

The potential for freedom within tonality exists today in a way that did not exist for composers 100 years ago. Atonality as it exists nowadays amounts to tonal avoidance and/or tonal chaos. I believe that it is a misconception that tonality and atonality are opposed. I feel they are relative states within the spectrum of tonal possibilities. This is what I refer to as tonal shading.

In my harmonic theory, a de facto state of atonality is easily achieved, along with any other gradation of tonal shading. Tonality and atonality are part of the same system. This theory also offers freedom by expanding tonal resources. All of the existing resources of tonality can be created within this one system, but the harmonic theory also supports an expanded conception of tonal function, a method for creating an unlimited number of different sonorities and new ways of transforming musical passages. This system is also adaptable to any tuning system and is capable of creating a functional microtonality.

In this work, all of the consonant structures and all of the dissonant structures are created through the same process. There is no real separation between the two and unlike most music, which tends to fall within a given area in this spectrum, this work contains passages of both extreme consonance and extreme dissonance, with many gradations in between. The duality of consonance and dissonance exists in most modern music primarily because the composer has focused on pitch classes and pitch collections. When notes are arbitrarily put anywhere with no consideration of the proportionality of their
frequencies, dissonance is an element that tends to stand out. There is no current methodology for the integration of consonance and dissonance, which causes dissonance to be an exotic element to be added. The act of adding dissonance to create a more “modern” sound or to lend the music an aura of sophistication is a long-standing dogma in the modern composition canon. But why is dissonance considered to be more sophisticated than consonance. Both are harmonic coloring agents and equal in value. In the visual arts, for instance, all colors are equal and artists do not select one color over another in order to appear sophisticated.

Dissonance is a natural part of acoustics. It is manifested in virtually every sound that exists. There are only a few simple frequency ratios that are consonant. Most of the frequency ratios found in the harmonic series will produce dissonance, especially in combination with other ratios. Therefore, from the standpoint of frequency and the knowledgeable use of frequency ratios, dissonance does not need to be added because it already exists and is everywhere. In my harmonic theory, there is an infinite gradation and combination of consonance and dissonance arising from one principle: frequency regulation. The various series that arise from frequency regulation create proportional sets of intervals, which are then realized as intervallic structures through the Intervalllic Design concept. These intervallic structures are complete and balanced from the beginning and already contain consonance and dissonance in various proportions. The coloristic unity of these sonorities is akin to the type of fusion of frequencies that exists in musical timbres. It then becomes a simple matter of choosing which type of harmonic color one wants in a given musical context.

There is an opinion that has been expressed by many in the general public and also by those composers who have embraced neo-romanticism and other similar post-modern styles, that intellectually-based music is often dry and in opposition to natural expression. This is mainly because intellectualism in contemporary composition is associated with serialism, and for those who do not use serialism, it is associated with composing by formulas and with “atonal” music in general. It follows that for many with this viewpoint, natural expression is associated with tonality and tonality is generally not associated with intellectualism or serialism. As a subcategory of intellectualism, mathematically based music in particular is usually considered to be dry and
unexpressive. However, in the present composition, the use of rigorous mathematical systems to create tonality is the norm and goes against this stereotype. In addition, the method used to create tonality has similarities with serialism. Consequently, I feel that my approach to composition bridges the gap between this fundamental opposition of outlooks.

It was always important to me that my natural expression be reconciled to my theoretical ideas and that there be no duality between my voice and my mind. My improvisations or simple human expressions can be easily integrated with my intellect. My theoretical ideas can accommodate and enrich a simple expression or a complex expression. In particular, the polychordal language of jazz can be mathematically constructed and expanded through my harmonic theory. This means that I do not have to abandon my native language, but can continue to explore it in a logical and consistent way.

Exploring the Waterfall embodies new theoretical ideas that are my unique contribution in the field of composition. I believe in the modernist conception of new composition being driven by new theoretical ideas. Unfortunately, a stereotype has existed for a long time that new theoretical ideas must embody esoteric inaccessible sounds. This is not necessarily the case. Modernism in music is progressiveness. Modern music is of necessity progressive music and one which points toward future developments. A new type of modernism may be called, New Clarity. This means that the new ideas are expressed with the maximum of clarity and intelligibility. This does away with the negative aesthetic of avoidance and the nihilism that is the legacy of the 19th and 20th centuries. It is the duty of the scientist to make the complex elegant and simple. I believe the same holds true in music theory and its application in composition. Composers should express intelligence in music, but should do it in a way that truly communicates. This has been my objective in Exploring the Waterfall.
Exploring the Waterfall

for

12 Strings

in 2 Contiguous Movements

I – Vengeance Is Mine, Sayeth the Groove
II – Precipitous Sanctuary

by

Timothy Jay Pickett

Duration: 13 minutes
© 2009 Timothy Jay Pickett
Performance Notes

vibrato – only to be used where indicated, except for the 1st violin at mm.207-225 (marked *espressivo*)

OR

percussive stop on the rest with hand, after pizz.

staccatissimo – a very short attack with intense marcato or martellato bowing

staccatissimo battuto

staccatissimo battuto using half hair and half wood

voltage fortissimo – a harsher fortissimo through greater bow pressure, but with more pitch clarity than a scratch tone

more diminuendo at the beginning

the strongest pizzicato accent (stronger than >)

A slur joining pizzicato notes indicates an attack on the first note only, with the following notes to be fingered.

The word *shadow* indicates that a given note is there to unobtrusively add a little color to the same note played louder in another part.
I. Vengeance Is Mine, Sayeth the Groove

Timothy Pickett 2009

funky: keep the beat, \( \text{d} = 112 \)

violin 1

violin 2

violin 3

violin 4

violin 5

violin 6

viola 1

viola 2

violincello 1

violincello 2

double bass 1

double bass 2
(pizz. tremolo)

p cresc. poco a poco
Bibliography


Appendix I: Intervallic Slope of the Harmonic Series

[curve of comparative change between intervals]
Appendix II: Intervallic Sets from Selected Equal Difference Series