

ABSTRACT

Title of Dissertation: Registral Space as a Compositional Element: A New Analytic Method Applied to the Works of Ligeti, Josquin, and Beethoven.

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The motion of a musical work through registral space is an important element of the listening experience. However, the tools developed for analysis of registral space are limited in number and are generally geared toward the study of 20th century music, where register is more frequently engaged with as an important component of musical structure. In this dissertation, I outline a new method I have created for the analysis of registral space and apply it to three compositions from different stylistic periods: György Ligeti's *Continuum* (1968), Josquin's "Benedictus" from his *Missa L'homme armé super voces musicales* (c. 1490-5), and Beethoven's Bagatelle in G major, Op. 126, No. 2 (1824). In so doing, I show how registral form can contribute equally, along with parameters such as melody and harmony, to the meaning of a composition.

The first chapter of this dissertation outlines and demonstrates the analytic procedure using a short passage from Frédéric Chopin's C minor étude from Op. 25. Registral space, a conceptual, two-dimensional space created by the coordinates of pitch and time, is represented graphically where pitch is notated along the vertical axis and time along the horizontal axis. From the pitch graph, I define and quantify four types of registral space: positive, upper negative, lower negative, and inner negative space. This

data is then used to create a series of graphs that elucidates a composition's registral form at both global and local levels.

Chapters 2, 3, and 4 contain full analyses of the Ligeti, Josquin, and Beethoven works respectively. Though these pieces are written in different styles, they share a number of common features with regard to the treatment of registral space. For example, all three pieces exhibit self-similarity at multiple structural levels. Additionally, they each appear to have been conceived with deliberate consideration of the pitch shape's placement within the range of the piece, often employing some form of registral centering or balancing. By considering registral space in a new and meaningful way, this method of analysis can be applied to a diverse body of music and reveals aspects of musical structure that might otherwise remain hidden.

REGISTRAL SPACE AS A COMPOSITIONAL ELEMENT: A NEW ANALYTIC METHOD APPLIED
TO THE WORKS OF LIGETI, JOSQUIN, AND BEETHOVEN

by

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CHAPTER 1: INTRODUCTION

The motion of a musical work through registral space is an important component of the listening experience and significantly contributes to the structural organization of a composition. Despite this fact, few studies of registral space exist and the tools and methods created for its analysis are limited. Moreover, those theorists who have touched upon the topic of registral space in one form or another by and large have restricted their study to spatial characteristics of 20th century, non-tonal music. Motion through pitch space, which is one of music's most fundamental elements, transcends the stylistic concerns of a single historical period. In this study I present a method I have developed for describing and formalizing our experience of motion through and placement in a defined pitch field that can elucidate musical structures in a variety of stylistic contexts.

After outlining my analytic method, I will use it to examine the spatial designs of three pieces from three different historical periods: György Ligeti's *Continuum* (1968), Josquin's "Benedictus" from his *Missa L'homme armé super voces musicales* (c. 1490-5), and Beethoven's Bagatelle in G major, Op. 126, No. 2 (1824). These analyses will show that an examination of a composition's spatial motion can add great depth to our understanding of that piece, especially when combined with more traditional harmonic and rhythmic analysis. They also demonstrate my method's flexibility and power through its application to different musical languages. Because the method is not language specific, the results can be used to engage in a meaningful comparison of musical structures drawn from a broad category of music that is inclusive of many styles.

Before continuing, let us look at a simple example demonstrating how motion through registral space can be an important expressive force in a composition. In the

opening phrase of Frédéric Chopin's C minor étude from Op. 25 (mm. 1-8), the regularity of rapid and continuous ascending and descending arpeggios creates an expectation that between every two downbeats, the music will travel up and down the pitch field a distance of three octaves. Chopin begins the second phrase in much the same way as the first, preserving the spatial-temporal pattern, until measures 15-16, where he expands the range of the arpeggio from three to four octaves, and, consequently, the amount of time taken to complete it (Fig. 1.1). Those two measures become marked for awareness through the manipulation of motion through pitch space. In this composition, motion through pitch space becomes a means for creating and, subsequently, thwarting the listeners' expectations. Moreover, in this passage, Chopin coordinates the shift in spatial motion with a change of mode from C minor to C major. This is a particularly expressive moment in the piece and the spatial and temporal expansion, executed in conjunction with a shift to major are largely responsible for the musical effect.

From the foregoing discussion, it should be clear that, for the purposes of this research, registral space is a perceptual, two-dimensional space, created by the coordinates of pitch and time. This space may be represented graphically where pitch is notated along the vertical axis and time along the horizontal axis. Figure 1.2 shows the opening of the Chopin étude represented in such a graphic form hereafter referred to as a pitch graph.

Almost any discussion of two-dimensional space includes some reference to that space's boundaries, the shape of which directly affects the nature of motion within the defined space. Think of the boundaries of a country, of a football field, or of the canvas of a painting and how they affect the politics of that country, the course of the game, or

The image displays a musical score for Chopin's Étude No. 12, in C minor, Op. 25, measures 9 through 17. The score is written for piano and consists of four systems, each with a treble and bass staff. The key signature is C minor (three flats) and the time signature is common time (C). The music features a complex, rhythmic texture with frequent sixteenth-note passages and slurs. Measure 9 is marked with a '9'. Measure 11 is marked with an '11'. Measure 13 is marked with a '13'. Measure 15 is marked with a '15' and includes an '8va' marking with a dashed line above it, indicating an octave shift. The score concludes with a final note in measure 17.

FIGURE 1.1. Excerpt from Chopin's *Étude* No. 12, in C minor, Op. 25, mm. 9 – 17.

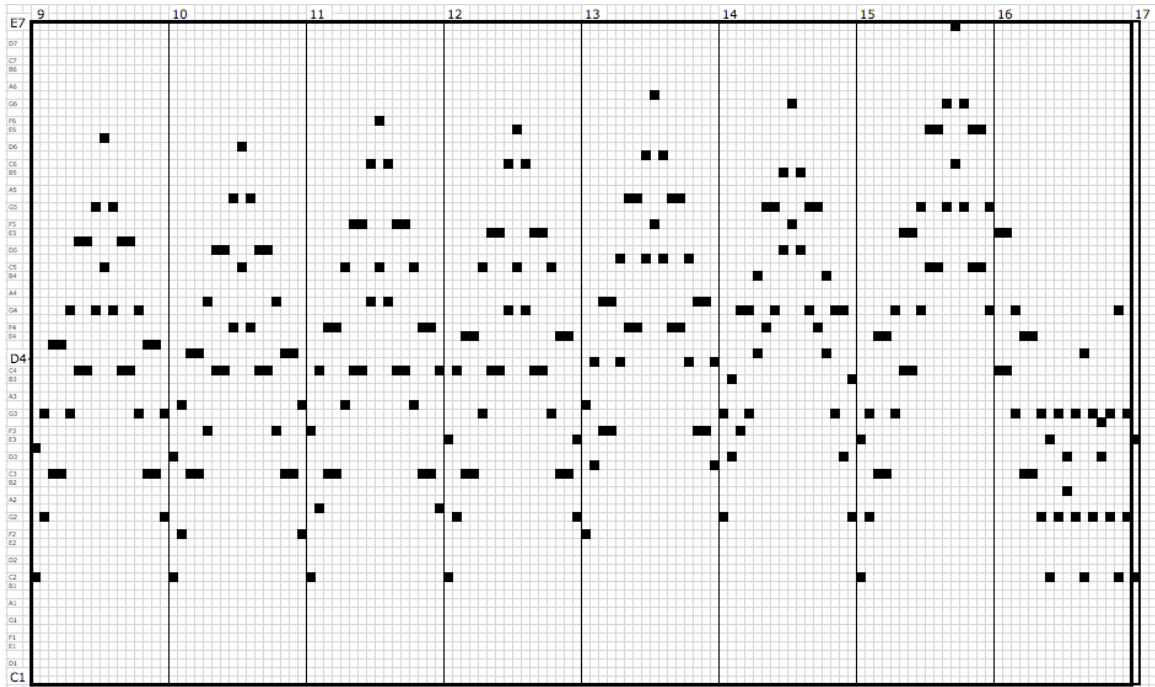


FIGURE 1.2. *Pitch graph of Chopin's Étude No. 12, in C minor, Op. 25, mm. 9 – 17.*

the way the subject of the painting is perceived. Any musical composition also takes place within a particular bounded pitch field defined by the piece's range and by its length. Aesthetic considerations of any particular piece will have to address how that piece moves *within* its particular framework.

Let us test this hypothesis using the Chopin example. How does the range of the Chopin étude contribute to our experience of the piece? Figure 1.3 shows two pitch graphs. The upper and lower boundaries of the first graph represent the actual range of the piece. Here we can see that the highpoint of the final expanded arpeggio in this passage, which has such an expressive effect, coincides with the highest note in the range of the piece. The top of the piece's range is reached only one other time near the end of

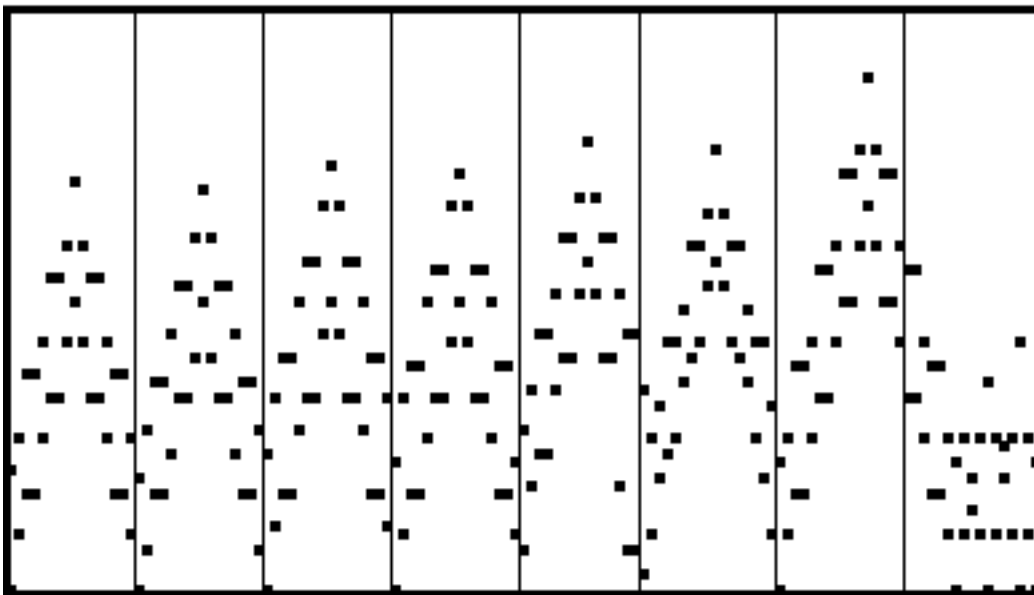
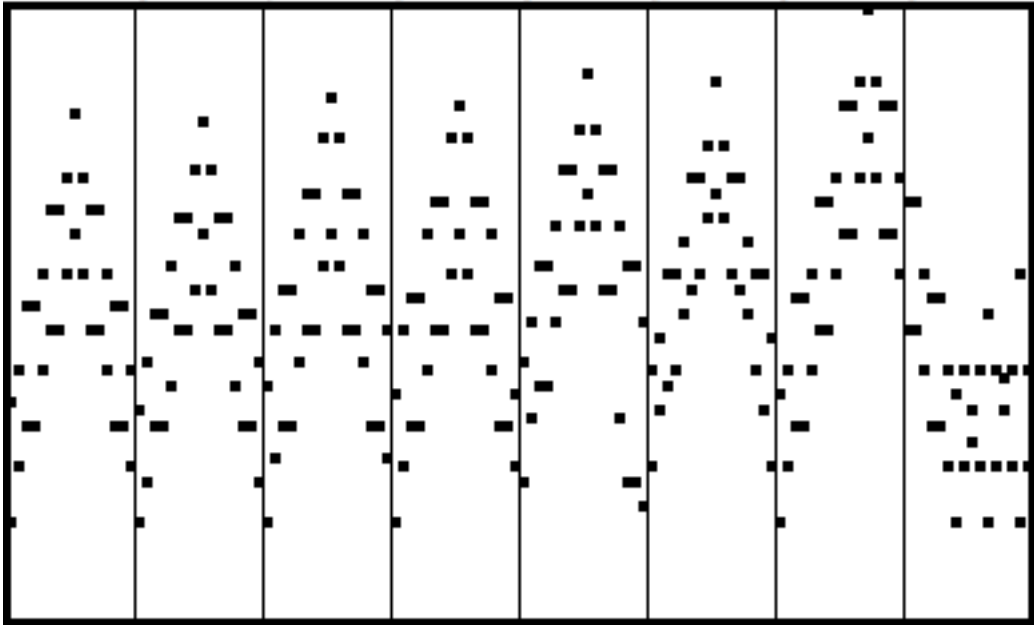


FIGURE 1.3. *Pitch graphs of mm. 9-17 in two different pitch fields. The top graph represents the actual range of the piece (C1-E7). The bottom graph represents a hypothetical range (C2-C8).*

the work, making this occurrence particularly memorable and expressive. The second graph places the very same pitch shape in a hypothetical range, rather than the actual range. Within this altered range, this expressive moment becomes less climactic as it does not involve the highest possible note. Additionally, in the first graph, the pitch shape does not extend into the lowest register, and, in fact, the lowest note is not utilized until the very end of the piece. The reservation of the lowest note for the final measures produces a very different effect from the hypothetical version represented in the lower graph, where the lowest note is repeatedly sounded in the beginning of the piece. Clearly the piece was composed with careful thought as to how it was placed in the overall range.

The analytic method which I have developed will not only reveal a piece's spatial design, but will show how that design is meaningfully placed within the compositional framework. Before outlining this procedure, however, let us briefly examine the concept of music as "spatial," some other models of "musical space," and some studies of musical space which directly relate to my analytic method.

I. MUSIC, SPACE, AND MODELS OF MUSICAL SPACE.

Perhaps the most often quoted descriptions of music as "spatial" come from the 20th-century composer Edgard Varèse:

"When new instruments will allow me to write music as I conceive it, the movement of sound-masses, of shifting planes, will be clearly perceived in my work, taking the place of the linear counterpoint. When these sound-masses collide, the phenomena of penetration or repulsion will seem to occur. Certain transmutations taking place on certain planes will seem to be projected onto other planes, moving at different speeds and at different angles."¹

¹ Varèse, "The Liberation of Sound," in *Contemporary Composers on Contemporary Music*. Elliott Schwartz and Barney Childs, ed., (New York: Da Capo Press, 1998), p. 197.

While Varèse's novel ideas inspired later composers to create music that was also specifically "spatial" in conception, associations between music and space were not entirely new. Despite the fact that music does not create a tangible space, as in visual arts, the language we use to describe music – high and low notes, dense and thin textures, tone color – suggests that we perceive music in some sort of imaginary space which in some ways parallels the physical space in which we live.

In fact, the association of pitch with vertical position in physical space (i.e. high and low notes) aligns our understanding of musical motion with our notion of how objects move in physical space. For example, ascents in pitch are often associated with increases in musical tension just as ascents in physical space require application of a force. Descents in pitch, on the other hand, are associated with motion towards rest, just as descents in physical space require no force other than that of gravity.² The affiliation between pitch space and physical space is likely to have resulted in the arch-shaped contour found in so many melodic phrases of western music. The peaks of these melodic motions are often considered as the climax of the phrase – the highest point of musical tension that then requires resolution through downward motion in pitch space.³ Mapping out such melodies in a two-dimensional model of pitch space, such as a pitch graph, can best describe this connection of musical tension and relaxation with vertical positions in pitch space.

However, because of certain acoustical properties and because of the influence of stylistic languages, specifically the tonal language, various other models of musical space

² See the discussion of the up-down metaphor in Lakoff and Johnson.

³ Eitan, Zohar. *Highpoints: A Study of Melodic Peaks*. Philadelphia: University of Pennsylvania Press. 1997. P.5.

have been constructed to account for how these factors influence perceptions of pitch proximity and distance. The notion of octave-equivalence, for example, would suggest that notes existing in octave relationship with one another are perceptually closer together than the two-dimensional model previously illustrated reflects. A simple helix model where octave relationships line up on the vertical plane expresses both the proximity of the semitone and the octave.⁴ The models become increasingly complex as other musical relationships are considered. By accounting for the perceived proximity of the octave *and* the fifth (which is particularly important in the tonal language), a four-dimensional torus model results.⁵ A model for tonal pitch space developed by Lerdahl describes a number of levels of pitch space for a given tonic where the highest level contains just the tonic, the second level the tonic and fifth, the third level the tonic, fifth, and third, the fourth level the diatonic scale, and the fifth level the chromatic scale. Using this system, proximity between pitches can be measured in various spaces (octave, fifth, etc.). For example, for a tonic of C, C to G is a step in fifth space, but a skip in triadic space. The logic behind this model can be extended to measure distances between chords, and between tonal regions.⁶

This above list is not meant to be an exhaustive account of all models of pitch space. Rather, it is meant to reinforce the fact that, when taking into account matters of music perception, factors like octave equivalence and relationships inherent in the tonal system can introduce new, context-sensitive, types of pitch proximity and, thus, lead to

⁴ Shepard, Roger N. "Geometrical Approximations to the Structure of Musical Pitch." *Psychological Review*, Vol 89, No. 4 (July 1982) 308.

⁵ Lerdahl, Fred. "Tonal Pitch Space." *Music Perception: An Interdisciplinary Journal*, Vol. 5, No. 3. (Spring, 1988) 317.

⁶ *Ibid*, 320-2.

various constructions of pitch space. One might reasonably question, then, in what contexts the two-dimensional, pitch-versus-time model could be useful for revealing meaningful aspects of a piece's spatial organization?

I will begin my answer to that question first by summarizing some important spatial studies that also use a two-dimensional model of pitch space. The first group of studies, which include contour theory as well as some of the work of Jonathan Bernard, shows that the two-dimensional model is appropriate and highly informative for spatial studies of certain non-tonal music. Then, I will discuss the work of Robert Cogan, upon which my project is more specifically built. His analyses of what he calls "musical space," also using a two-dimensional model of pitch space, include compositions written in a variety of styles and exhibiting a number of contrasting registral forms which result from different ways of moving in registral space.

The work that has been done in contour theory relates to this study as it illustrates that it is not just pitch class, but also the shape of a melodic line that forms an essential aspect of melody. Contour theorists have devised a system that, when applied, shows how contour similarity is used to form musical relationships between material that does not contain the exact same pitches or intervals. The theory grew out of a number of perception studies that prove the importance of contour to melody recognition and recall of pitch sequences. For example, an experiment by Deutsch shows that when the pitches of a familiar melody are randomly distributed across two octaves, the contour alteration that results interferes with the ability of subjects to recognize the melody.⁷ Additionally, when trained musicians are presented with a sequence of six tones from the first six notes

⁷ Deutsch, Diana. "Octave generalization and tune recognition." *Perception and Psychophysics*, Vol. 11, 411-412.

of the C major scale, recall is significantly impaired when the tones are chosen from two octaves rather than tones chosen from only a single octave. However, in either condition (range of one or two octaves) contour errors were extremely rare.⁸

As contour is such an important element of melody and thus any linear sequence of pitches, a number of theorists have worked out systems to categorize and compare contours. The methods vary slightly from theorist to theorist but a general understanding can be gained by examining the work of Robert D. Morris.⁹ ¹⁰ First a melody of n pitches is ordered from lowest to highest and the pitches are assigned an integer from 0 to $n-1$. Pitches are not necessarily adjacent and the numbering does not reflect interval distances. As measurements of contour have little to do with exact interval distances, all that is important is taking into account relative lowness and highness of pitches in the portion of melody being examined. Then the contour of the melody can be represented by writing the integers in the order presented in the melody or by a graph. By comparing the height of each note of the melody with every other note, a matrix, the COM-matrix, is formed. Comparing matrices of different melodic segments can isolate contours that are the same or similar and additional methods have been designed to quantify the degree of difference. Morris shows that contour analysis can complement set analysis to reveal a more complete picture of the experience of certain styles of atonal composition and can often explain any seeming inconsistencies.

⁸ Deutsch, Diana and Richard C. Boulanger. "Octave Equivalence and the Immediate Recall of Pitch Sequences." *Music Perception*, Vol. 2, No. 1 (Fall 1984): 40-51.

⁹ Morris, Robert D. "New Directions in the Theory and Analysis of Musical Contour." *Music Theory Spectrum*, Vol. 15, No. 2 (Autumn, 1993):205-228.

¹⁰ For additional articles on contour theory, see Marvin and Laprade, "Relating Musical Contours: Extensions of a Theory for Contour." *Journal of Music Theory*, Vol. 31 (1987): 225-67. and Polansky and Bassein. "Possible and Impossible Melody: Some Formal Aspects of Contour." *Journal of Music Theory*, Vol. 36, No. 2 (1992): 259-84.

With the aid of a reductive technique that Morris developed, any melody with a complex contour – one that frequently changes direction – can be simplified. The number of passes through the melody required to obtain the deepest-level contour is a measurement of the complexity of the contour. In this way, larger passages of music may be summarized and compared with one another, revealing important contour-related connections within the composition.

Contour theory is related to my study as it deals with shapes formed in two-dimensional musical space. However, it is for the most part used to understand and compare linear structures in atonal music. The reductive technique which allows for a more general view of overall contour may reveal some similar information as my method, but does not relate the way the shape is moving to the overall space defined by the piece. Additionally, this method is solely developed for the analysis of linear structures and does not reveal information about vertical sonorities.¹¹

On the other hand, Bernard's earliest published spatial studies begin with the analysis of symmetrical constructions of the vertical sonorities found in the works of Varèse. In these studies, he identifies and classifies different types of symmetrical structures that Varèse used as well as various developmental processes applied to these constructions to create new sonorities. He asserts that spatial configurations of vertical sonorities, or interval distances, are possibly more important than pitch class in these works. A graphic form similar to the pitch graph is used to illustrate his findings, though

¹¹ One fascinating aspect of this theory is that it can be applied to other musical parameters so that one could analyze rhythmic or dynamic contours in addition to melodic contours.

the time axis is not scaled. Bernard is more concerned with point-to-point comparisons of vertical structures that are removed from the real time in which the piece takes place.¹²

Bernard applies similar tools to analyses of passages of Elliot Carter's music. In the examples Bernard chooses, examples whose structure is *highly* dependent on pc sets, Bernard shows that, in a number of works, chord identity is formed not just by pc sets, but also by the registral distribution of those sets. The opposition produced by the various spatial sets are what help to create form in some of Carter's compositions.¹³ In another study Bernard examines the music of Bartók who, like Varèse, also used symmetrical vertical chord structures. More so than in his Varèse or Carter study, Bernard begins working on uncovering developmental processes on local symmetrical structures that have larger-scale implications in the form of the piece.¹⁴

These studies are vertically oriented and omit the time element to a certain degree. Bernard's analyses also tend to originate at the local level with a particular detail, such as a single chord structure, and extend outward. Because his method begins at such a detailed level, and because it is, by the author's own admission, somewhat cumbersome, it would be a daunting project to analyze an entire piece in that manner. While Bernard is able to beautifully uncover surface relationships for short passages of music, we are likely never to see how his method helps identify larger structures and connections within an entire composition.

¹² Bernard, Jonathan W. "Pitch/Register in the Music of Edgard Varèse." *Music Theory Spectrum*, Vol. 3 (Spring, 1981): 1-25.

¹³ Bernard, Jonathan W. "Spatial Sets in Recent Music of Elliott Carter." *Music Analysis*, Vol. 2, No. 1 (March, 1983): 5-34.

¹⁴ Bernard, Jonathan W. "Space and Symmetry in Bartók." *Journal of Music Theory*, Vol. 30, No. 2 (Autumn, 1986): 185-201.

With his series of articles on the music of Ligeti, Bernard begins to look at form, or spatial design, on a slightly larger scale. His use of pitch graphs for entire pieces attests to this new engagement with larger formal aspects. However, he still focuses mainly on intervallic relationships in vertical structures and how various processes applied to these structures contribute to the development of form at higher levels of organization. His method consistently deals with how details in the vertical dimension translate to formal progress at the next largest level. As such, spatial developments are always referenced to the pitch shape's internal construction.

A complementary way of viewing spatial developments would be to reference them within the pitch field in which they take place. Instead of showing how pitch shape is related to internal constructions, this approach would show how pitch shape is related to the range of the piece, or in other words, how the pitch shape is registerally positioned in its own particular registral framework. An approach such as this would allow easy comparison of various sections of the piece at a global level and can be retranslated to apply to more local levels as well.

This is precisely the approach I advocate. I have used the theoretical writings of Robert Cogan as a starting point. Cogan's approach to spatial analysis is more comprehensive than that of Bernard in that he examines spatial designs of pieces in multiple textures and styles. In his text, *Sonic Design*, he writes, "One way of regarding a musical work is *as a motion, display, or design unfolding in time and acoustical space.*"¹⁵ This statement suggests that any kind of musical work can be seen in this way. It also implies that the study of what he calls "musical space" includes both an

¹⁵ Cogan, Robert and Pozzi Escot. *Sonic Design*. (Englewood Cliffs, New Jersey: Prentice-Hall, 1976) 16.

examination of *motion* in space, which occurs through time, as well as architectonic spatial *design*, which exists outside of time but is revealed to the listener through time. Finally, Cogan's notion of acoustical space, as with any kind of space, can be bounded in various ways, as well as filled, or articulated, in various ways (with pitches or noises, for example).

In *Sonic Design*, Cogan discusses the pitch graph and how it more accurately represents spatial relationships than traditional music notation. With regard to spatial motion, he discusses the concept of linearity, linear embellishment and the interaction of lines in various textures. He also shows how register can be used as a compositional element revealing how an underlying linear design can be distributed among different registers to create a "registral form."¹⁶ Here he separates out the two types of motion, linear and registral, and thus addresses two reasonable ways of approaching pitch space mentioned earlier – the helix model which takes into account octave equivalence and the two dimensional space of time-versus-pitch. He suggests that analysis of registral space can be quite profitable to the complete understanding of a musical work.

Progressively examining spatial designs that are further removed from the concept of linearity, Cogan discusses pitch fields as a compositional element. He shows how the activity of different sections of a work can take place within different bounded areas of acoustic space, thus looking at the distribution of the pitch fields to uncover further interesting spatial relationships. At this point he introduces the concept of density of vertical structures as well. Of course, this last kind of spatial design is potentially useful in studying certain 20th-century styles. Overall, however, Cogan draws musical examples

¹⁶ Ibid, 42-49. See Cogan's discussion of Beethoven's Piano Sonata in E-flat, Op. 31, No. 3, first movement.

to support his various ideas about spatial motions and designs from a wide range of literature, including Josquin, Bach, Mozart, Beethoven, Schoenberg, and Carter.

The methods of the contour theorists and of Bernard describe, respectively, horizontal and vertical spatial constructions, and show how these constructions are used to create meaningful musical relationships. A limitation of these studies is their confinement to specific musical styles and, for the most part, their application to more detail-oriented analysis. Additionally, all spatial constructions are measured against the pitch shape itself in one way or another, as if the music were floating in an infinite acoustic space.

In actuality, each composition is contained within a particular, bounded, acoustic space, in the same way that a painted object is confined by the edges of a canvas. This space is limited in a number of ways. First, the instrumentation restricts the range of the pitch field. Then too, musical genre limits to varying degrees the amount of time in which a piece will unfold. Historic period will also affect both dimensions, due to mechanical developments in instruments and shifting temporal expectations for various types of works. Finally, within this loosely restricted space the composer exerts his own artistic vision, creating various shapes and motions that use all or parts of the available pitch field. It is the entire pitch shape and how it is placed in this space, not merely a linear edge or vertical slice, which should be examined, for this shape may be an integral component of a composition's design.

My study is an attempt to extend Cogan's work by creating a means of categorizing and quantifying different facets of musical space. The data thus collected

can be analyzed in a number of ways, according to the individual characteristics of a composition, to reveal meaningful relationships in its overall spatial design.

II. THE GOALS AND THE METHOD.

A. The Association of Positive and Negative Space with Music.

The first time I listened to a recording of Ligeti's *Continuum*, I was particularly struck by the ending of the work. The piece begins as a narrow band of sound in a middle register and gradually expands both higher and lower until the pitch shape stretches across almost the entire range. Directly after the point of maximum expansion, the middle and lower registers drop out and the final section of the work utilizes only the uppermost register.

Because of the earlier spatial developments in the piece, at this final section, I became aware of a vast region of sound – the lower and middle registers - that was missing. Areas of the range that were *not* being sounded became an equal part of my awareness with the range that *was* being sounded. After viewing a pitch graph of the piece, I realized I was experiencing what I thought of as a parallel development in “modern” visual arts.

An important consideration when composing a drawing, painting, or photograph is the relationship between positive and negative space. Positive space is what we would consider the “subject” of the painting. Negative space would be the background to the subject and may consist of objects such as the floor or ground and the walls or sky. Traditionally, a good composition would take into account the geometric shapes formed by areas of negative space, but it was primarily the subject of the painting that formed the

“meaning” of the painting. However, in the second half of the 19th century, as the medium became just as much a part of the meaning of a painting as the subject, the relationship between positive space and negative space changed for some artists. Sometimes the canvas plane was painted in such a way that the sense of space was flattened out. In this way, the “subject” of a painting might simultaneously be a landscape scene as well as a pattern of color and shape resulting from careful division of the picture plane into geometric shapes where positive and negative space are of equal importance. Thus the consciously shaped negative space serves as an important formal element in the visual design.

To me, in the final section of *Continuum*, the lower and middle range, which is not activated, translated into a kind of sonic negative space. At that moment I realized that a piece’s spatial design could be more accurately accounted for and understood by including in the analysis both what was and wasn’t sounding within the work’s range, thus analyzing both its “positive” and “negative” space.

B. The Pitch Graph and Quantification of Positive and Negative Space.

A pitch graph provides an overall view of the shape of a composition and is a format from which the pitch data of interest can be easily quantified. The vertical axis of the graph represents pitch, and will match the range of the piece exactly so that the highest note in the piece is the highest value on the graph and the lowest note of the piece is the lowest value on the graph. Time forms the horizontal axis with the smallest note value in the composition representing the smallest time unit. For example, in the Chopin etude, the range of the entire work (not just the excerpt here) is from C1 to E7 so these

notes form the outer values of the y-axis (Fig. 1.2).¹⁷ From this information, the midpoint of the range can be calculated, which, in this case, is D4. This central pitch axis can serve as an important reference point during the analysis. The etude moves in constant 16th notes so each 16th is recorded as one square. On this particular graph, measures are marked with vertical lines.

From the pitch graph, four types of space can be quantified: positive space (PS), internal negative space (INS), upper negative space (UNS), and lower negative space (LNS). For example, the first sonority in measure 9 consists of C2 and E-flat3. Because there are two sounding pitches, PS=2. Between the outer boundaries of the pitch shape, C2 and E-Flat3, there are 14 pitches which are not being sounded, thus INS=14. UNS is calculated by counting the number of pitches above the highest sounding note (E-flat3) to the uppermost range of the piece (E7), which equals 49. Below the lowest note (C2) to the bottom of the range (C1) there are 12 possible pitches, thus UNS equals 12. These values are calculated for the entire piece. A sample of the data for measure 9 can be seen in Table 1.1.

C. The Line Graphs of Positive and Negative Space.

From this data, a series of graphs can be generated which illustrate the spatial developments in a piece. The line graph of positive space shows that for the entirety of mm. 9-17, the etude remains in a two-note texture (Fig. 1.4). The graph of internal negative space shows that for each measure, the internal negative space fluctuates within a narrow band of values (Fig. 1.5). The consistency in this example results from the

¹⁷ C4 refers to middle C.

TABLE 1.1. Space values for measure 9 of Chopin's *Étude No. 12*.

Measure	PS	INS	UNS	LNS
9	2	14	49	12
9.0625	2	11	45	19
9.125	2	14	37	24
9.1875	2	14	37	24
9.25	2	11	33	31
9.3125	2	14	25	36
9.375	2	14	25	36
9.4375	2	11	21	43
9.5	2	14	13	48
9.5625	2	11	21	43
9.625	2	14	25	36
9.6875	2	14	25	36
9.75	2	11	33	31
9.8125	2	14	37	24
9.875	2	14	37	24
9.9375	2	11	45	19

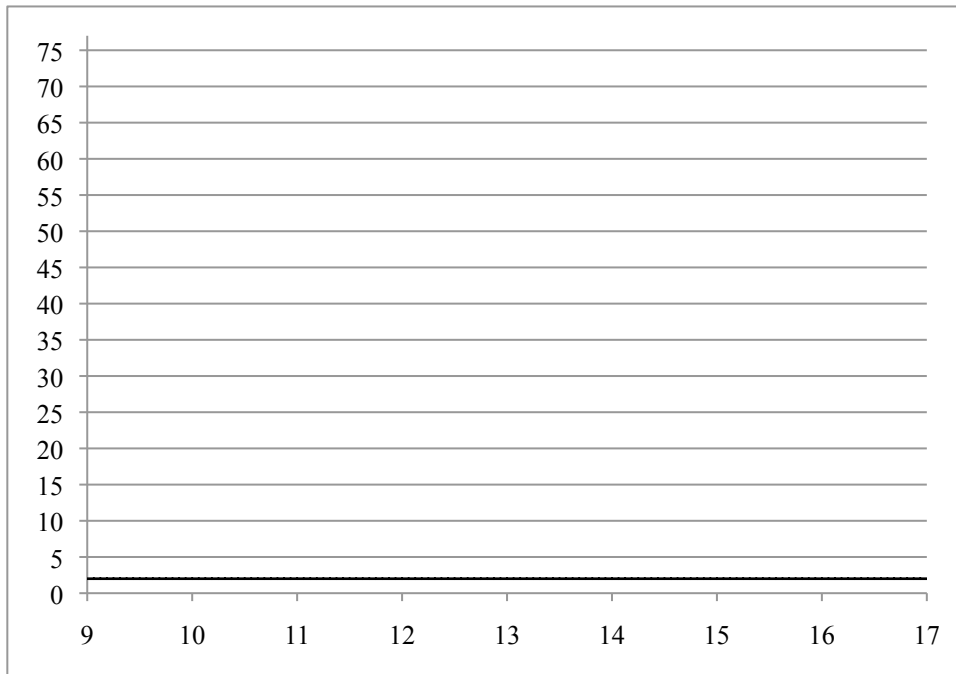


FIGURE 1.4. Positive space (PS), mm. 9-17.

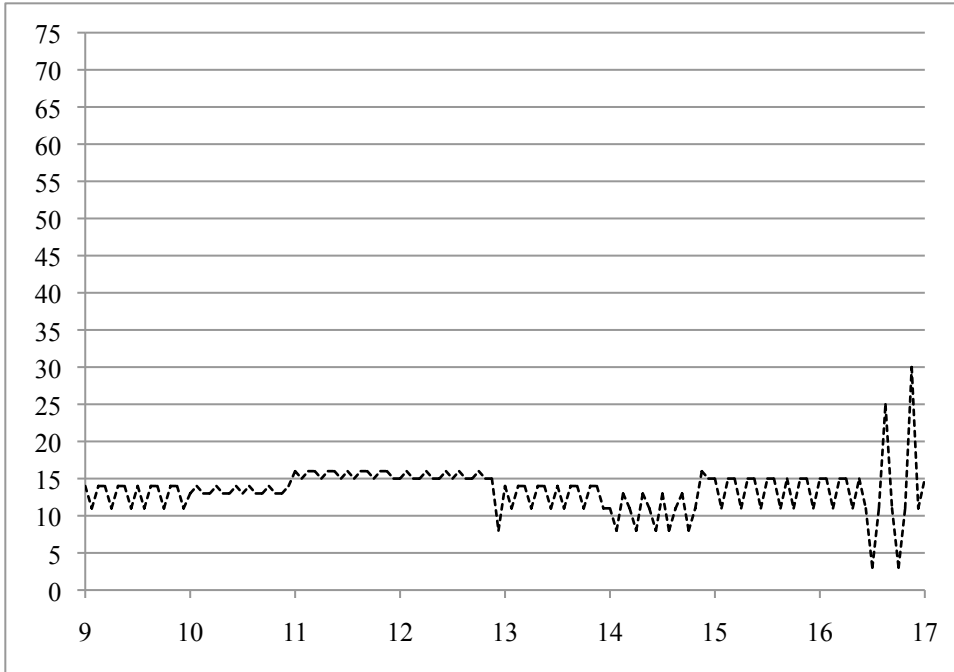


FIGURE 1.5. *Internal negative space (INS), mm. 9-17.*

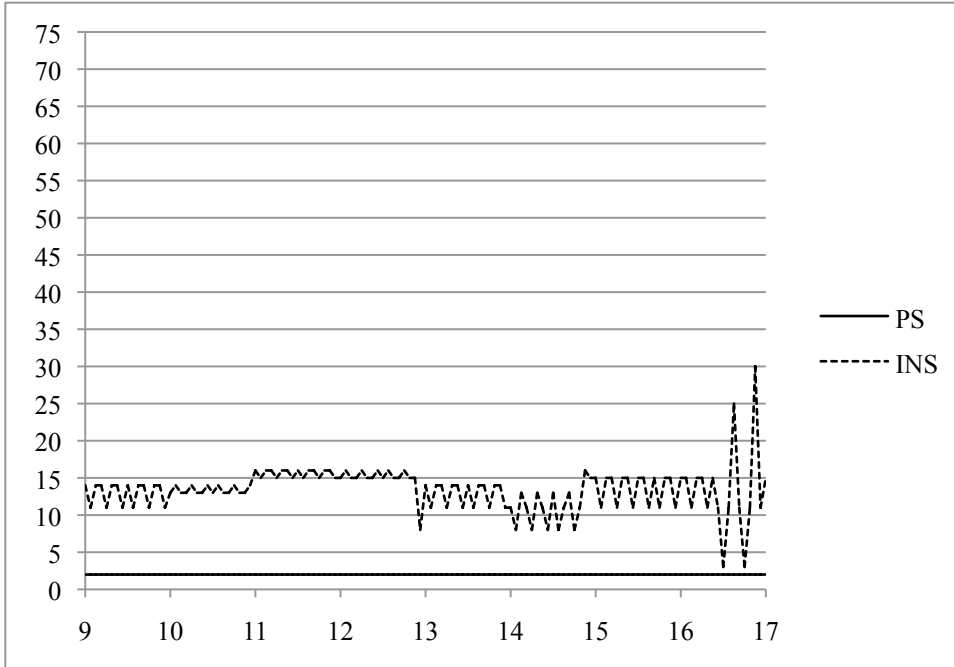


FIGURE 1.6. *PS and INS, mm. 9-17.*

broken chord pattern, which, for the most part remains the same for each measure aside from being transposed up and down to different registers. The two peaks in INS that occur in measure 16 coincide with the only instance of contrary motion thus far in the piece. The sudden change from continuous parallel motion to contrary motion at this point, as well as the change in sonority due to the increased INS, assists in bringing out the soprano melody notes which are placed precisely at the peak of INS. The combined graph of PS and INS (Fig. 1.6) shows that any developments in the pitch shape have to do with shifts in INS as PS remains constant. The line graphs of PS and INS provide information concerning the pitch shape and texture – information that is isolated from how the shape moves through the pitch field.

The graphs of UNS and LNS, on the other hand, show how the outer boundaries of the pitch shape are moving within the range of the composition. In the etude, a general pattern emerges which results from the ascending and descending arpeggios. A peak in UNS occurs at the start of each measure, corresponding to the lowest point of the arpeggios (Fig. 1.7). As the arpeggio rises during the measure, UNS decreases, and as the arpeggio falls again, UNS increases. In measure 15, UNS descends to 0, which means the piece has reached the highest note in the range. Additionally, the temporal distance between peaks at bar 15 and the subsequent peak in the middle of bar 16 is a measure and a half rather than a measure like the rest of the passage. These graphs show that the expansion of the arpeggio's range and the expansion of time taken to complete the arpeggio are coordinated with the apex of the entire work creating a climactic moment in the piece.

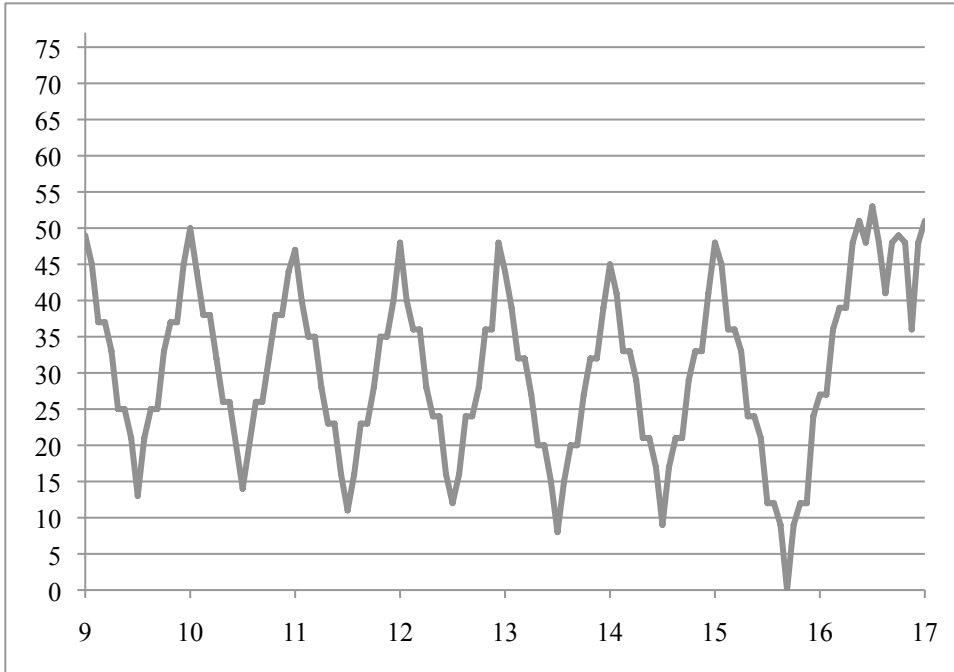


FIGURE 1.7. *Upper negative space (UNS), mm. 9-17.*

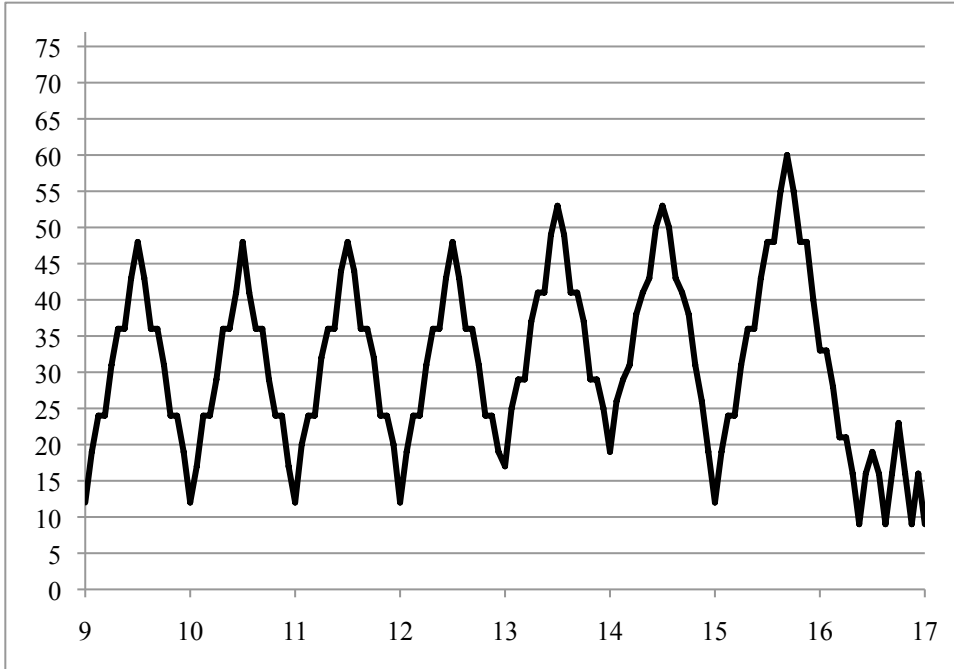


FIGURE 1.8. *Lower negative space (LNS), mm. 9-17.*

Because the main motion is that of ascending and descending arpeggios, the graph of LNS is almost an exact inversion of the UNS graph (Fig. 1.8). As the arpeggios ascend, LNS increases, and as they descend, LNS decreases. This inverse relationship can be seen on a graph of both UNS and LNS (Fig. 1.9). It is clear from the last portion that at the end of the passage, the arpeggio pattern has changed, and is replaced by material which stays lower in the composition's range.

A graph of total space shows that the most dynamic types of space are UNS and LNS and that they will be primarily responsible for the motion in the piece (Fig. 1.10). It is true that the ascending and descending arpeggios will be more noticeable than the more subtle shifts that take place in INS due to shifting harmonic intervals. However, at the end of this section, after UNS has reached 0 and LNS has peaked, INS becomes more prominent in the spatial profile. The shifting INS may be both a response and an echo of the climactic shifts in UNS and LNS in measures 15-16.

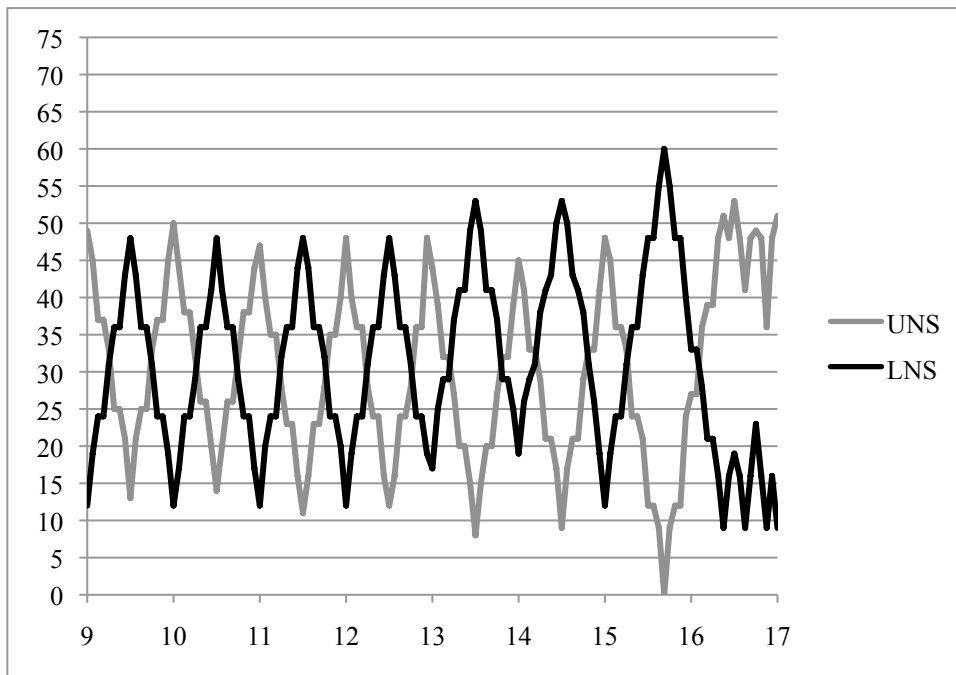


FIGURE 1.9. *UNS and LNS, mm. 9-17.*

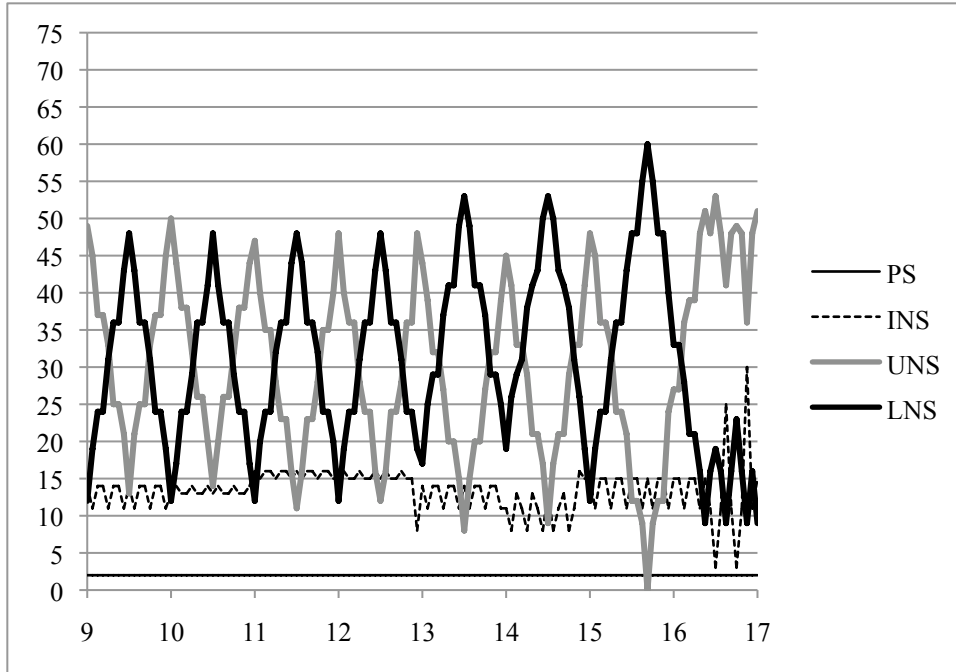


FIGURE 1.10. *Total registral space, mm. 9-17.*

D. The Median Trajectory Graph.

This final graph tracks the path of the central point of the pitch shape for each vertical slice of measured time, thus showing the sum motion of the pitch shape through the pitch field (Fig. 1.11). $Y=0$ represents the midpoint of the piece's range so the path which the pitch shape travels can be easily referenced to the central pitch in the range.

This graph reveals two important types of information – the overall motion of the piece as well as how this motion is placed within the registral frame of the piece.

To calculate the values for this graph, UNS is subtracted from LNS. For example, the first two pitches in measure 9 are C2 and E-flat3. For this sonority, which is placed in the low range of the piece UNS=49 and LNS=12. When subtracted from LNS we see that UNS is greater than LNS by -37 pitches, with the negative value representing that the pitch shape is lower than the midpoint of the range. To find the center of the

pitch shape this value must be divided by 2, resulting in a value of -18.5. The actual midpoint between C2 and E-flat3 falls between two pitches, G2 and A-flat2, which explains why the final value is not a whole number. To check accuracy of our method we find that A-flat2 lies 18 pitches below D4, the central pitch in the piece's range, thus the central point in our pitch shape is, indeed, 18.5 pitches below the midpoint of the range.

For this particular excerpt in the Chopin we see the arpeggios in the piece move up and down within a fairly centered range. The outermost points remain within a range of -19 to -13 for the low end and 17 to 22 for the higher end. We see that the arpeggio in measures 15-16 takes the piece off balance by traveling up to a value of 30. This movement toward the upper range of the piece is immediately balanced by an extended return to the lower range of the piece in the second half of measure 16. The median trajectory graph is a particularly powerful tool as it summarizes a piece's overall motion *and* registral placement.

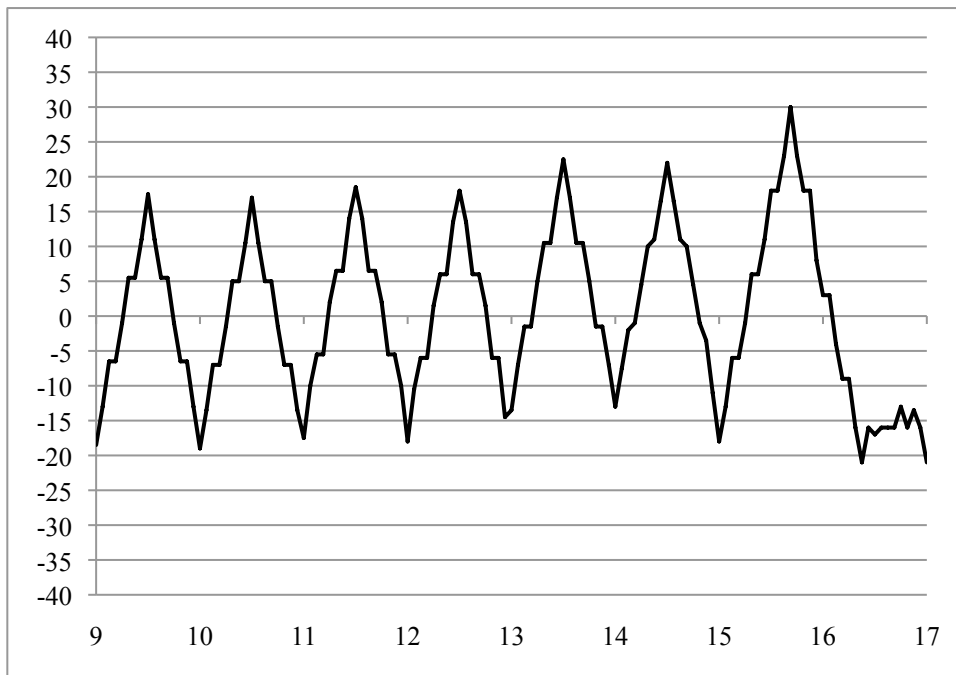


FIGURE 1.11. *Median trajectory graph, mm. 9-17.*

In subsequent chapters I will use these tools to examine in detail the spatial designs of the three compositions mentioned earlier: György Ligeti's *Continuum* (1968), Josquin's "Benedictus" from his *Missa L'homme armé super voces musicales* (c. 1490-5), and Beethoven's Bagatelle in G major, Op. 126, No.2 (1824). The reasons that I have chosen these specific works are threefold. First, I wanted to demonstrate the applicability of my method of analysis to music from vastly different historical periods of Western music. (This is not to suggest that it is inapplicable to the study of non-Western music. I have chosen only to frame my discussion within the traditions of Western art music.) Second, as I hope to show, in each of these works spatial motion is extremely important to our musical experience – indeed as important as harmony, rhythm, or virtually any other aspect of composition. Third, each of these works presents a uniquely different focus on spatial motion. For example, in his bagatelle, Beethoven is specifically concerned with internal negative space and develops this aspect of space in dramatic ways. As such, in this composition he makes this particular aspect of musical space a central part of our musical experience.

CHAPTER 2: A PRELIMINARY STUDY – LIGETI’S *CONTINUUM*

I. OVERVIEW OF *CONTINUUM* AND SUMMARY OF SCHOLARSHIP.

Continuum, composed in 1968 for two-manual harpsichord, is an example of one of György Ligeti’s sound mass compositions. In sound mass composition, timbre, texture, density, range, rhythmic activity, and register are manipulated to create various qualities of sound. These sounds form shapes in musical space, and their placement within the piece’s registral framework acts as an important formal element. Because register is one of the foremost structural elements, a sound mass composition such as *Continuum* serves as a good preliminary study to test my new method for spatial analysis.

Continuum was commissioned by the Swiss harpsichordist, Antionette Vischer, who also commissioned harpsichord works from Henze, Berio and Earle Brown. This piece was composed for the modern two-manual harpsichord, which contains 16’, 8’, and 4’ stops. During the mid-1900’s, the modern harpsichord was more common than the period instrument which was later revived as interest in historically informed performances grew.¹⁸

In *Continuum*, two single lines of pitches played evenly and rapidly create the illusion of continuous sound. Each hand plays a repeating pattern of pitches which is gradually transformed. Ligeti indicates that the piece is to be performed in less than four minutes, resulting in a rapid tempo - at least 13 notes per second. The composition can be divided into five sections, each defined by an initiating trilled dyad from which a cluster of sound develops and constantly evolves at varying rates (Fig. 2.1). Each section’s unvarying initial dyad, referred to as an “interval signal” by Ligeti himself, is

¹⁸ R. Steinitz, *György Ligeti: Music of the Imagination* (Boston: Northeastern University Press, 2003) 164.

heard for a comparatively long duration (between approximately 6 and 11 seconds), and serves as a stable sonority to which pitches are gradually added.¹⁹ The added pitches either fill in the space created by this signal or expand its range both above and below the dyad boundaries. These clusters have a number of distinguishing factors such as shape, placement, and density, all of which will be addressed in this study. A pitch graph of the entire work shows how each of the sections' distinct cluster formations creates a particular shape in pitch space (Fig. 2.2). Together, the five sections of the work describe a unique motion through space, the boundaries of which are defined by the highest and lowest notes of the piece (C#1 to E7).

Section:	I	II	III	IV	V
measures:	1-49	50-86	87-118	119-143	144-205
# of measures:	49	37	32	25	62
Subdivisions:					
initiating dyad:	1-9	50-55	87-91	119-125	144-149
# of measures:	9	6	5	7	6
					150-154
					5
cluster:	10-49	56-86	92-118	126-143	155-177
# of measures:	40	31	27	18	23

FIGURE 2.1. *Formal outline of Continuum.*

¹⁹ M. Hicks, "Interval and Form in Ligeti's *Continuum* and *Coulée*," in *Perspectives of New Music* (1993) 31/1: 173.



FIGURE 2.2. *Pitch graph of Ligeti's Continuum.*

Two fairly recent articles summarize the analytic work on *Continuum*. Clendinning's "The Pattern-Mecchanico Compositions of György Ligeti"²⁰ and Hick's "Interval and Form in Ligeti's *Continuum* and *Coulée*." Clendinning's article contains the most comprehensive analysis of the work, addressing pattern shifts, the pacing of pattern changes, and the interaction of pattern beginnings as well as the ways in which sections I through IV constitute an overall expansion with increasing intensification and harmonic tension. Hick's work on *Continuum* deals with specific intervallic relationships in the piece. He discusses how the construction of the initial interval signals initiate a process by which notes are added to form each cluster and also locates the use of symmetric harmonic structures in the composition.

A 2008 paper by Cambouropoulos and Tsougras attempts to use principles of musical stream perception to determine how *Continuum* may be perceived by a listener.²¹ He describes and supports through these principles of auditory streaming a number of structures that perceptually emerge and continues to analyze the piece accordingly. While his final analysis of the piece does not come to entirely new conclusions, it does provide both a clear explanation of what a listener will hear as structurally important and then uses this information to create a reductional analysis of the piece.

My spatial analysis of *Continuum* contributes to and complements this body of work in two ways. First it deals primarily with facets of the piece that are easily perceptible such as large-scale spatial motion and cluster density rather than detailed

²⁰ J. P. Clendinning, "The Pattern-Mecchanico Compositions of György Ligeti," in *Perspectives of New Music* (1993) 31/1.

²¹ E. Cambouropoulos and C. Tsougras, "Auditory Streams in Ligeti's *Continuum*: A theoretical and perceptual study," in *Proceedings of the Fourth Conference on Interdisciplinary Musicology (CIM08)* (2008).

intervallic analysis of harmonic structures. More importantly, it shows how the interaction of the pitch shape with the registral framework of the piece directly influences the development and placement of the clusters.

II. SPATIAL ANALYSIS OF SECTION I.

The pitch graph of section I reveals a narrow opening cluster placed in the middle range of the piece (Fig. 2.3). The cluster forms around an initiating dyad by gradually adding pitches within and around the dyad boundaries. The activated range for this section spans only 7 pitches from F4 to B4 (C-flat4). The local central axis of A-flat4 is almost a perfect 5th higher than the global central axis (D/D-sharp4).

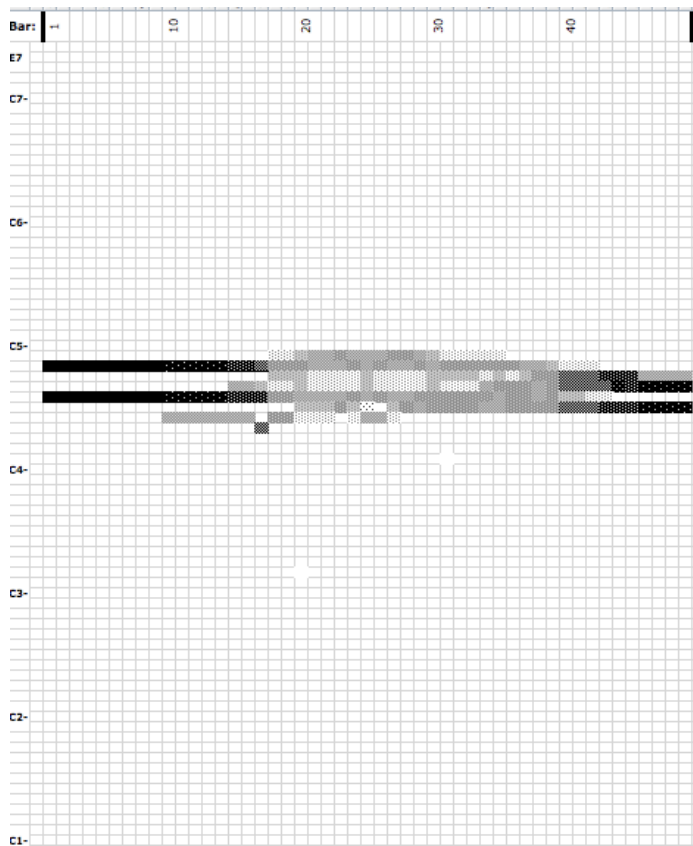


FIGURE 2.3. *Pitch graph of section I (mm. 1-49).*

As pitches are added to the cluster, PS increases from an opening value of 2 to a maximum value of 7 (Fig. 2.4). As the cluster loses pitches, PS decreases again, ending at a value of 3. On the other hand, as the cluster develops, INS decreases to a value of 0 as all the pitches within the range of the pitch shape's outer boundaries are sounded. The final sonority contains an INS value of 1. The density of the cluster increases from an opening value of 0.50 to a maximum value of 1.00, reflecting the decrease in INS (Fig. 2.5). Before the end of the section the density decreases to 0.75. The average density for section I is 0.80.

The line graph of upper and lower negative space shows relatively little change in values as the pitch shape maintains a narrow range and central placement (Fig. 2.6). LNS is consistently higher than UNS so the pitch shape sits above the global central axis. The graph of total registral space shows that the shifts in spatial development are quite small with respect to the total registral space in the piece (Fig. 2.7). The pitch shape remains relatively static within the registral framework of the composition.

The median trajectory graph of section I reflects this lack of dramatic registral motion (Fig. 2.8). The section opens with a value of 6 and closes with a value of 5, which indicates a very slight descent of the overall pitch shape. The extremely narrow range of the median trajectory is between 4.5 and 6 with an average placement of 5.5. Though the cluster expands and contracts in width slightly, its center remains fairly constant for the entirety of section I.

The opening section lacks any dramatic spatial motion or use of register. The cluster that develops is in a middle range and is narrow so only a small portion of the eventual range of the piece is used. The cluster formation develops in such a way that the

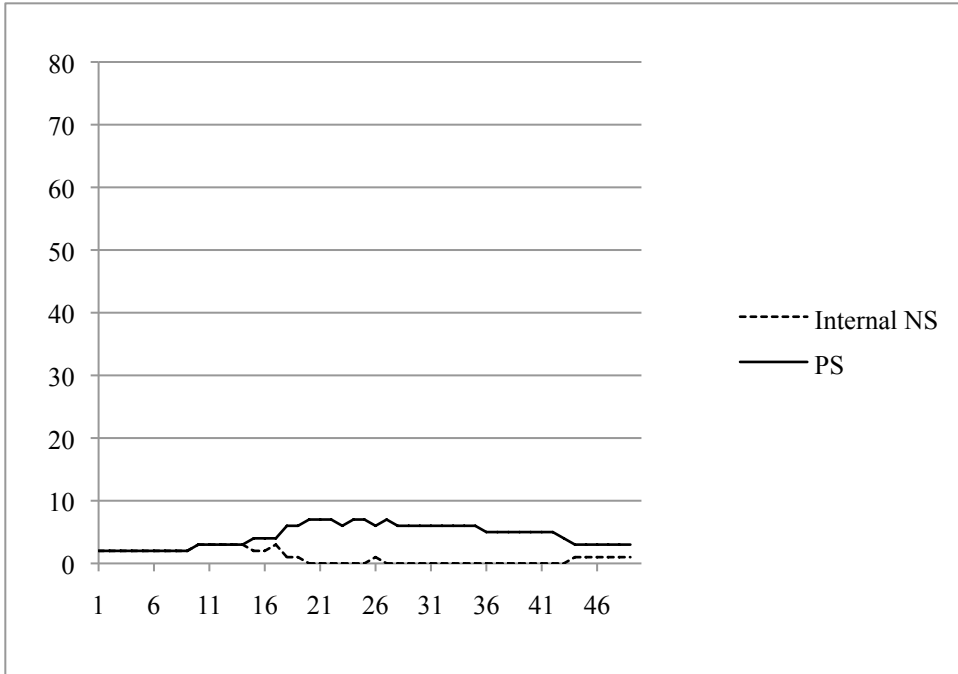


FIGURE 2.4. *INS and PS, section I.*

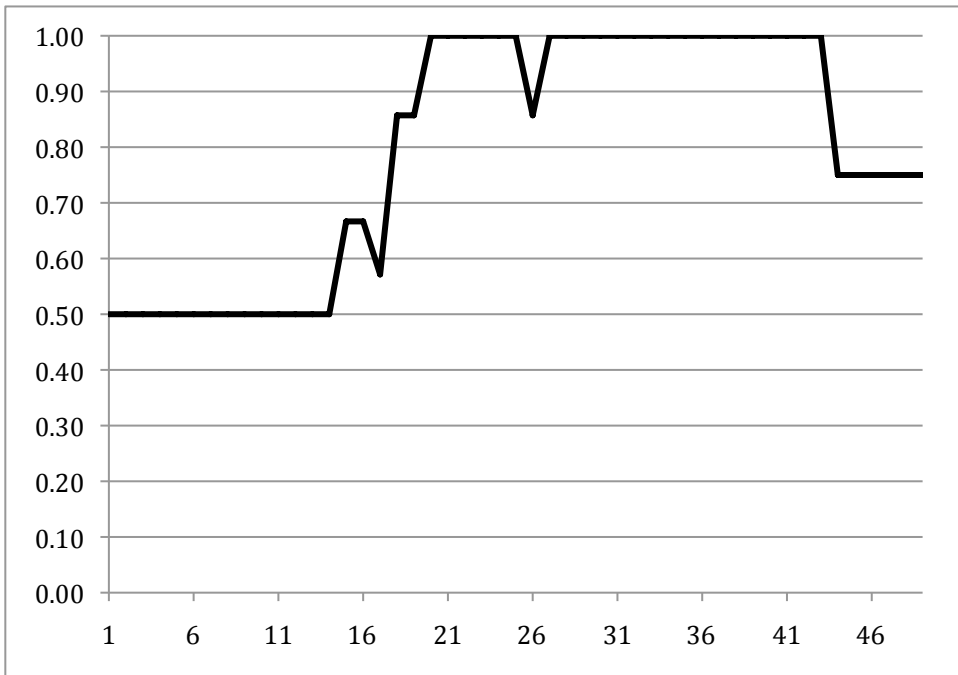


FIGURE 2.5. *Pitch shape density, section I.*

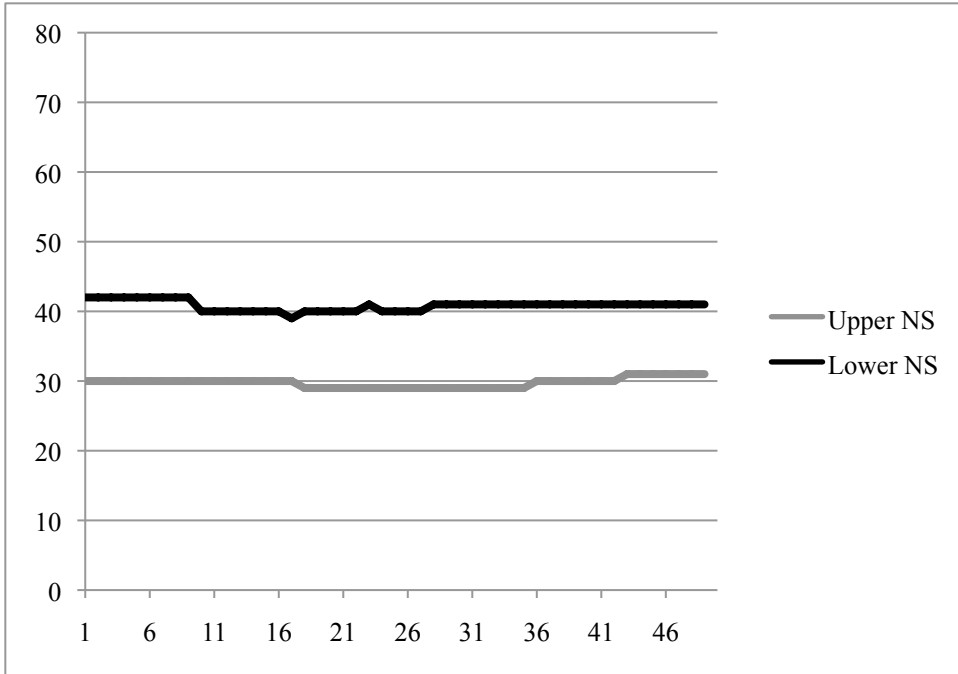


FIGURE 2.6. *UNS and LNS, section I.*

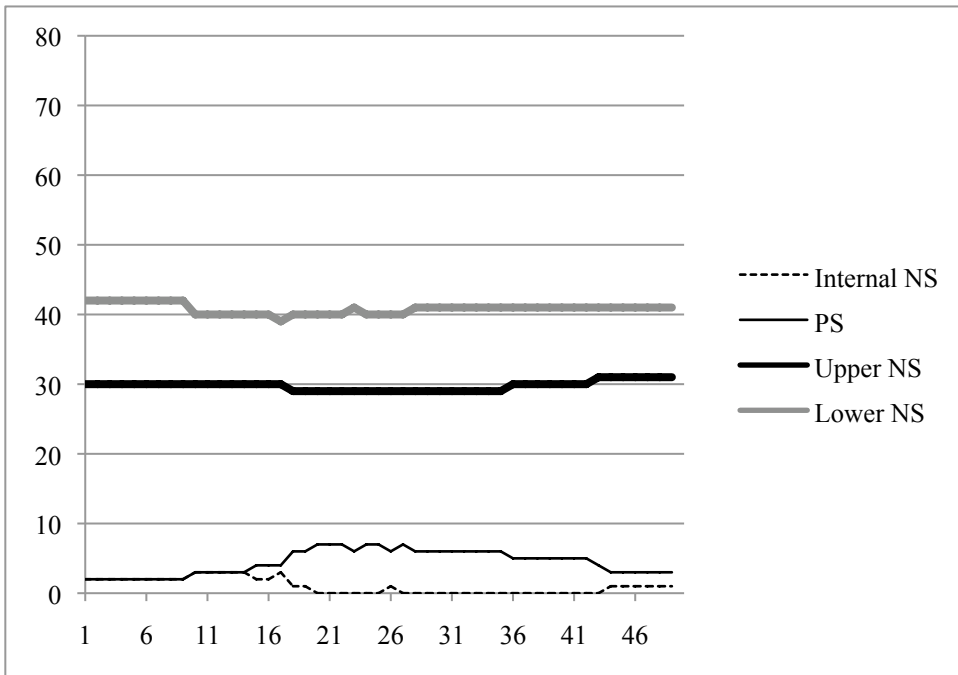


FIGURE 2.7. *Total registral space, section I.*

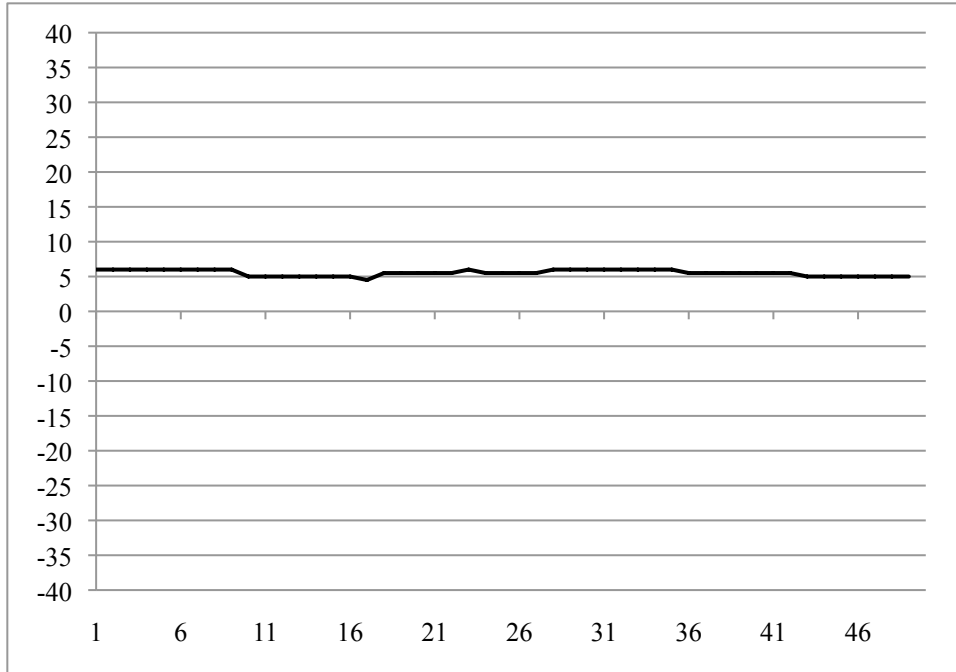


FIGURE 2.8. *Median trajectory graph, section I.*

center of the pitch shape remains basically static. The small motions within this section help to increase the drama of larger motions later in the piece by providing contrast.

III. SPATIAL ANALYSIS OF SECTION II.

The pitch graph of section II shows a cluster that is still centrally placed, but which is wider than the first cluster (Fig. 2.9). The range of section II extends from B3 to D5, spanning 16 pitches, and has a local central axis of F-sharp/G4. The local central axis for section II is approximately the midpoint between that of section I (A-flat4) and the global central axis (D/D-sharp4). While the range extends both higher and lower than the range of the opening section, the central axis is falling toward the global central axis or, in other words, toward a state of equilibrium.

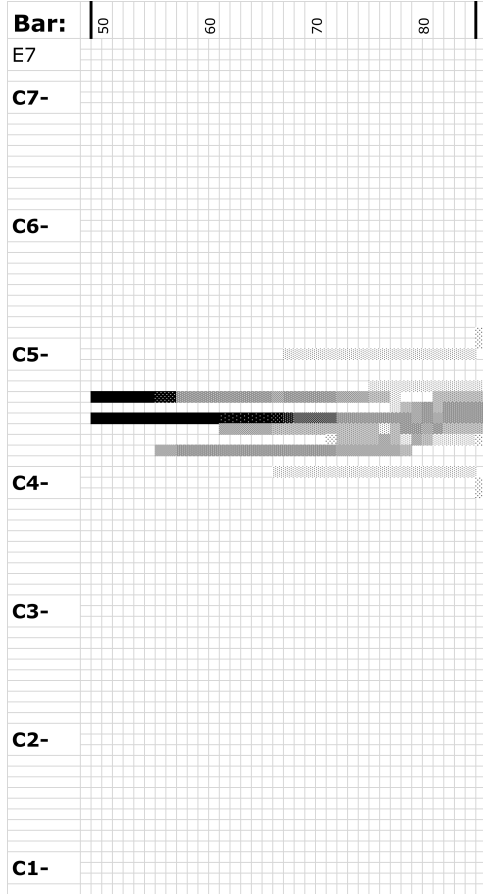


FIGURE 2.9. *Pitch graph of section II (mm. 50-86).*

Unlike in section I, in section II there is an overall increase in both PS and INS from the opening to the closing (Fig. 2.10). PS steadily increases from 2 to 10 while INS increases from 1 to 6. The pitch shape is continually expanding. The density of the cluster fluctuates between 0.50 and 0.75 with an average density of 0.61 for the entire section (Fig. 2.11). While in section I the density of the pitch shape developed in a very direct way, the development of density in section II lacks direction. Overall, the cluster is less dense than that of section I.

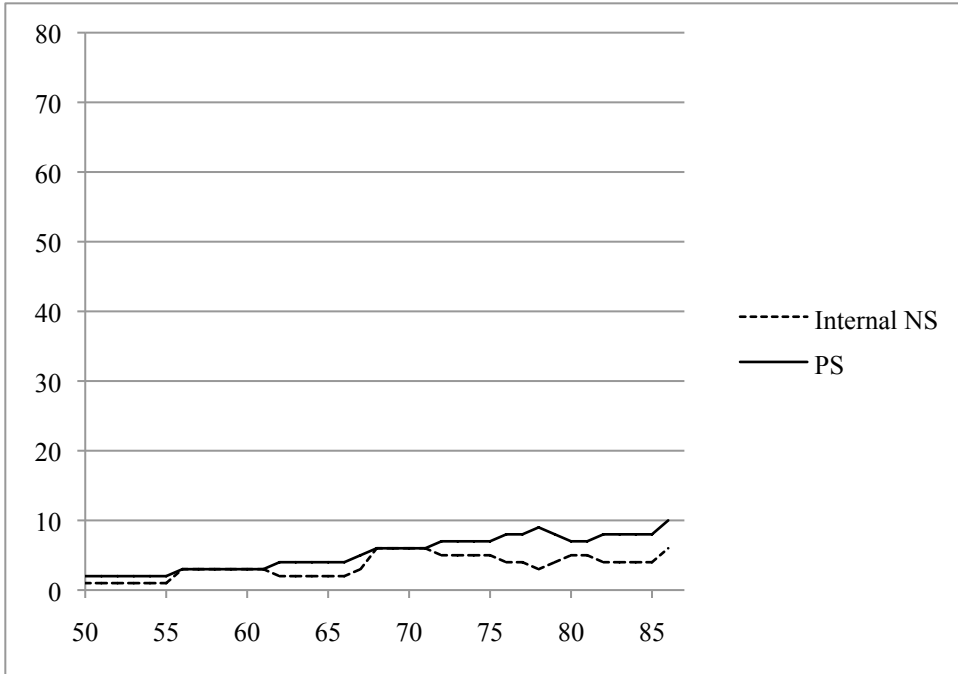


FIGURE 2.10. *INS and PS, section II.*

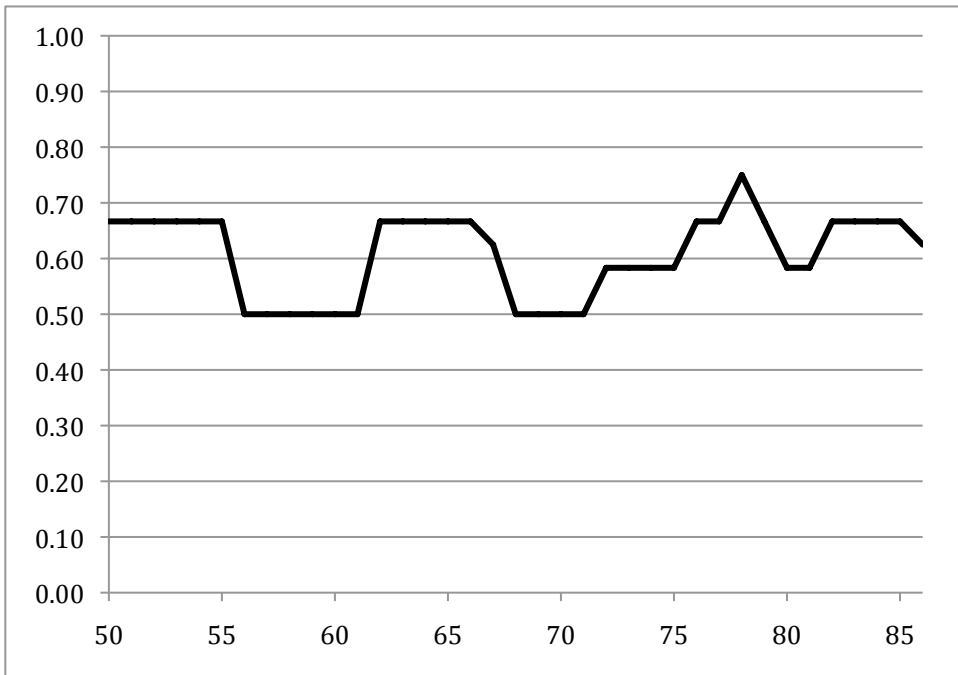


FIGURE 2.11. *Pitch shape density, section II.*

LNS continues to be higher than UNS for the entirety of this section, thus the shape is still placed above the global central axis (Fig. 2.12). The gradual decrease in both LNS and UNS is caused by the cluster expansion. The graph of total registral space shows the overall decrease in UNS and LNS and the overall increase in INS and PS (Fig. 2.13). The types of space are polarized into two groups at the beginning of section II – one with high values (LNS and UNS) and one with low values (PS and INS). As section II progresses, these types of space make a motion towards convergence or toward a state of equilibrium. However, the values never do converge before being interrupted by the initiating dyad of the next section.

The median trajectory graph shows that the center of the cluster remains fairly stably positioned (Fig. 2.14). The section opens at 4.5 and closes at 4 signifying a negligible drop. The range of motion is also narrow, lying between 2 and 4.5. The average median trajectory is 3.7 which is slightly lower than the average value of the first section (5.5). The center of the cluster consistently lies lower than that in section I.

Section II repeats the expanding motion found in section I but, rather than contracting again as in the first section, the expansion continues through the entire section, resulting in a cluster whose width is twice that of the first cluster. This section seems to have more energy available for the pitch shape to expand. Perhaps some of this energy is gained from the falling pitch shape as seen in the median trajectory graph.

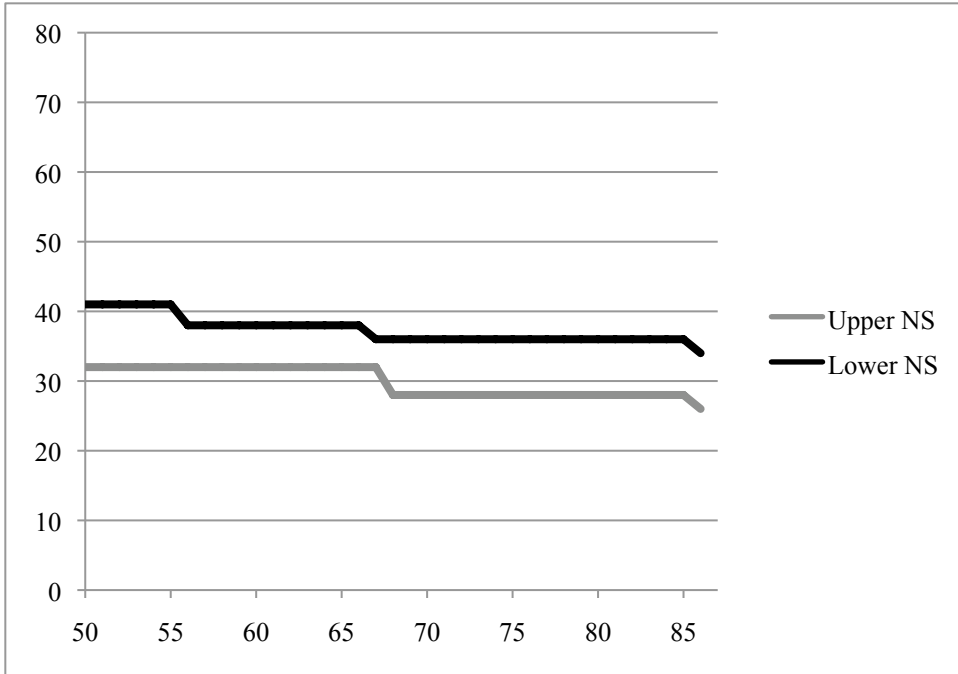


FIGURE 2.12. *UNS and LNS, section II.*

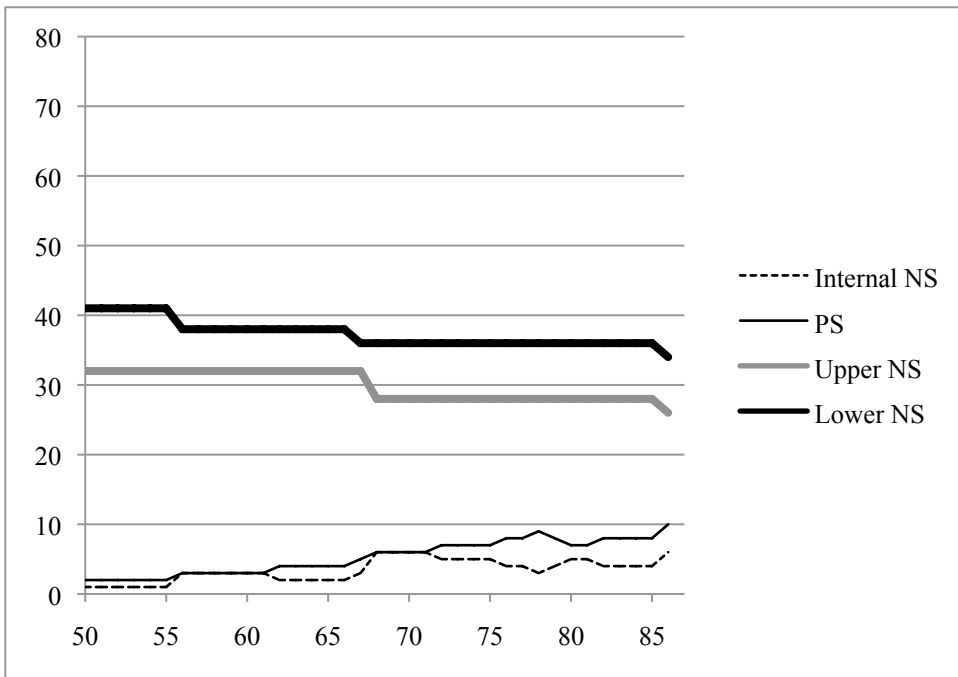


FIGURE 2.13. *Total registrational space, section II.*

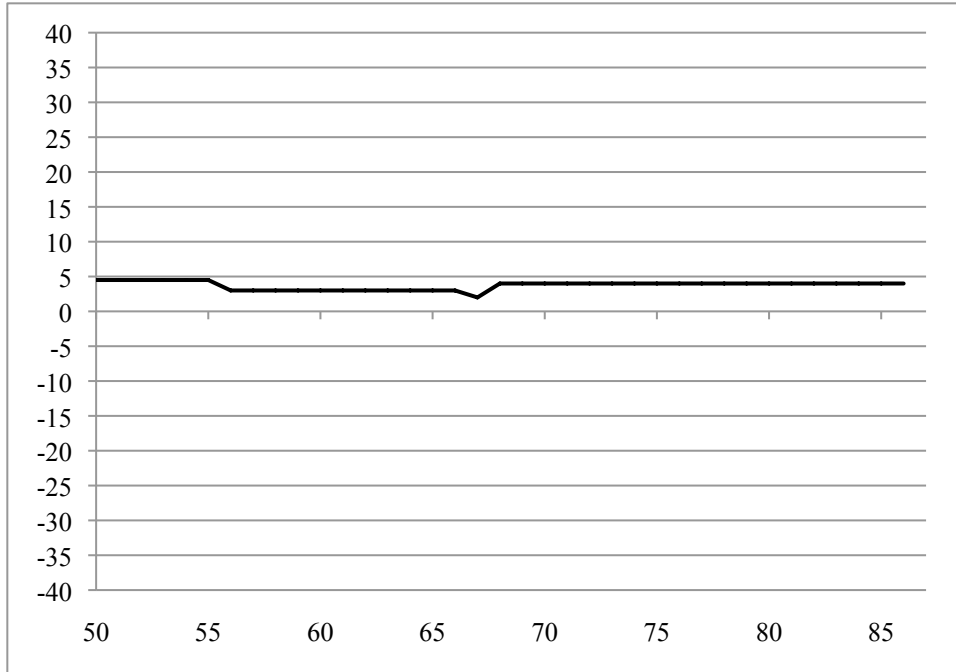


FIGURE 2.14. *Median trajectory graph, section II.*

IV. SPATIAL ANALYSIS OF SECTION III.

The pitch graph of section III reveals a cluster that expands in an even more dramatic way (Fig. 2.15). The range for this section, F-sharp2 to G-flat5, spans 37 pitches and has a local central axis of C4. Once again, though the range is widening in both directions, the local central axis continues to fall lower, and this time, it is situated approximately one note below the global central axis. For the first time in the piece we see, near the end of the section, an emptying out of a large contiguous area within the pitch shape boundaries.

The development of PS and INS in section III is similar to that in the previous section as both show an increase over the course of the section (Fig. 2.16). However, there are two significant differences: the increase in PS and INS is more dramatic and, for

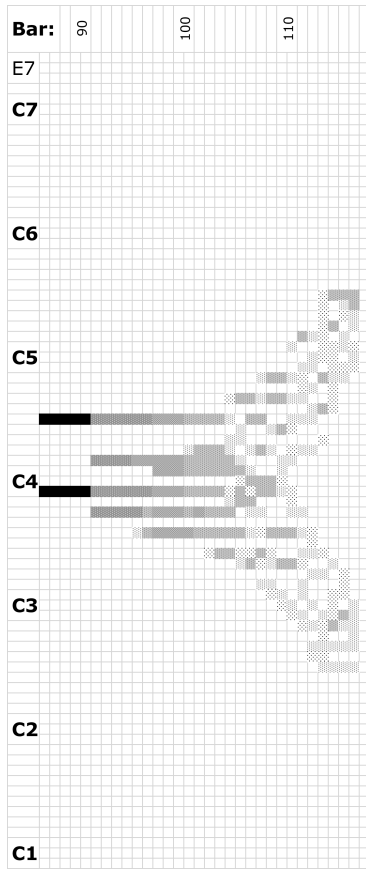


FIGURE 2.15. *Pitch graph of section III (mm. 87-118).*

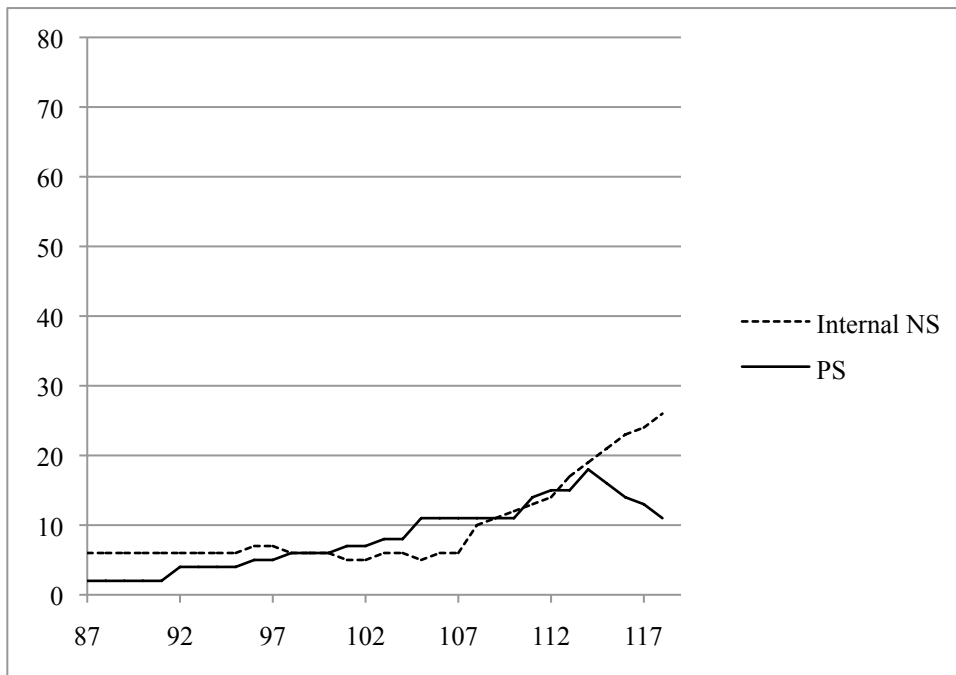


FIGURE 2.16. *INS and PS, section III.*

the first time in the composition, INS values are, at times, higher than PS values. PS increases from 2 (m. 87) to 18 (m. 114) before dropping off slightly to 11 in the last few measures before the conclusion of the section. INS increases from 6 to 24. INS values exceed PS values in mm. 87-97 and mm. 113-118. The increase in both PS and INS result from the larger expansion and the higher INS levels cause a drop in cluster density.

Unlike section II, there is a clear, directed development of density (Fig. 2.17). The cluster opens at 0.25, gradually increases to 0.69 in m. 105, and decreases to 0.30 in the final measure. The average density for this third cluster is 0.45 which is lower than that of the previous two clusters, forming a trend of decreasing density across the first three sections.

As we have already seen, section III contains some significant shifts in spatial development. There are also some important shifts in the development of INS and UNS (Fig. 2.18). The section opens with both INS and UNS at an equal value of 34. This means that the initiating dyad for this section is perfectly centered within the range of the entire piece. From that point on, UNS is greater than LNS, demonstrating that the cluster, for the first time, sits lower than the central axis of the piece.

The line graph of total registral space shows that, as in the opening of section II, the high values of LNS and UNS and the low values of PS and INS at the opening of section III polarize these types of space into two groups (Fig. 2.19). Throughout the course of the section, the types of space converge so that at m. 113, the values for LNS, INS and PS become roughly equal (18, 17, and 15 respectively) and UNS is only slightly higher (26).

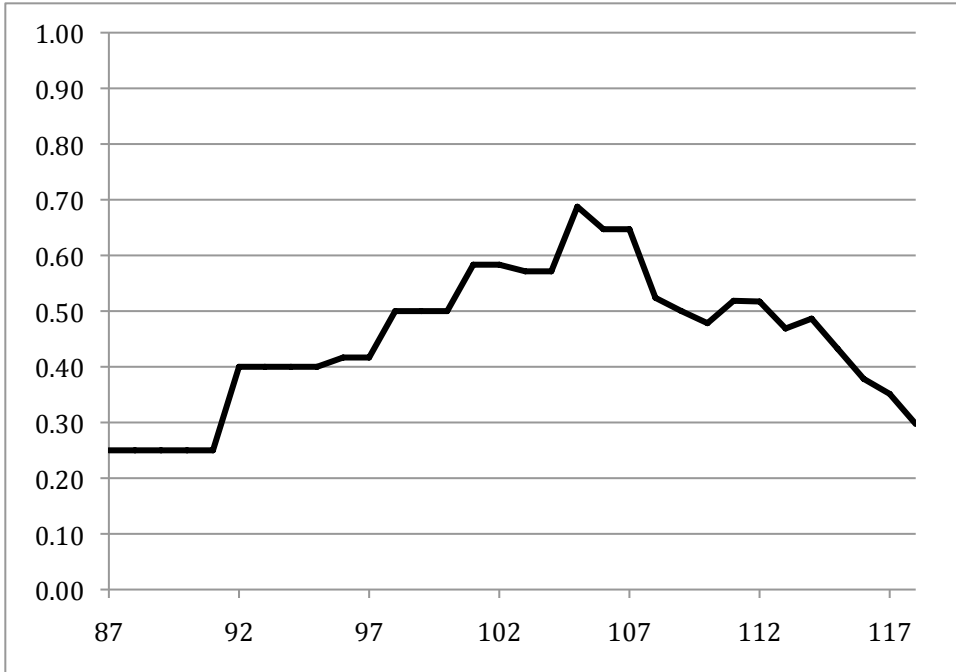


FIGURE 2.17. *Pitch shape density, section III.*

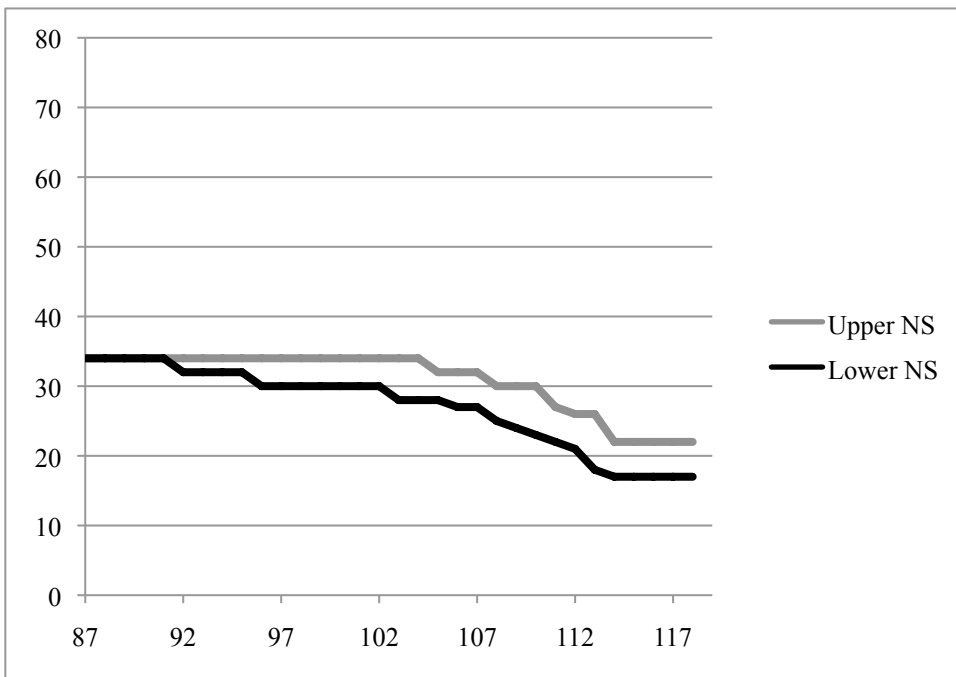


FIGURE 2.18. *UNS and LNS, section III.*

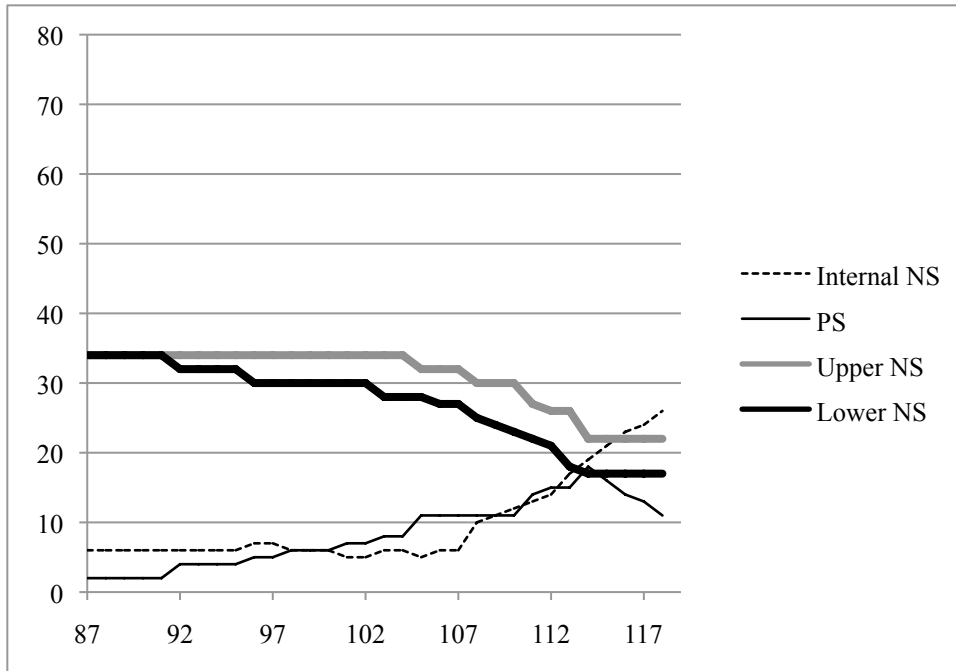


FIGURE 2.19. *Total registral space, section III.*

In the median trajectory graph we can see that at the opening, the initiating dyad is perfectly centered and that the cluster descends slightly throughout the course of the section to -2.5 (Fig. 2.20). The average placement for section III is at -1.9. Each section thus far features a cluster whose center is slightly lower than that of the previous section.

The third section continues the kinds of spatial developments found in sections I and II, though in a more exaggerated or magnified way. The expansion is more than twice the width of that in section II, average density of the pitch shape decreases, and the cluster continues to drop slightly within registral space. What is fascinating in this section are the two kinds of spatial equilibrium found at the beginning and the end of the cluster. The initiating dyad is perfectly centered within the range of the piece which provides a point of balance for the overall pitch shape. Near the end of the section, the convergence of all types of space toward roughly equal values creates a kind of

equilibrium which precedes the significantly more dramatic spatial developments found in the next section.

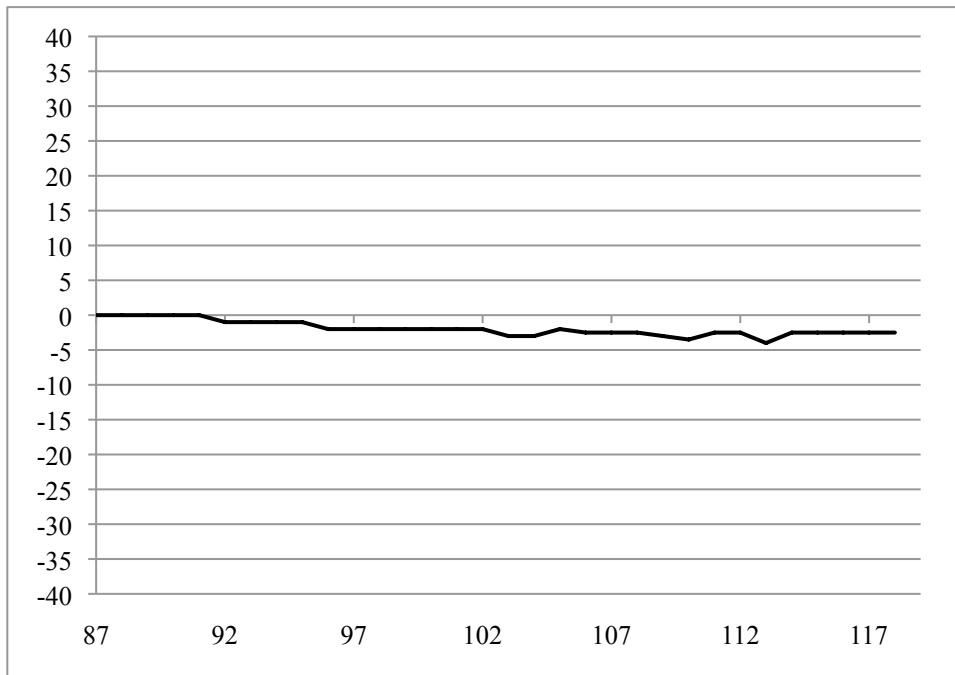


FIGURE 2.20. *Median trajectory graph, section III.*

V. SPATIAL ANALYSIS OF SECTION IV.

The range of section IV is significantly wider than that of the previous sections, spanning 71 pitches from C-sharp1 to B6. The central pitch axis, however, is the same as that of section III: C4. The cluster in this section is enormously magnified, and the initiating structure at the opening is slightly altered to reflect this magnification. Instead of an initiating dyad, there are two bands of sound that span 5 contiguous pitches each. From these two bands, the largest cluster of the piece forms (Fig. 2.21).

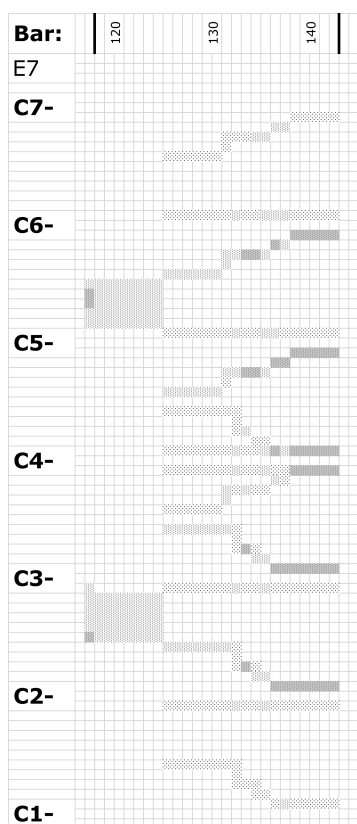


FIGURE 2.21. *Pitch graph of section IV (mm. 119-143).*

The enormity of the cluster is reflected in the graph of PS and INS (Fig. 2.22). INS dramatically increases from 27 to 59 by the close of the section. PS values show an increase from 10 to 22 (m. 133) and then a decrease to a final value of 12. INS remains higher than PS for the entirety of the section, thus this cluster is less dense than those of the previous sections (Fig. 2.23). The average density of the fourth cluster is 0.23 and there is an overall decrease in density as this cluster develops (0.27 to 0.17).

The graph of UNS and LNS is similar to that of section III in that UNS is consistently higher than LNS and both decrease due to the expanding pitch shape (Fig. 2.24). However, for the first time, LNS reaches a value of 0 which means the piece has

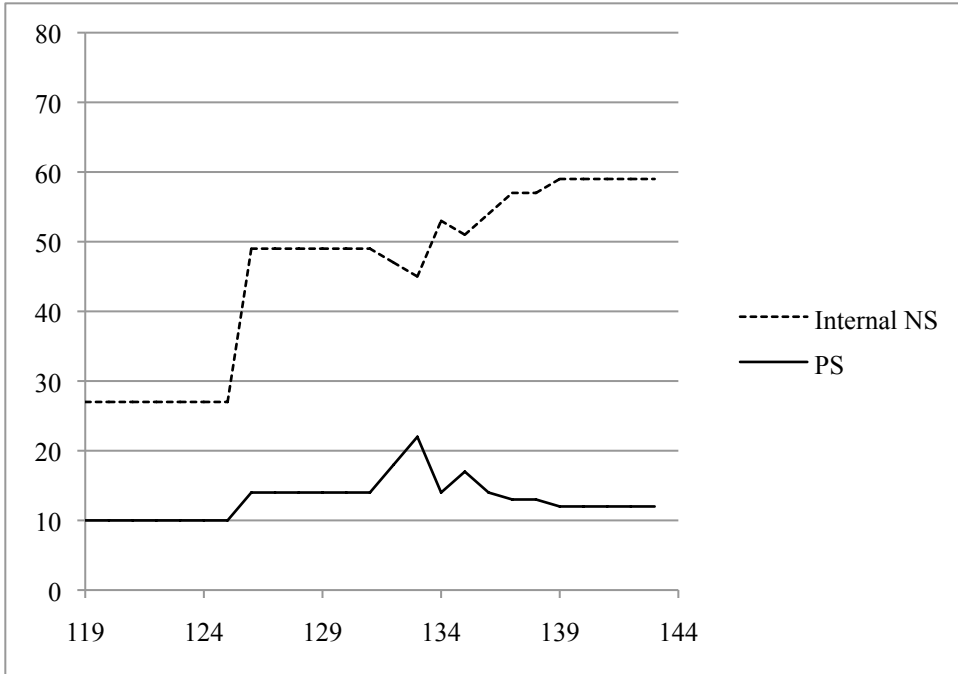


FIGURE 2.22. *INS and PS, section IV.*

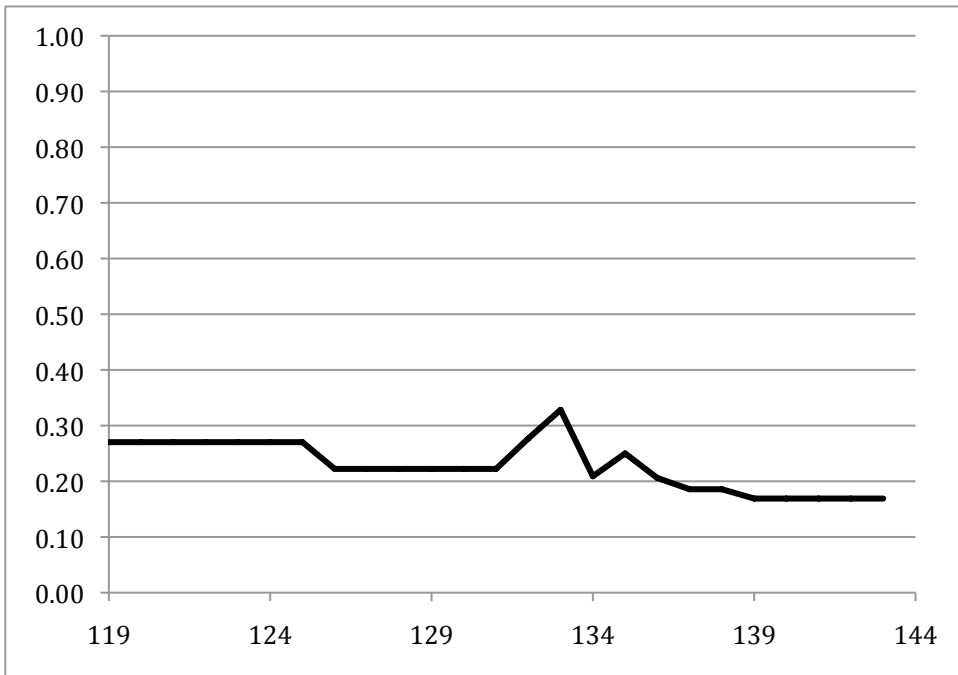


FIGURE 2.23. *Pitch shape density, section IV.*

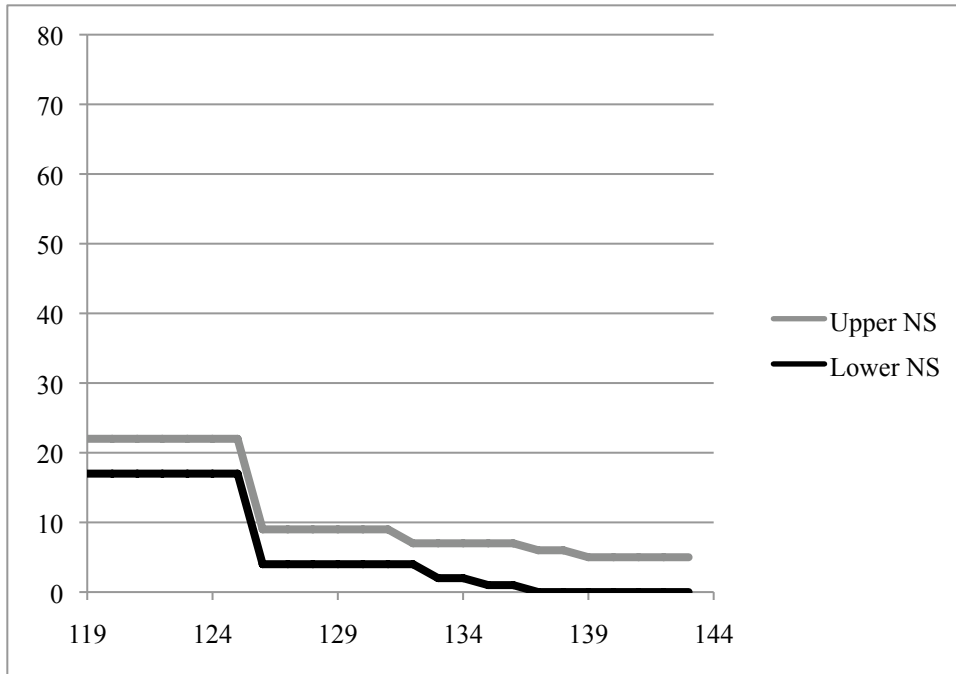


FIGURE 2.24. *UNS and LNS, section IV.*

reached the lowest note of the range. From sections I to IV, LNS and UNS have developed in similar ways, gradually decreasing in value as the pitch shape expands. The close proximity of the two values means that the pitch shape has remained relatively, though not perfectly, balanced with respect to the global central axis. Now that LNS has reached a value of 0, there will have to be some significant change in its future path as well as a possible break in the similarity of development exhibited between LNS and UNS.

The graph of total registral space shows that a significant change in the organization of spatial types has occurred (Fig. 2.25). INS is now significantly higher than any other type of space. The median trajectory graph shows that there is little shift in placement of this cluster as it opens and closes at a value of -2.5 and barely changes

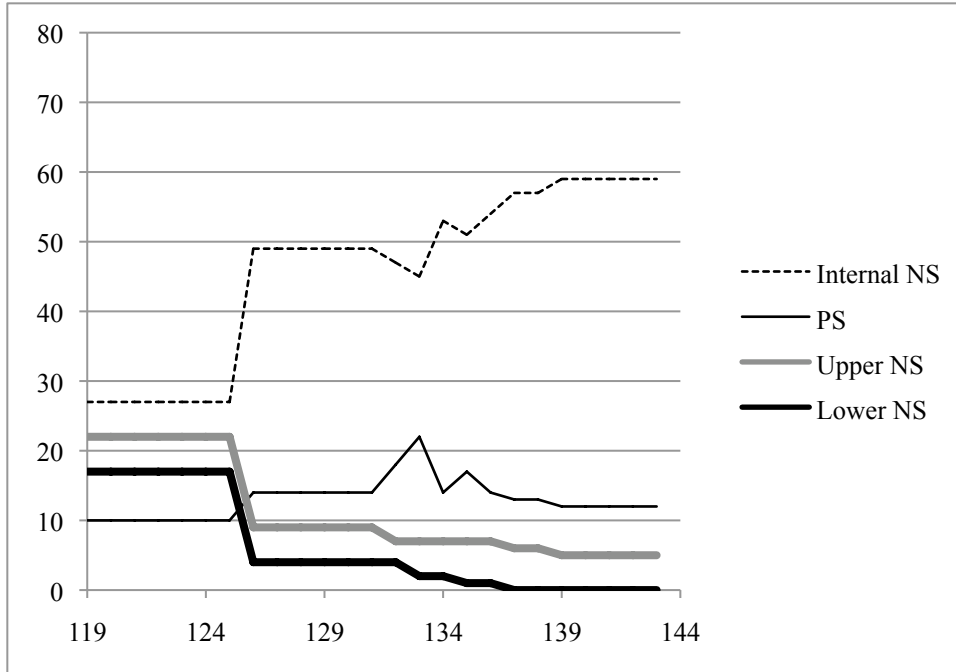


FIGURE 2.25. Total registrational space, section IV.

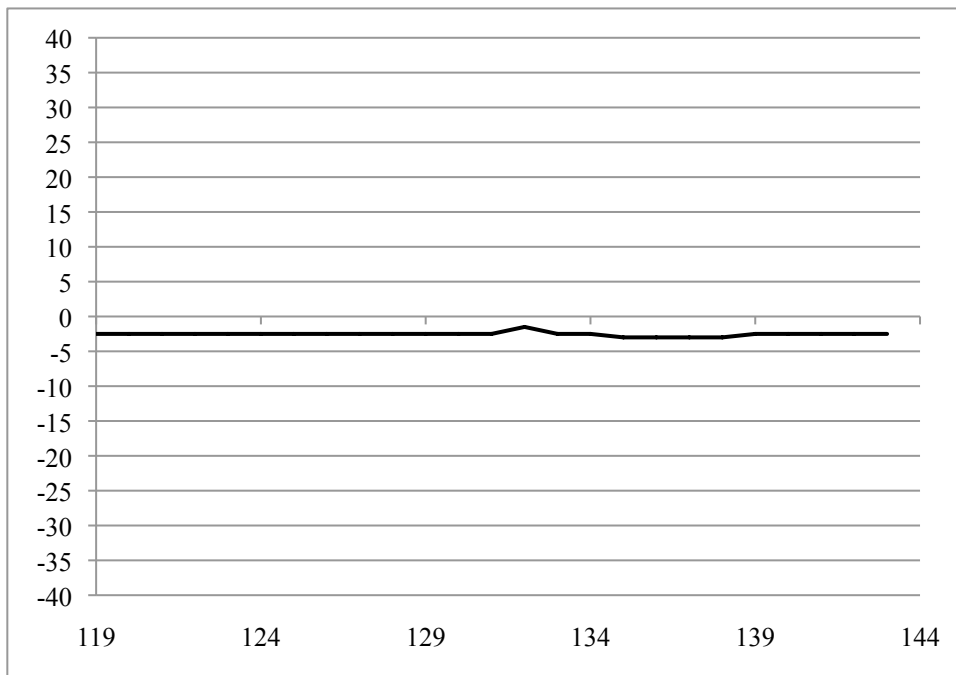


FIGURE 2.26. Median trajectory graph, section IV.

within its range of -1.5 to -3 (Fig. 2.26). The average placement is -2.5 which is the lowest placement yet. However, the dynamic spatial activity for this section is relegated to the large expansion rather than a shift in the median trajectory.

This section contains the most dramatic spatial developments seen in the piece thus far. In most respects, it continues the same trends found previously but on a magnified scale: increases in PS and INS, coupling and decreasing values of UNS and LNS, and an overall descent in registral space. However, the motion towards equality in the types of space found at the end of section III allows for some uncoupling of spatial types. INS, which for most of the piece has grouped with PS either because both had such small values (section I) or because they developed in a similar manner (sections II and III), uncouples from PS, taking over as the predominant spatial type. This new development in INS follows quite logically from what preceded. Because the composition is played on the harpsichord by one player, PS is limited by the physical reality of the hand. In order for the expansions to continue, the only option is for a large increase in INS. The next section contains another dramatic spatial development which is, in some ways, an answer to LNS reaching the final limit of the descent that has occurred throughout the course of the piece.

VI. SPATIAL ANALYSIS OF SECTION V.

The pitch graph for section V reveals a narrow cluster in the uppermost range of the piece (Fig. 2.27). The range of this section is from A6 to E7 spanning only 8 pitches with a central pitch axis of C/C-sharp⁷.

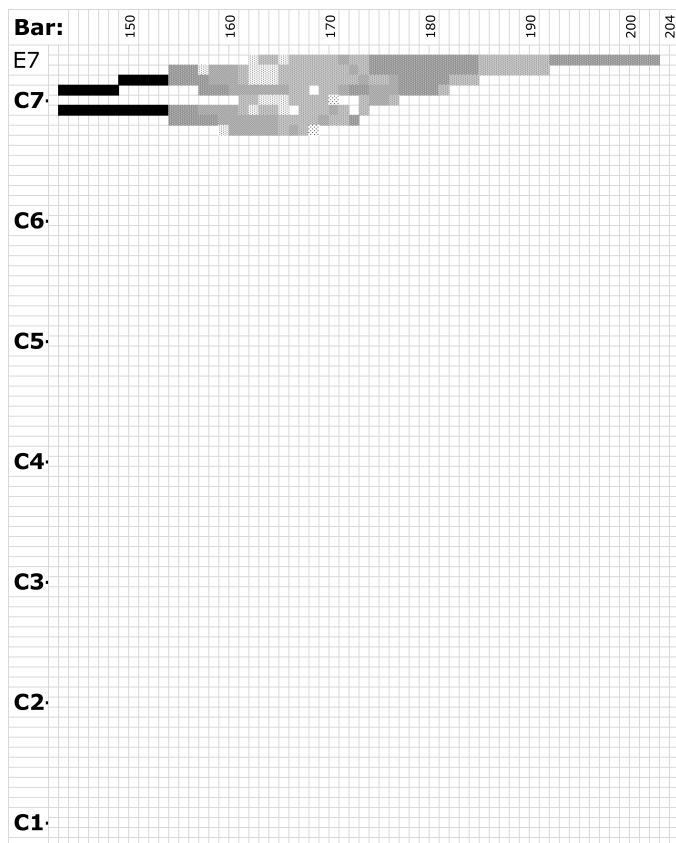


FIGURE 2.27. *Pitch graph of section V (mm. 144-205).*

The graph of positive and internal negative space shows that this cluster develops in a very similar way to the cluster in section I (Fig. 2.28). PS increases from 2 to 8 and then decreases to a final value of 1 while INS decreases to 0 for a good portion of the final section. This cluster, like that in section I, is both narrow and dense. As in section I, the density increases to 1.00 (m. 162) and then begins to decrease (Fig. 2.29). However, as the final sonority is a unison pitch, the density increases to 1.00 again. At an average density of 0.89, this is the densest cluster of the composition, though it closely matches that of the opening cluster (0.80).

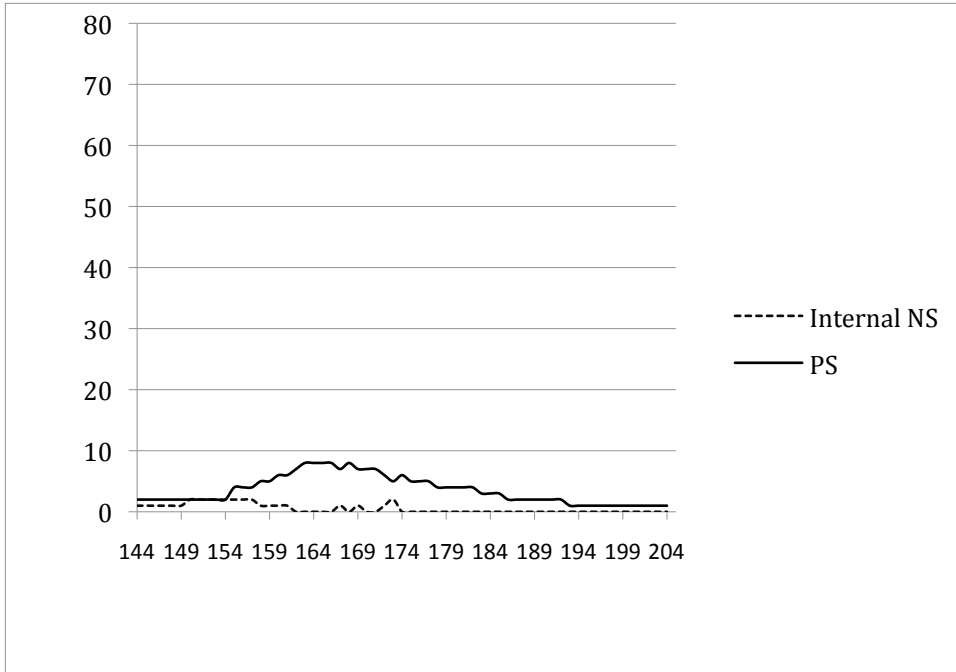


FIGURE 2.28. *INS and PS, section V.*

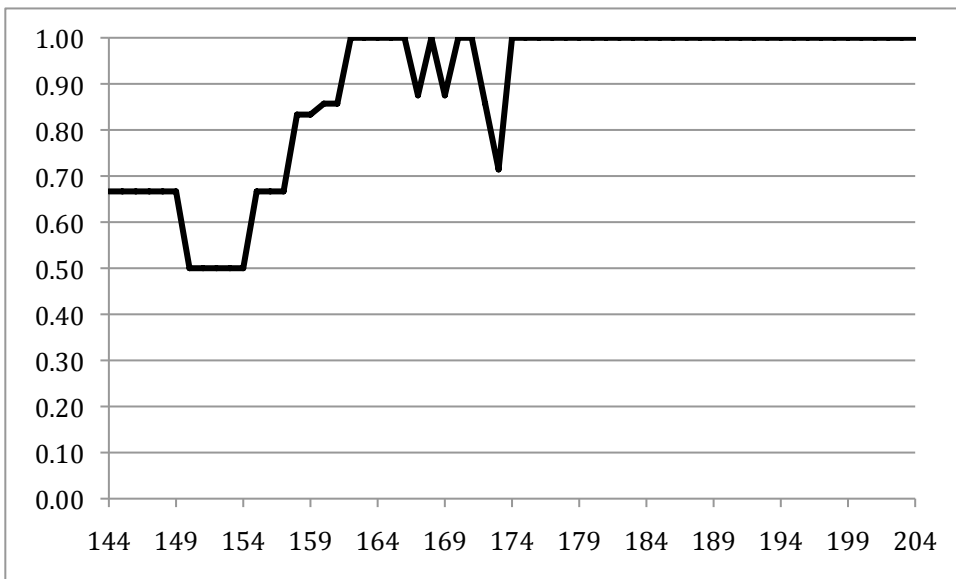


FIGURE 2.29. *Pitch shape density, section V.*

The graph of upper and lower negative space is significantly different for this section than for any previous section (Fig. 2.30). For the duration of the piece, UNS and LNS have been coupled so that they decrease together at approximately the same rate. We saw that in section IV, LNS decreased to its lower limit, 0, meaning the piece reached the lowest note. In this concluding section, LNS can descend no further, thus LNS and UNS are uncoupled with LNS jumping to 70 at the opening and ascending to 75 by the conclusion of the piece. On the other hand, UNS has now made its complete descent to 0 meaning the piece has reached the upper note of the full range of the piece.

The graph of total registral space shows that LNS is the predominant spatial type for this section (Fig. 2.31). The values for LNS are the highest values for any type of space in the entire composition creating what could seem like an imbalanced ending to the piece. The median trajectory graph also reflects this imbalance as this cluster is located in the extreme upper range of the work unlike the other clusters whose midpoints remained fairly close to the global central axis (Fig. 2.32). While the final cluster may seem to create an imbalanced ending, the information gleaned from the above spatial analysis shows that this final section may be nothing but a logical response to previous spatial activity in the piece and that the piece has built into it a number of balancing factors to offset the high final cluster.

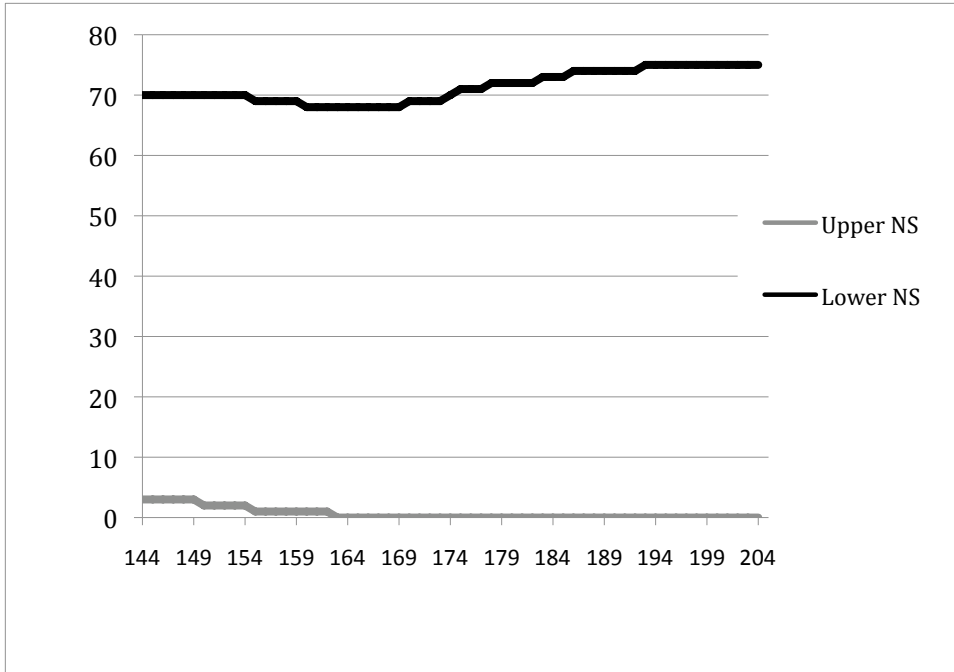


FIGURE 2.30. *UNS and LNS, section V.*

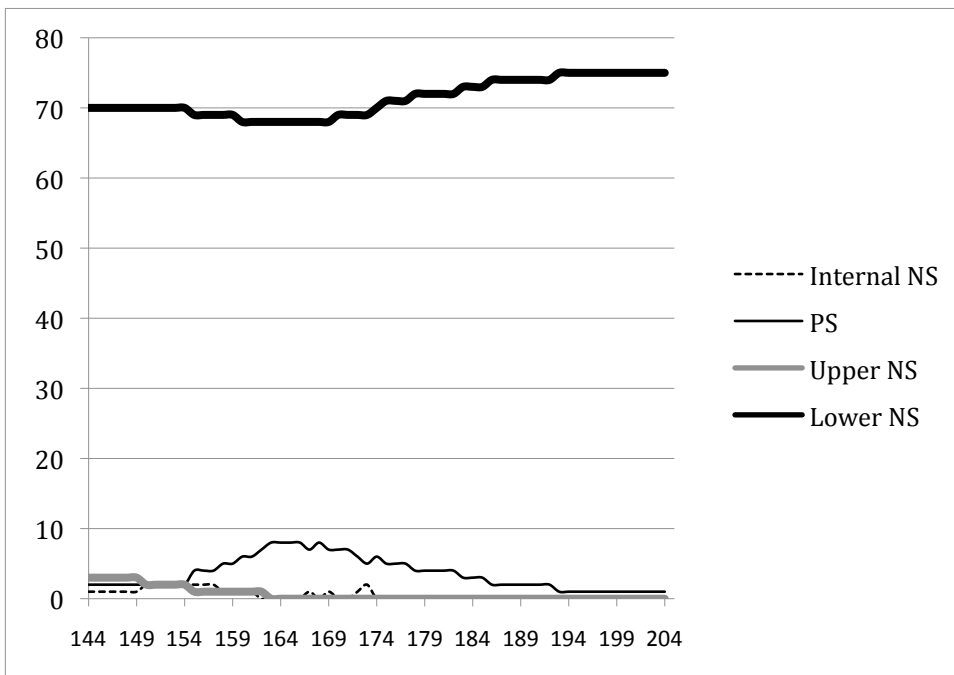


FIGURE 2.31. *Total registral space, section V.*

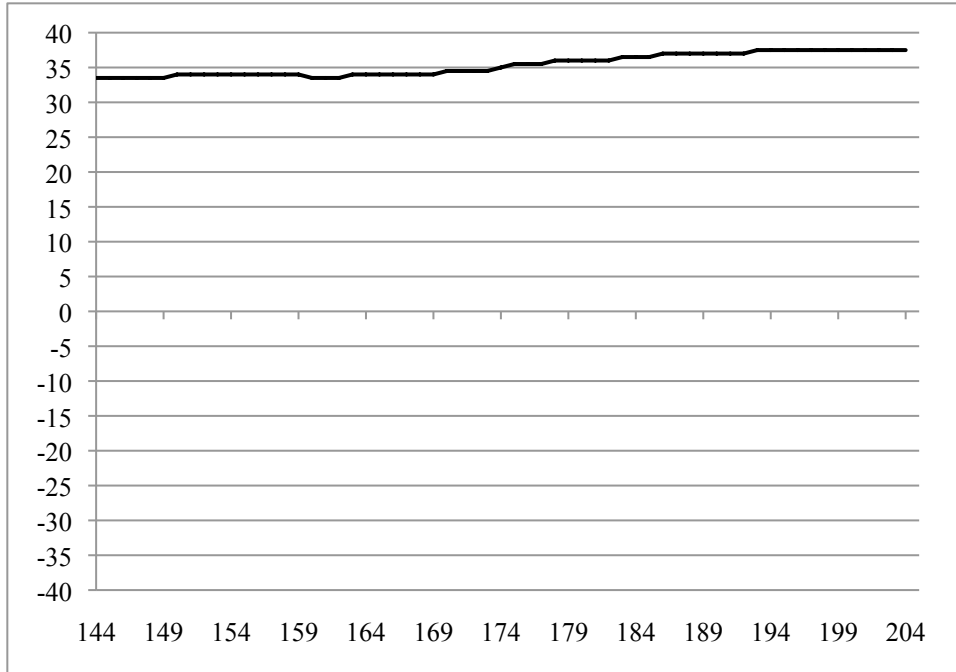


FIGURE 2.32. *Median trajectory graph, section V.*

VII. SUMMARY OF IMPORTANT SPATIAL TRENDS.

The local expansions in sections I through IV join together to create a single global expansion (Fig. 2.33). Sections II through IV contain similar clusters in that they continually expand and are cut off at their widest point. Section IV stands out among all the sections, however, as there is significantly more INS than PS, UNS, or LNS. Sections I and V group together in that they contain clusters which undergo a narrow expansion followed by a contraction.

Cluster density develops in a clear, directed manner (Fig. 2.34). The piece opens with a density of 0.50 and increases to 1.00 in the first section. As the pitch shape undergoes further expansions, density decreases until it reaches an all time low of 0.17 at the end of section IV. In section V density increases once again to 1.00.

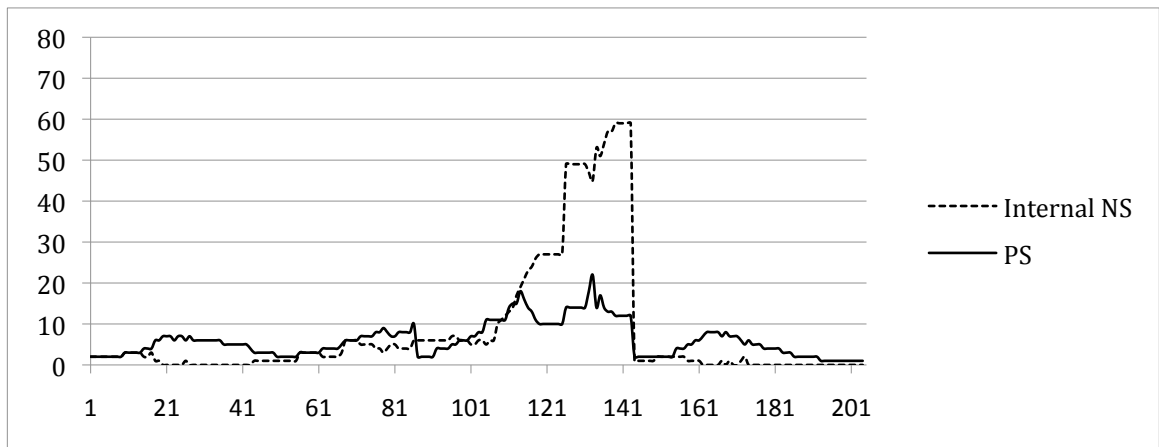


FIGURE 2.33. *INS and PS, entire piece.*

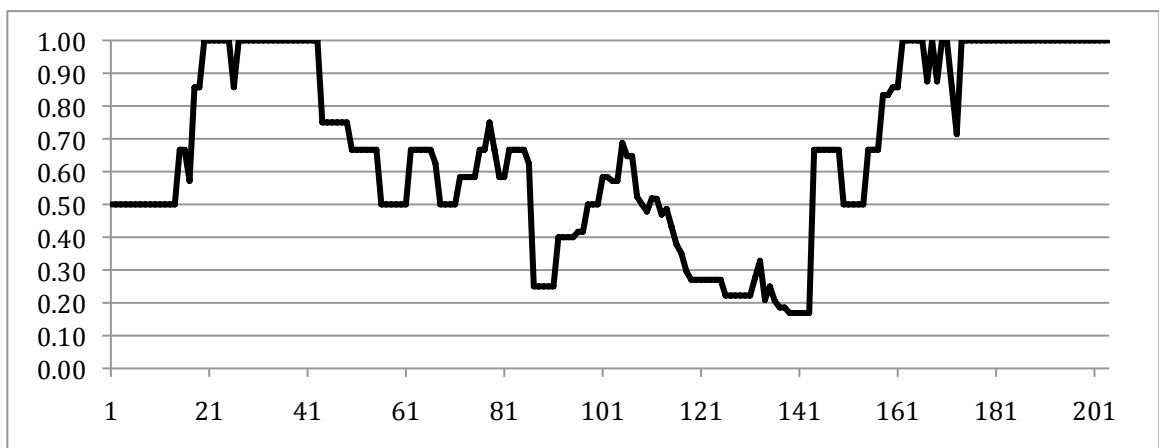


FIGURE 2.34. *Pitch shape density, entire piece.*

The line graph of upper and lower negative space reflects both the large expansion through section IV as well as the shift from placement above the central axis to placement below the central axis (Fig. 2.35). The intersection of the two lines marks this transition. Where the two lines are equal (starting at m. 87), the pitch shape is perfectly

centered within the registral framework of the piece. As mentioned earlier, this coincides with the opening of section III. During the first four sections, LNS is decreasing at a slightly faster rate than UNS and so reaches 0 before UNS. Once the piece bottoms out, there is an abrupt increase in LNS while UNS continues its decrease to 0. When the pitch shape reaches the bottom of its range at the end of section IV, it springs into the top register where it then reaches the top of its range.

The line graph of total registral space for the entire piece shows an initial polarization of spatial types with high LNS and UNS values and low PS and INS values (Fig 2.36). These spatial types reach a state of equilibrium near the end of section III (m. 113) after which point a new direction necessarily begins. As former spatial types uncouple, one type becomes dominant – INS in section IV and LNS in section V.

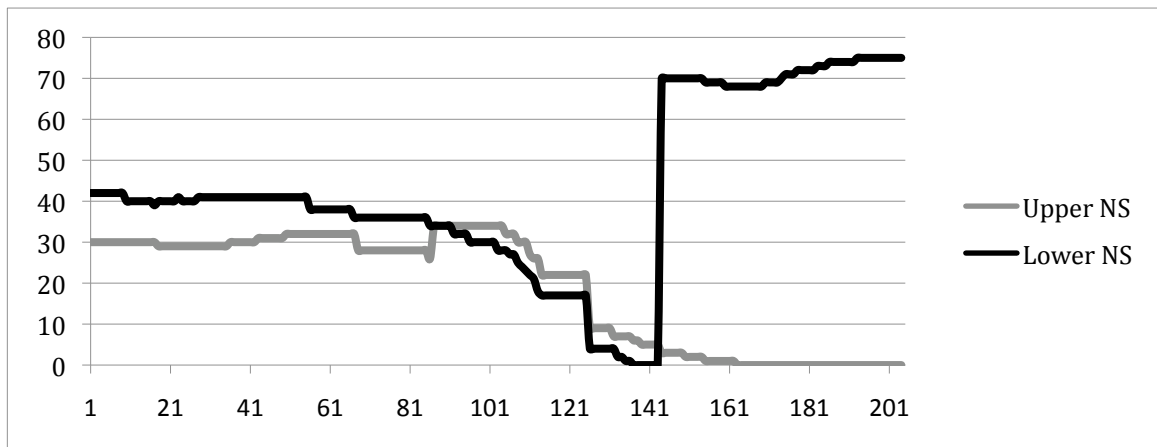


FIGURE 2.35. *UNS and LNS, entire piece.*

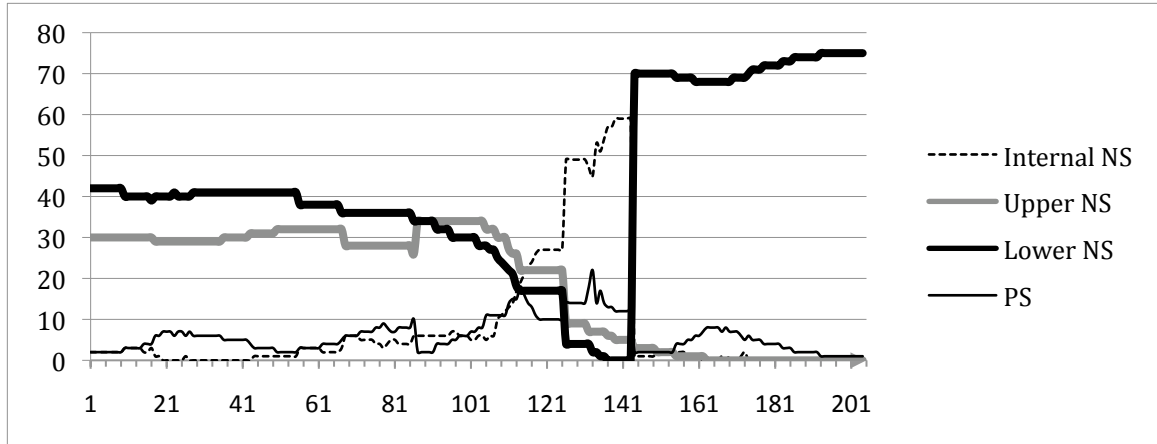


FIGURE 2.36. *Total registral space, entire piece.*

The developments in sections IV and V may seem unusual and do create a sense of asymmetry in the pitch shape. Perhaps the description of a childhood nightmare which Ligeti cites as an important influence on the structural design for his 1959 orchestral work, *Apparitions*, also applies to developments in *Continuum*:

As a small child I once had a dream that I could not get to my cot, to my safe haven, because the whole room was filled with a dense confused tangle of fine filaments. It looked like the web I had seen silkworms fill their box with as they change into pupas. I was caught up in this immense web together with both living things and objects of various kinds – huge moths, a variety of beetles – which tried to get to the flickering flame of the candle in the room; enormous dirty pillows were suspended in this substance, their rotten stuffing hanging out through the slits in torn covers. There were blobs of fresh mucus, balls of dry mucus, remnants of food all gone cold and other such revolting rubbish. Every time a beetle or a moth moved, the entire web started shaking so that the big, heavy pillows were swinging about, which, in turn, made the web rock harder. Sometimes the different kinds of movement reinforced one another and the shaking became so hard that the web tore in places and a few insects suddenly found themselves free. But their freedom was short-lived, they were soon caught up again in the rocking tangle of filaments, and their buzzing, loud at first, grew weaker and weaker. The succession of these sudden unexpected events gradually brought about a change in the internal structure, in the texture of the web. In places knots formed, thickening into an almost solid mass, caverns opened up

where shreds of the original web were floating about like gossamer. All these changes seemed like an irreversible process, never returning to earlier states again.²²

As shown in the above analysis, certain sections contain spatial motions that become reinforced or exaggerated to a maximum point. Once the maximum point is reached, there is a break, and a new development begins which changes the overall state of the spatial design in a dramatic way.

Sections I through III can be seen as a gradual movement toward spatial equilibrium. An expansion begins in section I, but contracts again. In section II, the momentum gathered in section I results in a larger expansion with no contraction. In section III, the expansion is large enough that, by the section's conclusion, the spatial types are roughly equal. Once this equilibrium is reached, the piece must develop in a different direction. This new direction is the large expansion in section IV which begins at the Golden Mean of the piece, m. 126. The opening interval signal, instead of consisting of two pitches, consists of two bands of sound, reflecting the magnified scale of this section. The distribution of space in the cluster formation is significantly different as INS predominates while all other values remain relatively low. While this new spatial distribution sets section IV apart from previous sections, a sense of continuity persists because the development is still one of cluster expansion.

When this large expansion reaches the bottom limit of the registral framework (LNS=0), spatial development in the piece necessarily changes direction once again. The only possibility is for an ascent in registral space which is the course Ligeti takes – and in

²² R. Steinitz, *György Ligeti: Music of the Imagination* (Boston: Northeastern University Press, 2003) 7.

a most extreme manner. The overall descent in the pitch shape in sections I through IV may be one way in which the composer creates enough musical energy to shift the final cluster upwards (Fig. 2.37). While the narrow final cluster in the uppermost register may seem to create spatial imbalance, it is a logical choice in a number of ways. First, UNS continues to follow the path of LNS and decrease to a value of 0. This results in a cluster whose uppermost pitch will be the top note of the range. Second, the cluster's high density and narrow shape relate it back to the first cluster, so despite the high register, it acts as a balancing return of the opening idea in the piece.



FIGURE 2.37. *Median pitch trajectory, entire piece.*

The third way in which this final high cluster serves as a logical choice brings us back to the idea of positive and negative space in the visual arts. In the late 19th century and early 20th century, with such artists as Cézanne, Matisse, and Braque, to name a few, the significance of negative space in painting began to change. Before this time, though

always important to the overall composition of a painting, negative space was not as important as the subject of the painting. In modern painting, however, the picture plane often has a flattened out quality with negative space and positive space becoming more like interlocking pieces of a jigsaw puzzle. Negative space is activated in these paintings and becomes an equal contributor to the meaning of painting.

In *Continuum*, the pitch shape begins as a narrow cluster of sound in a middle register. The listener is not yet aware of the full range of the piece. As the composition progresses and the global pitch shape continues to expand, the listener becomes aware of a larger pitch range. In the final section, all the registral space that had been previously activated now becomes negative space while a new, higher register becomes positive space. Because of the way Ligeti prepared the registral space, when the middle and low register drop out, the listener is aware both of what sound is present (the high cluster) as well as what sound is absent. Thus the listener is made aware of the sonic negative space in the music and the high cluster, rather than creating spatial imbalance, is simply juxtaposed with this negative space.

CHAPTER 3: A SPATIAL ANALYSIS OF THE “BENEDICTUS” FROM JOSQUIN’S *MISSA L’HOMME ARMÉ SUPER VOCES MUSICALES*

I. INTRODUCTION.

While registral space is widely understood to be an important compositional element in many styles of 20th century music, it is a rarely studied aspect in music from earlier historical periods. However, Robert Cogan, a pioneer in the study of musical space, is the first theorist to treat space as equal to pitch, rhythm, and tone color in music composed in many styles and historical periods.²³ In his text *Sonic Design*, Robert Cogan begins his chapter on musical space with an analysis of an early Renaissance work - the “Benedictus” from Josquin’s *Missa L’homme armé super voces musicales* (c. 1490-5).

Josquin’s “Benedictus” - a modal, contrapuntal work for pairs of voices - contrasts with *Continuum* in almost every way. Despite the stylistic and textural differences, a thorough analysis of registral space is equally important to understanding the structure of both compositions. Building on Cogan’s analysis, this chapter will further explore musical space in the “Benedictus.” The method I have developed for the analysis of positive and negative space is adaptable to music of different textures, and the various graphs that can be derived from the quantification of positive and negative space are quite useful in uncovering this work’s fascinating spatial relationships.

II. HISTORICAL BACKGROUND AND SUMMARY OF SCHOLARSHIP.

The *Missa L’homme armé super voces musicales* was most likely composed in the first half of the 1490s while Josquin was employed by the papal chapel in Rome. This mass survives as the sole work in the choirbook, CS197 (CS=Cappella Sistina) and was

²³ Cogan’s term “musical space” is equivalent to “registral space.”

probably copied during the period of Josquin's employment at the Sistine Chapel.²⁴ The Italian publisher Ottaviano Petrucci published the work on September 27, 1502 as part of a collection of five masses, all by Josquin. The collection, *Misse Josquin*, is historically important for two reasons. It is the first publication devoted to a single author and it was printed in partbooks rather than the more traditional choirbook format.²⁵

Misse Josquin opens with *Missa L'homme armé super voces musicales* and closes with *Missa L'homme armé sexti toni*, the other Josquin mass based on the same medieval tune. These two masses are part of a 200-year tradition which began in the middle of the fifteenth century where the *L'homme armé* tune serves as a cantus firmus, thus musically unifying the sections of the mass. Over 40 *L'homme armé* mass cycles exist and an examination of them shows that composers reserved this particular format for exhibiting their compositional prowess. DuFay, Ockeghem, Busnoys, Tinctoris, and Obrecht all wrote masses based on the *L'homme armé* tune prior to Josquin's setting.

The only surviving copy of the melody with its text is found in a cycle of six anonymous masses in a manuscript dating from the 1460s which is now in Naples.²⁶ The melody itself was probably of unwritten origin which would explain the slight variations existing from mass to mass. Josquin, however, altered the tune to a much greater extent than most composers (Fig. 3.1 and 3.2). His melody retains the 3-part form (Fig. 3.1: mm. 1-11, 12-23, 24-32), but the ending of the first part is highly ornamented, the middle section is in a different meter from the outer sections, and the last section is rhythmically

²⁴ D. Fallows, *Josquin* (Turnhout: Brepols Publishers, 2009) 145.

²⁵ B.J. Blackburn, "Masses Based on Popular Songs and Solmization Syllables," in *The Josquin Companion*, ed. R. Sherr (Oxford: Oxford University Press, 2000) 51.

²⁶ D. Fallows, "L'homme armé," *Oxford Music Online* (accessed June 13, 2010).



FIGURE 3.1. L'homme armé *tune*.



FIGURE 3.2. Josquin's version of the L'homme armé *tune*.

augmented by a factor of two.²⁷ Despite the liberties Josquin took with the original melody, in *Missa L'homme armé super voces musicales*, he treats his version of the melody with a strictness uncharacteristic of most cyclic masses: in almost all its appearances, the melody remains unchanged.²⁸

The *Missa L'homme armé super voces musicales* is unique in that, for each section of the mass, the tune is transposed to the degrees of the natural hexachord in ascending order. It begins on C in the Kyrie, D in the Gloria, E in the Credo, F in the Sanctus, G in the Agnus Dei I, and A in the Agnus Dei III.²⁹ Though the tune is transposed, all movements of the mass maintain a final of D. Prior to Josquin, this technique was quite uncommon in masses containing borrowed cantus firmi that generally were stated in the mode of the mass. DuFay's *Missa Se la face ay pale* and the six anonymous *L'homme armé* masses mentioned above have some instances of the borrowed tune ending on a final different from the mode of the mass.³⁰ A work that may have more closely influenced Josquin is the *L'homme armé* mass by Marbrianus de Orto who was one of his colleagues at the papal chapel. De Orto's mass is in G-Mixolydian with statements of the tune on A, C, D, and B. Jesse Rodin suggests that Josquin's mass was a response to de Orto's mass as well as a systematization of his methods.³¹

Most analytic discussions of this mass deal primarily with tonal issues caused by the transposition of the cantus firmus. In their treatises on counterpoint, Renaissance

²⁷ Fallows, *Josquin*, p. 149.

²⁸ *Ibid*, p. 149.

²⁹ J. A. Lyle, "The Integration of Thematic Design and Tonal Structure in Josquin's Two Masses on "L'homme armé" (Master's Thesis, The University of North Carolina at Chapel Hill, 1980), pp. 26-29.

³⁰ Fallows, *Josquin*, p. 149.

³¹ J. Rodin, "'When in Rome...': What Josquin Learned in the Sistine Chapel," in *Journal of the American Musicological Society* (2008) 61/2: 323.

theorists Pietro Aaron and Johannes Tinctoris both asserted that the tenor part determines the mode of a polyphonic work.³² However, despite the transpositions of the tenor in *Missa L'homme armé super voces musicales*, D is maintained as the tonal center for the mass as a whole. Josquin was clearly pioneering new compositional methods both with the systematic transposition of the cantus firmus as well as the relationship of the cantus firmus to the tonal center and this is certainly the reason for the narrow focus of much of the theoretical literature on the mass.

Bonnie J. Blackburn provides a general overview of the mass's tonality and harmony, suggesting that the conflict between the cantus firmus and the overall tonality provides many opportunities for tonal ambiguity and surprising harmonies. She also discusses some of the mensural and rhythmic complexities of the mass.³³

Leeman L. Perkins describes how the cadences in the work reveal that modal relationships are an integral part of the structural design. While all sections of the mass have a final of D, there are cadences to A, and, to a lesser extent, E. He provides a useful chart listing most of the cadences for each section.³⁴

Jean Alberts Lyle builds on Perkins' work, discussing specifically how Josquin places these cadential points carefully with respect to the cantus firmus so the tenor pitch reinforces the cadence. The cadence points in the transposed tenor melody itself must also be weakened so as not to disturb the tonal center of the mass. He suggests that Josquin veils these cadences in the tenor with activity in the other three voices. A chapter

³² O. Strunk, ed. *Source Readings in Music History* (New York: W.W. Norton & Company, 1998), 420.

³³ Blackburn, 51-87.

³⁴ L. Perkins, "Mode and Structure in the Masses of Josquin," in *Journal of the American Musicological Society* (1973) 26/2: 189-239.

on the development of the *Missa L'homme armé* tune shows the very strict treatment of the tune as a complete entity in the tenor as well as its freer motivic treatment in the remaining voices. However, Lyle does not include in his list of motivic entrances any fragments of the melody that have been subjected to developmental procedures such as retrograde or inversion. He makes an interesting point that the interplay of fixed and variable elements is key to the musical meaning of the mass: The form of the cantus firmus melody in the tenor is unchanging, though it is transposed, and the mass maintains a fixed tonal reference while motives are treated freely within the texture.³⁵

Clearly Josquin was making an important musical statement by treating the cantus firmus in such an unusual and methodical way. However, a deeper discussion of the contributions of the unchanging form of the cantus firmus and its stepwise ascent through the natural hexachord to the structure and meaning of the mass seems absent from the literature. The unaltered presentation of the tenor, save its systematic transposition up the hexachord, provides a structural backbone for the mass as a whole. Though this lies beyond the scope of this chapter, it is important to note that the stepwise transposition of the cantus firmus forms an extended upward motion through the registral space of the mass. One of the most unusual sections of this mass, the “Benedictus,” reflects and intensifies this motion, spanning a larger pitch range in a shorter amount of time.

³⁵ J. A. Lyle, “The Integration of Thematic Design and Tonal Structure in Josquin’s Two Masses on “L’homme armé” (Master’s Thesis, The University of North Carolina at Chapel Hill, 1980), p. 78.

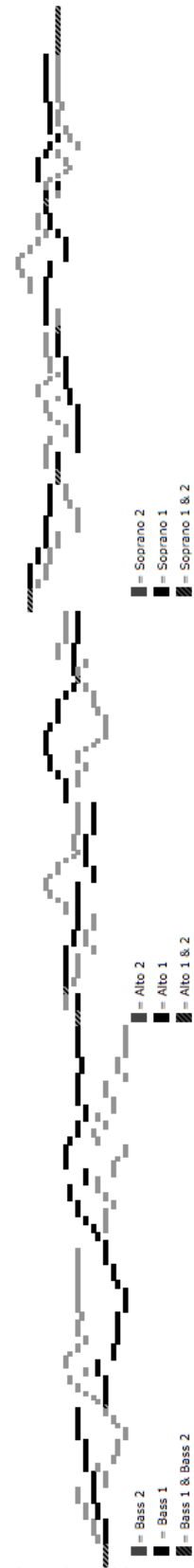
III. OVERVIEW OF THE “BENEDICTUS.”

The overall musical shape of the “Benedictus” is a pair of ascending melodic lines that open on a unison D3 and close on a unison D4. The “Benedictus” is unique among the sections of the mass as it is the only one where there is a registral displacement between the opening and closing sonorities. The piece both forms a beautifully balanced architectonic structure within its active registral space while also presenting a musical problem of achieving closure in a registrally open composition. A thorough spatial analysis using my new techniques both elucidates this structure as well as reveals some possible solutions to Josquin’s musical problem.

This 49-measure work has a range from A2 to C5 with a central pitch axis falling between B-flat3 and B3 (Fig. 3.3). At the exact temporal midpoint (m. 25), the pitch shape is perfectly centered within the piece’s range on an A3-C4 dyad providing spatial equilibrium for the ascending pitch shape. The ascent from the opening D3 to the closing D4 takes place in three stages with each of these three sections delineated not only by a change of voice part, but also by a self-contained mensuration canon, as well as a cadence with a prolonged final note followed by a dramatic shift in register at the opening of the next section (Fig. 3.4).

The range of the entire “Benedictus” is much wider than that of any single voice so each stage of the ascent is, necessarily, distributed to different voice parts: the first section is sung by two basses, the second by two altos, and the third by two sopranos. Throughout the rest of the mass, the tenor is assigned the *L’homme armé* tune, and, as the

FIGURE 3.3. *Pitch graph of the “Benedictus.”*



	Section I	Section II	Section III
Measures	1-17	18-30	31-49
# of measures (% of Benedictus)	17 35%	13 26	19 39
Range	A2-C4	D3-F4	A3-C5
Opening and closing tonality	D -- A	A -- A	A -- D
Voice Part	Bass 1, 2	Alto 1, 2	Soprano 1, 2

FIGURE 3.4. *Formal outline of the “Benedictus.”*

“Benedictus” is one of three sections where the tune is not stated explicitly, the tenors are absent.³⁶ Thus, the overall spatial motion and the absence of the cantus firmus directly influence the number of formal sections present in this portion of the mass.

As mentioned above, each formal section consists of a mensuration canon.³⁷ For example, in the first section, the second bass sings two phrases, one from mm. 1-10 and another from mm. 11-17. The first bass part, which consists of the second bass’s first phrase in augmentation by a factor of two, determines the length of section I. Each of the sections is organized in the same way, with the opening phrase of the second voice being simultaneously presented in augmentation in the first voice.

The most dramatic shifts in register occur between sections that, in addition to the above-mentioned factors, contribute to the partitioning of the work. For example, in section I, the basses cadence on the dominant, A2 and A3. The duration of the final note

³⁶ The tune is also omitted from the “pleni sunt caeli” of the “Sanctus” and the “Agnus Dei II.” The absence of the cantus firmus in these sections was common in the fifteenth century. F.H. Sawyer, “The Use and Treatment of Canto Fermo by the Netherlands School of the Fifteenth Century,” in *Proceedings of the Musical Association*, 63rd Sess. (1936-1937) 100.

³⁷ A mensuration canon is a canon where the main melody is accompanied by itself, though at a different speed.

is significantly longer than the durations throughout the rest of the section. At the opening of section II, the altos enter in unison on A3, with the second alto then moving to C4. A significant portion of the range traversed in the opening section is left unactivated in the opening of section II. Similar to what occurs in the transition from the fourth to fifth section of Ligeti's *Continuum*, the uppermost boundary of the final sonority of the first section becomes a pivot above which the pitch shape flips. The positive space activated in section I has now become lower negative space and the pitch shape of section II begins activating a higher range of the frequency field.

The shift in register from section II to section III is even more dramatic. After the altos cadence on A3-C#4, the melodic line breaks completely and the sopranos enter in unison on A4. Throughout the "Benedictus," the discontinuity caused by a leap in one voice, tends to be balanced by smooth stepwise motion or a sustained tone in the other voice. At no other moment does this work display such a degree of disjunct motion. This important moment happens to be coordinated temporally with the Golden Mean of the entire piece. Continuity of line and registral shifts within pitch space assist in the segmentation of the piece into three sections.

The range of each section, outlined in Fig. 3.4, reflects the large-scale ascent of the work. Each section spans the same amount of registral space, but the minor tenth span of section II is positioned a P4 higher than that of section I. The tenth span of section III is placed yet another P5 higher, making it exactly one octave higher than the range of section I. As this chapter progresses we will see that interesting spatial relationships in the piece exist with respect to the entire range of the work, but also with respect to the more limited range of each individual section.

At a more local level, there is a basic motive, or “module,” prevalent throughout the “Benedictus” which serves as a microcosmic reflection of the large-scale spatial motion (Fig. 3.5). The motive may first be found in the opening six notes of the second bass part. The six notes form a stepwise ascent of a P5 followed by a downward leap to the opening pitch and have temporal proportions of 3:1:2:2:2:2. This basic module appears in varied forms throughout the “Benedictus.” It may be abbreviated to only the first four or five notes or found in augmentation, diminution, and inversion. At times it is subjected to rhythmic variation, but the opening 3:1 temporal relationship is always preserved. The module’s linear ascent is a reflection of both the large scale ascent of the “Benedictus” and the linear ascent formed by the stepwise transposition of the *L’homme armé* tune from movement to movement in the mass as a whole. As we shall see, this module is also consistently involved in the process by which new areas of registral space are activated.

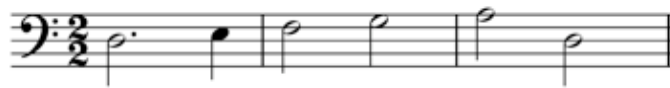


FIGURE 3.5. 6-note motive from the opening of the Bass 2 part.

Given the overall ascent in the piece, it is not surprising that the lowest note, A2, is present only in the first section and the high focal point, C5, is present only in the third section of the work. In the first section, A2 is articulated five times and is a member of the final cadence. The constant return to this note, as well as its involvement in the cadence suggests that it serves as a point of stability in the piece. In contrast, the C5 is reached only once in the course of the composition. As is well known, in this style of

music, ascending motion tends to be associated with an increase of melodic tension, while descending motion is associated with dissipation of tension. The single appearance of the apex reinforces this idea, and suggests that a certain amount of energy is required to bring the line further up the registral field. After the apex appears in m. 41, the line falls down to the tonic note, D4, thus leaving the piece tonally resolved. Additionally, at a local level, the descent of the line down a minor 7th from the apex results in the dissipation of melodic tension created in section III. However, the large-scale ascent of the work would seem to require a final return an octave lower - to D3 in order to fully resolve the piece. Much of this chapter will examine how spatial motion in the “Benedictus” is balanced locally and globally and how spatial motion is involved in the creation and dissipation of musical tension.

Before proceeding to a more detailed analysis of each of the sections, I will examine Robert Cogan’s analytic work on the “Benedictus.” Cogan is the only author to date to extensively analyze this section of the mass. He uses this piece to demonstrate musical concepts in three chapters of his text, *Sonic Design*: “Musical Space,” “Musical Language,” and “Time and Rhythm: Dimensions and Activity.”

In the chapter on musical space, Cogan identifies the overall ascending spatial motion of the composition with a line graph of the work and then limits his spatial analysis to the first section of the piece. He posits that the primary upward motion is controlled by the slower voice and analyzes in detail this voice’s linear motion, including elaborations contained within this line, which slow its ascent. He also comments on the coordination of the two voices: as one voice ascends the other descends and the local

spatial goals (high points) of one voice are generally reinforced at the lower octave by the other voice.

In the chapter on musical language, Cogan comments that preservation of intervallic content of the opening ascending 5-note motive (or “module,” in Cogan’s terminology) - M2-m2-M2-M2 - dictates the pitch levels where this motive may appear. In this way, spatial motion is linked to the musical language of the piece. Additionally, he shows that the final appearances of the motive in inversion and inversion-retrograde unveil the source of the motive: the end of the *L’homme armé* tune.

Finally, Cogan examines how the temporal relation of 2:1 set out originally by the mensuration canon, generates both formal dimensions of the work as well as the speeds of activity in the piece. Each section is partitioned in half due to the simultaneous slowing of rhythmic activity in both voices at the end of the faster voice’s first phrase. He also shows how the opening module is presented in three speeds - the original, in augmentation, and in diminution - and that the slower forms of the module are presented within the first half of each section while the faster forms appear in the second half of each section.

Cogan not only provides an initial look at spatial motion in this piece, but also shows how this motion is linked to some of the piece’s linguistic and temporal characteristics. The following analysis is an extension of Cogan’s work and will proceed with an in-depth analysis of the spatial motion within each section of the “Benedictus.” After considering each section in detail, I will summarize the important spatial trends that contribute to the global structure of the work. Finally, I will show how the spatial motion

in the “Benedictus” relates to the mass as a whole and how it may be a symbolic representation of Christian rites and imagery.

IV. SPATIAL ANALYSIS OF SECTION I.

Section I utilizes primarily the lower half of the work’s full range, rarely rising above the B-flat3/B3 global central axis (Fig. 3.6). The limited range of the first section extends from A2 to C4 with a local central axis falling between E3 and F3 (Fig. 3.7). The second bass’s first phrase (which is augmented by a factor of 2 to form the first bass’s part) contains two highpoints of A3 and C4. The minor third A3-C4 is the reduced form of the minor tenth range of section I. These two melodic apexes also symmetrically neighbor the B-flat3/B3 global central axis by a whole step on either side. The conspicuous placement of these two pitches, as well as their relationship to both the local range and the global central axis flag them as possibly important structural tones.

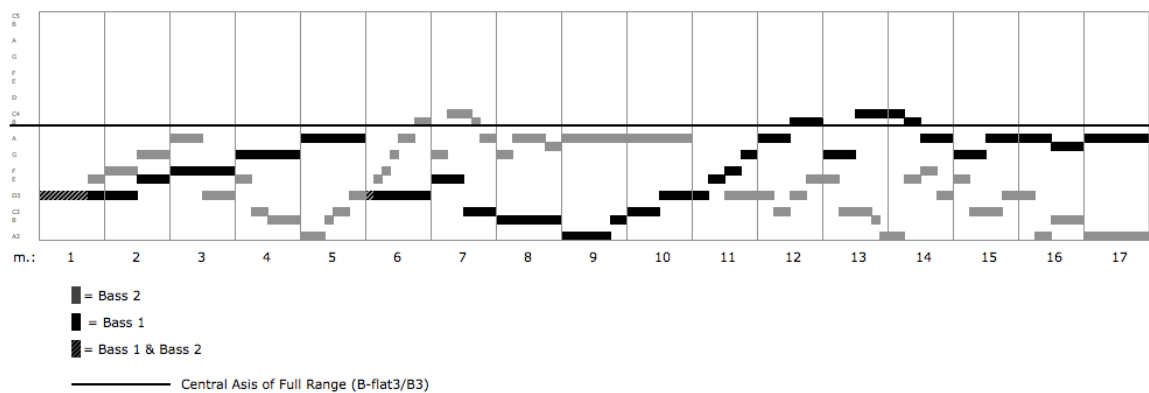


FIGURE 3.6. *Pitch graph, section I, showing central axis of global range.*

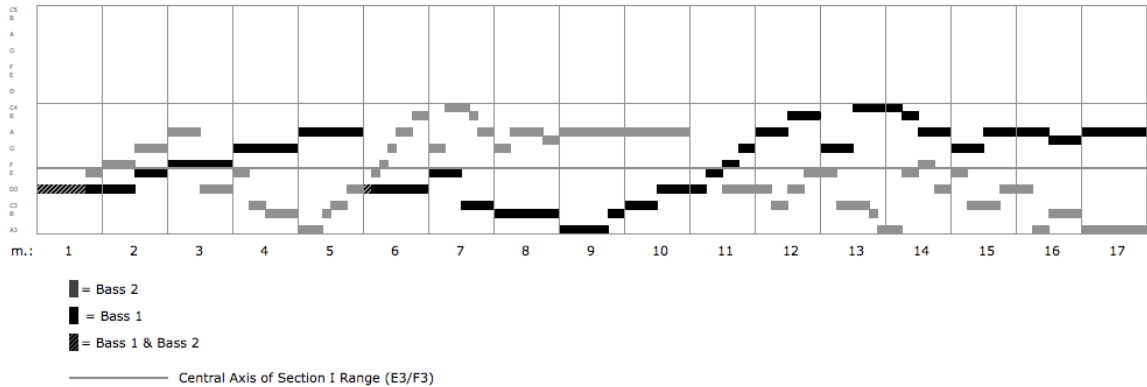


FIGURE 3.7. *Pitch graph, section I, showing central axis of local range.*

The two bass voices enter on a unison D3, establishing the D as the piece’s tonality and the unison as the most stable sonority. Both D and the unison serve as the work’s point of departure as well as the work’s ultimate goal and point of rest. Section I, however, cadences on octave A’s (A2-A3) creating both a tonal and registral opening that will require future resolution.

Positive space primarily rests at a value of 2, as the texture of this particular work is two voices (Fig. 3.8). The only times PS descends to 1 are when the two voices are in unison or one voice is resting. Because the unison has been established as the most stable sonority, and because the piece maintains a two-voice texture, the more rare occurrences of PS values of 1 may prove significant. PS values of 1 occur three times in section I: at the opening, at the beginning of measure 6, and in measure 11. The importance of the opening unison has already been discussed, but the other two occurrences help to mark off important moments in the piece.

The unison at measure 6 occurs exactly at the final note of the first bass’s augmented statement of the main 6-note motive. This motive, whose importance has already been established by its spatial similarity to the work’s global ascent, is presented

multiple times throughout section I in its original and diminished rhythmic forms. However, its presentation in the augmented form occurs only once in section I. The extended 5-note ascent is marked for attention by its placement at the opening of the piece, and is separated from the rest of the piece by its initial motion out of a unison sonority and a return to the unison at the motive's descending leap to D in measure 6. At measure 11, the PS value of 1 occurs where the second bass rests before the entrance of the second phrase. This entrance coincides with the Golden Mean of section I. Decreases in PS in section I reflect the importance of the unison sonority and its role in helping articulate other formal aspects of the "Benedictus."

The unisons reflected in the PS graph are also reflected in the graph of internal negative space where INS equals "0" (Fig 3.9). The INS graph also reveals other crucial information concerning registral space and the structure of the piece. The registral opening created by the octave A's at the final cadence of the section is recorded on the graph as a value of 11. A number of expansions take place between the opening unison and final octave sonorities, which contribute to the high average INS value of 6.2. Three expansions of an octave (INS=11, mm. 5, 7, and 9) are followed by one larger expansion of a minor tenth (INS=14, m. 13-14). This minor tenth is formed by the pitches A2 and C4, the same pitch classes that form the boundaries of section I's range. The function of these initial octave expansions could be to lead to the one larger expansion, which is nothing other than a harmonic expression of the upper and lower boundaries of the local range. Once this large expansion takes place, it shifts the two voices so they end separated by an octave rather than on a unison.

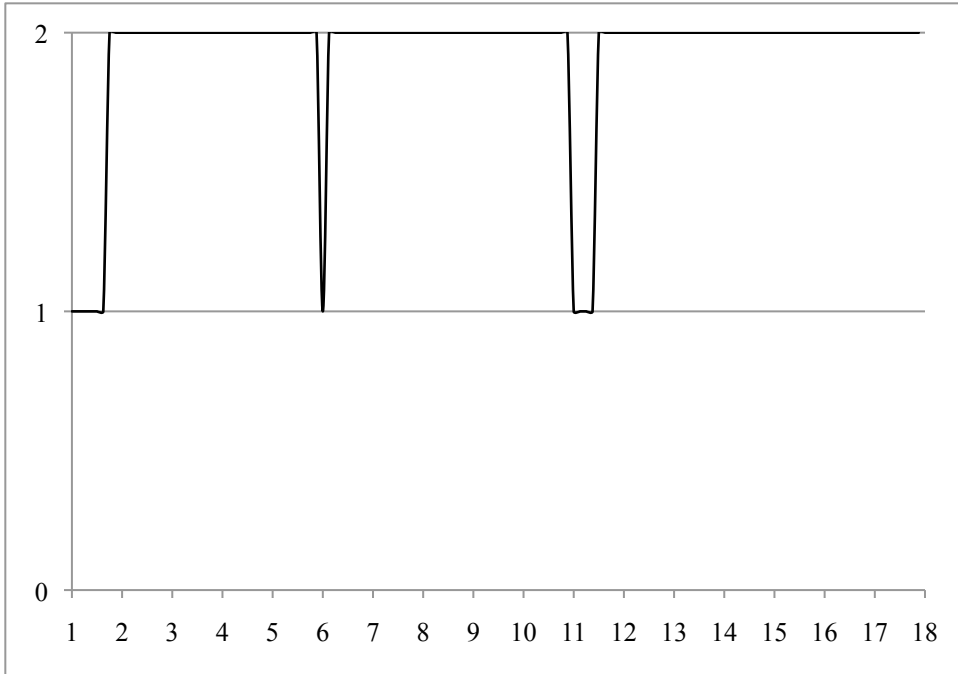


FIGURE 3.8. *PS, section I.*

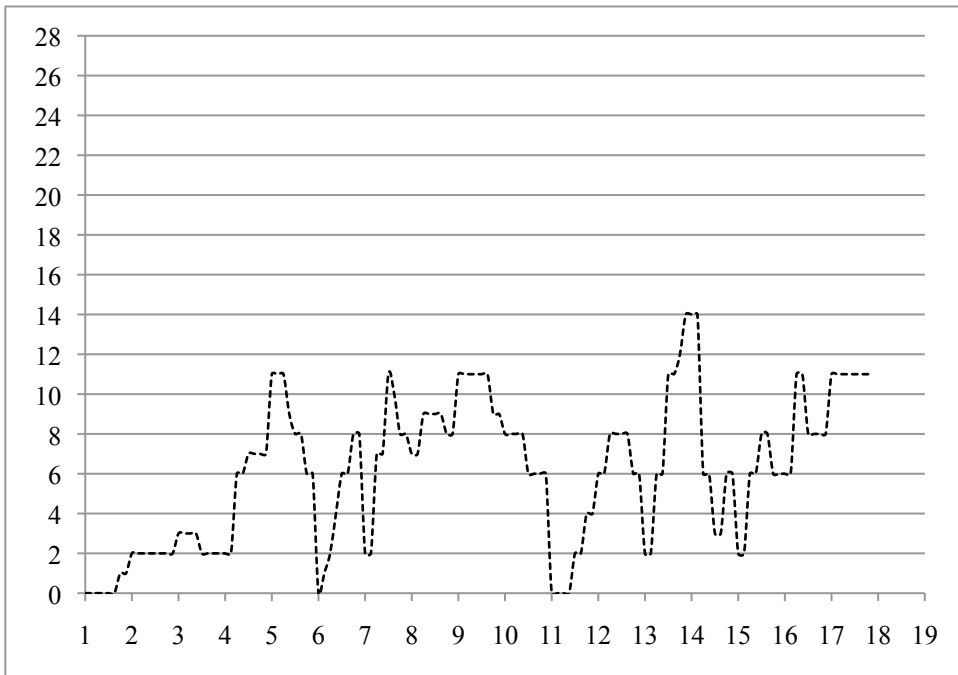


FIGURE 3.9. *INS, section I.*

With reference to the full range, there is significantly more upper negative space than lower negative space for the entirety of section I as the pitch shape sits in such a low register (Fig. 3.10). The graph of UNS and LNS with respect to the local range of section I, on the other hand, provides useful information about how the piece is operating in this more limited range (Fig. 3.11). The LNS line shows that the piece extends down to its lowest point five times (LNS=0, mm. 5, 9, 14, 16, and 17). In contrast, the piece reaches the uppermost pitch in section I twice (UNS=0, mm. 7 and 13). The graph of UNS also contains two secondary low points (UNS= 1, mm. 6 and 12). These high pitches have a special significance as melodic expressions of what later becomes a symmetrical formation around the global central axis. As the lowest note of the range is sounded multiple times while the highpoints are sounded relatively few times, these apexes are highlighted as being particularly important.

While LNS peaks frequently at various levels for the entirety of section I, UNS opens at a high level (UNS=10) and peaks back to that level two more times (mm. 6 and 11) while remaining significantly lower during the remainder of section I (generally below 5.) Peaks in UNS coincide with the decreases in PS to 1 and drops of INS to 0 (Fig. 3.12). The absence of activity in high registers assists in articulating the augmented version of the motive.

Once again, in the graph of total spatial activity the most salient feature is the preponderance of UNS (Fig. 3.12). The same graph, limited to the range of section I, more clearly shows the coordination of the different types of space (Fig. 3.13). The coordination of PS, INS, and UNS in measures 6 and 11 can be seen. The three peaks of UNS are particularly visible. Additionally, the peaks in INS, which represent expansions

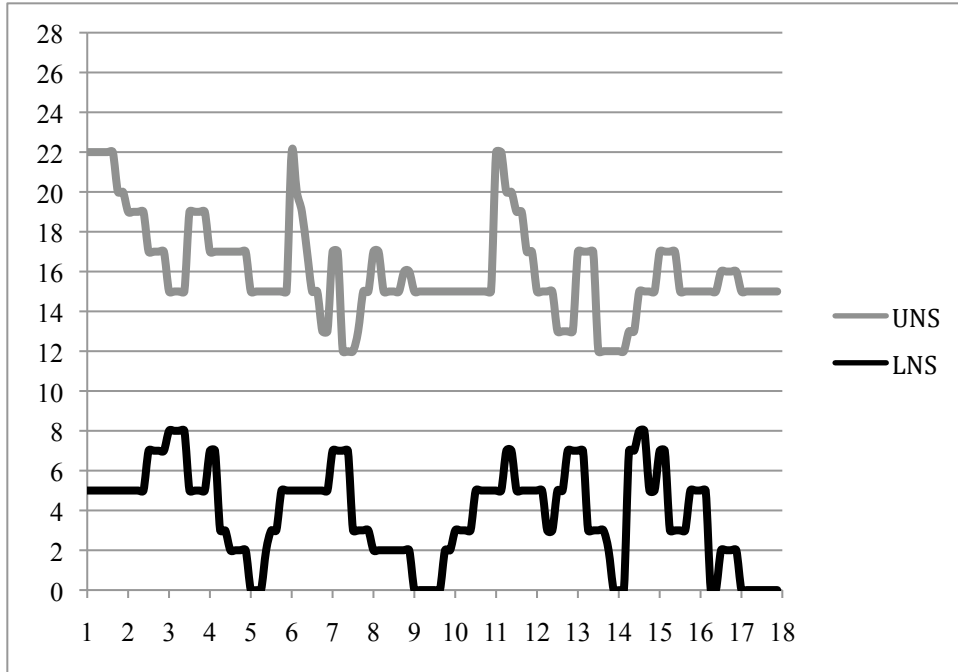


FIGURE 3.10. *UNS and LNS, section I, full range.*

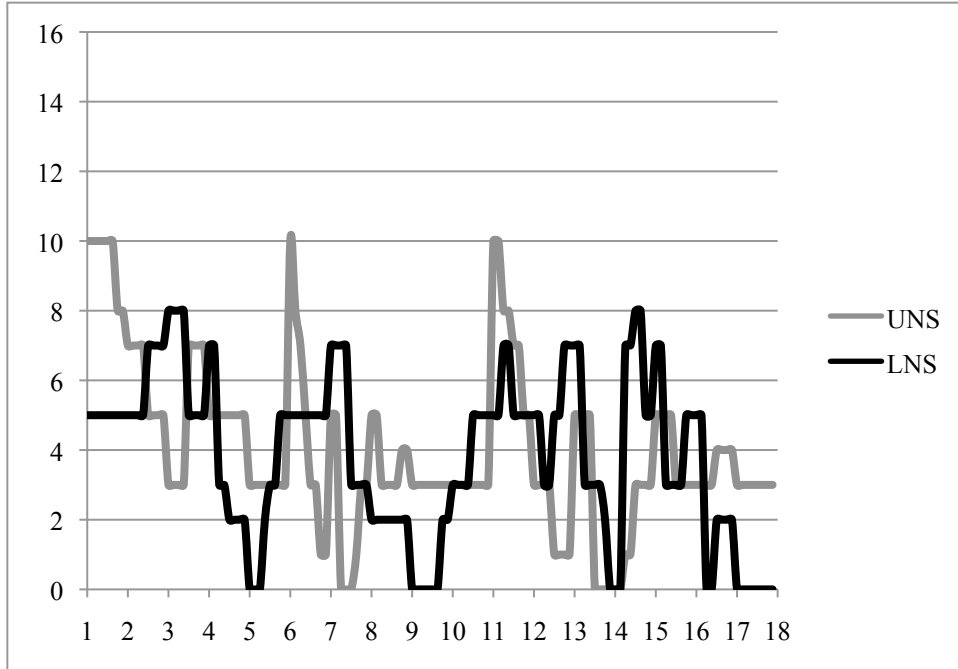


FIGURE 3.11. *UNS and LNS, section I, local range.*

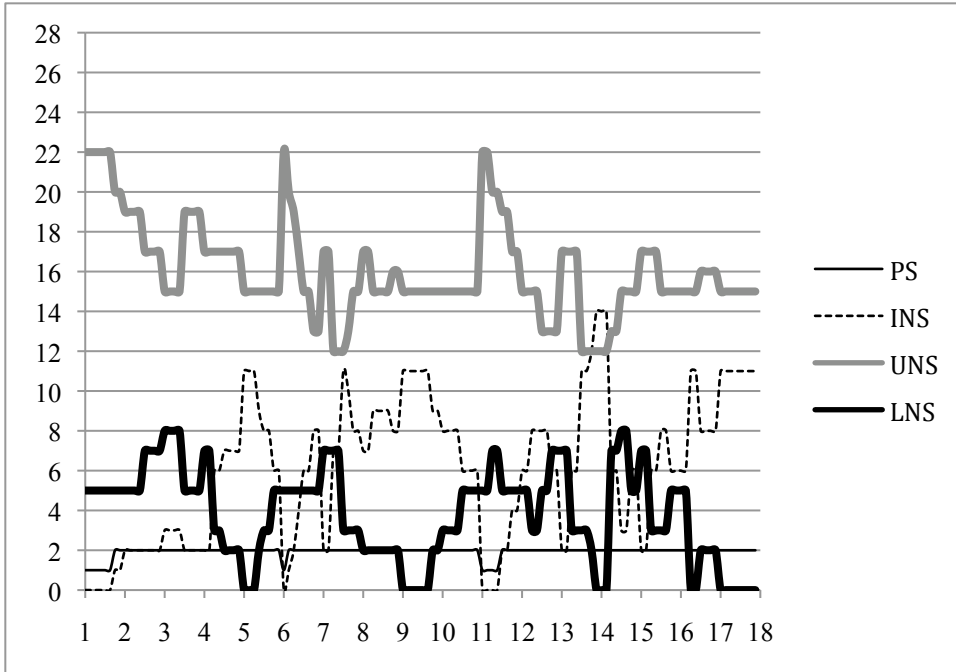


FIGURE 3.12. *Total registrational space, section I, full range.*

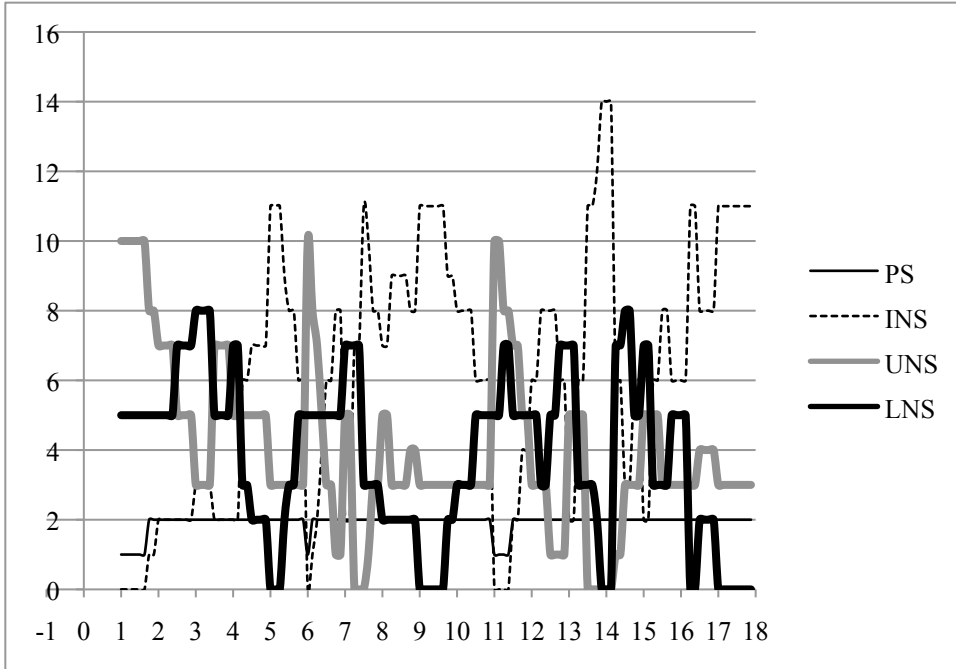


FIGURE 3.13. *Total registrational space, section I, local range.*

of the pitch shape to the octave and one expansion to a minor 10th represent the highest spatial values. These pitch shape expansions will be particularly noticeable because the INS they create dominates the spatial profile.

The median trajectory graph for section I with reference to the full range expresses the low registral placement of section I (Fig. 3.14). The midpoint of the pitch shape moves within a range of 6 steps (-8.5 to -2.5). The pitch shape is never centered in the global pitch field, nor does it even approach center. The average value for placement is -6.1, which corresponds to the area around E3/F3. E3/F3 corresponds to the local central pitch axis for section I, thus the median trajectory graph with respect to the local range expresses how the pitch shape is quite centered from a local perspective (Fig. 3.15). The average value for placement in the smaller local range is -0.1, which is very close to center.

The pitch shape is locally centered at eight locations in section I, with centered sonorities accounting for 13% of the opening section (Table 3.1). Just as the centered sonority at the piece's central moment provides a sense of balance for the overall spatial motion in the piece, these moments of centering create a sense of balance locally in the opening section – a balance that is entirely absent from a global perspective. Almost every instance of balancing involves the pitches C and A, relating these sonorities to the overall range of the piece, the range of section I, and the centered sonority placed at the temporal midpoint of the entire piece.

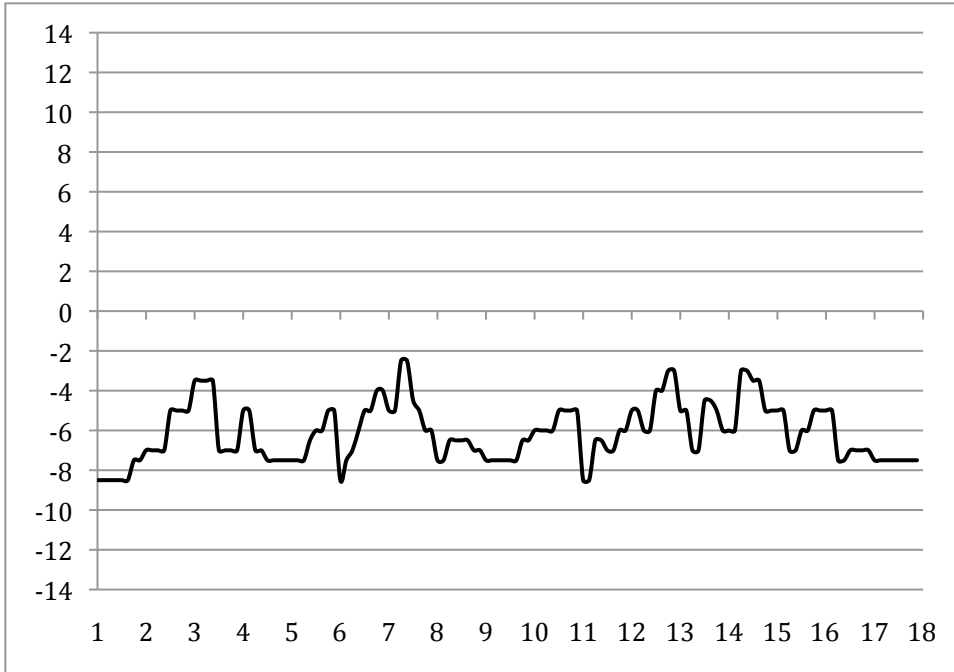


FIGURE 3.14. *Median trajectory graph, section I, full range.*

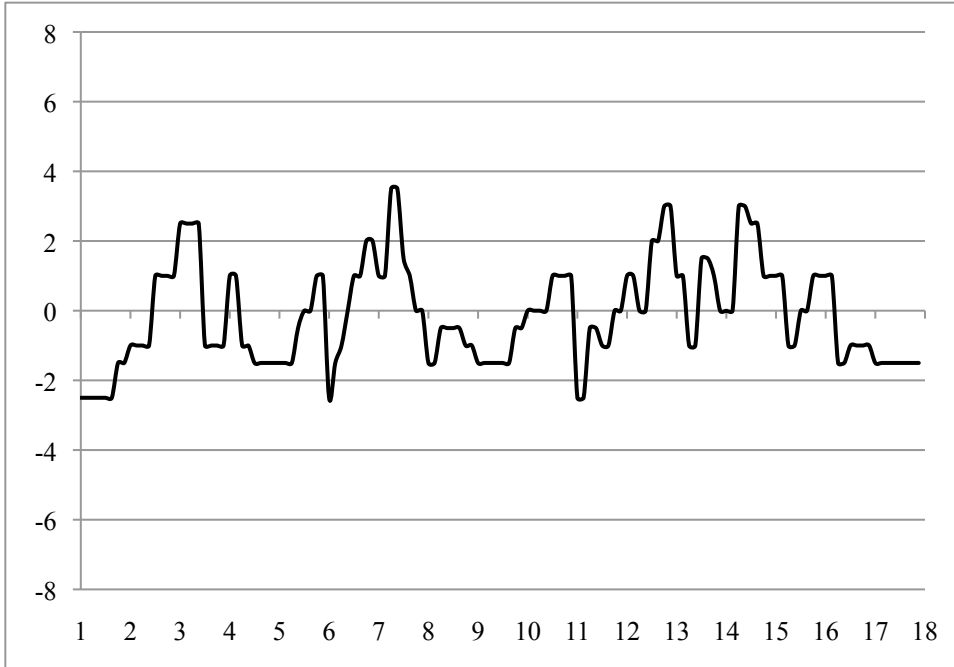


FIGURE 3.15. *Median trajectory graph, section I, local range.*

TABLE 3.1. *Location, constitution, and duration of sonorities centered with respect to section I.*

Measure	Pitches involved	Duration (in eighths)
5	C3-A3	2
6	D3-G3	1
7	C3-A3	2
10	C3-A3	4
11	D3-G3	1
12	C3-A3	1
13-14	A2-C4	3
15	C3-A3	2

Section I establishes the importance of the pitches A and C, by highlighting them as melodic goals, as the predominant harmonic interval used to balance the pitch shape locally, and as the outer boundaries of the local range. The frequent use of these pitches in section I, as well as their use at the central point of the entire work as a balancing interval, suggest that they will have additional importance as the piece progresses.

As the piece is written in a two-voice texture, unison sonorities stand out aurally, providing a useful tool for marking musically important moments. In the first section, these unisons appear to be a means of articulating the beginnings and/or endings of important structures. The opening unison functions globally as the point of initiation and ultimate rest, but also functions locally as the start of a statement of the ascending main motive in augmentation. The end of the motive is punctuated by a return to a unison sonority. Additionally, the return to a PS value of 1 occurs at the end of the first phrase, marking off the material used for the mensural canon.

Section I contains a number of expansions to the octave which culminate in a larger expansion to the minor tenth. This minor tenth, consisting of the highest and lowest pitches of the local range, exhausts the registral space available in section I,

requiring the piece to continue by opening up in a new register in the next section. The final sonority of section I is an octave which creates a registral opening in need of closure.

The median trajectory for section I oscillates rapidly and lacks a focused direction. The section closes slightly higher than the opening (-8.5 to -7.5, ascent of 1). The opening section establishes centering as an important structural feature by containing a high proportion of locally centered sonorities and by highlighting the two pitches involved in the main globally centered interval.

To summarize, the end of section I creates a tonal and registral opening that requires further closure. Additionally, during the course of the first section, the pitch shape expands so that the outermost pitches of the range are sounded simultaneously. At this point, the pitch shape has outgrown the local range requiring an extension of usable registral space. While the first section presents some musical problems which require resolution, it also establishes and highlights some important structural features which will be used to provide balance and closure to the piece such as the A-C interval, the centered sonority, and the main motive in its rhythmically augmented form.

V. SPATIAL ANALYSIS OF SECTION II.

The pitch graph of section II shows that, in this second section, the central portion of the full range is activated while the extreme upper and lower portions of the range are unused (Fig. 3.16). The same dyad (A3-C4) used at the work's midpoint (m. 25) to registrally balance the pitch shape is also present as the first and last dyad of section II rendering this section a balancing function for the overall work. The local range of

section II extends from D3 to F4, which, like section I's range, traverses the space of a minor tenth (Fig. 3.17). The local central axis lies between A3 and B-flat3, which almost coincides with the global central axis (B-flat3/B3).

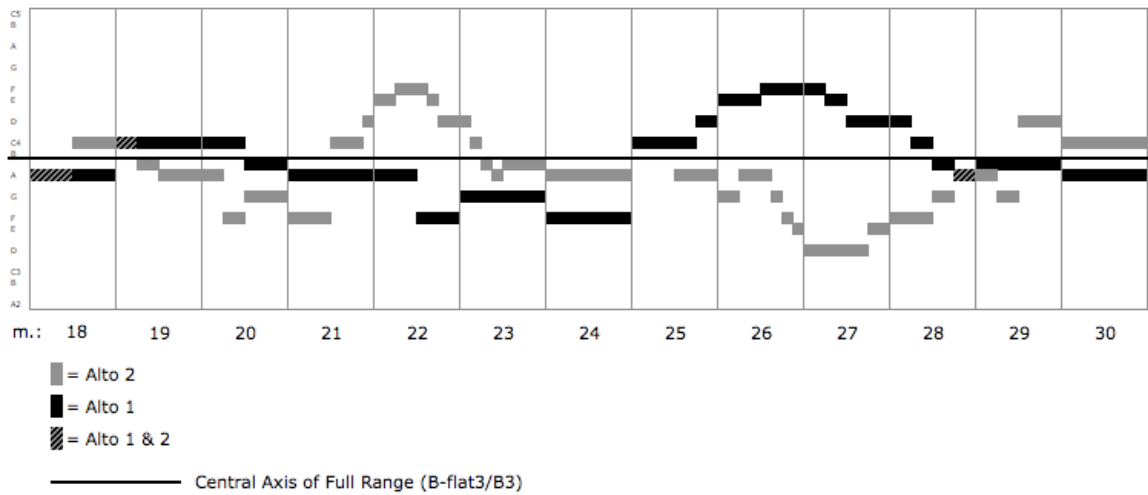


FIGURE 3.16. *Pitch graph, section II, showing central axis of full range.*

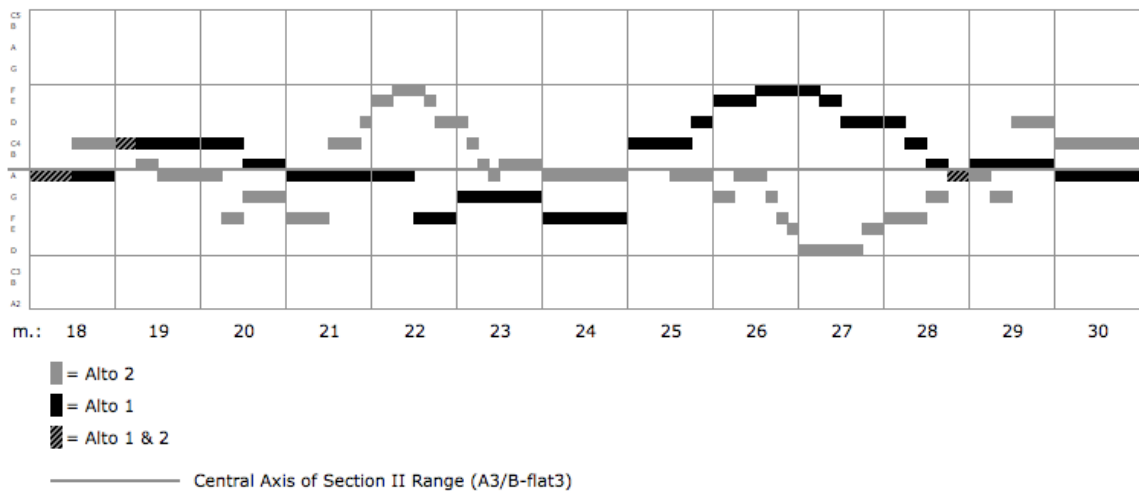


FIGURE 3.17. *Pitch graph, section II, showing central axis of local range.*

Section II begins on unison A3 and ends on the interval A3-C4. Unlike the opening section, the pitch “A” serves both as the point of departure and point of arrival, making this section tonally closed, though not in the overall key. Like the first section, the second section contains a registral opening, though the final minor third is significantly smaller than the final octave from section I.

As in section I, the majority of section II maintains a positive space value of 2 (Fig 3.18). However, there are more occurrences of decreases to a value of 1 than in the opening section. Like the first section, this section begins on a unison, once again establishing the unison as a stable sonority (m. 18). The very next measure (m. 19), contains a unison as well, this time on C4. The closely spaced unisons on A3 and C4 accentuate these two structurally important pitches. These pitches which had been highlighted as melodic apexes in the first phrase of section I, are now being presented melodically again but in closer proximity than in section I. In the second half of measure 19, these same two pitches are fused into a harmonic interval.

At measure 25, PS decreases to 1 as a result of a rest in the second alto part. This brief change in texture occurs directly before the midpoint of the entire work where the harmonic interval A3-C4 serves to balance the larger pitch shape. Again, a drop in PS is used to help articulate a structurally important event. The pitch sounding at this point in the first alto part is C4. The final unison of the section (m. 28) is on A3. To balance the opening two unisons, which articulate a motion from A3 to C4, the second two decreases in PS articulate a motion from C4 back to A3.

In section I, we saw that the unison texture was used to articulate the single statement of the principle motive in its augmented form (bass 1, mm. 1-6). In this second

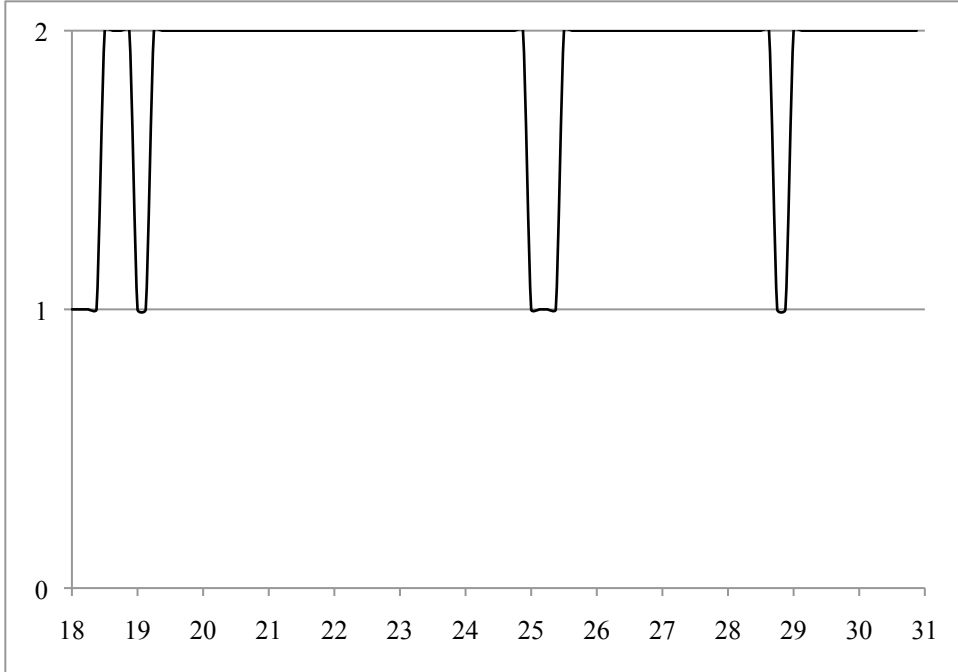


FIGURE 3.18. *PS, section II.*

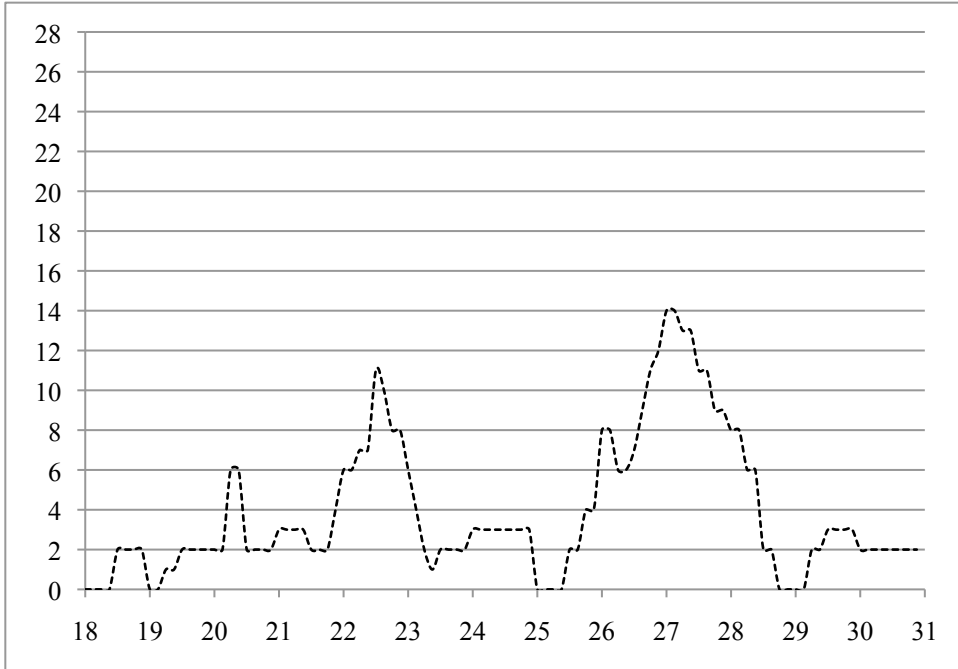


FIGURE 3.19. *INS, section II.*

section, the principle motive is also stated in augmentation only one time, but in an inverted form (alto 1, mm. 19-24). The opening pitch, C4, at m. 19 is stated in unison and directly after the descent to F3, alto 2 has a rest. Thus, in the same manner as section I, changes in texture articulate the beginning and end of an augmented statement of the motive.

The graph of internal negative space for section II lacks the rapidly oscillating motion seen in the same graph for the first section (Fig. 3.19). Two large expansions can be seen at measures 22 and 27. The first expansion peaks at a value of 11 and the second at a value of 14 corresponding to the ordering and the size of the larger expansions in section I. However, section II contains far fewer expansions than section I. The reduced number of expansions and the generally narrower pitch shape result in an average INS of 3.9 which is significantly lower than the average INS for section I (6.2).

The graph of upper and lower negative space with respect to the full range shows that the pitch shape basically lies within the middle register (Fig 3.20). Both UNS and LNS values fall within a range of 5 to 15. The two drops in both types of space in bar 22 and 27 reflect the two large expansions of section II. Additionally, UNS and LNS values are frequently equal, meaning this section is often centered within the piece's full range. As the central pitch axis of section II and the entire work are so close, the graph of UNS and LNS with respect to the local range is fairly similar to the same graph with respect to the global range (Fig. 3.21).

With respect to the composition's full range, the total space graph shows that, unlike section I, no one type of space is dominant (Fig. 3.22). However, UNS and LNS tend to be more prominent. As such, the actual pitch shape usually occupies a small

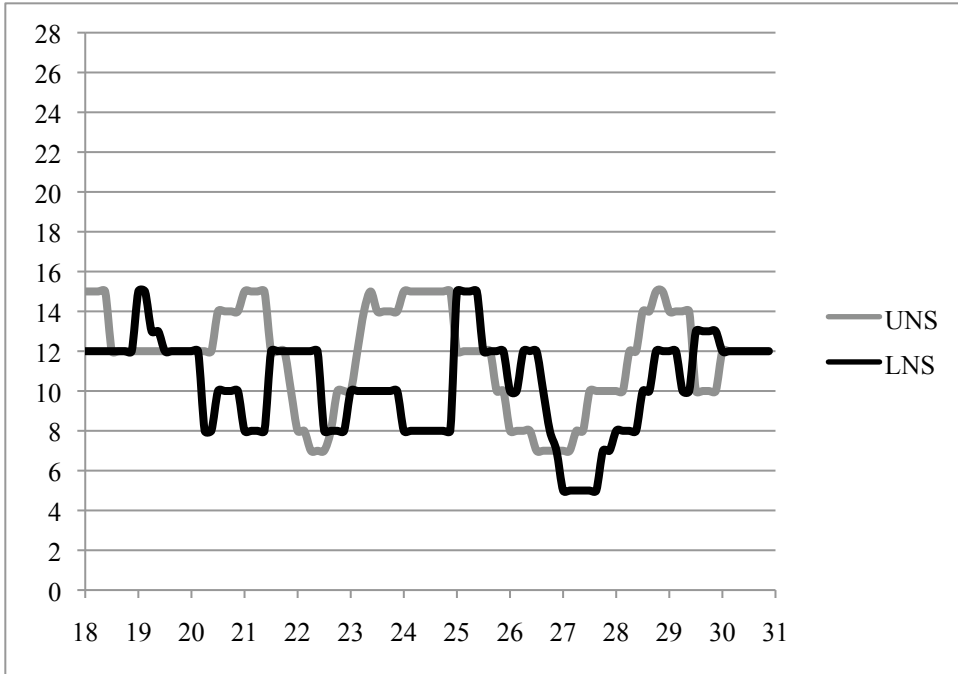


FIGURE 3.20. UNS and LNS, section II, full range.

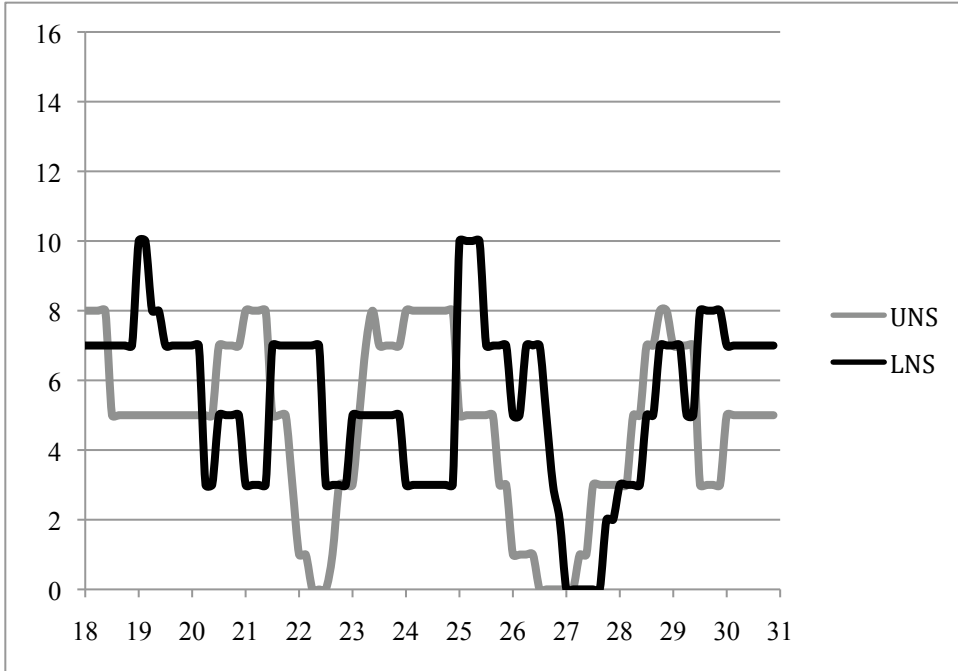


FIGURE 3.21. UNS and LNS, section II, local range.

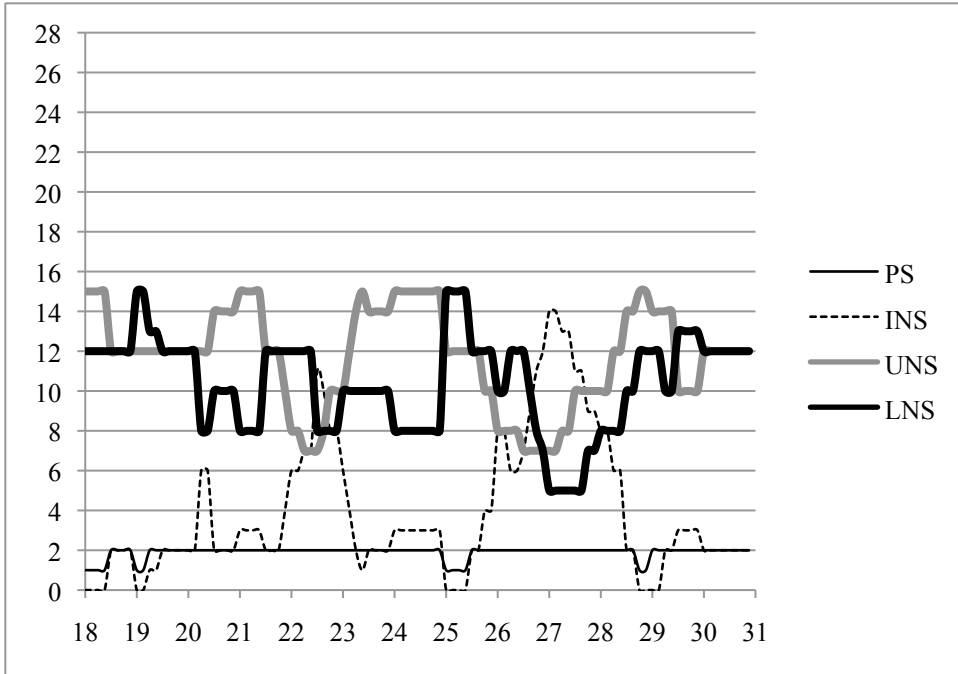


FIGURE 3.22. Total registrational space, section II, full range.

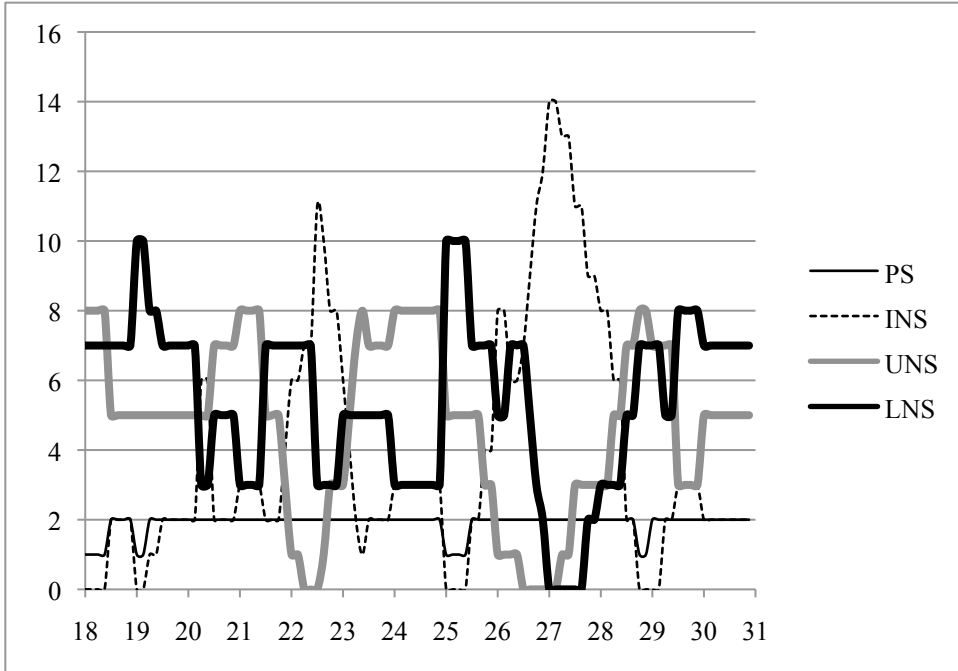


FIGURE 3.23. Total registrational space, section II, local range.

range. The two large expansions constitute the only moments where INS levels reach the same range of values as UNS and LNS. On the other hand, with respect to the local range of section II, spatial values, aside from PS values, generally fall within similar ranges with the two main expansions prominently exceeding those ranges (Fig. 3.23).

Again with respect to the full range of the piece, the median trajectory graph for section II expresses the pitch shape's central location globally (Fig. 3.24). As in the opening section, the midpoint of the pitch shape moves within a range of 6 steps, but is placed higher, between -3.5 and 2.5. The graph reveals eight occurrences of centering in the global pitch field (Table 3.2) which account for 25% of section II. The average value for pitch shape placement is -0.7 (approximately A3), reflecting this high degree of global centering. The pitches A3 and C4 are involved in the majority of centered sonorities and form the balancing interval at the piece's temporal midpoint. The A3-C4 dyad is also the first and last harmonic interval present in section II giving this central section of the "Benedictus" a stabilizing function.

Section II's pitch shape is briefly centered five times within the smaller local range of section II (Fig. 3.25, Table 3.3). The durations of these pitches are quite brief so that locally centered sonorities exist for only 9% of section II. While the majority of centered dyads have consisted of A and C, the majority of these dyads consist of D and F which point to the tonic of the "Benedictus." While local centering was prominent in section I, global centering is prominent in section II.

The median trajectory graph has a significantly smoother shape than that of the first section. This means the pitch shape moves in a more gradual fashion rather than quickly oscillating up and down in the range as in section I.

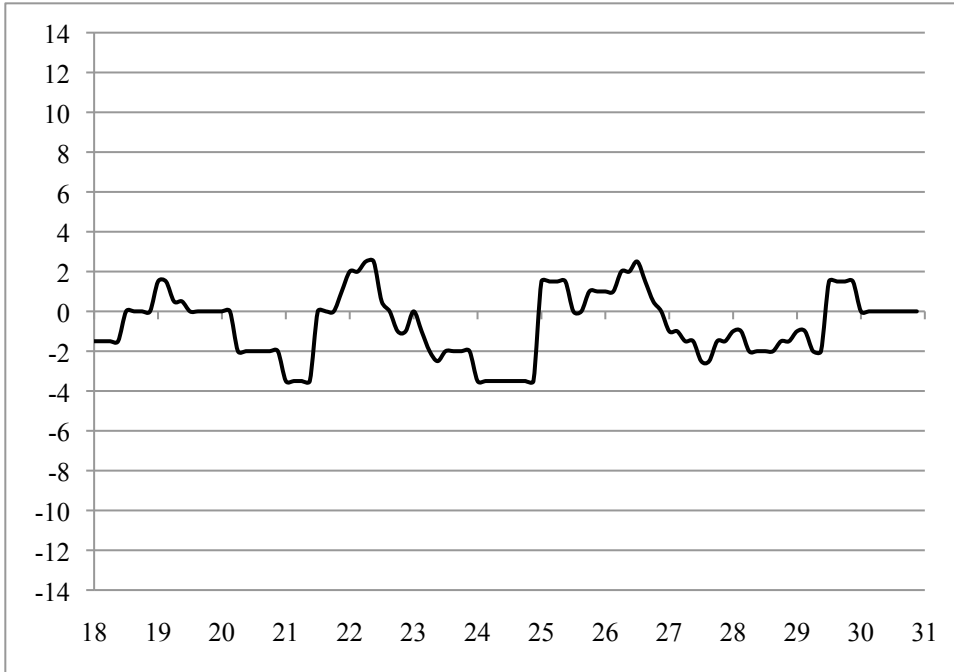


FIGURE 3.24. *Median trajectory graph, section II, full range.*

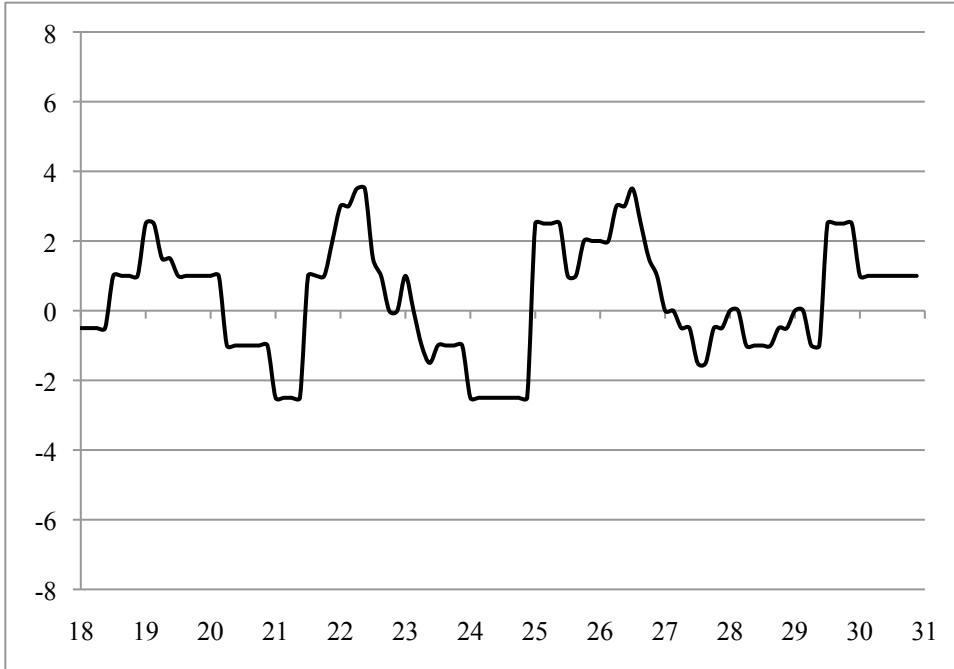


FIGURE 3.25. *Median trajectory graph, section II, local range.*

TABLE 3.2. *Location, constitution, and duration of globally centered sonorities, section II.*

Measure	Pitches involved	Duration (in eighths)
18	A3-C4	4
19	A3-C4	6
21	A3-C4	3
22	F3-E4	1
23	G3-D4	1
25	A3-C4	2
26	F3-E4	1
30	A3-C4	8

TABLE 3.3. *Location, constitution, and duration of locally centered sonorities, section II.*

Measure	Pitches involved	Duration (in eighths)
22	F3-D4	2
23	G3-C4	1
27	D3-F4	2
28	F3-D4	2
29	A3-B-flat3	2

In this second section, A and C continue to serve as important structural pitches. As in the opening section, they are individually highlighted but as the first two unison pitches rather than as two melodic goals which are spaced further apart. This process of bringing the pitches closer together culminates in their fusion into a harmonic interval in measure 19 – the harmonic interval which is centered with respect to the full range of the piece. This harmonic interval not only appears at the global and local temporal midpoint, but as the first and last interval presented in section II. Its presence in these important locations gives the second section a stabilizing function for the overall shape of the piece.

As in the first section, unison sonorities are used to highlight important notes as described above, and to articulate the beginning and end of the main motive in

augmented form. In the opening section, the augmented form ascended to A3. In this section it descends from C4. These two statements of the augmented motive are directionally balanced and articulate the all-important A3 and C4 pitches.

In the second section there are only two major expansions, one of an octave and one of a tenth. These expansions function much the same way as those in the first section, only they are fewer in number. In fact, overall, INS is less prominent than in section I. While section I contains a fair amount of local centering (13%), section II, in contrast, contains significantly more global centering (25%) and slightly less local centering (9%).

In summary, section II echoes the registral opening that takes place in section I, though the final dyad is considerably narrower. Since high levels of musical energy are expressed as increases in INS, this smaller registral opening of section II may indicate a decreasing energy level and a motion towards closure to the unison. Again, the expansion to a harmonic tenth exhausts the local range requiring the extension of the range into a new register. However, there are far fewer expansions in this second section – another indicator of a decline in musical energy and a motion toward closure. The unison sonority continues to be important in highlighting structural features such as the A-C dyad as well as a new statement of the augmented motive whose spatial motion and placement complement the augmented statement from the first section. A high degree of centering, both local and global, gives this middle section a balancing function.

VI. SPATIAL ANALYSIS OF SECTION III.

The pitch shape in section III lies in the upper portion of the full range, rarely descending below the global central axis (Fig. 3.26). The range of this final section extends from A3 to C5 with a local central axis of E4/F4, both of which lay exactly one octave higher than their counterpart in section I (Fig. 3.27). All three sections, then, possess local ranges that span a minor tenth. Differences in Josquin's use of registral space from section to section can be more easily perceived because of the equal size of each section's range.

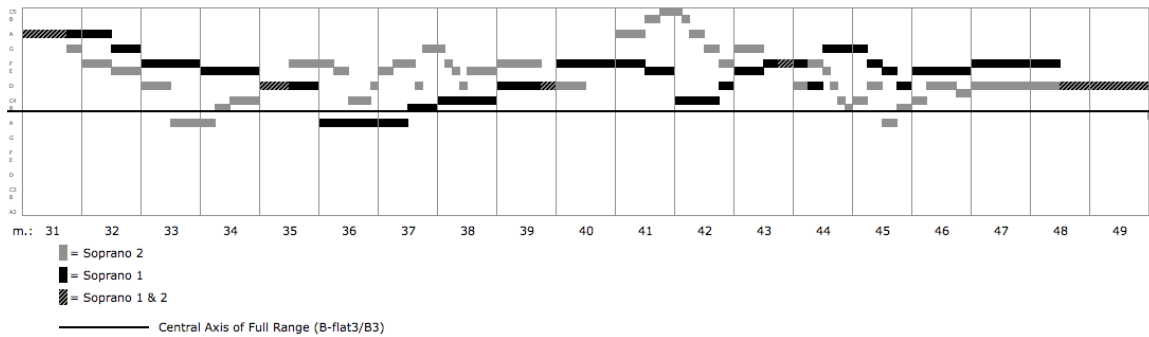


FIGURE 3.26. Pitch graph, section III, showing central axis of full range.

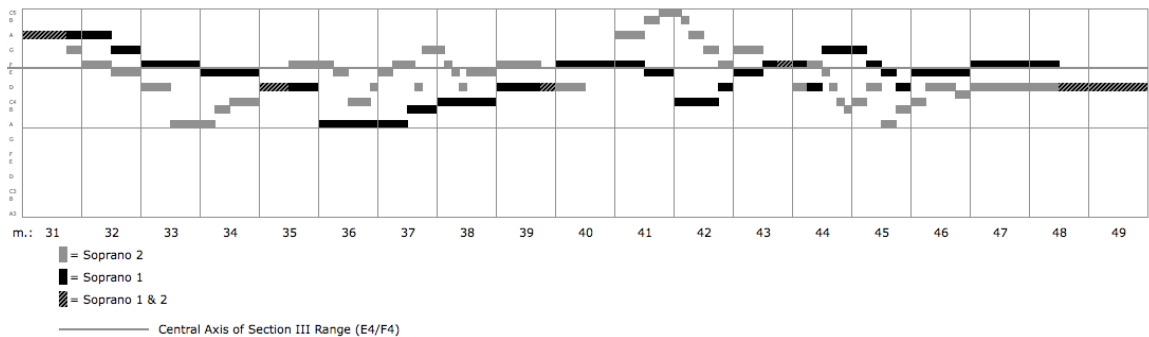


FIGURE 3.27. Pitch graph, section III, showing central axis of SIII range.

This section opens on a unison A4 and closes on a unison D4. The return to a unison and the tonic, D, provides both registral and tonal closure for the entire work. It is the only section which ends on D and the only section which ends on a unison. The final sonorities of each section form a series of decreasing intervals, octave - minor third – unison, which indicate a gradual progression back to the original opening sonority of a unison.

The A-C interval remains an important structural feature in the third section. These two pitches form the boundaries of the local range. In bar 36, they return in the form of the A3-C4 harmonic interval that provides global centering. As in section I, the two pitches are found as the peaks of two melodic highpoints – the opening unison of A4 is the second highest note of the section and the C5 in measure 41 is the apex of the second soprano's second phrase. Because these highpoints appear at the beginning and in the second phrase of the second soprano part which is not restated in augmentation, they only occur one time each, as opposed to the double presentation in the opening section.

In section III, PS decreases to 1 six times with the unison sonority durationally present for a total of 32 eighths (Fig. 3.28). The unison sonority is heard more times and for a longer amount of time in section III than in any other section. The final unison lasts for a total of 12 eighths, bringing the piece to a state of rest. The increase in unison sonorities as the piece progresses contributes to the sense of rest with which the piece concludes.

As in the previous sections, the decreases in PS help to articulate important structural features in section III. The unison is articulated at the open and close of the section – a reflection of the same phenomenon that occurs at the global level of the piece.

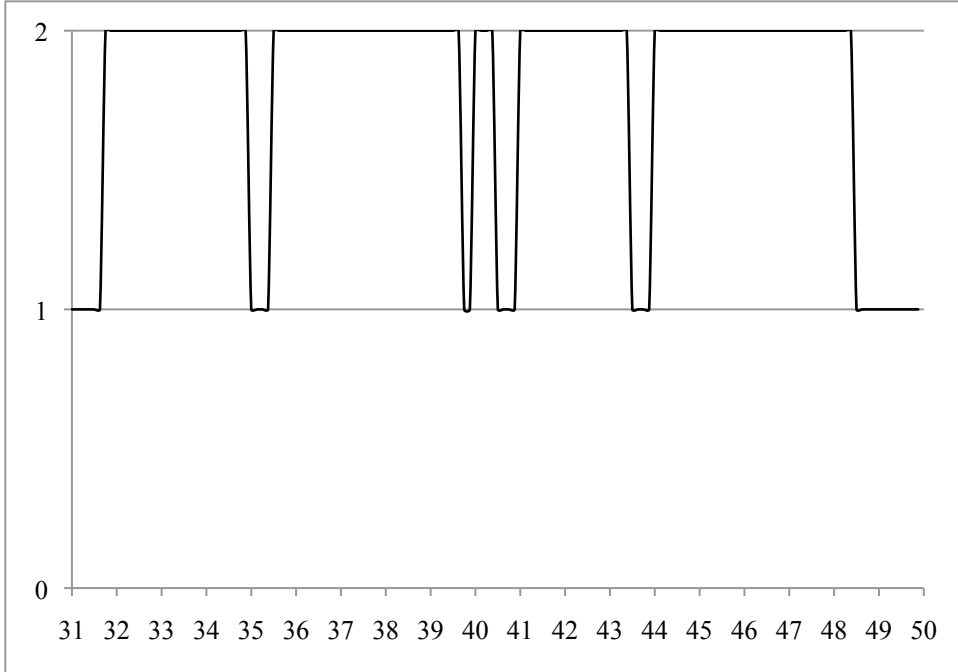


FIGURE 3.28. *PS, section III.*

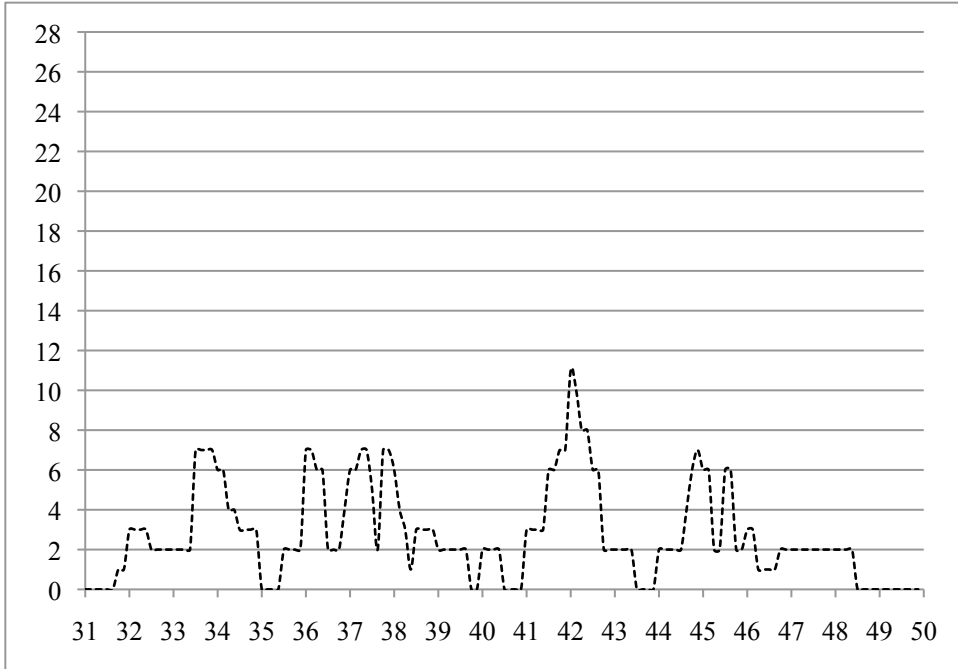


FIGURE 3.29. *INS, section III.*

In sections I and II, the unison was used to punctuate the rarer instances of the augmented main motive. In section III, the motive is found in augmentation twice, though once in inversion (soprano 2, mm. 31-35) and once in its original ascending form (soprano 2, mm. 36-39). The presence of the unison at the opening of measure 31 (A4) and the opening of measure 35 (D4) punctuate the inverted motive while the unison in measure 39 (D4) marks the end of the ascending motive. The other two decreases in positive space also occur at structural points. The three phrases of the second soprano's part are separated by rests (m. 40 and m. 43).

The large number of returns to a unison sonority can be seen in the graph of internal negative space for section III (Fig. 3.29). As in both the previous sections, there are smaller expansions that lead up to a larger expansion. However, this time, an expansion to a minor tenth (INS=14) never occurs and the largest expansion of the section is only an octave wide (INS=11, m. 42). This octave is preceded by four expansions of a minor sixth (INS = 7; m. 33, 36, and twice in m. 37) creating a smaller-scale version of the INS development in sections I and II. The lack of a minor tenth expansion means that the pitch shape never extends simultaneously to the outer boundaries of section III's range. The pitch shape never "outgrows" the range of section III and thus, further expansions to the global range of the piece are no longer necessary. The average INS value of 2.8 reflects the overall closer placement of the two voices and continues the pitch shape's narrowing trend that began in section II.

The graph of upper negative space and lower negative space with respect to the full range shows the generally high placement of the third section (Fig. 3.30). UNS and LNS are equal once in measure 36, which means the pitch shape is globally centered.

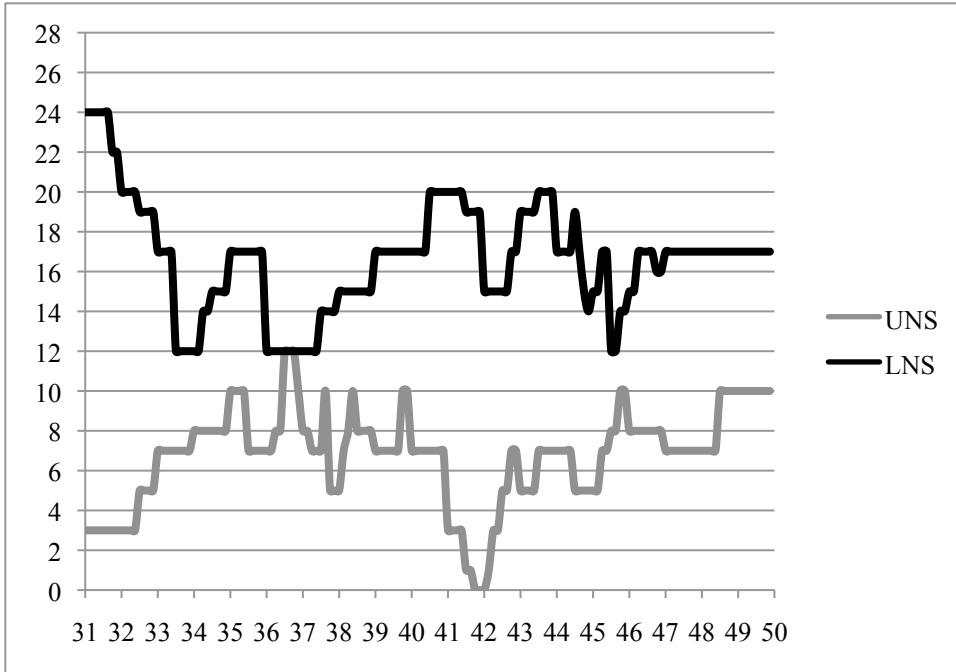


FIGURE 3.30. *UNS and LNS, section III, full range.*

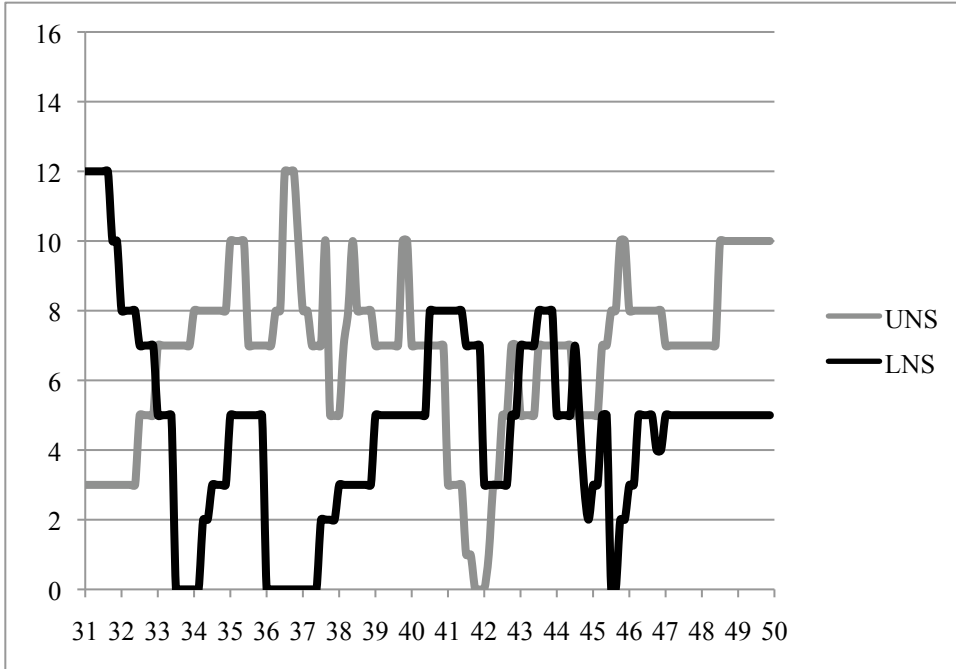


FIGURE 3.31. *UNS and LNS, section III, local range.*

UNS drops to a value of 0 once in bar 41 which means the highest note of the piece is reached. UNS bottoms out only this one time throughout the course of the composition. The UNS/INS graph with respect to the local range of section III shows that the piece reaches the lowest note of the local range three times (Fig. 3.31). However, UNS and LNS never reach a value of 0 simultaneously which means an expansion to the edges of the range never occurs.

The graph of total space with respect to the full range shows the dominance of LNS in section III (Fig. 3.32). In fact, the opening LNS value of 24 is the highest value for any type of space in the entire piece. As mentioned before this vast amount of lower negative space is in part caused by a large shift in register between the close of section II and the opening of the third section.

Though LNS is dominant with respect to the full range, UNS is the more dominant type of space with respect to the local range of section III (Fig. 3.33). The high positioning of the pitch shape at the opening of section III allows for a local descent. This, in part, helps to balance the global ascent that takes place over the course of the Benedictus.

While INS often peaked above other types of space in section I and had two significant peaks in section II, in section III INS does not stand out as a dominant type of space. This is due to the generally narrower pitch shape of section III. The local descent and the narrow pitch shape indicate a decline in musical energy in the final section, which allows the piece to come to a state of rest.

The median trajectory graph with respect to the full range also shows the high placement of the pitch shape (Fig. 3.34). The trajectory moves within a range of 10.5

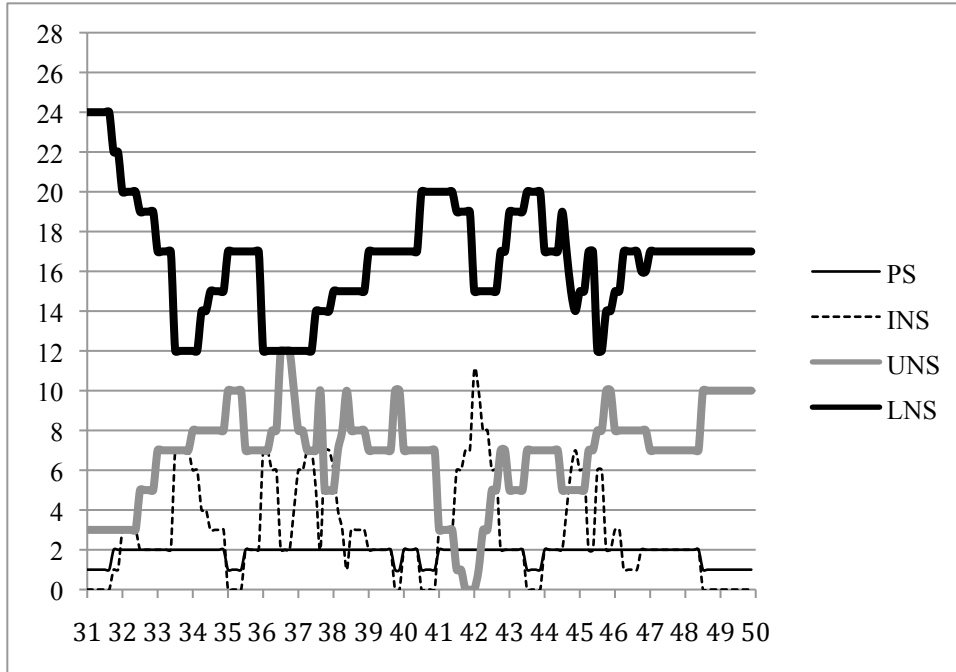


FIGURE 3.32. *Total registrational space, section III, full range.*

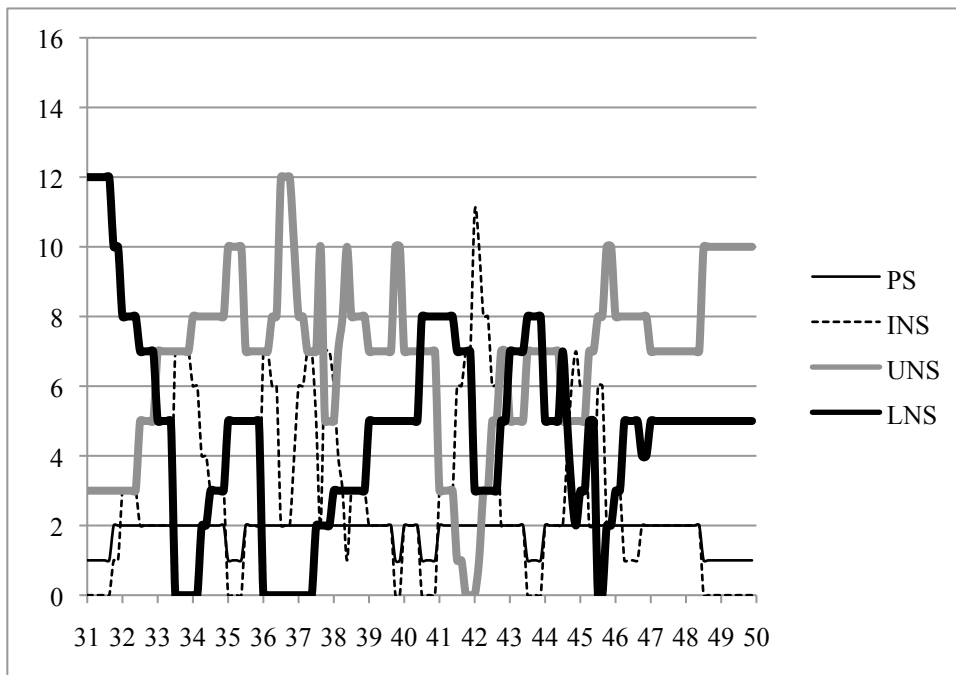


FIGURE 3.33. *Total registrational space, section III, local range.*

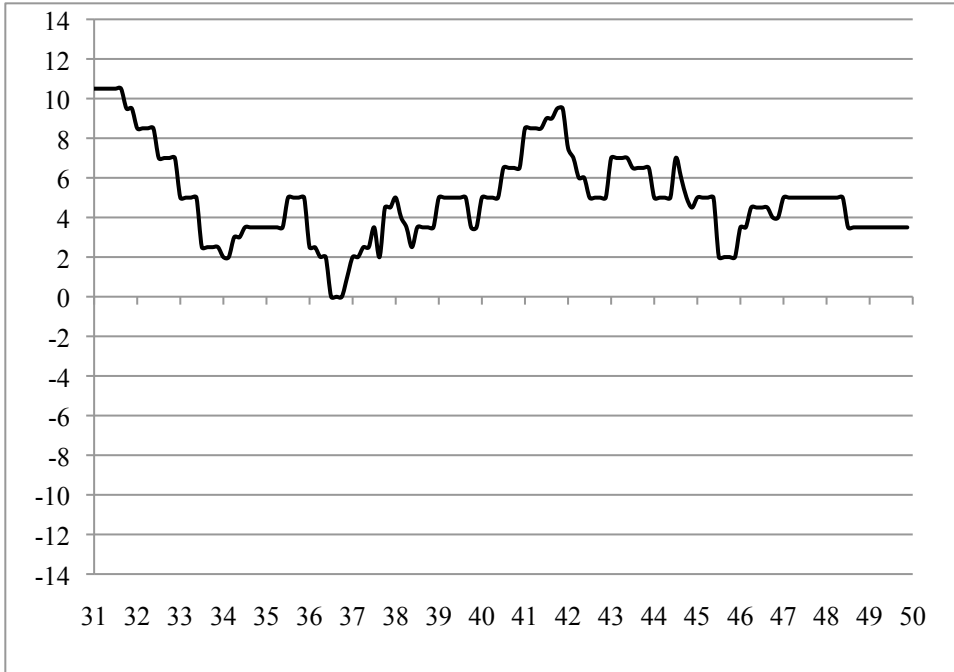


FIGURE 3.34. Median trajectory graph, section III, full range.

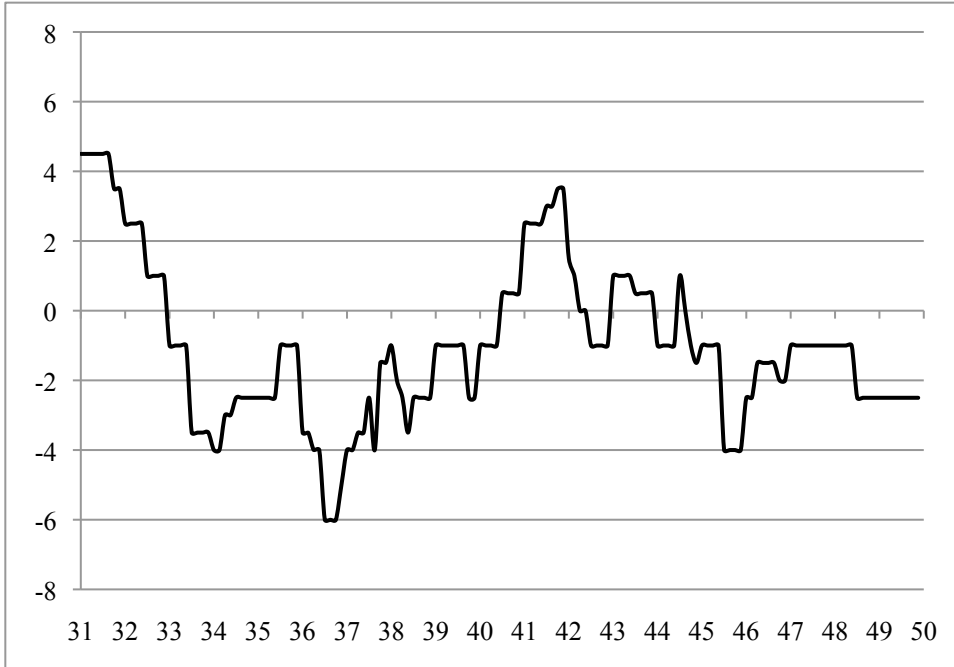


FIGURE 3.35. Median trajectory graph, section III, local range.

steps (0 to 10.5) with an average placement of 5. This corresponds to E-flat₄/E₄ – a perfect fourth above the global central axis. It also clearly shows the one occurrence of global centering that takes place in m. 36 for a total duration of 3 eighths (Table 3.4). Locally, there are two brief instances of centering, also for a duration of 3 eighths (Table 3.5, Fig. 3.35). As the range for section III is the same as section I displaced up an octave, it is not surprising to find the same pitches involved in local centering. However, this final section contains an equal amount of global and local centering and, from that perspective, provides a kind of balance that was lacking in the previous two sections.

TABLE 3.4. *Location, constitution, and duration of globally centered sonorities, section III.*

Measure	Pitches involved	Duration (in eighths)
36	A3-C4	3

TABLE 3.5. *Location, constitution, and duration of locally centered sonorities, section III.*

Measure	Pitches involved	Duration (in eighths)
42	C4-A4	2
44	D4-G4	1

The overall contour of the trajectory is remarkably different from those of the previous sections and is more easily compared when viewed with respect to the local range. The median trajectory graph for the local range of section III spans from -6 to 4.5 with an average placement of -1. The range of this trajectory (10.5) is significantly larger than that of the previous two sections (both of which are 6). Rather than the more chaotic

oscillating motions found in the trajectory graphs of sections I and II, this trajectory has a smoother overall shape with a clear direction. As we shall see, the transition in the shape of the trajectory is a clue to how the Benedictus achieves closure despite the registral opening at the end.

In summary, the third section completes the overall ascending motion of the “Benedictus.” Unlike the other two sections, it both opens and closes on a unison with the final unison providing closure at both a local and global level. The third section contains an encapsulation of important features in the other two sections. For instance, all the forms in which A-C have been presented in sections I and II are found in the final section. Like section I, A-C is expressed as the range and each of the two pitches create the two melodic highpoints in the section. As in section II, the A3-C4 dyad is presented harmonically as a centering sonority. The main motive in augmentation is found twice – once in its original form (as in section I) and once in its inverted form (as in section II) - and each instance is articulated on either end by a unison. As in both earlier sections, a series of smaller expansions leads to a larger expansion, though all are smaller in scale. Globally and locally centered sonorities are present for an equal duration.

On the other hand, this final section contains some significant differences in spatial design from the opening two. The decrease in INS values, the overall motion of the final section, and the shape of the median trajectory graph form important contrasts with previous developments and are the specific traits of section III which create its unique function in the “Benedictus,” bringing the piece to its conclusion.

VII. SUMMARY OF IMPORTANT SPATIAL TRENDS.

From the detailed spatial analysis of each section, a number of features stand out as being particularly important to both the architectonic structure of the “Benedictus” as well as the creation and dissolution of musical energy. The pitches A and C are highly significant pitches and are highlighted as local ranges, as melodic highpoints, and as centering dyad structures. Decreases in positive space to a value of 1 are often used to help articulate important structural events. Internal negative space is manipulated in the piece so that expansions suggest a high level of musical energy while unisons function as places of rest. The analysis techniques that give us the most information about these structural features are the pitch graph, the graphs of positive and internal negative space, and the median pitch trajectory graph. Using these tools, I will discuss how these features contribute to the structure of the “Benedictus” as a whole.

The overall global ascent from the opening D3 to the closing D4 creates a rather unusual registral opening from the perspective of the rest of the mass. What could be conceived as an off-balance global spatial motion is actually very carefully situated within the registral space of the piece to help stabilize the pitch shape. For instance, we have already seen how the A3-C4 interval that is present at the temporal midpoint forms a centering structure. Another important balancing feature is the main motive in its augmented form. This form of the motive is highlighted within the piece in two primary ways. Compared to the original and diminished statements, it occurs only rarely – in ascending form in section I (bass 1, mm. 1-5), in inversion in section II (alto 1, mm. 19-24), and once each in ascending (soprano 1, mm. 36-39) and descending (soprano 1, mm.

31-35) form in section III. Additionally, the beginning and end of each appearance of the motive are punctuated by unison sonorities.

The augmented motive in section I forms a linear ascent from D3 to A3. The ascending augmented motive in the final section, which begins on A3, continues this linear ascent up to D4. These two augmented statements together form a structural backbone across the registral space spanned between the opening and closing pitches of the entire work (Fig. 3.36).

Together, the two statements of the augmented motive in inversion found in sections II and III form a continuous linear *descent* – from A4 to F3 (Fig 3.37). The descent in the first alto is interrupted at A3 by both a relatively long duration (dotted whole note) as well as a leap to F3, which serves as an incomplete neighbor to the G3 – the next note in the linear descent. The descent from A4 to A3 would then counter the ascent from D3 to D4, which forms a structural backbone for the entire piece. The extension of this descent down to F, which makes the descent (A4-F3) longer than the ascent (D3-D4), may be one means of balancing the overall global ascent of the “Benedictus.” Additionally, when superimposed with the other augmented statements, these linear ascents and descents form the shape of a cross possibly imbuing the augmented motives with a symbolic as well as a structural function (Fig. 3.38).

Another structurally important feature are the pitches A and C which contribute in numerous ways to the spatial design of the “Benedictus.” At the most global level, they form the upper and lower boundaries of the range (A2-C5), defining the registral space in which the pitch shape will move. When this space is reduced by an octave, there are two possible registers these pitches may define: A2-C4 which is the range of section I, and

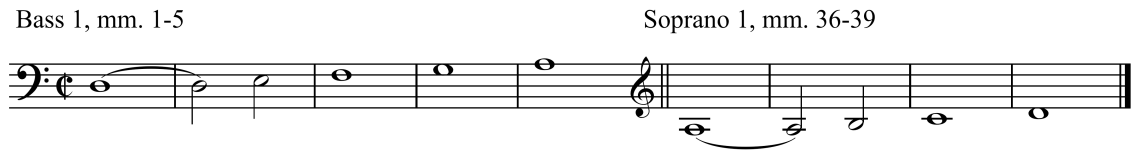


FIGURE 3.36. *Linear ascent formed by the two statements of the motive in augmentation.*



FIGURE 3.37. *Linear descent formed by the two statements of the inverted motive in augmentation.*

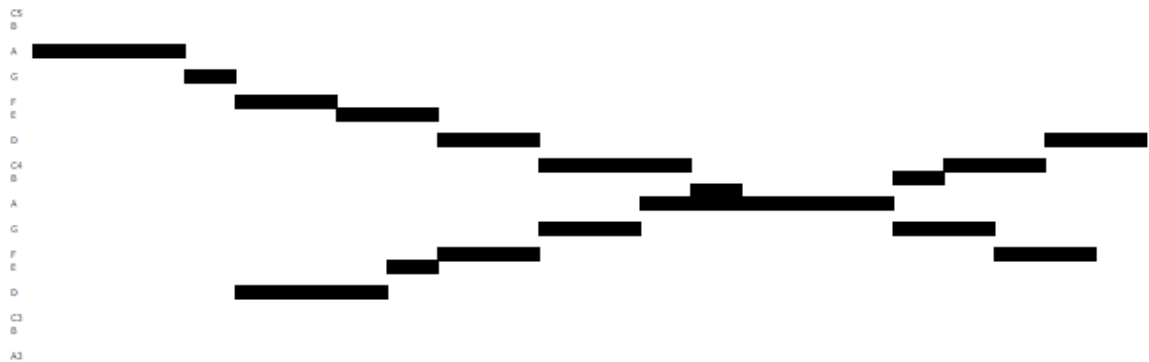


FIGURE 3.38. *Pitch graph of augmented motives intersecting at A3.*

A3-C5 which is the range of section III. The range of sections I and III are a reduction of the global range.

The area where these two local ranges intersect is A3-C4 – the range reduced to its smallest interval. This interval is significant because it symmetrically surrounds the global central pitch axis, making it a perfectly centered sonority with respect to the global range. This dyad is presented harmonically both as the first and last dyad of section II as well as at the central point of the entire *Benedictus*. It is sounded a number of other times in section II. Its prominence in section II help this middle section to balance the lower and upper extensions of the pitch shape which precede and follow. The inversion of this interval forms a major sixth and appears in section I (C3-A3) and in section III (C4-A4) as sonorities that are locally centered (Tables 3.1 and 3.5). We can see that the range-defining and centering properties of A and C function at both global and local levels.

In addition to being presented as a range and as a dyad, A and C are highlighted as melodic highpoints in the first and last sections. In the first section the highpoints A3 and C4 foreshadow the centering dyad that forms such an integral structure in the middle section. In the final section, A4 and C5 are melodic highpoints, which now have the function of recalling the highpoints in the first section, only now an octave higher.

While the pitches A and C are important in creating a balanced architectonic structure, positive space and internal negative space play an essential role in the creation and dissipation of musical energy. The unison that opens and closes the piece is the sonority with the greatest degree of rest. As the piece progresses, there is a gradual increase in the number of unisons and an increase in the duration of those unisons (Figures 3.39, 3.40).

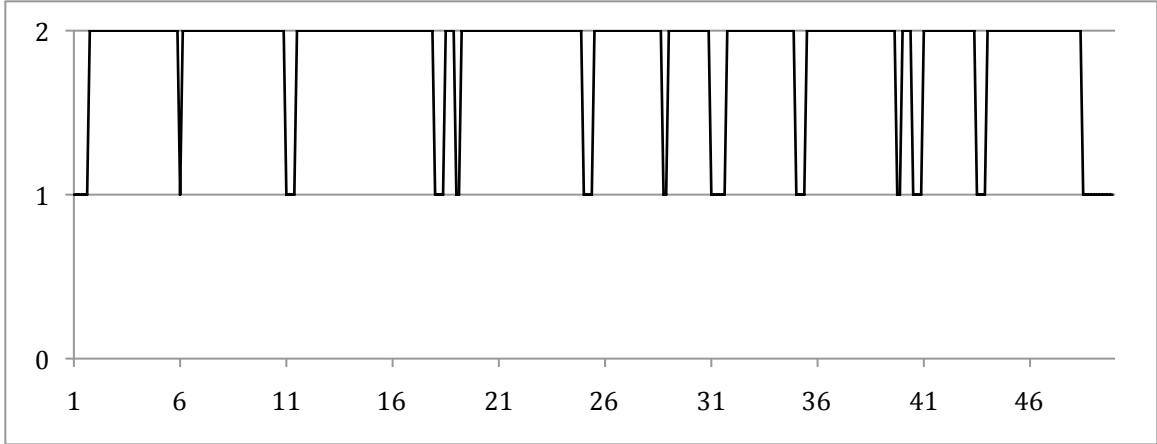


FIGURE 3.39. *PS, entire piece.*

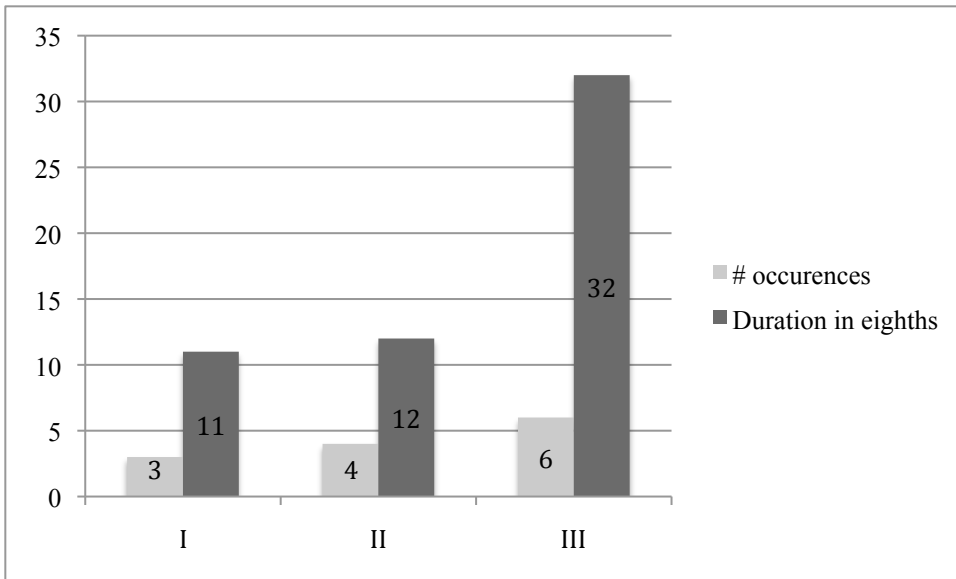


FIGURE 3.40. *Increase in occurrences and duration of unisons across the three sections.*

Expansions of the pitch shape, reflected in increased INS values, represent a high level of energy. As the piece progresses there are fewer expansions, and the expansions decrease in size (Fig. 3.41). We can see that there are two large expansions to 14, one in section I and the other in section II. The first major expansion is preceded by 3 subsidiary expansions to 11 (an octave) and followed by the octave at the close of section I (m. 18). The second major expansion is preceded by only one subsidiary octave expansion within section II. There is no return to the octave after the second major expansion for the remainder of section II. In section III there is no large expansion to 14, rather the whole scheme of subsidiary expansions leading to a primary expansion is scaled down in size. Four smaller expansions of 7 lead to the one larger expansion, now only an octave (11). In each section subsidiary expansions create energy that culminates in the one large expansion. At the major expansion in section I and in II, the pitch shape reaches the outer limits of the local range. At that point, the piece has exhausted the local range and requires movement into new and higher registral space. However, in section II, a dissipation of energy is reflected in the decreasing number of expansions. In the final section the energy required for the pitch shape to expand to the limits of the range is lacking and the largest expansion only reaches an octave. Therefore, the piece requires no movement into new registral territory so the global ascent draws to a close. The decrease in musical energy is also reflected in the decrease of average INS across the three sections (Fig. 3.42).

The median pitch trajectory for the entire work clearly displays the overall ascent of the pitch shape, however this ascent is not due to an uninterrupted linear ascent of two voices, but from the activation of three successively higher registral fields (Fig. 3.43).

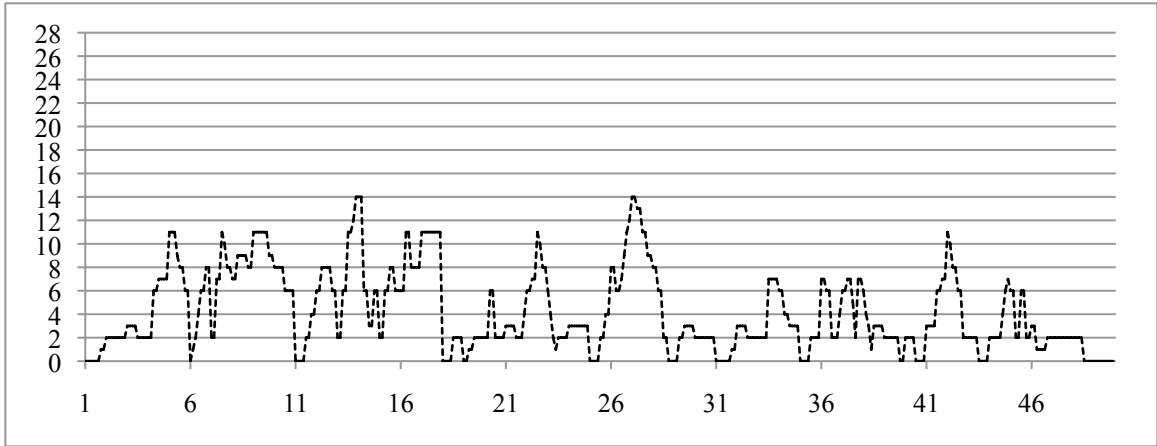


FIGURE 3.41. *INS, entire piece.*

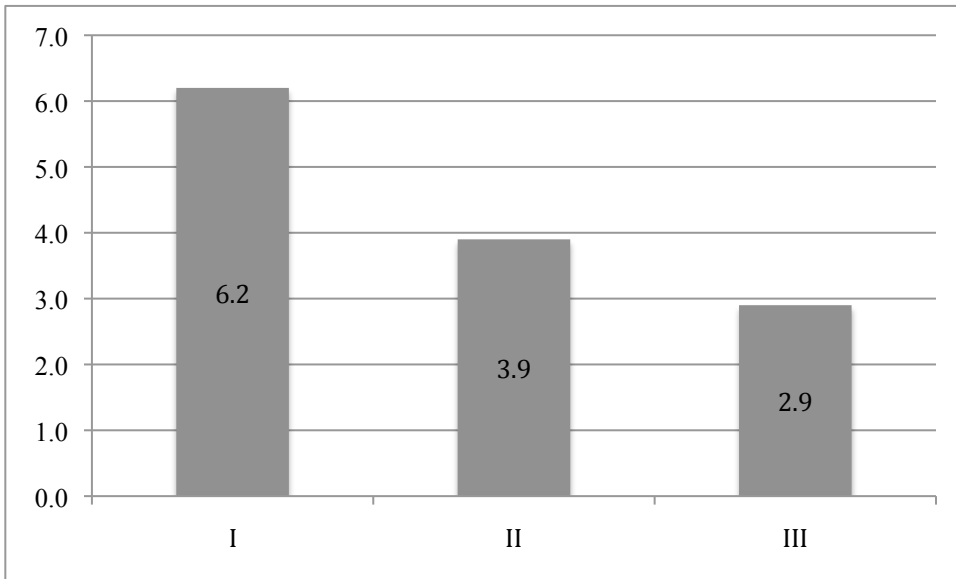


FIGURE 3.42. *Average INS for each section.*

For example, the overall motion from start to close of the first two sections is quite small with a median trajectory ascent of 1 and 1.5 respectively (Table 3.6). So though the successive registral fields result in a global ascent, the local motions within each field may be quite independent, and even, as in section III, contrary to the global motion.

The pitch trajectory in section III is significantly distinct from those of the opening two sections for a number of reasons. First, the overall motion is a descent rather than an ascent, and the distance traveled is between 6 and 4 times greater than in the previous sections. The highest placement of the pitch shape occurs at the very beginning of section III. The absence of any low sonority at the opening is reflected by the peak in LNS, which is 24 (Fig. 3.32). This is the highest value reached for any type of space for the duration of the *Benedictus*. The sudden jump into a high register after the low registral placement of the previous sections makes this high opening in section III particularly salient and helps to highlight the subsequent descent. The local descent balances the global ascent, providing some closure to the overall registral opening.

Another distinct characteristic of the final section's median pitch trajectory is its contour. Rather than quickly oscillating as in section I and II, the trajectory for the final section forms a smoother more directed motion and covers a wider range. The trajectory of each section with respect to each local range, viewed together, highlights this important shift (Fig. 3.44). From section I to II, the oscillating motion of the trajectory slows, but in section III, it slows further while also expanding in range. This shift runs in parallel with a shift in INS values over the course of the piece. The high levels of INS

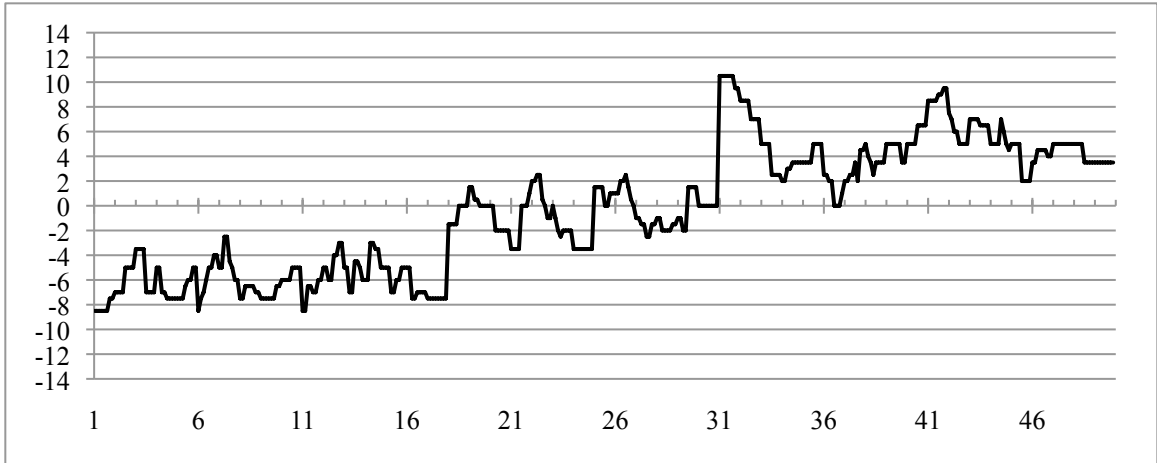


FIGURE 3.43. *Median trajectory graph, entire piece, full range.*

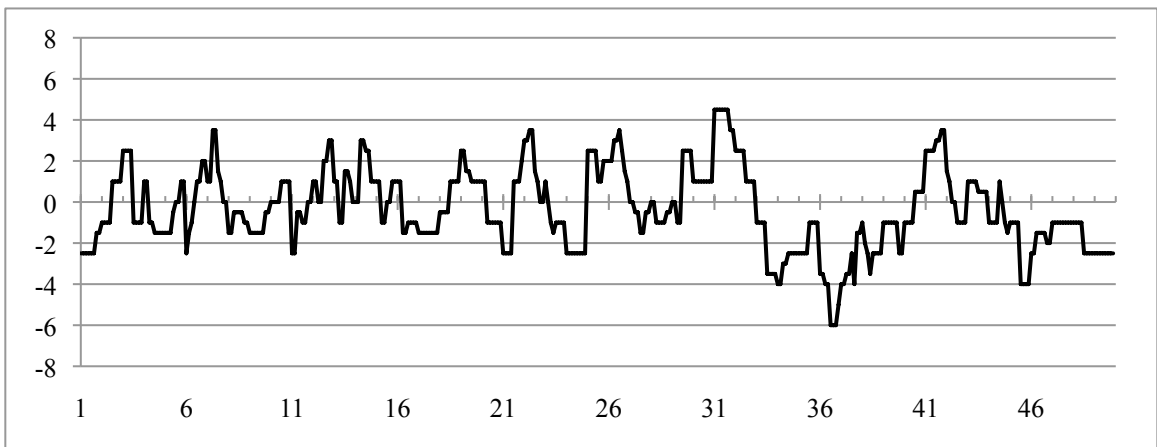


FIGURE 3.44. *Median trajectory graph, entire piece, each section with respect to its local range.*

TABLE 3.6. *Net local displacement of the median pitch trajectory.*

Section	Start	Close	Overall motion
I	-8.5	-7.5	+1
II	-1.5	0	+1.5
III	9.5	3.5	-6

corresponding to multiple, large-scale expansions, creates a pitch shape whose overall motion is randomly oscillating. As the INS values decrease across the sections, the two melodic lines, rather than moving in contrary motion to create the expansions, begin to cooperate in forming a more directed overall line. The energy from the expansions in sections I and II is now transferred to a different dimension of the piece. Where formerly, large portions of the range were simultaneously activated by widely spaced dyads in the aforementioned expansions, the range is now activated progressively as melodic lines move together across a wide range. As INS decreases over the course of the piece, that energy is transferred into an overall wider range of the median trajectory. The narrowing of the trajectory range in section III, which occurs with each trough and peak on the graph, represent a final dissipation of musical energy until the piece comes to rest on its final unison.

The spatial design is coordinated with the temporal framework of the piece, and this coordination helps to highlight two of the main global spatial balancing forces. Already mentioned is the positioning of the centering dyad A3-C4 at the temporal midpoint of the piece (m. 25). This centering dyad assists in balancing the upper and lower extensions of the pitch shape. The opening of section III coincides with the Golden Mean of the “Benedictus.” As mentioned above, this is a particularly dramatic moment because it contains the largest leap in the piece, it is the highest point of the median trajectory, and it is the point where the piece leads toward a sense of closure. It is also the start of the local descent that will balance the global ascent of the piece. The careful placement of these registrally important moments both highlights their importance which extends to other areas of the “Benedictus” as well.

The foregoing analysis both elucidates the beautiful and intricately formed spatial design of the “Benedictus” while also revealing the relationship between spatial motion and musical energy. It simultaneously outlines the musical problem created by the global registral opening, explains some of the musical forces which contribute to the global ascent, and reveals the balancing forces – both in the static spatial design as well as the dissipation of musical energy – which allow the piece to come to a state of rest.

VIII. SPATIAL CONNECTIONS BETWEEN THE “BENEDICTUS” AND THE MASS AS A WHOLE.

As we have seen, there are certain global spatial relationships in the “Benedictus” that are echoed at various local levels creating a most intricate spatial design as well as helping to unify the work. In the same way, the “Benedictus” echoes an important spatial motion that exists on a more global level – that of the entire mass. The most unusual aspect of the mass has to do with the transposition of the cantus firmus across the movements. The order of transpositions is stepwise from C to A. Of course, we have already seen how the pitches C and A play important structural roles as definers of range, as melodic highpoints, and as centering structures. It is likely that structural roles were assigned to these particular pitches as they outline the range of the cantus firmus transpositions.

Though the *L'homme armé* tune in the tenor is absent from this section of the mass, the main motive used in the “Benedictus” is taken from the last five measures of the original tune (Fig. 3.1). The ascending motive, first heard at the opening of the piece, is actually the final portion of the tune in inversion. As described earlier, this initial motive of the “Benedictus” is found numerous times in inversion, and the return of the

motive to its descending form makes its relationship to the *L'homme armé* tune even more noticeable.

Earlier it was stated that one of the unusual aspects of this *L'homme armé* mass is the transposition of the tune up a step for each section of the mass. The slow ascent of the tune over the course of the entire mass is reflected in the Benedictus at a number of levels. The stepwise transposition of the tune upward across the movements of the mass obviously relates to the global ascent of the “Benedictus.” Yet the connection is more intricate. The linear backbone of the ascent, formed from two statements of the motive in augmentation, also relates, perhaps in an even more direct way, to the linear ascent of the cantus firmus across the movements of the mass. The statements of the motive in shorter durations reflect the ascending motions at even more local levels in the “Benedictus.” Finally, the tenor statements of the tune form a global ascent, yet the end of the tune contains a local linear descent. This solution of using a local descent to provide balance for an ascent on a more global level is used within the confines of the “Benedictus” alone where the local descent in section III balances the overall ascent of the movement. Additionally, the very portion of the tune that provides local balance for the global ascent of the cantus firmus is used both to create and solve the registral puzzle of the “Benedictus.”

Finally, the spatial motion in the “Benedictus” may also have symbolic significance. The shape formed by the augmented statements of the motive could be an expression of the shape of the cross. I suspect that the singing of this “Benedictus” may have occurred at the elevation of the host so that the pitch shape’s ascent is a musical representation of the raising of the sacrament. There is evidence that during high Masses,

and especially during polyphonic masses, the elevation of the host occurred during the “Benedictus.”³⁸

One of the most fascinating aspects of this work is that one of the primary unifying forces is the piece’s spatial motion. It connects the most local level of the “Benedictus” movement with the most global level of the entire mass. Spatial motion is also a primary generator of musical energy, spurring the pitch shape of the “Benedictus” on in its registral ascent. Finally, the spatial design of the “Benedictus” may be a musical representation of Christian rites and imagery.

³⁸ M. Long, “Symbol and Ritual in Josquin’s ‘Missa Di Dadi.’” in *Journal of the American Musicological Society* (1989) 42/1:5-6.

CHAPTER 4: A SPATIAL ANALYSIS OF BEETHOVEN'S BAGATELLE IN G MAJOR, OP. 126, NO. 1

I. BACKGROUND AND ANALYTIC OVERVIEW

Beethoven's Op. 126 Bagatelles, composed in May and June of 1824 and published by Schott's Sons of Mainz in April of the following year, were likely initiated as a way to repay debt to his brother Johann.³⁹ While external forces such as commissions, demand from publishers, and financial need often dictated the genre in which Beethoven composed, he would not allow his employers or patrons to dictate the musical content of the work. He expresses this in a letter:

“My situation demands that my actions [i.e. in deciding what to write] be determined by what is likely to be more or less of advantage to me. Quite different considerations operate, of course, in the case of the work itself [i.e. the style]. There, thank God, I never think of the advantage to be reaped, but only of how I am composing.”⁴⁰

Beethoven rarely wrote “easy” pieces to lend the work a more popular appeal, but instead always kept artistic aims in mind.

“Bagatelle” literally means “trifle” in both French and German and generally refers to a short, unpretentious piece, usually for piano. However, in keeping with Beethoven's goal of forwarding his art, his sets of late bagatelles, Op. 119 and Op. 126, are not “light” pieces, but rather they exhibit complex and thoroughly original musical designs. Often these works pose a compositional problem resulting from experimentation with an unusual technique.⁴¹ For example, the theme to be developed in Op. 119, No. 7

³⁹ B. Cooper, “Beethoven's Portfolio of Bagatelles,” in *Journal of the Royal Musical Association*, (1986-7) 38.

⁴⁰ Ibid, 40. Anderson letters, A-1158.

⁴¹ E. Cone, “Beethoven's Experiments in Composition: The Late Bagatelles,” in *Music: A View from Delft* (Chicago: The University of Chicago Press, 1989) 180.

is simply a trill. Op 119, No. 10 lasts only around ten seconds, yet it starts in a key other than the tonic, contains an AAB form, and resolves to the tonic.⁴²

The late bagatelles demonstrate characteristics of Beethoven's late style including an engagement with unusual musical concepts such as those mentioned above, a concern for finding ways of developing unity, particularly across works in multi-movement forms, and often the rather dramatic use of register as an essential expressive device. The Op. 119 bagatelles, completed in 1822, are actually a reworking of older compositions or even fragments of compositions, some from as early as 1794. Differences in ink or pencil in the autograph versions as well as stylistic differences help determine which parts of the composition were reworked shortly before publication.⁴³ For example, in Op. 119, No. 2, Beethoven added to the original work a new coda written in an extremely high register. This unusual development creates a link spatially with the next bagatelle in the collection which opens in a high register. This example demonstrates both Beethoven's use of register as a fundamental compositional device as well as his increasing interest in developing continuity and unity across pieces in a collection or movements of a composition. Furthermore, Beethoven incorporates pitches from the newly expanded range of the piano in his revisions, also demonstrating an increasing concern with register. Clearly, Beethoven is experimenting with register as a way of solving musical problems and this experimentation continues in the Op. 126 bagatelles.

While the Op. 119 bagatelles consist of a collection of mostly older works cobbled together in an effort to create a cohesive whole, the Op. 126 bagatelles were

⁴² Cooper, 25-6.

⁴³ B. Cooper, "A Creation in Three Phases: The Late Bagatelles," in *Beethoven and the Creative Process* (Oxford: Clarendon Press, 1990) 267.

conceived from the outset as a unified cycle indicated in the sketches by the words “Ciclus von Kleinigkeiten.”⁴⁴ Maynard Solomon suggests that the op. 126 bagatelles, with their cyclic form, may be the result of a preliminary working out of the multi-movement form of some of the late string quartets.⁴⁵

I suggest that the main musical problem in the first bagatelle of Op. 126 has to do with spatial motion. The developments in registral space found in the first bagatelle turn what is in most other respects a simple, conventional “trifle” into an unusual and aurally striking work. Before moving on to an analysis of its unique spatial design, I will first lay out a general overview of its form, which, for the most part, is quite orthodox.

This bagatelle, written in G major, is cast in sectional rounded binary form: A – BA’ (Fig. 4.1). The first reprise (mm. 1-16) is tonally closed and shares similar melodic material with A’ (mm. 32-47) in the second reprise. The B section prolongs the dominant harmony and contains contrasting melodic material, though, as is typical of Beethoven’s organic developmental procedures, the material is derived from the A section.

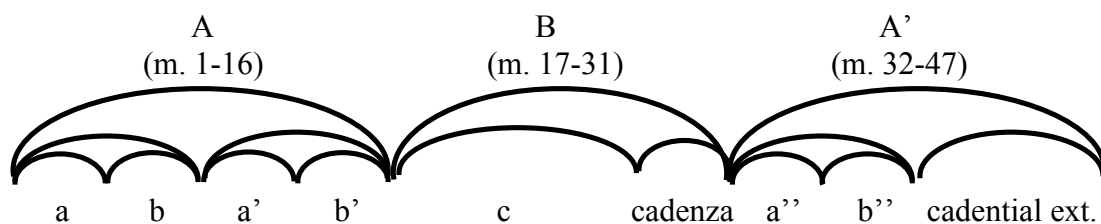


FIGURE 4.1. Formal overview of the first bagatelle from Beethoven’s *Six Bagatelles*, op. 126.

⁴⁴ Trans. “Cycle of Little Things.”

⁴⁵ M. Solomon, *Beethoven* (New York: Schirmer Trade Books, 1990), 399.

The phrase structure and harmonic language of the bagatelle are quite standard as well. The opening A section (mm. 1-16) consists of two symmetric, 8-bar periods. The first period contains two closely related phrases (mm. 1-4 and mm. 5-8). The melody of the first phrase, played by the right hand, is found stated in thirds in the left hand of the second phrase. Though the left-hand statement is transposed to a different tonal level, the contour, or spatial motion, remains the same. The repetition of this period (mm. 9-16) is mainly varied through arpeggiation in the accompaniment articulated in eighth notes. This second period structure is more rhythmically active than the opening period, the composite rhythm of which primarily moves in quarter notes. Harmonically, the A section contains conventional, entirely diatonic progressions which conform to typical phrase models of the common practice period.

The prolongation and tonicization of the dominant harmony which occur in the B section (mm. 17-31) provide tonal contrast with the A section. The increase in rhythmic activity found in the second half of the A section continues as the composite rhythm moves from eighth notes to triplet eighth notes and then to sixteenth notes. A change in time signature, from 3/4 to 2/4, contributes to the accelerated feeling as the downbeats now fall closer together.⁴⁶ The B section is followed by a cadenza written in continuous 32nd notes leading to the dominant seventh harmony that prepares the return to the tonic in the final section.

⁴⁶ The change in time signature from 3/4 to 2/4 and then back again to 3/4 creates a complexity with regard to the time axis (x-axis) for the graphs of spatial motion that follow. Because the measure is not a consistent length for the entirety of the piece, it cannot function as a unit of time. Instead, the 16th note will serve as the unit for measuring time in the graphs. In the text, when referring to the graphs or the score, I will address the location in terms of measure number as well as 16th note.

This closing section (mm. 32-47) can be labeled A' as its first 8 measures contain another variation of the opening period structure. However, in contrast with the A section in which the opening period structure is repeated, the second 8 bars in the final section act as a cadential extension in which a closing cadential gesture is repeated in various registers. This gesture, however, always forms an imperfect authentic cadence until the final repetition, where the piece closes with a perfect authentic cadence.

This bagatelle possesses all the typical features of a standard sectional, rounded binary form. It also possesses a high degree of symmetry in a multitude of dimensions: overall tonal plan, motivic design, and phrase structure. As stated earlier, and as I will now show, the notably original and expressive feature in this composition is its spatial design. As such, I will now turn to an analysis of its spatial design and show how this design functions as one of the composer's central compositional schemes in the music.

I will first summarize some of the general spatial characteristics of the piece and then move on to an in-depth analysis of spatial motion in each of the three sections. After elucidating the spatial design of the entire bagatelle, I will show how certain, often dramatic, choices of register are essential to creating this structure in musical space by comparing those passages with recomposed versions containing less extreme uses of register. Finally, I will show how Beethoven's more traditional use of musical parameters such as form, rhythm, and harmony are coordinated in such a way as to assist in the articulation of the bagatelle's original spatial design.

As can be seen in a pitch graph of the entire work, the range of the composition spans five octaves plus a P4 – from F#1 (m. 32) to B6 (m. 43) (Fig. 4.2). The central pitch axis lies between D4 and D#4. The overall spatial motion of the composition

FIGURE 4.2. *Pitch graph of the first bagatelle from Six Bagatelles, op.126.*



consists of both a large expansion as well as an ascent (Fig. 4.3). The pitches of the opening sonority span one octave plus a perfect 4th (D3-G4) while the closing sonority spans four octaves (G2-G6). This expansion is reflected in the first and the final INS values of 15 and 45 respectively. As the range expands, the piece also shifts higher in registral space. The center of the opening sonority, A#/B3, lies 4 semitones below the central axis while the center of the closing sonority, G4, lies 4.5 semitones above the central axis. Thus the center points of both the opening and closing sonorities are almost perfectly balanced around the central pitch axis of the entire piece, adding yet another symmetrical feature to the work.

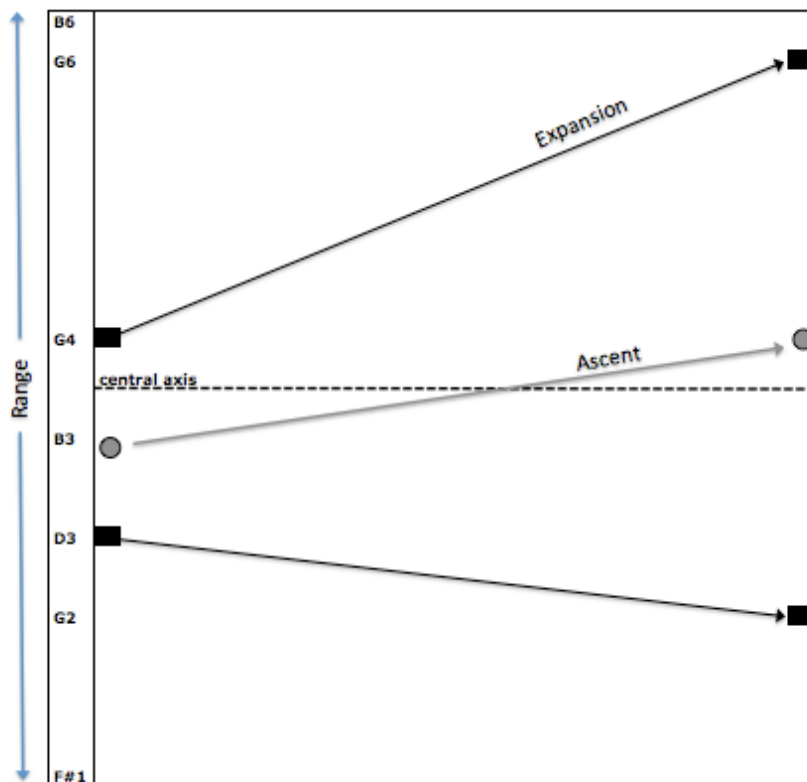


FIGURE 4.3. Overall spatial motion of the first bagatelle of op. 126.

Examining the pitch graph, we can see that the expansions that take place are generally accompanied by an emptying out of the middle part of the pitch shape (see mm. 1-6 in Fig. 4.4 and mm. 32-38 in Fig. 4.16 for examples). In other words, as the pitch shape expands, the sounding pitches are placed at the extreme high and low parts of the pitch shape, forming a vast amount of continuous internal negative space. As this analysis will show, this particular composition is largely about developments of internal negative space that are highly coordinated with registral, harmonic and temporal aspects of the piece.

II. SPATIAL ANALYSIS OF SECTION A.

The range of section A spans three octaves plus a perfect 4th (G2-C6), which is two octaves narrower than the full range of the entire bagatelle. However, the central pitch axis of the A section, between D#4 and E4, is located only a half step higher than that of the entire piece. From the pitch graph of A, we can see that this section divides into halves and that each half contains two expansions (Fig. 4.4).

An additional spatial feature is the process of “emptying out” of the center of the pitch shape mentioned above. Each period begins with essentially a balanced sound where the inner voice is placed centrally within the boundaries of the two outer voices. As the pitch shape expands, the inner voice is pulled toward the lower voice leaving a great deal of unsounded pitch space between the upper and lower voices. This expansive inner negative space and the close positioning of the two voices in a low register create a stylistically unorthodox sonority that surely sensitizes the listener to this unusual spatial development.

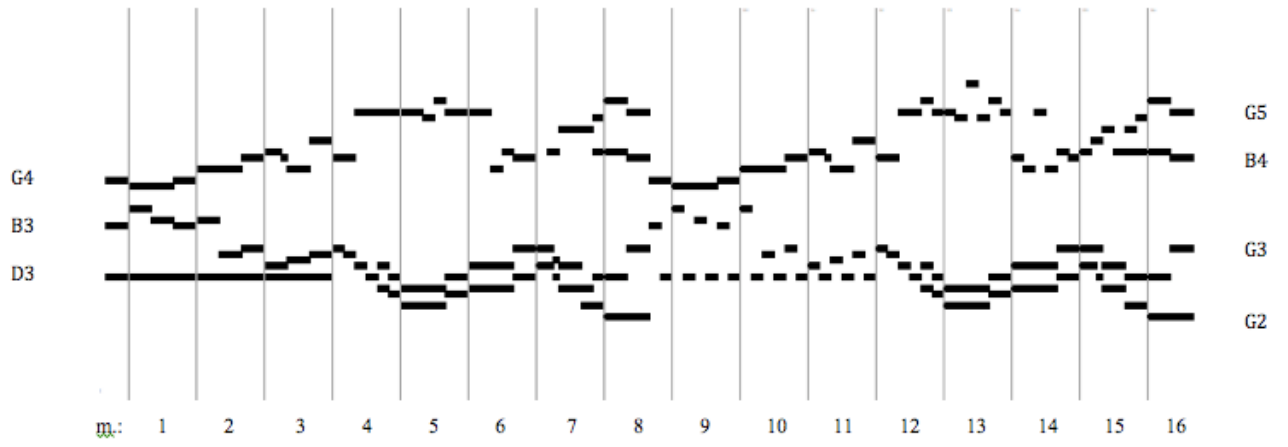


FIGURE 4.4. *Pitch graph, A section.*

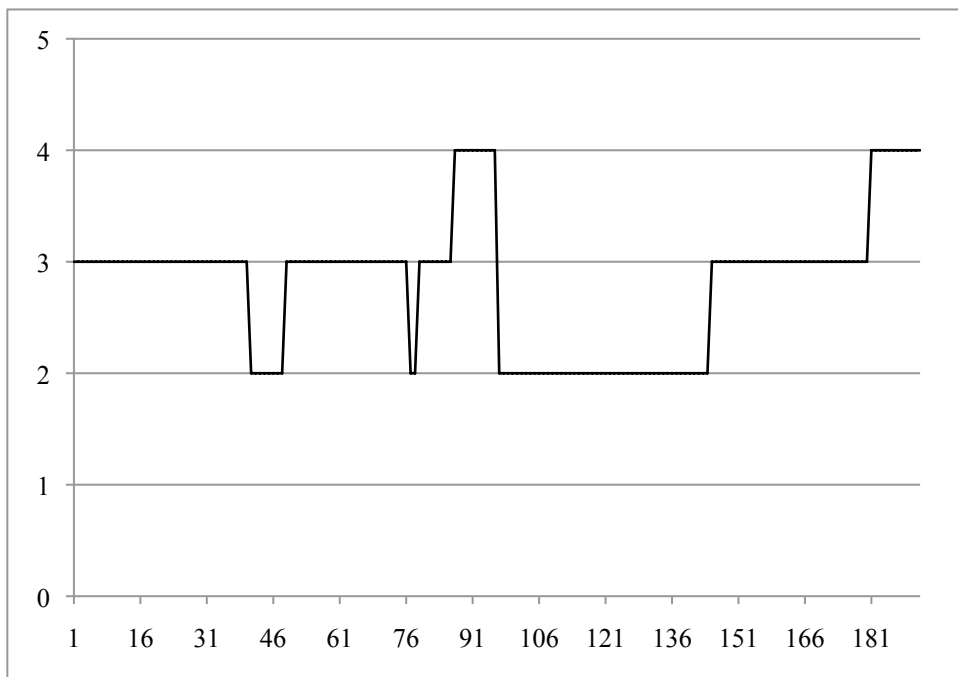


FIGURE 4.5. *PS, A section.*

As seen in the graph of positive space, the texture varies with sonorities containing between two and four simultaneous pitches (Fig. 4.5). PS increases to 4 twice, both times coinciding with the cadence at the end of each period structure. This increase merely reflects a rise in density that is typical at cadences punctuating structural units.

Just as PS is coordinated with the period structures in A, the development of INS is also similar within each period (Fig 4.6). Each half of A (♩=1-96 and ♩=97-192) contains two peaks of INS which reflect the two expansions already seen in the pitch graph. At m. 1 an INS value of 15 expands to 34 at m. 5, beat 2.5 (♩=59-60), contracts, and then expands to 35 in m. 8, beat 1 (♩=89-92). The second period begins with an INS value of 16 which expands to 37 in m. 13, beat 2 (♩=153-154), contracts, and then expands again to 35 in m. 16, beat 1 (♩=185-188).

As in the pitch graph and PS graph, the graph of LNS and UNS also reflects the division of section A into two halves (Fig. 4.7) and the decrease in both INS and UNS at the end of each half reflects the expansion that takes place. One significant difference between the two period structures in A is the rapid oscillation of LNS that occurs at the opening of the second period (pickup to m. 9-12, ♩=97-140). This oscillation reflects the accompaniment's arpeggiated figure that is articulated in eighth notes. The increase in rhythmic activity that occurs in this section is also accompanied by an increase in spatial activity. What is a common keyboard figuration takes on new meaning in the context of this work as the increase in both spatial and rhythmic activity lead to a restlessness, or increase in energy, which will continue in the B section. This graph also reveals that there

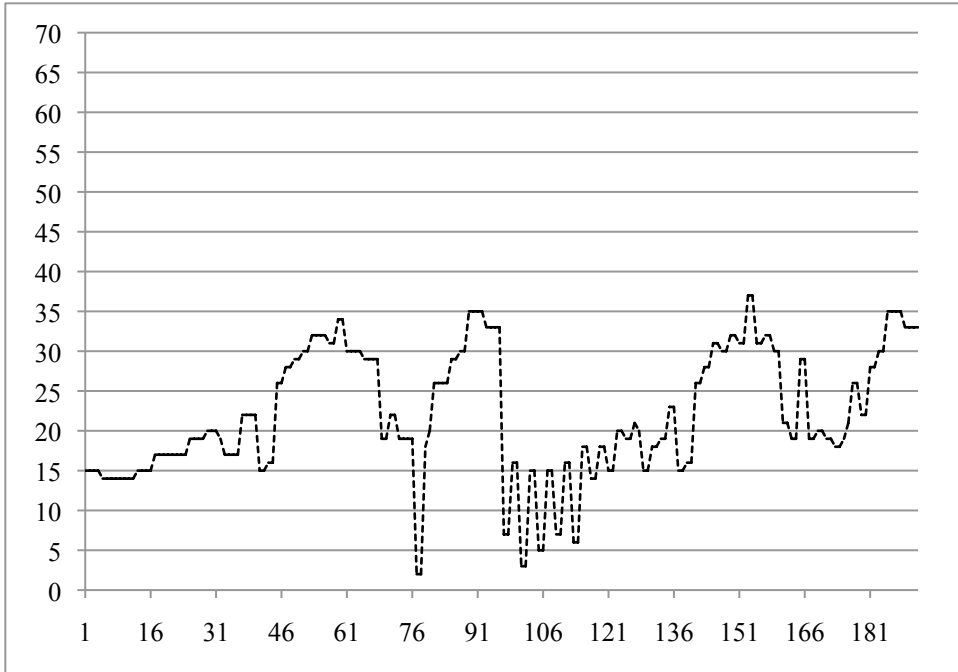


FIGURE 4.6. *INS, A section.*

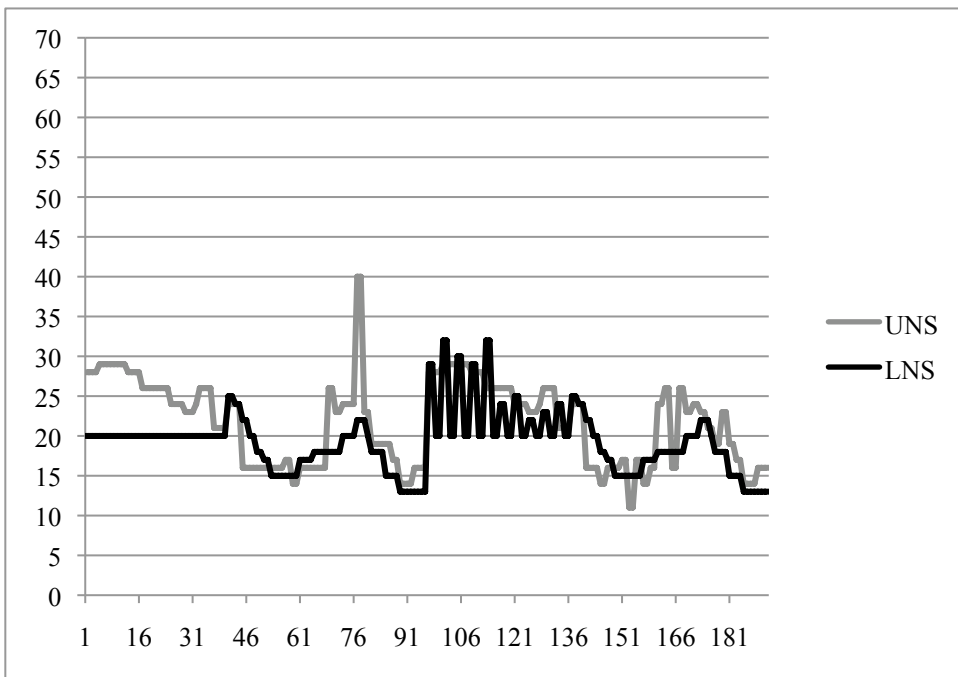


FIGURE 4.7. *UNS and LNS, A section.*

is generally more UNS than LNS, thus the pitch shape sits lower than the central pitch axis.

From the graph displaying the data of all spatial categories, we can see even more clearly that spatial motion is closely linked with the phrase structure of A (Fig. 4.8). The spatial evolution within each period structure leads to an end goal (m. 8, ♩=93-96 and m. 16, ♩=189-192) articulated by very similar spatial profiles. INS is the most prominent type of space, PS has increased to 4, UNS and LNS have decreased, and UNS is slightly higher than LNS.

As mentioned previously, the A section sits slightly below center. However, from the median trajectory graph (Fig. 4.9) we can see that the spatial motion of the pitch shape overall is a slight ascent from -4 to -1.5 which means that by the end of A, the pitch shape is closer to being centered. The center of the pitch shape moves within a range of 12 semitones, between -9 and +3. An increasing rate of oscillation can be seen at the pickup to m. 9 that corresponds to the arpeggiation in the left hand at the beginning of the second period. While the overall motion of the pitch shape is ascending, each period contains a slight ascent followed by a slight descent.

From these various graphs, we can see that spatial developments are highly coordinated with the phrase structure of section A. The expansions and “emptying out” which are portrayed in the above graphs serve as a reflection in microcosm of the overall expansion and emptying out that take place on a global scale from the opening to the close of the bagatelle. The repeat of this spatial design, which occurs as a result of the period structure found in mm. 9-16, serves to establish its importance. The variations

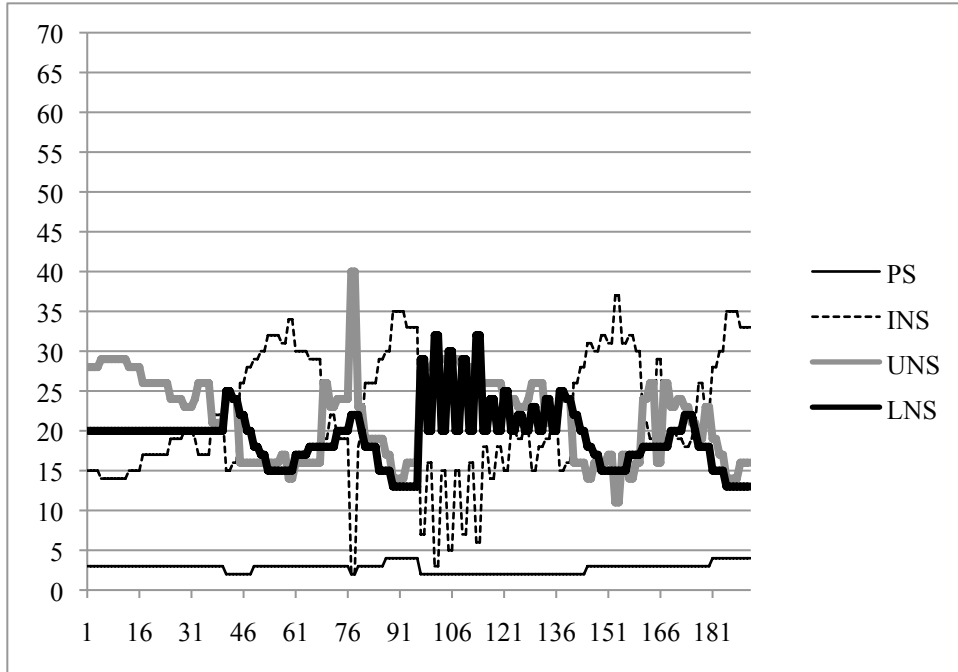


FIGURE 4.8. Total registrational space, A section.

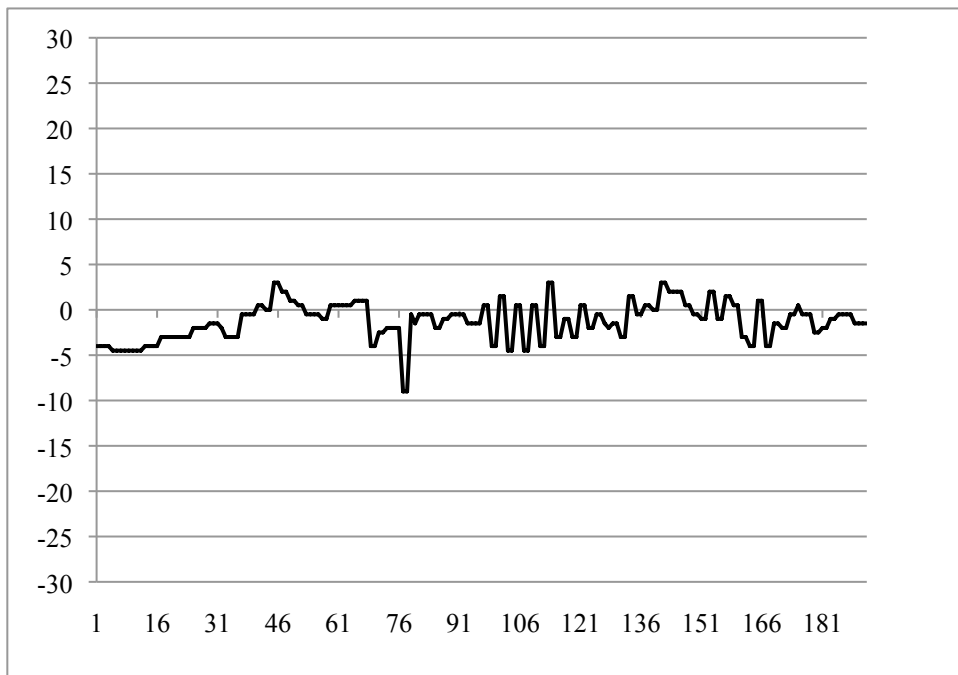


FIGURE 4.9. Median trajectory graph, A section.

present in this repeated material lead to an increase in energy that will continue into the B section.

III. SPATIAL ANALYSIS OF SECTION B

Like section A, the range of the B section spans approximately three octaves (C#3-E6), but the general spatial properties of B contrast with those of A in three important ways (Fig. 4.10). The central axis of section B lies between G#4 and A4 which is a perfect 4th higher than the central axis of section A. In the same way that an ascent in a melodic line creates a sense of tension that must be resolved, this shift in range creates a registral opening that must be resolved in some way.

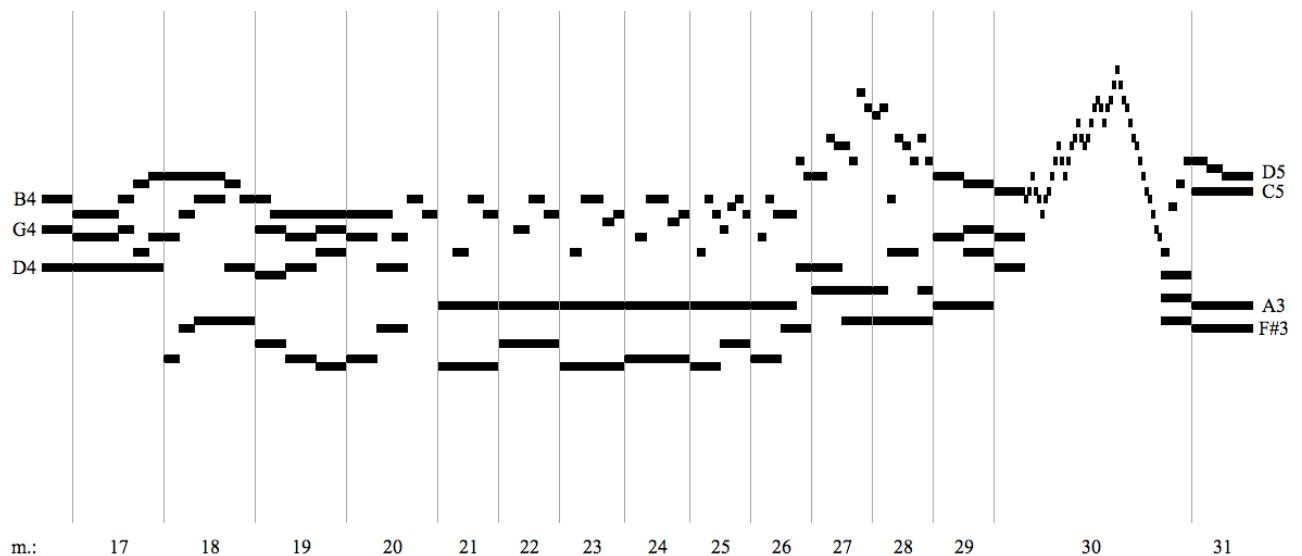


FIGURE 4.10. *Pitch graph, B section + cadenza.*

A second contrasting spatial property concerns the degree of variance in range of the pitch shape. The expansions and contractions of the pitch shape in section A form one of this section's most salient spatial features. In contrast, the outer boundaries of the pitch shape in section B, prior to the cadenza, are fairly stable, creating a comparatively static effect with regard to spatial motion.

Thirdly, the way in which the tones are vertically spaced in section B also contrasts with that of A. The A section introduced an unusual voicing created by an emptying out of the central portion of the pitch shape. The pitches that form the harmonies in B are more evenly distributed so the striking aural effect found in A becomes conspicuously absent for most of section B.

All of the spatial properties described above apply to the B section before the cadenza at m. 30 (♩=321). As we shall see below, the cadenza introduces a new type of spatial profile into the piece. This cadenza, with its arch-shaped contour peaking at E6, the highest note of the bagatelle thus far, breaks the static spatial motion established by the B section and also leads into a return of the open spaced sonority characteristic of the A section.

The cadenza, which contains a single line of 32nd notes, introduces a new texture into the piece, expanding the range of PS values from 2-4 in section A to 1-4 in section B (Fig. 4.11). PS is more variable in the B section than in the A section and there is no repeating pattern such as the one found in A. For example, for the first time in the piece, PS decreases to 1 in section B. The first decrease to PS=1 occurs in m. 20 (♩=241-244), directly before the meter change and the accelerated increase in rhythmic activity that takes course over the next ten measures where the composite rhythm incrementally shifts

from 8th notes to 32nd notes. The return to a PS value of 1 in m. 30 coincides with the arrival of 32nd notes – the goal of this rhythmic acceleration - as well as a return to the original meter. Thus the PS value of 1 marks the beginning and conclusion of a process whereby the speed of rhythmic activity increases four-fold within a metrically contrasting section. After the cadenza in m. 30, PS returns to 4. The final sonorities in both A and B, contain the highest value for PS found thus far in the bagatelle. This is consistent with the tendency in this style for an increase in density at the conclusion of structural units.

In section B, the evolution of INS differs from that in A in three respects (Fig. 4.12). Sonorities tend not to contain as much INS, meaning that the range of any particular sonority is smaller. Section B also lacks the large expansions arranged in a symmetrical fashion. There are three expansions, asymmetrically placed, that occur in section B: one that leads to an INS value of 22 in m. 18 (♩=210), another more gradual expansion which leads to an INS value of 28 in m. 27 (♩=299), and a final expansion after the cadenza with a maximum value of 19 (♩=346-347). These expansions are significantly smaller than those found in A.

For the first time in the bagatelle there are INS values of 0 and these values correspond to the same areas described above where PS equals 1 (m. 20, ♩=241-244 and m. 30, ♩=321-341). From the graph, we can see that areas with no INS flank a section of music where INS development is fairly static yet unstable, as it rapidly oscillates between the values of 5 and 20. The INS graph of this area, which corresponds to mm. 21-27, has a similar quality to the INS graph for mm. 9-11 in section A. In fact, these measures act like a development of that passage in the A section.

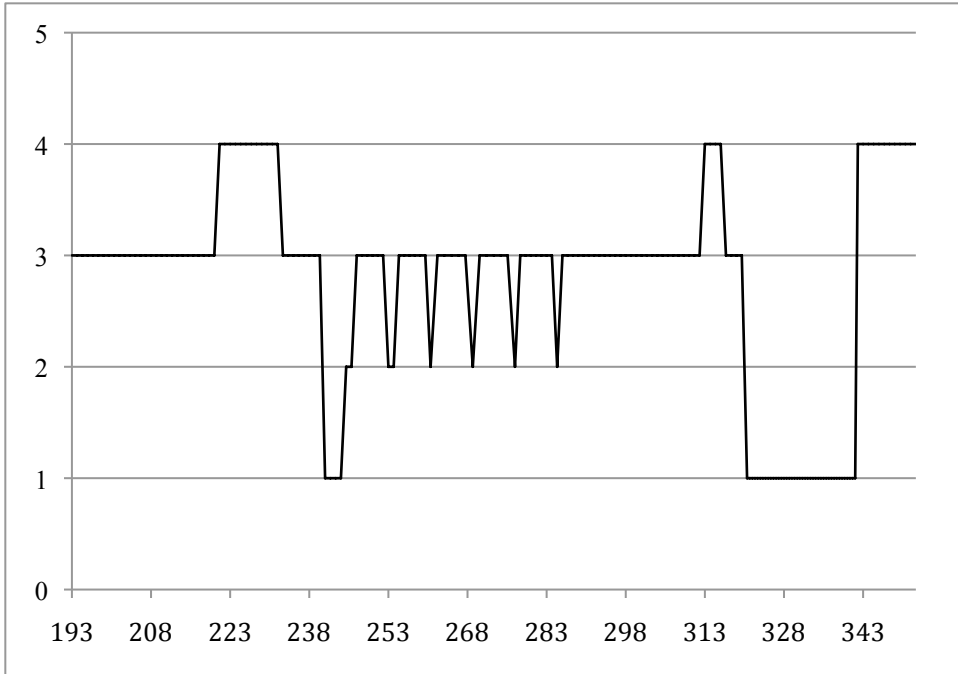


FIGURE 4.11. *PS, B section + cadenza.*

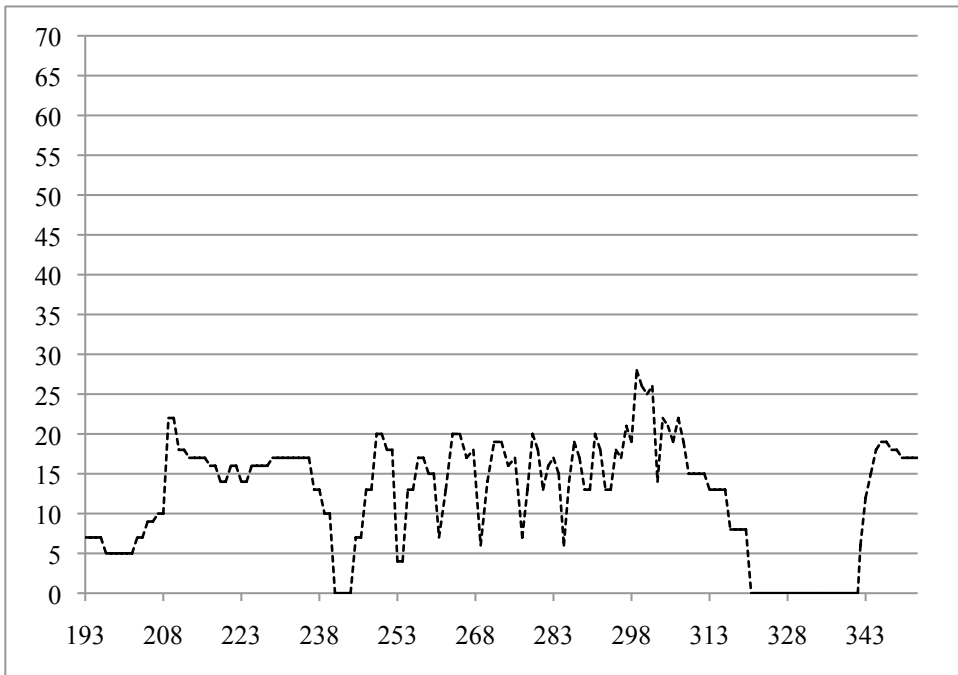


FIGURE 4.12. *INS, B section + cadenza.*

From the graphs of UNS and LNS, we can see that section B sits slightly above center at the outset (Fig. 4.13). From the meter change up to the cadenza (mm. 21-27, ♩=245-290), UNS becomes higher than LNS, meaning the piece has shifted lower in register. In this same area, UNS rapidly oscillates, creating an increase in energy that leads to a very large shift in both UNS and LNS – the most dramatic shift in registral space thus far. The peak in LNS and inverse peak in UNS at ♩=335 correspond to the rapid ascent and descent of the cadenza in m. 30. Section B ends slightly above center, but there is less UNS and LNS than at the outset, reflecting the expansion that takes place from open to close.

The graph of total space shows quite clearly the coordination between INS and UNS in the ten measures (mm. 21-27, ♩=245-290) leading up to the cadenza (Fig. 4.14). As mentioned earlier, these measures recall a similar spatial motion from the opening of the second period structure in the A section, only previously, this oscillation occurred in INS and *LNS* values. From the total space graph we also see that the most dramatic shifts thus far in LNS and UNS are coordinated with the drop of INS to 0 and PS to 1. This area, of course, corresponds to the cadenza.

The overall spatial trajectory of section B may be summarized as a gradual descent and ascent (mm. 16-30, ♩=193-320) followed by a rapid ascent and descent (mm. 30-31, ♩=321-353) (Fig. 4.15). The opening of the middle section is positioned four semitones above center but drops to 9.5 semitones below center by measure 21. The piece remains below center, but the rapid oscillations within a somewhat fixed band of registral space create a sense of increasing instability which in turn suggests a buildup of

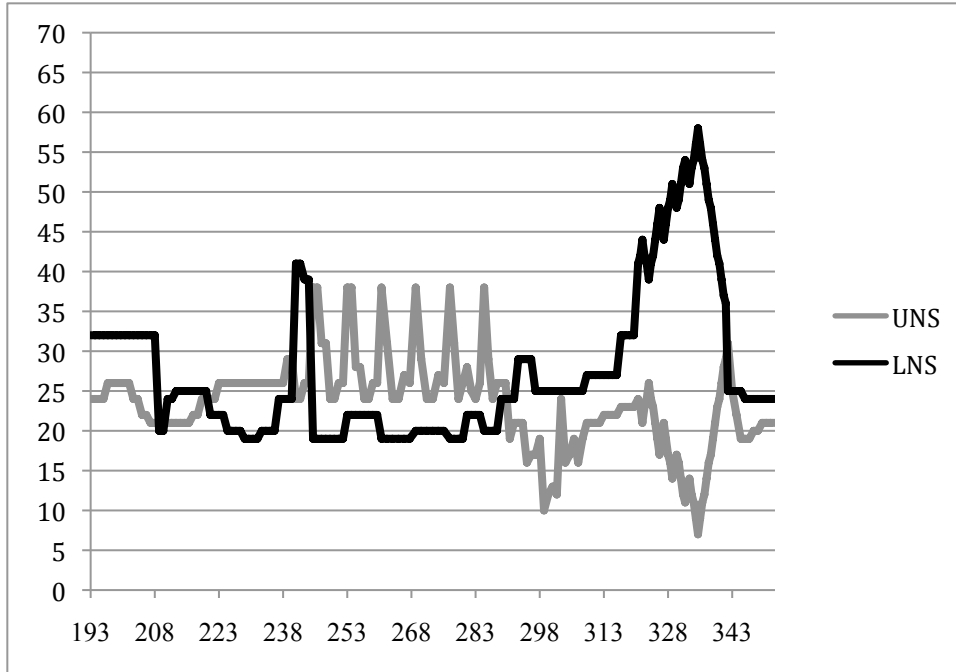


FIGURE 4.13. *UNS and LNS, B section + cadenza.*

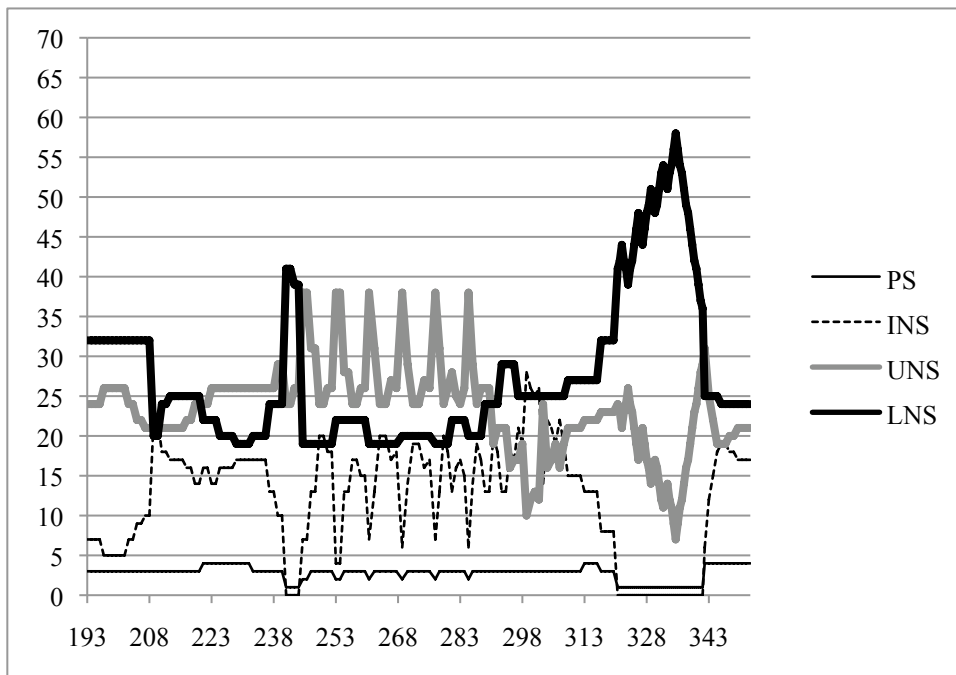


FIGURE 4.14. *Total registrational space, B section + cadenza.*

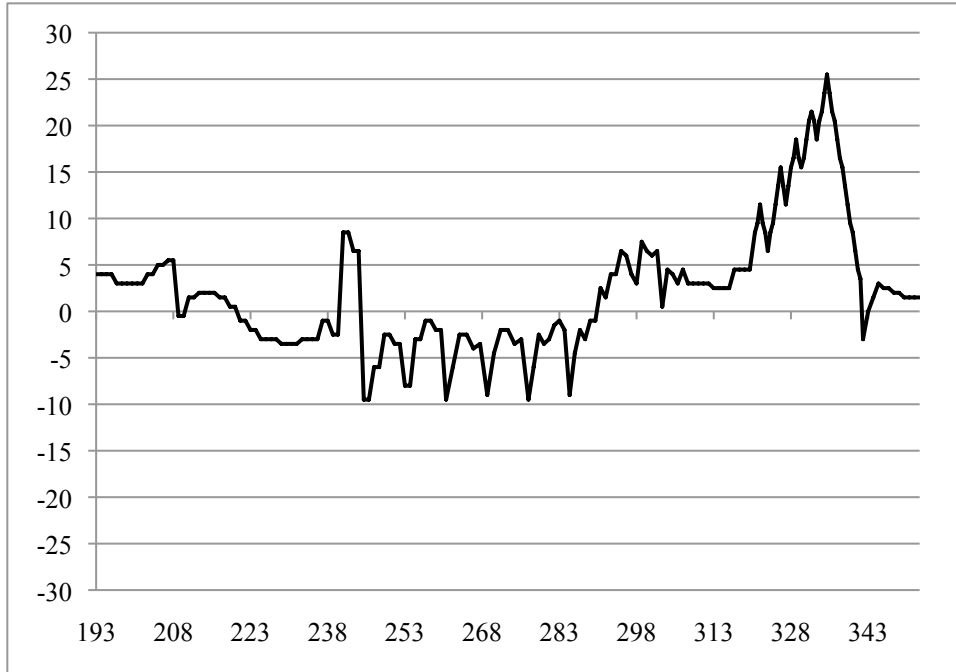


FIGURE 4.15. *Median trajectory graph, B section + cadenza.*

energy. As mentioned before, this buildup of energy coincides with increasing rhythmic activity at the surface level and a change of meter from $3/4$ to $2/4$. The increase in musical tension culminates in the rapid ascent of the cadenza (m. 30) which, after falling again, leads to a final sonority that is almost centered within the range of the piece. In fact, the descent from the opening value of 4 to the closing value of 1.5 is the inverse of the overall motion in A which articulated an ascent from -4 to -1.5. Both sections demonstrate an attempt to move toward the center or towards a state of spatial equilibrium.

Despite the similarity in the overall motions of the first two sections, an important difference exists in the path of the trajectory between the two endpoints. The B section contains a range from -9 to 25.5, a range of 34.5 that is significantly wider than the values

for A (-9 to 3, range of 12). The pitch shape in section B travels farther from the central axis creating a source of spatial imbalance.

Before moving on to a spatial analysis of the final section, let us review the important features of this middle section in relation to the opening section. Section B contrasts with A in several important respects. As in A, the closing sonority of B is expanded in range compared to the opening chords and is spatially positioned to envelop the narrower range found in the opening of the section. However, in contrast to A, the overall motion in B is a descent and the opening and closing position sits above the central axis of the piece. Despite the opposing directions of spatial motion exhibited in the first two sections, these motions are related as the distance traveled from open to close is exactly the same and is positioned the same distance from the central axis.

Another important difference between the two sections has to do with the size, number, and placement of expansions. In section A, four expansions take place. In general, the center of each of these expansions is located quite close to the central pitch axis of the piece and the expansions help fashion the clear, symmetric pattern in the opening section. On the other hand, section B contains fewer and smaller expansions, the overall placement of which does not create a symmetric pattern. In addition, for the first time in the piece, a monophonic texture (area with no INS), is introduced. Though this section lacks the large expansions of A, the entire pitch shape undergoes greater shifts in its position, and we find that the central point of the pitch shape is traveling greater and greater distances from the central pitch axis. The registral opening created by section B's higher range, the rapid oscillations in spatial motion, and the increasingly larger shifts in

the pitch shape's position are all spatial developments leading to an increase in musical tension whose results we shall see in the final section.

IV. SPATIAL ANALYSIS OF SECTION A'

The most pronounced feature of the pitch graph for the final section of this bagatelle is its enormously expanded range (Fig. 4.16). The range of A' (F#1-B6) spans a distance of five octaves - approximately two octaves wider than that of sections A and B. Furthermore, prior to this final section, the lowermost (F#1-F#2) and uppermost (F6-B6) portions of A's range have not been utilized at all. The use of previously unexplored registral territory lends a more dramatic effect to the overall expansion.

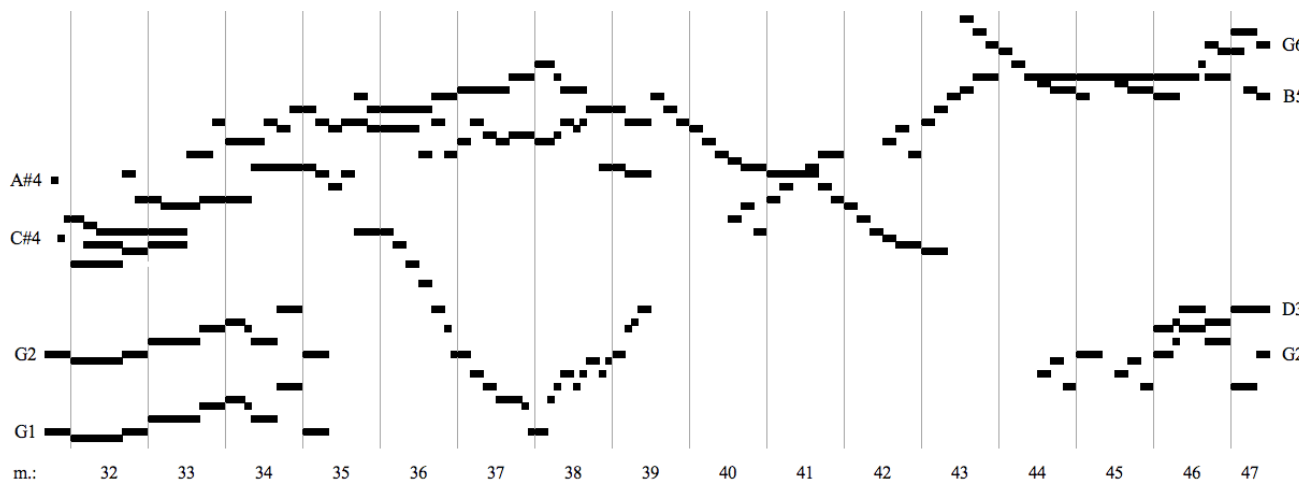


FIGURE 4.16. *Pitch graph, A' + cadential extension.*

The central pitch axis for the final section lies between D4 and D#4 which is also the central pitch axis for the entire work. Despite the enlarged range, the central pitch

axis of A' is only a half step lower than that of the opening section. This return brings closure to the registral opening created by the higher central axis in the B section.

The expansions and contractions found in the A section, as well as the process of emptying out of the middle of the pitch shape returns in the A' section, only this time on a magnified scale. For example, the pitches forming the vertical sonorites in mm. 32-35 display fairly even spacing. These chords, whose ranges span near three octaves, are approximately twice as wide as those chords found at the parallel position in A. In the second phrase, mm. 36-39, an enormous expansion is heard – the largest one yet. With this expansion the middle of the pitch shape empties out as well. At the widest part of the expansion, which takes place in m. 38 and is formed by G1 and E6 in the outer voices, there is an empty middle that spans 44 half steps. This is significantly larger than the expansions in section A. In the cadential extension there is yet another expansion with an empty middle. The uninterrupted portion of INS present in this sonority also peaks at 44 half steps in the middle of bar 45.

Positive space values for the closing section exhibit the widest range of all the sections in the bagatelle – from one to five pitches (Fig. 4.17). The use of PS is also quite different in this section compared to the other sections. This section begins with the highest value of PS for the entire piece, 5, then drops to between 1 and 2 for the first four bars of the cadential extension (♩=448-507), and finally rises to 4 for the final chords of the piece. Once again, the density increases at the approach of the final chords - the structural endpoints for section A' as well as for the entire work.

INS peaks twice in the first eight bars of the A' section (Fig. 4.18). The first peak of 47 occurs in m. 35, beat 1 (♩=394-395) at the cadence of the first phrase. The second

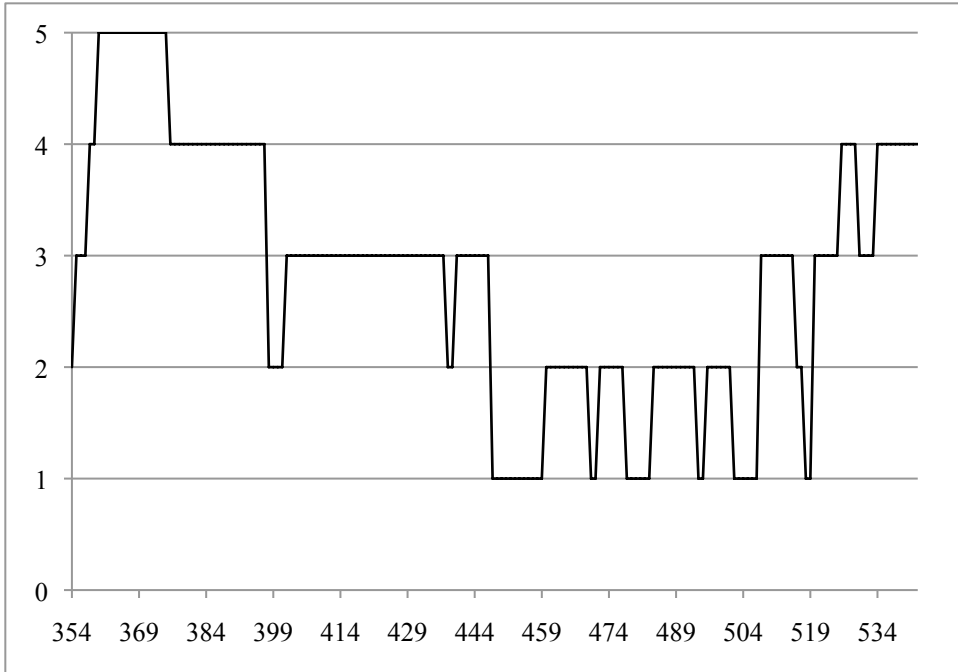


FIGURE 4.17. $PS, A' + \text{cadential extension}$.

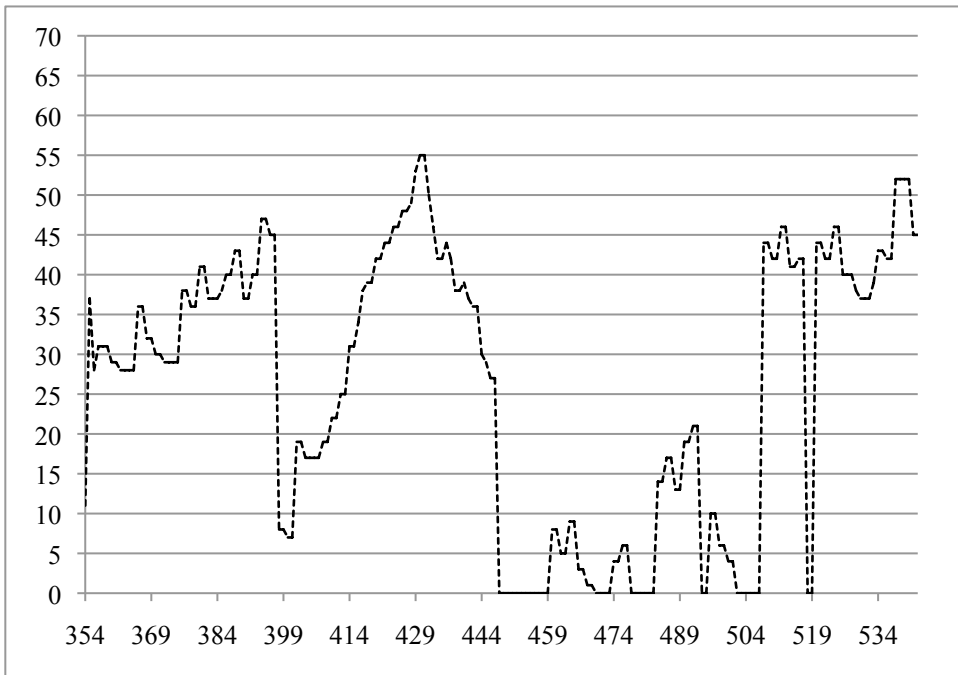


FIGURE 4.18. $INS, A' + \text{cadential extension}$.

peak of 55 occurs at m. 38, beat 1 (♩=430-431) in the third measure of the second phrase. These two increases in INS constitute an augmentation of the previous INS peaks in A which ranged between 34 and 37.

The cadential extension consists of four main expansions all of which take place after a drop in INS to 0. The continual return to an INS value of 0 makes each expansion more dramatic, for, as the expansions get wider, a greater amount of distance must be travelled *in the same amount of time*. These expansions also summarize the spatial motion of the entire piece. The first expansion to 9 (m. 40, ♩=464) is close to INS values for the opening of both the A and the B sections. The second expansion to 21 (m. 43, ♩=492) is close to the values for expansions in the B section. The final two expansions of 46 and 52 (m 45 and 47, ♩=512 and 538) are close to the values of the first and second expansions in A' respectively. The return to an INS value of 0 after each expansion also creates a baseline from which the ear can measure and compare the expansions.

From the line graph of UNS and LNS in Fig. 4.19, we can see that the opening of A' sits lower than the central axis of the piece with UNS remaining significantly higher than LNS for the first four measures (♩=354-397). While UNS steadily decreases over the first eight measures, a jump in LNS from 1 to 39 in bar 35 (♩=397-398) helps to articulate the entrance of the second 4-bar phrase. By the end of the second phrase, UNS and LNS values are more equal, with differences for the final tonic chord (m. 39, ♩=442-447) ranging between 1 and 4 semitones. Thus, by the close of the final statement of A material, the piece has worked its way toward center.

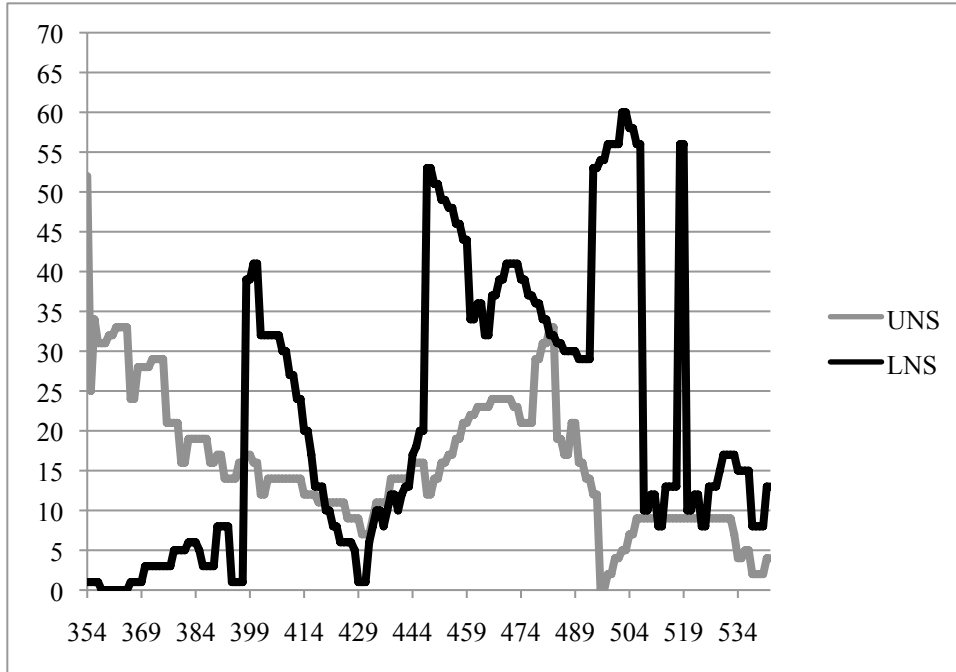


FIGURE 4.19. *UNS and LNS, A' + cadential extension.*

However, another jump in LNS from 20 to 53 signals the start of the cadential extension at m. 39 (♩=447-448). For both A sections, all phrases are of equal length. In this final section, jumps in LNS every four bars help to articulate the phrases (39, m. 35/ ♯=398; 53, m. 39/ ♯=448; 53, m. 43/ ♯=493). While the cadential extension tends to form segments every two bars, a jump in LNS in bar 43 (♯=493-494) from 29 to 53 divides the total eight bars into two larger 4-bar segments. For almost the entirety of the cadential extension, LNS values are larger than UNS values meaning the pitch shape sits above the central axis.

Examining the total space graph separately for each half of section A' reinforces the different functions of each part within the context of the piece – a final and registrally expanded statement of A material (mm. 32 – 39) and a summary of the overall motion

which occurred over the course of the composition (mm. 40-47) (Fig. 4.20). An inverse relationship can be found between INS and UNS in the first four bars of A' (♩=354-397), which means that the shape is primarily expanding upward. The opposite is true for the next 4-bar phrase (♩=398-445) where there is an inverse relationship between INS and LNS. Though there is a slight decrease in UNS as well, the expansion is primarily accomplished by a descent in the lowest line of music. Here is yet another example of how Beethoven balances spatial motions in the piece.

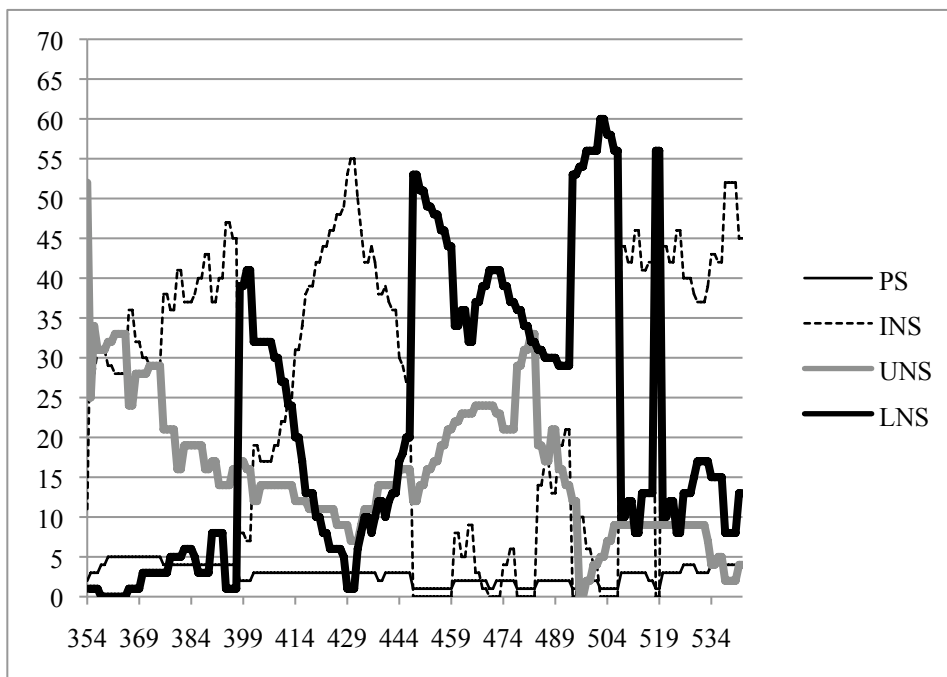


FIGURE 4.20. *Total registral space, A' + cadential extension.*

The final portion of A material in the final section exhibits a different closing spatial profile from the close of previous statements of A material. As may be recalled,

the approach to the cadences in both periods of the opening section each ended in a spatially expanded state. The expansion was reflected in the total space graphs by an ascent in INS and descents in both UNS and LNS (Fig. 4.8). The motion outward from a spatially contracted sonority, which occurs twice in section A, suggests that the contracted sonority could be considered a more stable state and that movement into the expansion is a way of introducing musical tension which will require resolution. In contrast to the period structures in section A, the close of A material found in section A' contains a *contraction* rather than an expansion. In this way, the spatial opening in the first two statements of A material in section A are resolved or closed in the final statement of A material in section A'. Moreover, the values for INS, UNS, and LNS for the closing sonority of A material return to the range of values found for the very opening sonority of the bagatelle (Table 4.1). The three types of space all contain figures in a middle range, whereas extreme values near 0 or close to 66 suggest more extreme spatial states (extreme contraction, expansion, or especially high or low positioning of the pitch shape.)

TABLE 4.1. *Comparison of INS, LNS, and UNS for the opening chord of section A and the closing chord of A material in section A'.*

	Opening chord	Closing chord of A material in section A'
INS	15	27
LNS	20	20
UNS	28	16

The INS, LNS, and UNS values for the final sonority in the A' period are almost exactly the same as the values for the final sonority of the first period structure in A (m.

8) (Table. 4.2). However, the chord in A is approached by an expansion, while the chord of A' is approached by way of a contraction – another way of incorporating balance into the spatial design.

TABLE 4.2. *Comparison of INS, LNS, and UNS for the final chord of the 1st period structure in section A and the closing chord of the A material in section A'.*

	Final chord of 1 st period structure, A (m. 8)	Final chord of A material in A' (m. 39)
INS	28	27
LNS	20	20
UNS	16	16

For the majority of the cadential extension, LNS is the predominant type of space (mm. 39-44, ♩=448-507). The only other area of the bagatelle where this is also the case is the cadenza, which functioned as a way of increasing the musical tension and preparing the large expansion which takes place in the first half of A'. Here we see a similar pattern where the predominance of LNS or high placement of the pitch shape leads to an area with a large expansion. For the final section of the cadential extension (mm. 44-47, ♩=508-543), INS becomes predominant, and the final sonority, as well as the approach to the final sonority – an expansion - has a spatial profile similar to that at the end of each period structure in the first section (A) (Table. 4.3).

TABLE 4.3. Comparison of *INS*, *LNS*, and *UNS* of the final chords for the first and second period in Section A and the final chord in Section A'.

	Final chord: 1 st period, Section A m. 8, ♯=96	Final chord: 2 nd period, Section A m. 16, ♯=192	Final chord: cadential extension, Section A' m. 47, ♯=543
INS	33	33	45
LNS	13	13	13
UNS	16	16	4

The trajectory of the pitch shape as a whole forms an overall ascent from the opening to the close of A' (-25.5 to 4.5) (Fig. 4.21). This gentle ascent is interrupted three times, when the pitch shape leaps to a higher level and descends, folding back into the line of the overall ascent. The first leap (-7.5 up to 11) takes place at m. 35, leading into beat 2. This jump reflects the increase in LNS, which helps to articulate the end of the first phrase and beginning of the second phrase. The second and third upward leaps (m. 39, 2 to 20.5 and m. 43, 7.5 to 27) are also caused by the increases in LNS that help articulate each 4-bar structural unit. As each leap is approximately the same size (17.5, 18.5, and 19.5, respectively) and each is originating from an ascending line, the peaks, in relation to one another, form a parallel, secondary ascent in a higher register articulated by the openings of each phrase.

Just as section B displays a widening range of motion around the central axis compared to section A, this final section continues that same trend with a range that extends from -25.5 to 27 - a distance of 57.5 semitones. Even though the pitch shape travels even farther from the central axis, a sense of control and balance is maintained: the furthest two points from the central axis are nearly equidistant, these points are only

reached once within the course of the final section, and they are well integrated into the overall spatial plan.

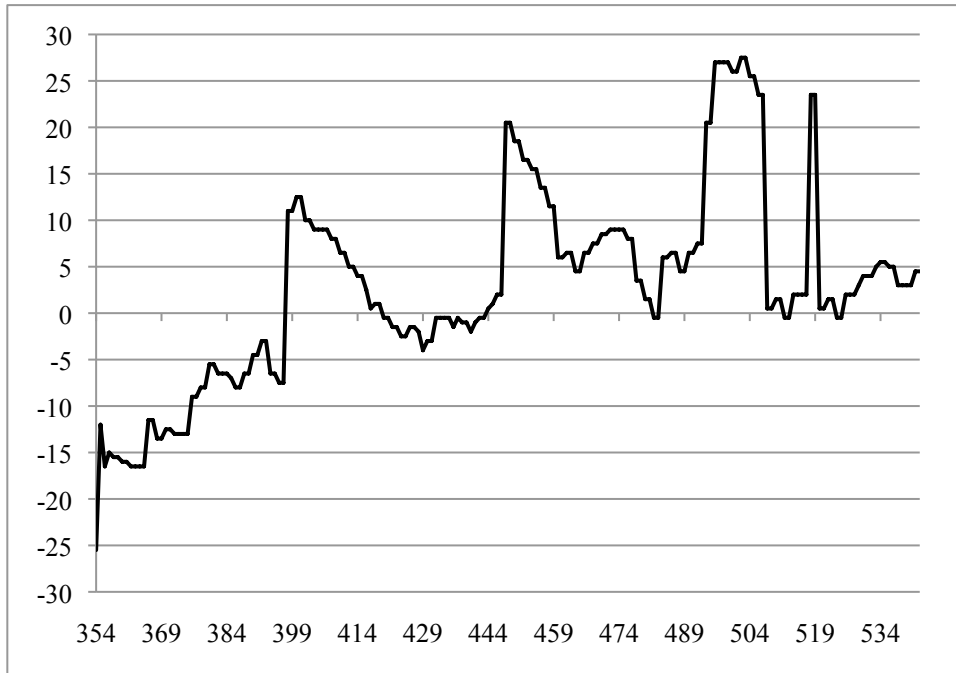


FIGURE 4.21. *Median trajectory graph, A' + cadential extension.*

V. SUMMARY OF IMPORTANT SPATIAL TRENDS

The pitch graph and line graphs for PS, INS, and median pitch shape trajectory reveal the most information about important structural features of the bagatelle. In this section, I will discuss and summarize those spatial developments across the entire composition.

Table 4.4 summarizes some general spatial statistics for each section and the entire work. Sections A and B have ranges that are similar in size while the final section's range is wider by approximately two octaves. The pitch field for section B sits

higher than that of section A. The pitch field for the final section extends out in both directions from the lowest and highest point found in sections A and B.

TABLE 4.4. *Summary of general spatial statistics.*

	A	B	A'	Entire piece
Range	G2 – C6	C#3 – E6	F#1 – B6	F#1 – B6
Span	3 octaves + P4	3 octaves + m3	5 octaves + P4	5 octaves + P4
Central axis	D#/E4	G#/A4	D/D#4	D/D#4

Sections A and A' share essentially the same central pitch axis, which is the pitch axis for the entire piece. The central pitch axis of section B sits approximately a fourth higher creating one means for providing contrast with the outer statements of A material. The higher positioning also creates a registral opening that is resolved in the final section.

Another process that occurs in the piece repeatedly is the transformation of a sonority with somewhat evenly spaced pitches into a sonority with completely uninterrupted INS in the middle. This process occurs with each phrase in the opening A section. In contrast, the B section contains sonorities with the middle filled in until the very last measure after the cadenza. The first eight bars of A' (i.e. the portion without the cadential extension), contain the same kind of process found in A, only greatly magnified in scope. This process is absent in the cadential extension, which juxtaposes repeatedly areas of no INS with areas of high INS, reinforcing the end result of the process described above. In other words, only the smallest possible point of initiation and the final goal of an expansion are articulated in this section.

As the bagatelle progresses, the texture becomes more variable (Fig. 4.22). While sonorities in the opening section contain between 2 and 4 notes, those in the final section

may contain between 1 and 5 notes. Additionally, in the first section, the texture varies less frequently than in the subsequent two sections which contain areas of rapid oscillation in PS. The two areas correspond with the dominant prolongation in B (mm. 20-25) and the cadential extension (mm. 39-42).

Internal negative space is a particularly important structural component in the bagatelle (Fig. 4.23). The A section contains two expansions to values between 34 and 38 in each period structure for a total of four expansions. How INS is developed in the B section is one of the factors used to create contrast between it and the first section. The B section, though only 17% shorter than A, contains only two smaller expansions (22 and 27.5). The INS in B acts as a diminution of that in A in both size and number of expansions. In general, the harmonies in the B section are more closely spaced than those in A resulting in a significantly less INS overall. Directly after the cadenza, where INS has decreased to 0, we find the two largest expansions yet. These two much larger expansions (47 and 55) take place in the final section during a variation of the musical idea found in the opening section. In this way, the expansions serve as a registral augmentation of the A expansions, an augmentation which is more dramatically felt after the significantly smaller expansions in B.

The cadential extension summarizes the overall development of INS over the course of the work. There are four main expansions of ever-increasing size always preceded by an INS value of 0. The fact that each expansion in the cadential extension grows from an area with no INS sheds light on the function of the cadenza in the B

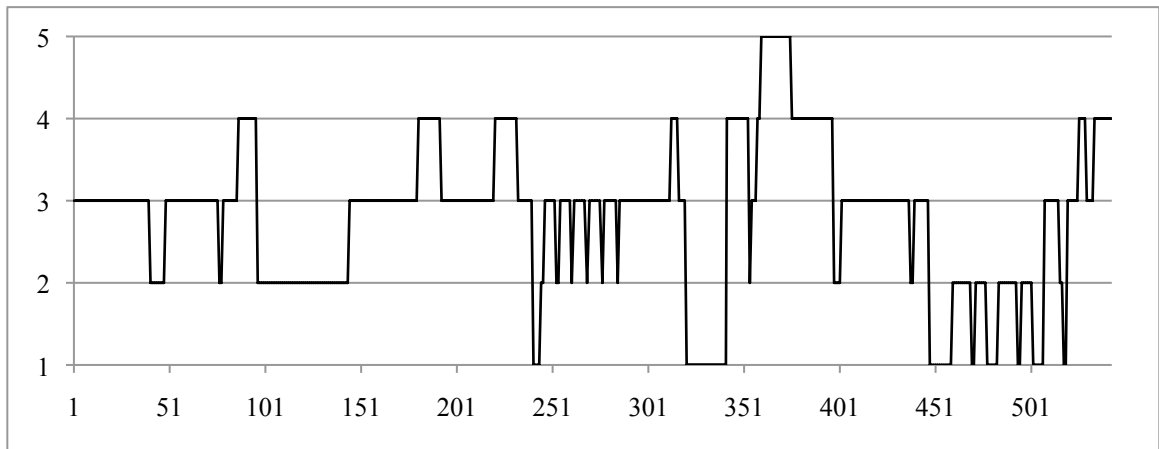


FIGURE 4.22. *PS, entire piece.*

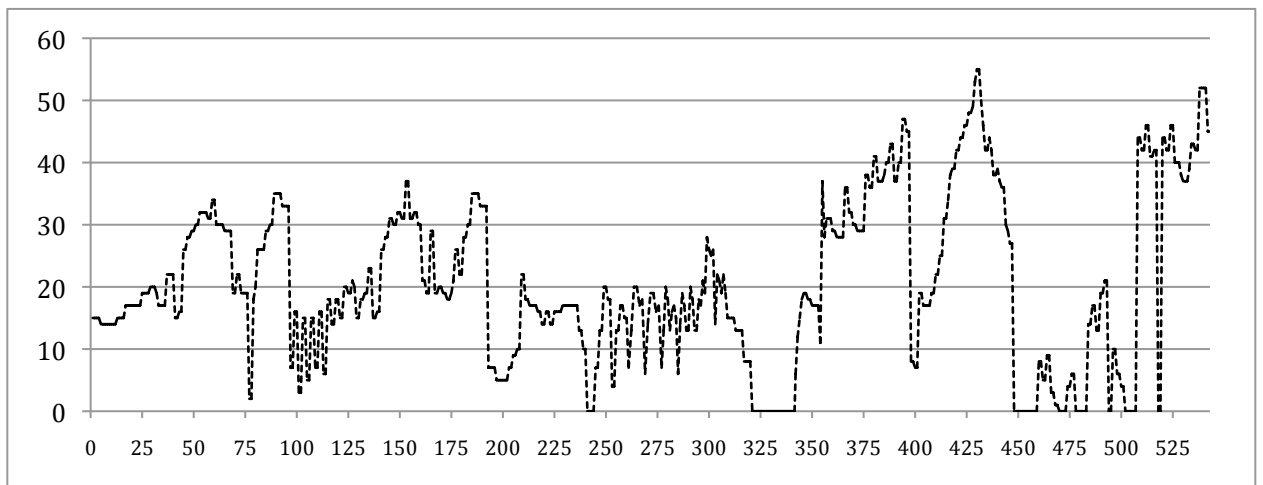


FIGURE 4.23. *INS, entire piece.*

section. The two large expansions in the first half of A' occur directly after the cadenza which contains no INS. In this work, areas of no INS prepare the expansions – the contrast in INS values, on the one hand, increases the drama of the expansions, and the expansions, on the other hand, balance out the former absence of INS.

The expansions and their relative sizes may be the most easily perceptible cues to the development of INS over the course of the entire piece. Another way of examining the differences in INS among the various sections is to take an average INS value for each section. Data for all types of space have been taken at every 16th note. By adding up all the INS values of and dividing by the number of 16th notes in a particular section, we can compare the average INS value for each section. From Fig. 4.24, we can see that average INS in B is about half that of A while the average A' sonority contains more INS than either A or B.

The final section, however, contains two parts with very different musical functions. The first half consists of a variation on A material with the enlarged expansions and the second half functions as a summary of the development of INS throughout the piece. Therefore, it makes sense to compare average INS values where the two parts of section A' are calculated separately (Fig. 4.25). Now we see that the return of A material in the final section (mm. 32-35) brings with it sonorities that contain dramatically more INS – around 55% more. The average INS values of section B and the cadential extension approximately mirror this relationship with the value for the cadential extension being 50% greater than the value for section B. Additionally, each section with A material, A and A' (without the cadential extension), is followed by a contrasting section or passage containing 55% and 53% less average INS respectively. Examining

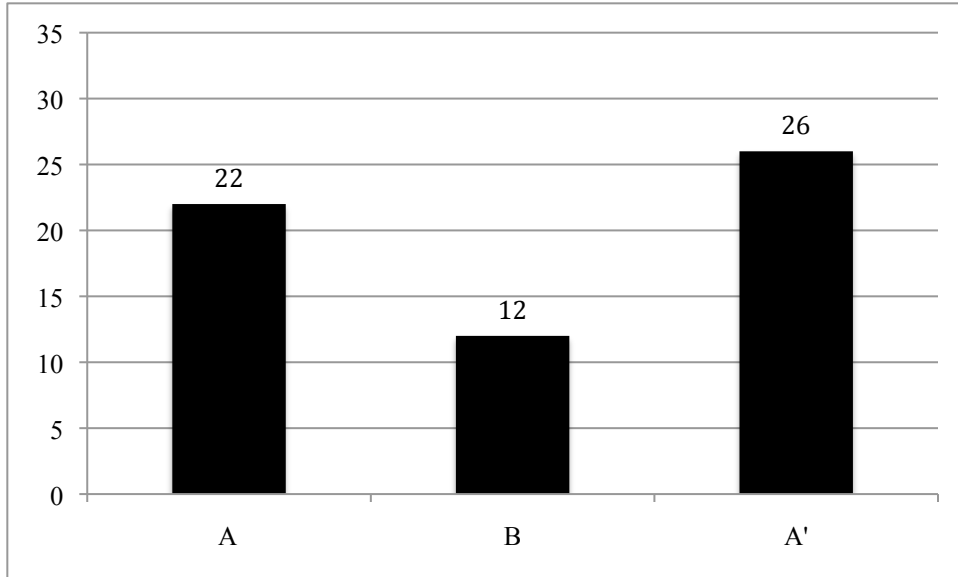


FIGURE 4.24. Average INS values for each section.

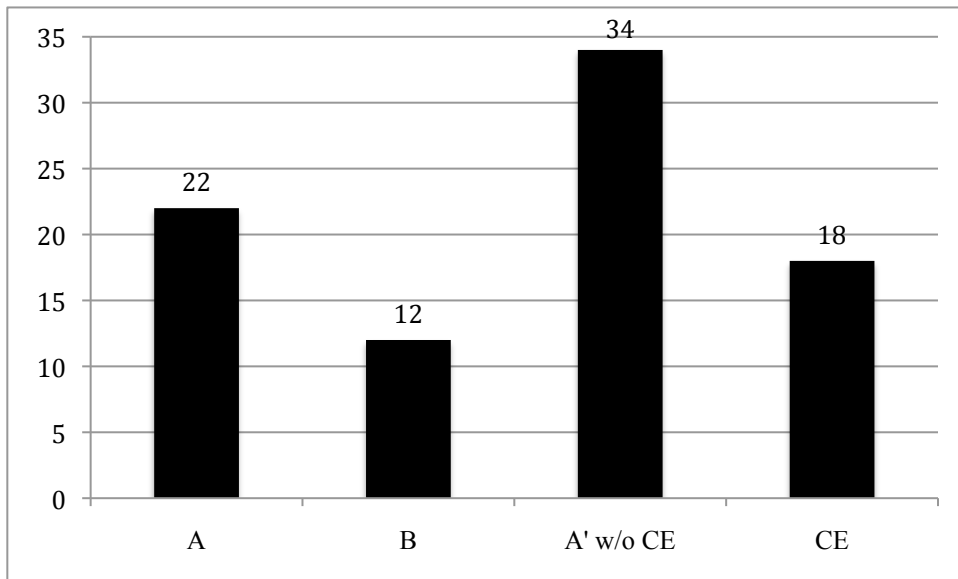


FIGURE 4.25. Average INS values for A, B, A' without the cadential extension, and the cadential extension alone.

the average INS for A' and the cadential extension separately exposes a new, beautifully balanced network of spatial relationships. In his works cast in sonata form, Beethoven often included an extended coda whose purpose was to counterbalance the development section.⁴⁷ In this miniature piece, the cadential extension, through its spatial motion, provides a counterbalance to the B section.

The median pitch shape trajectory of the entire composition shows a gradual increase in distance traveled from the central pitch axis as the piece progresses (Fig. 4.26). The upper extremity of the cadenza, 25.5, is immediately balanced by a lower extremity of -25.5 placed near the opening of the final section. After this point, a gentler, arch-shaped ascent occurs though it is interrupted by upward leaps followed by step-wise descents (Table 4.5). These descents end, however, at or near where the arch leaves off prior to the upward leap, thus the piece resumes its path along the arch shape. These leaps serve as a temporary, local diversion, or elaboration of an essentially linear trajectory.

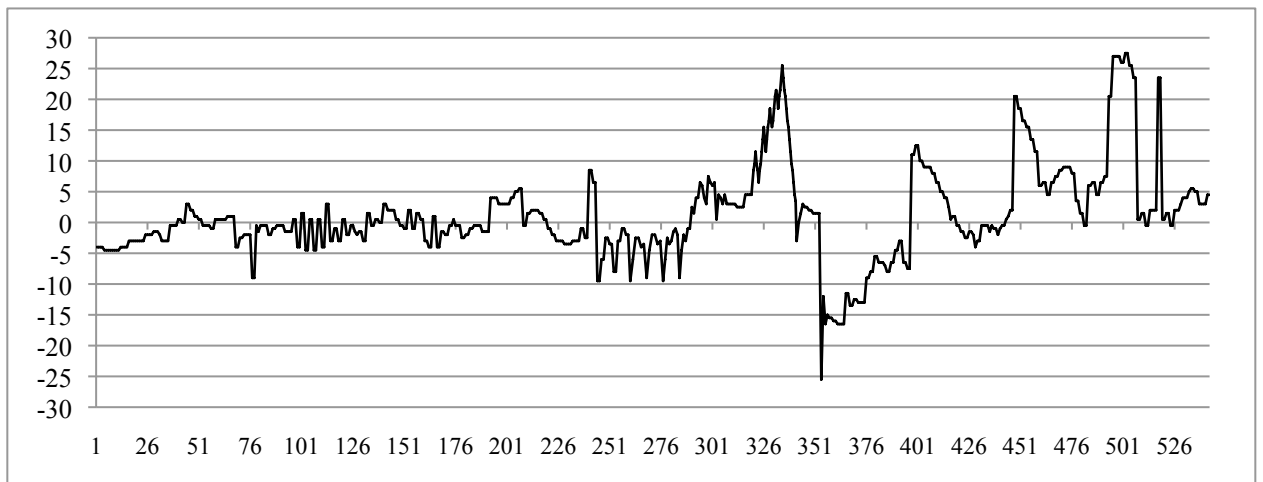


FIGURE 4.26. *Median trajectory graph, entire piece.*

⁴⁷ C. Rosen, *Sonata Forms* (New York: W.W. Norton & Company, 1988) 324.

TABLE 4.5. *Placement of leaps which interrupt the overall median pitch trajectory in section A'*

Leap #	Placement (16 th notes)	Placement (measure)	Leap values
1	397-398	m. 35, beat 2	-7.5 to 11
2	447-448	m. 39, beat 2.5	2 to 20.5
3	483-496	mm. 42-43	-0.5 to 27

These local leaps, or peaks, described above, are actually related to the cadenza, which initiated the various spatial motions in the final section. While the initial peak of the cadenza was approached gradually through stepwise motion and left swiftly, the peaks in the final section are approached swiftly and left more gradually, functioning as a retrograde of the cadenza.

Table 4.6 summarizes the information gleaned from the median pitch trajectory graphs. I will first compare the motion from open to close of each section with the overall motion of the entire composition. As mentioned above, sections A and B function like inversions of one another with A containing a slight ascent from -4 to -1.5 and B containing a slight descent from 4 to 1.5. In contrast, A' contains a large ascent from -25.5 to 4.5, once again demonstrating that all the motions in A' tend to occur on a much larger scale than those in the rest of the piece. The motion from opening to close of the entire bagatelle however is an ascent from -4 to 4.5, so that the point of initiation and the final goal are perfectly balanced around the central pitch axis.

From Table 4.6, we can see that the median pitch trajectory travels further from the central pitch axis as the piece progresses. Perhaps the most interesting relationship

here is that, though sections A and B share a similar pitch range of slightly over three octaves (Table 4.4), how the sonorities are balanced around the central axis is significantly different. For section A, the median pitch trajectory stays closer to center with a range of only 12 semitones. On the other hand, in section B, the median pitch trajectory travels fairly far from the central pitch axis with a range of 34.5, almost three times that of section A. Furthermore, the range of the median pitch trajectory for A (-9:3) is balanced below the central pitch axis and for B (-9:25.5) is balanced above the central pitch axis. Once again, in keeping with the generally magnified motions of the final section, the median pitch trajectory range in A' has increased to 57.5, nearly five times that of section A. This means that the midpoint of the pitch shape travels farther from the central axis than in any of the previous sections. However, the range placement of the median pitch trajectory (-25:27), unlike that of the first two sections, is balanced around the central pitch axis.

TABLE 4.6. *Summary of median pitch trajectory.*

	A	B	A'	Entire piece
Position from open to close	-4 ⇒ -1.5	4 ⇒ 1.5	-25.5 ⇒ 4.5	-4 ⇒ 4.5
Range	-9 : 3	-9 : 25.5	-25.5 : 27	-25.5 : 27
Range width	12	34.5	57.5	57.5

VI. THE SIGNIFICANCE OF BEETHOVEN'S SPATIAL DESIGN ILLUMINED BY COMPARISON WITH A MODIFIED VERSION

As has been shown above, the local developmental process of spatial expansion and “emptying out” which is introduced in each period of section A becomes a global developmental process whose result is the magnified spatial design found in the final section, A'. A recomposition of select passages where unusual spacing or extreme uses of register are modified will show the significance of Beethoven's choice of register to the design of the bagatelle.

First, I will begin with the opening period as this is where the main developmental process is introduced. According to common practice harmony guidelines, this passage has at least one grave error having to do with the spacing of the chords. Generally, in a four-voice texture, adjacent voices, except for the bass and tenor, may not be more than one octave apart from one another. The bass line, on the other hand, may be separated by more than an octave from the tenor line. Additionally, in many piano works written in the common practice period, close spacing in low registers tends to be avoided because of the resulting muddy sound. The stylistic goal is to have generally clear, balanced harmonic structures.

In this bagatelle, however, which generally contains three voices, two closely spaced lines in the bass register result in exactly the muddy effect which would be considered “incorrect” (mm. 2-8). Secondly, what functions here as a tenor line, is separated from the upper line by more than an octave and, in some cases, by more than two octaves (mm.4-6, m.7). Fig. 4.27 shows a recomposition of the first eight bars in a more typical style with a fourth voice added to fill out the texture. The outer lines have been preserved so the pitch shape contour remains unchanged. The bass line of the

second phrase, articulated in thirds, has been raised up an octave, which allows for closer spacing. Additionally, placing the parallel thirds in a higher register rids the piece of the unusual muddy bass sonorities. An examination of the pitch graph (Fig. 4.28) of the recomposed version shows the more even spacing as well as the absence of the emptying out process. The line graph of internal negative space shows that, while there are still two main expansions, they are significantly smaller than those in the actual version (Fig. 4.29).



FIGURE 4.27. *Modified opening, mm. 1-8.*

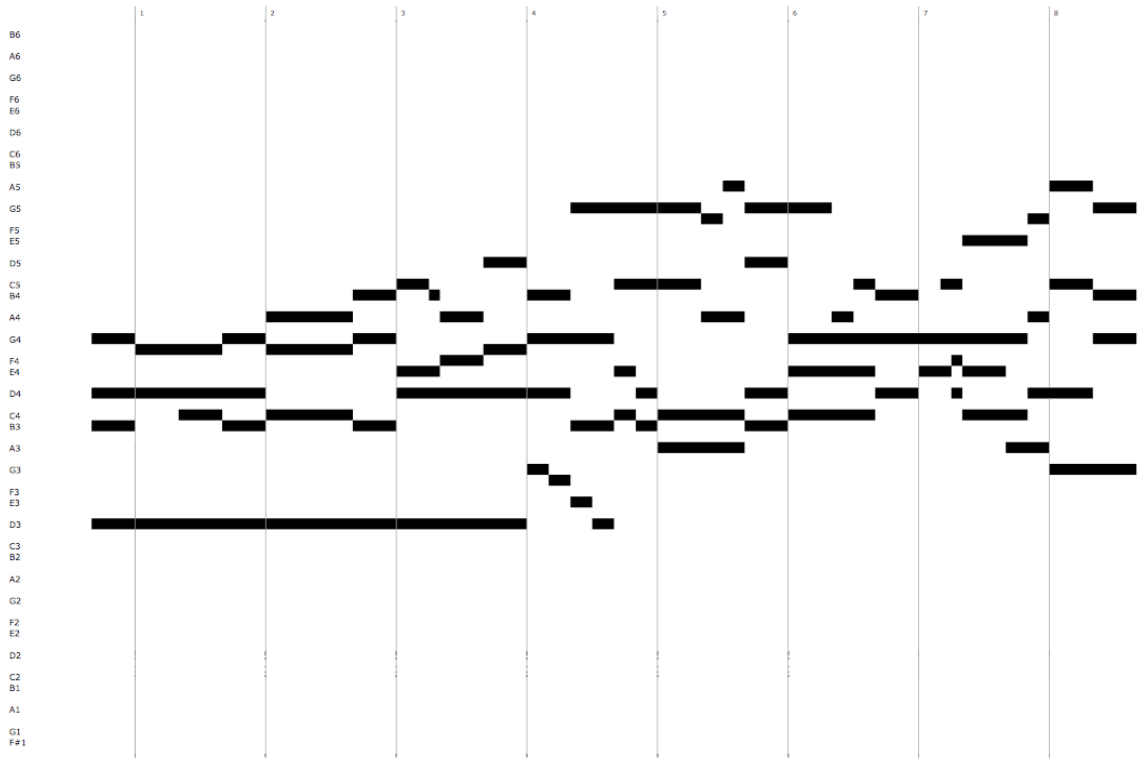


FIGURE 4.28. *Pitch graph of modified opening, mm. 1-8.*

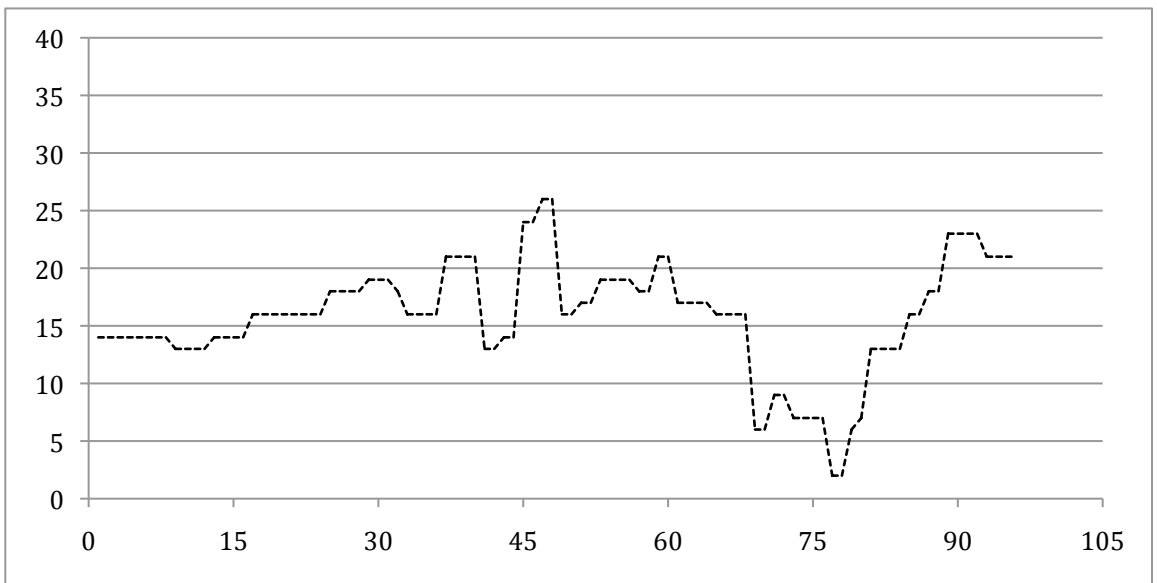


FIGURE 4.29. *INS, mm. 1-8 of the modified version.*

These two versions result in very different effects. Beethoven must have chosen the unusual spacing which exists in the true version with a specific compositional goal in mind. I believe he used the stylistically odd sonority to draw the listener's attention to the developmental process of expansion and "emptying out" which will continue to function on a larger scale as the work progresses, becoming an essential expressive device for the entire work.

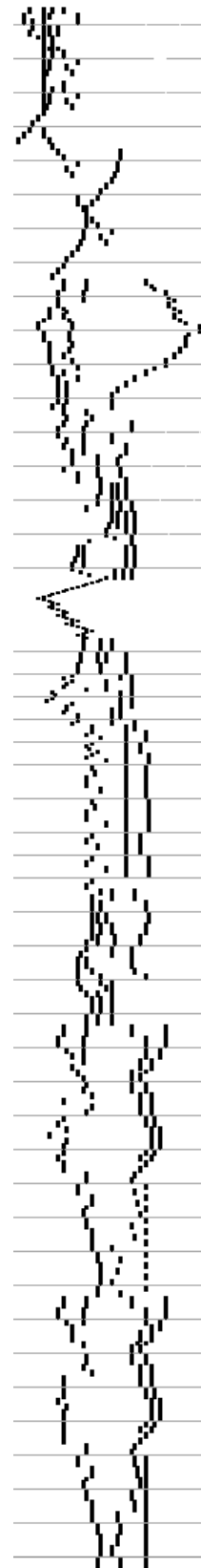
Now I will turn to the final section, where the developmental process results in the magnified expansions already described above. One of the first ways in which the expanded register is activated is through the doubling of the bass line in octaves in mm. 31-35. Measures 44-47 also contain a bass line in an extreme low range. Figure 4.30 contains a recomposed version where these extreme low parts are absent. In the recomposition, mm. 31-35 do not contain octave doubling and the bass line is shifted up into register 3. In the final four measures, the bass line is shifted up three octaves so it is closely positioned with the upper lines of the work. To understand how Beethoven's choice of register contributes to the spatial design of the piece, I will compare the pitch graph and graphs of INS and median pitch shape trajectory of the recomposed version with those of the original.

The pitch graph of the modified final section (Fig. 4.31) shows the first phrase of A' (mm. 32-35) has a much narrower range, only two octaves plus a minor third (F#3-A5), which is closer in size to the range of the opening four measures in A. The lower part of the frequency field has not yet been activated as it is in the original. In the original, the octave doubling serves, in part, to prepare the new low register for the expansion that takes place in measures 36-39.

The image displays a musical score for piano, consisting of four systems of music. Each system is written for two staves: a treble clef staff and a bass clef staff. The key signature is one sharp (F#), and the time signature is 3/4. The first system begins at measure 32 and ends at measure 35. The second system begins at measure 36 and ends at measure 39. The third system begins at measure 40 and ends at measure 43. The fourth system begins at measure 44 and ends at measure 47. The music features a variety of rhythmic patterns, including eighth and sixteenth notes, and rests. There are several instances of slurs and ties across measures. The bass line often provides a steady accompaniment, while the treble line features more melodic and complex passages.

FIGURE 4.30. *Recomposition of mm. 32-47.*

FIGURE 4.31. *Pitch graph of entire piece, original A section and recomposed A' section.*



Additionally, the pitch graph of the recomposed final section reveals an overall ascent that takes place from the widest point of the main expansion (m. 38) to the end. A final ascent such as this would leave the piece sounding incomplete as it leaves a registral opening that begs for closure. Beethoven's registral choice for the bass line in measures 44-47 helps to balance that ascent.

A comparison of INS graphs for the modified ending (Fig. 4.32) with those for the actual ending (Fig. 4.18) also suggest that Beethoven's registral choices were made in order to resolve specific compositional problems posed by the work's spatial design. For example, measures 32-35 of the modified version contain a maximum INS value of 25, which is similar to that of the parallel passages in the original opening section (max INS=28 for both mm. 1-4 and mm. 9-12). The modified version contains no notable development of INS like that which occurs in the real version. A consistent feature of Beethoven's style is continual development throughout the course of a composition and the spatially expanded form of A material in the opening four measures of the final section serves as a typical example of this.

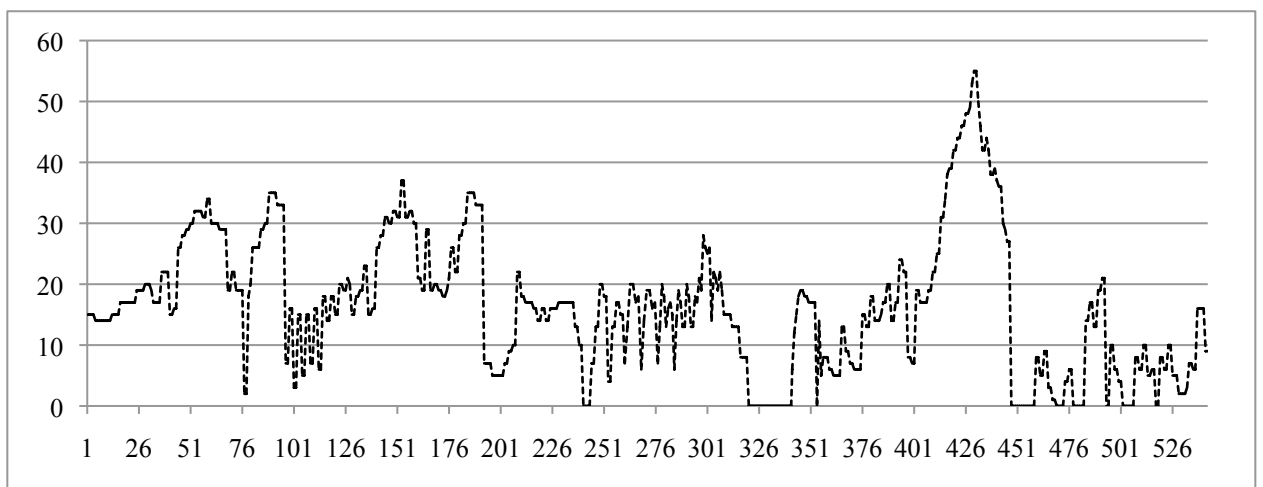


FIGURE 4.32. *INS, entire piece with original A section and recomposed A' section.*

Additionally, each period in the opening section (A) contains two larger expansions that are almost equal in size (Fig. 4.31). The parallel moments in the modified final section break this pattern and create a spatial imbalance as the second expansion measures more than twice as large as the first. The period in the actual final section contains expansions that are closer in scale with INS values of 47 and 55. This larger first expansion also allows for a greater drop in INS prior to the second expansion, which increases the drama of this final phrase of A material.

TABLE 4.7. *INS values for larger expansions found in periods from sections A and A'.*

PERIOD		INS Value	Measure	16 th note
Period 1, A	1 st exp.	34	5	59-60
	2 nd exp.	35	8	89-92
Period 2, A	1 st exp.	37	13	153-154
	2 nd exp.	35	16	185-188
<i>Modified Period 3, A'</i>	<i>1st exp.</i>	<i>24</i>	<i>35</i>	<i>394-395</i>
	<i>2nd exp.</i>	<i>55</i>	<i>38</i>	<i>430</i>
Actual Period 3, A'	1 st exp.	47	35	394-395
	2 nd exp.	55	38	430

An examination of the INS graph for the modified cadential extension (Fig. 4.32) reveals that, without the bass line in the low register for the final four measures, there is no systematic development of INS. The modified ending contains no summary of the ever-expanding spatial design of the piece. Instead, peaks in INS range between 6 and 21 and the ordering of these peaks do not conform to any organizational plan.

The doubled octaves in the left hand of measures 31-35 and the low bass line in the final four measures are essential to articulating the spatial design of the piece.

Without activation of these lower registers which generate larger amounts of INS, the

expansion in the second phrase of A' (mm. 35-39) creates an imbalance in the composition and seems out of place. This expansion, however, is the culmination of the development of registral space that begins at the outset of the composition and it is crucial that it be properly prepared. The doubled octaves in measures 31-35 create a context in which this expansion can logically take place without creating imbalance. The low bass line in the final four measures results in a cadential extension whose spatial design confirms this developmental process of expansion as being an essential expressive device in the composition.

These two key passages (mm. 31-35 and mm. 44-47) not only contribute to the logical development and balancing of INS, but also to the balance of the piece's placement within its pitch field. The median trajectory graph of the modified ending shows that, without the low registral activation in the final section, the passage from the cadenza to the end is top-heavy. In other words, the piece almost continually lies above the central pitch axis from the cadenza on.

In Fig. 4.26, we saw how the passage from measures 31-35 (♩=354-397) balances the high peak of the cadenza in measure 30 (♩=321-341). The modified ending shows that, without the low doubled octaves, no spatial balancing of the cadenza is achieved. Thus the registral placement of the passage in measures 31-35 serve two crucial purposes: it provides spatial balance for the cadenza which precedes it and balances the INS of the expansion that follows. Thus, the common practice of octave doubling of the melody, which is often considered as merely a means of varying the melody and creating a fuller sound, becomes structurally essential to the spatial design of this composition.

The median trajectory graph of the final four measures of the modified ending (Fig. 4.33) also show that without the low registral placement of the bass line, the piece trails off into an upper register and is left registrally open. As discussed earlier, registral closure, defined in this work as either rises in pitch falling again or bringing the pitch shape to a centered position within its range, is demonstrated repeatedly throughout the course of the bagatelle. For example, the central pitch axis of section B lies higher than that of section A and this registral opening is closed by the return of the central pitch axis in A' to the original level. The overall motion toward the central pitch axis found in the A and B sections also serve as an example of gravitation toward the center as a means of creating spatial equilibrium. Additionally, the open and close of the piece are balanced 4 and 4.5 half steps below and above the central axis, respectively. Without the low final bass line of the final four measures, this piece would not demonstrate such registral closure. Furthermore, Beethoven could have chosen a number of different octaves in which to write the final bass line as the right hand sits in such a high register. The octave he chose, in register 2, pulls the median trajectory down to 4.5, providing an exact, exactly balancing the ending and opening of the composition.

Comparing the modified ending with the real ending for this bagatelle clearly shows how A' is the result of a developmental process of expansion with the final expansion of A material, measures 35-39, being the end goal of the process. The cadenza in section B initiates this expansion by both de-centering the piece as well as expanding the range upward. The low doubled octaves at the opening of A', which could be overlooked as a meaningless detail, spatially balance the cadenza in the opposite

direction as well as expand the range of the piece downward. In doing so, the space is prepared for the final expansion presented with A material.

Returning to the opening period in section A, we see the expansion process introduced on a more local scale accented by the unusual sonority created by the close spacing in the lower voices. The process occurs on a global scale as described above, resulting in the spatial design of A'. The cadential extension summarizes the spatial motion of the entire piece, even bringing back the close spacing, in parallel thirds, of low voices in the penultimate measure.

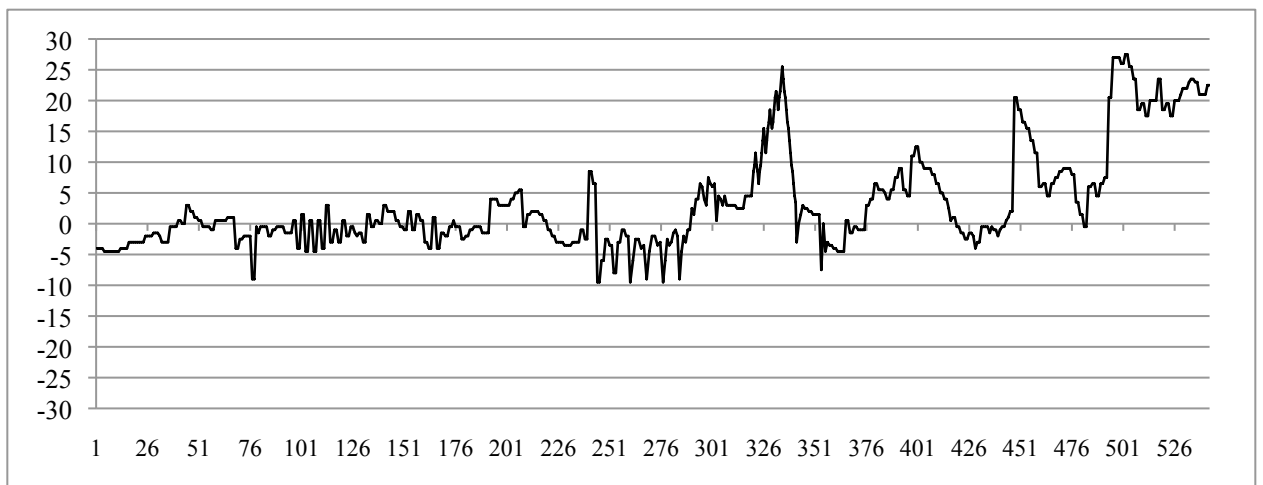


FIGURE 4.33. *Median trajectory graph, entire piece with original A section and recomposed A' section.*

VII. THE FUNCTION OF SECTION B.

Part of the genius of so many of Beethoven's works is the way in which they exhibit a sense of constant evolution; however this evolution somehow remains contained within a balanced structure. In his essay, "In the Time of the *Eroica*," Reinhold

Brinkmann considers two approaches to compositional form which he refers to as “form as architecture” and “form as process.” “Form as architecture” describes a musical structure in which all parts function in reference to a center. The music conforms to a constructed symmetry that exhibits stillness in its balance. “Form as process,” on the other hand, is path or goal-oriented. This kind of form is constantly and powerfully moving forward.⁴⁸

The relationship of the two outer sections of this bagatelle is clearly part of a carefully constructed, architectonic design. However, as became clear above, each move forward creates a new set of problems to be solved, so that each moment is both a result of what preceded it and influences what follows, unfolding a process of continual development. The cadenza at the end of section B is a case in point. For reasons of spatial balancing, the cadenza necessitates the expansion in range found in the final section. The A' section simultaneously results from a linear process taking place through time *and*, along with the opening A section, forms the frame of an architectonic structure that exists outside of time.

I will show in the following discussion that the main function of the B section is to prepare the cadenza, the principal catalyst for the exaggerated spatial motions of the final section. While the outer sections have elements of “form as process” and “form as architecture,” this middle section conforms more completely to the “form as process” model with the cadenza being the final goal. As mentioned earlier, the cadenza introduces a new spatial profile (one that contains no INS), extends into a higher register

⁴⁸ Reinhold Brinkmann, “In the time of the *Eroica*,” in *Beethoven and his World*, ed. Scott Brunham and Michael P. Steinberg (Princeton: Princeton University Press, 2000), p. 17.

than has previously been activated, and contains the fastest note values in the piece. Throughout the B section, a building of energy occurs which culminates in this new gesture.

One way of increasing the musical tension is through definition of a new and higher register. Recalling from earlier, the range of B is approximately the same width as that of A, but is placed approximately a perfect fourth higher. This not only creates the registral opening previously mentioned, but, as higher frequencies traditionally do, suggests an increased level of energy.

Though the range of B remains narrow, we find increased motion in the median pitch shape trajectory as well as motion that travels farther from the central pitch axis. Within the narrow pitch space, this increase in spatial activity combined with pitch shape positioning which is less balanced result in increased musical tension. Progressive increases in the speed of surface-level rhythmic activity as well as the meter change, which shortens the time between downbeats, assist in the creation of this musical tension.

Finally, the overall structure of the middle section lacks the formal symmetry of the opening section. The opening A section segments into 4-bar phrases which join in pairs to form period structures. The spatial expansions are placed in such a way that they reflect this symmetry. In the B section, however, segmentation is a more difficult matter and the laying out of antecedent-consequent, 4-bar phrases is replaced by a section of music that spins out of metric bounds. The placement of spatial expansions found in this section reflects this asymmetry.

It is this asymmetry in conjunction with the higher range, increased and less balanced types of spatial motion, and faster rhythmic activity that raises the musical

tension in section B. The cadenza, then, is a logical release of the built-up musical energy which preceded it and the nature of the cadenza results in the new, magnified spatial design of the final section.

VIII. THE COORDINATION OF THE BAGATELLE'S SPATIAL DESIGN WITH FORMAL, HARMONIC, AND TEMPORAL ASPECTS

Though I have been focusing almost solely on the musical form of this piece as created by its spatial design, the structure of a composition generally does not result from a single musical parameter. Rather it is the interaction of numerous musical parameters – harmony, melody, rhythm, registral space, dynamics and so on – which articulate a composition's structure. I mentioned at the outset of this chapter that form and harmony in this piece are quite conventional and that what is truly original about the composition is its spatial design. Now that the spatial design has been thoroughly examined, I will discuss how Beethoven's coordination of other musical parameters such as form, harmony, and rhythm with spatial developments help to elucidate that design and emphasize some of its key moments.

The coordination of the spatial design with the piece's rounded binary form and phrase structure has already been discussed so I will only briefly outline it here. In rounded sectional binary designs, the return of A material tends to be similar to the first reprise, if not an exact replication, with the B section providing contrast. The contrast can be accomplished by manipulating a number of musical parameters that include, but are not limited to, stability of tonal center, modulation or change of mode, clarity of phrase structure, and contrasting melodic themes.

Here, spatial motion helps to create that contrast as well. The clear expansions of pitch shape from the A sections are absent in the B section as can be seen from the pitch graphs and the INS graphs. Average INS values of the B section are significantly lower than those in the outer sections reflecting the generally narrower spacing of harmonies. Additionally, the pitch shape expansions help to reinforce the symmetric phrase structures for all statements of A material. On the other hand, the asymmetric placement of expansions in the B section coordinate with the loss of symmetric phrase structures in this middle section.

Temporal properties of the bagatelle also coordinate with the spatial design in terms of both speed of surface-level rhythmic activity and temporal proportions. I will first discuss how developments in the composite rhythm complement spatial motion in the piece and then I will discuss how several important or dramatic moments in the spatial design occur consistently at particular temporal proportions on global, sectional, and more local levels.

From the first full measure to the cadenza, there is an overall increase in the composite rhythm of the piece from three attacks per measure to twelve attacks per measure (Fig. 4.34).⁴⁹ The composite rhythm combines with the spatial motion, to increase the musical tension that results in the cadenza. In the graph (Fig. 4.37), we see that the composite rhythm is significantly faster than that in the rest of the work. Just as, after the cadenza, the size of the pitch shape expansions and the range is irreversibly enlarged, the composite rhythm, likewise, never returns to the quarter note level found at

⁴⁹ The data for this graph was calculated by counting the number of individual attacks for each 3/4 measure. So as not to skew the data, values for the section in 2/4 were not calculated every measure, but continued to be calculated for every three quarter notes.

the opening. Developments in the composite rhythm and the spatial motion, together, point to the cadenza as a pivotal moment in the bagatelle.

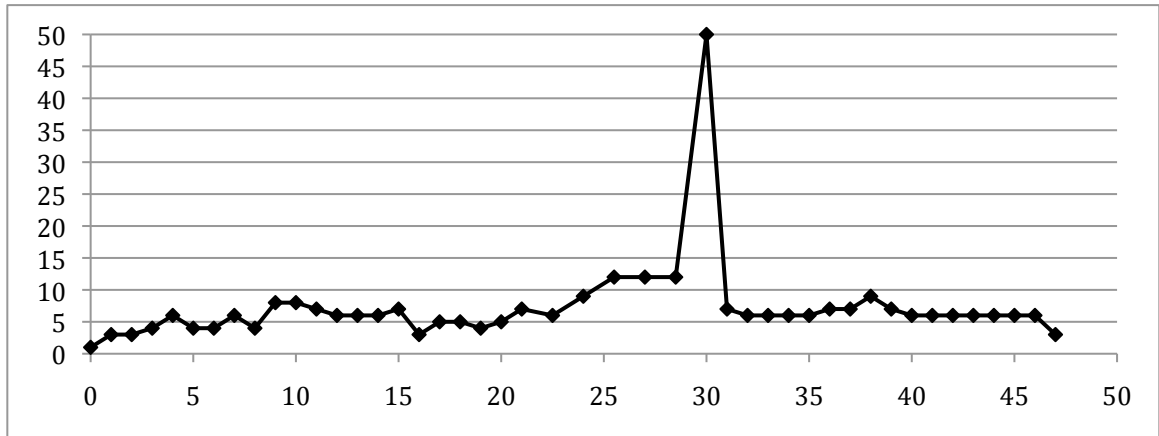


FIGURE 4.34. *Composite rhythm graph, entire piece.*

Some important moments, such as the peak of the cadenza, happen to be coordinated with certain temporal proportions, and that coordination occurs repeatedly at either global levels, or more local levels of structure such as sections or periods. For example, the peak of the cadenza in measure 30 coincides with the Golden Mean of the entire work (m. 30, ♩=335). The Golden Mean proportion is significant in some of the individual sections such as section B where it occurs one 16th note prior to m. 27 (♩=292) corresponding to start of a smaller, primary ascent that takes place just before the cadenza (Figs. 4.10 and 4.15). In the A' section, the inverse golden mean is significant, and occurs at the third beat of measure 37, right before the large expansion which is the overall goal of spatial development.

At even smaller local levels, significant events often are placed at the golden mean. The widest point of the first expansion in the piece (measure 5, beat 1) is the golden mean of the opening period. The first expansion is, of course significant, as it introduces one of the primary kinds of spatial motion in the piece. The golden mean of the cadential extension is located at measure 44, precisely halfway through beat 2. This is the very first note of the low bass line, whose registral placement results in the final expansion, creating a cadential extension that completely summarizes the spatial motion of the piece. The similar placement of these introductory and concluding spatial gestures within the first and last eight bars of the piece, and their relationship to spatial developments in parallel places on larger levels adds another layer of cohesiveness to the spatial design.

Finally, harmony is closely coordinated with the spatial design as well, and contributes to the overall compositional problem in the bagatelle. I have discussed at length how the periods in the A section end in an expanded form, that this creates a spatial opening, and that this opening receives closure when, in the A' section, the period structure containing A material ends with a spatial contraction. Part of the interest in the spatial design of the opening section is that the expansion that takes place at the end of each 4-bar phrase is paired with a cadence on the tonic. Thus, each phrase is tonally closed, but spatially open.

In measures 28-30 of section B, a spatial contraction takes place right before the cadenza, as can be seen both in the pitch graph (Fig. 4.10) and in the INS graph (Fig. 4.12). This contraction coincides with a ii° – cadential 6-4 progression which seems to be leading to the tonic. This would give us a sense of closure, both spatially and

harmonically. However, all of this is taking place in the dominant key and of course the cadential 6-4 in D major leads to a dominant seventh chord in the tonic key of G major. So there is a sense of spatial closure without a sense of harmonic closure.

In the last statement of A material in the closing section, the cadence on the tonic in measure 39 is approached as a contraction, as mentioned earlier. This final statement of A material provides both harmonic and spatial closure. However, the cadence is an imperfect authentic cadence. Beethoven seems to have wanted a stronger sense of harmonic closure which is provided by the repeated perfect authentic cadences in the cadential extension. These seem to match the sense of closure of spatial activity also provided in this extension. Thus the function of the cadential extension is not only to summarize the overall spatial activity in the piece, but also to provide stronger harmonic closure with repeated perfect authentic cadences.

There is one final detail worth mentioning. This concerns the coordination of the harmony and spatial design. Earlier it was noted that the final spatial expansion of A material (mm. 36-39) is the most dramatic of all such expansions and serves as the spatial goal of the entire bagatelle. I also mentioned that the harmony found in the opening A section is completely diatonic. In this final statement of A material, the widest portion of the expansion (mm. 37-38) is accompanied by the only non-diatonic harmony present within the outer two sections. This harmony, V^7/IV , while not unconventional, sounds somewhat exotic given the completely diatonic context in which it takes place and helps to highlight this particularly important moment within the spatial design.

CHAPTER 5: CONCLUSION

The analyses of Ligeti's *Continuum*, Josquin's "Benedictus" from his *Missa L'homme armé super voces musicales*, and Beethoven's Bagatelle in G major, Op. 126, No. 2 show that registral space is particularly important to the overall design of each piece. Any examination of these works that does not take spatial motion into account will miss this crucial aspect of each composition's content. To date, few tools exist for the analysis of registral space. The method I have developed compliments existing methods by addressing some aspects of spatial motion that have not yet been adequately explored. Moreover, this method can be flexibly applied to music in varying textures and musical styles.

The applicability of my method to an analysis of *Continuum* is the most self-evident of the three pieces as cluster shapes and register placement are widely accepted as important aspects of compositional design in sound-mass music. While pitch graphs are commonly used to portray structure in published analyses of this work, my method of analyzing the work in terms of positive and negative space brings to light important characteristics of the piece not revealed by other methods.

For example, a pitch graph of *Continuum* clearly displays the overall symmetrical development of the pitch shape through the first four sections as well as the element of asymmetry introduced by the final section. However, a pitch graph offers no way to understand the asymmetry introduced into the pitch shape in the fifth section. My analysis shows that this can be understood as a development that extends logically, even though unexpectedly, from previous developments in the piece. By analyzing the evolution of each type of registral space – positive space, internal negative space, lower

negative space, and upper negative space - it becomes clear that the very large expansion of section IV and the dramatic shift in register and narrowing of pitch shape in section V occur when one or more types of space, after consistent development in a particular direction, have reached some limit. The sudden changes in sections IV and V are the outcome of a necessary shift in development of one or more types of space.

While offering a possible explanation for developments in sections IV and V, my analysis also reveals three main ways in which this spatial asymmetry is balanced. The median trajectory graph shows that throughout the course of the first four sections, the pitch shape is gradually descending. This descent is balanced by a gradual ascent in the fifth section. Moreover, the slope of a straight line connecting the endpoints of the descent is practically equal to that of the same for the ascent: 0.06 and 0.07 respectively. Secondly, graphs of pitch shape density, INS, and PS show that the cluster in section V is similar in density, shape, and development to the cluster of section I, providing a sense of return after the expanding clusters of sections II, III, and IV. Finally, the UNS and LNS graph, as well as the median pitch trajectory, show that, at the beginning of section III, the middle section, the entire pitch shape is perfectly centered within the range of the piece. Certainly, this centering provides stability for the pitch shape as a whole.

My analysis also raises an interesting point that because of the gradual expansion in range of the pitch shape in sections I through IV, the listener becomes more acutely aware of the lower negative space in section V. Thus, negative space becomes a particularly important aspect of the work, in the same way negative space plays a more equivalent role to positive space in some modern painting.

Similarly, a spatial analysis of the “Benedictus” from Josquin’s *Missa L’homme armé super voces musicales* reveals significant aspects of the piece that would otherwise be overlooked by a more conventional modal, contrapuntal, and cadential analysis. For example, the stepwise ascent of the principle 5-note motive, contrapuntally developed throughout the “Benedictus,” becomes the spatial motion that permeates the work at multiple structural levels, translating at the most global level into the overall ascent of this movement of the mass. This stepwise ascent that unifies the “Benedictus” simultaneously connects the movement with the mass as a whole in two ways. First, it is derived from the end of the *l’homme armé* tune and, second, it echoes the step-wise, ascending transposition of the cantus firmus across the movements of the mass. Thus, spatial motion is an enormously important unifying device in this composition.

Developments in registral space, particularly those of internal negative space with respect to the local ranges of each section, create the musical energy required for the global ascent in the “Benedictus.” In the first two sections, smaller expansions lead to a larger expansion that fills the available space in the local range. As the local range is now exhausted, a new section follows in a new, higher register.

Finally, my analysis reveals a number of instances where balanced spatial motion is built into the spatial design to offset the imbalance of the overall ascent. Such balances include global centering of the “Benedictus” at the temporal midpoint as well as the local descent in the third section as seen in the median trajectory graph. The spatial design of the “Benedictus” is every bit as intricate and significant to the meaning of the work as its contrapuntal design.

In the case of the Beethoven bagatelle, analysis of registral space is essential to understanding what is inventive in the piece since other aspects of the composition such as melody, harmony, and form are very conventional. The development of contiguous internal negative space within the pitch shape boundaries is an essential characteristic of both A sections. In the B section, one means of providing contrast with the outer sections is this lack of contiguous internal negative space as well as a narrowing of range. Beethoven's music often has a quality of continuous development and, in this case the significantly larger expansions that take place in the final A section serve as a variation of the opening A material. In this composition, spatial motion helps to articulate the ternary form.

The cadenza and coda of this bagatelle, which are at times viewed as an extemporaneous and non-essential aspect of the form, are actually crucial elements of the form. It is the ascent in the cadenza, an ascent that activates the highest range of the piece thus far, which disrupts the spatial centering so characteristic of the A and B sections. The median trajectory graph shows that, at the opening of the A' section, octave doubling, which activates the extreme lower register, serves to provide an exact counterbalance to the extreme high register introduced in the cadenza. Thus the cadenza actually precipitates the larger expansions in the A' section which serve as a variation of the opening. In this bagatelle, the coda not only serves to reinforce the final cadence in the piece, but it also summarizes the spatial motion in the work by incorporating a series of expansions that increase in size.

Another beautiful feature in this piece is the use of self-similar structures at multiple structural levels. The expansion and emptying out that take place in the opening

period of the bagatelle (mm. 1-8) are not only reflected on a larger scale in the final A' section, but also constitute the overall global motion in the piece. This composition is a perfect example to support the notion that, even in his late works, Beethoven still frequently depended on traditional classical forms, but found ways to be inventive within their constraints.

My discussion of these three pieces demonstrates that spatial motion can be important to the structure of music written in a variety of styles. One interesting feature of this method for spatial analysis is that its analytic approach is not style-specific. Methods for analysis intended to deal with music written in a particular language, must, necessarily, examine that music from a narrowed perspective – a perspective shaped by what commonly occurs in that body of music. These methods give musicians a powerful means for understanding a composition and its relationship to other works written in a similar style. However, the information produced from this type of analysis cannot easily assist a discussion about pieces written in two different styles.

One fascinating result of these analyses of registral space is that, though these pieces are written in different musical styles, they share a number of common features with regard to the treatment of musical space. For example, all three pieces exhibit self-similarity at multiple structural levels with regard to spatial motion and pitch shape. Both *Continuum* and the bagatelle feature smaller local expansions that are nested within larger global expansions. In fact, the expansion that initiates motion in each piece both foreshadows and grows into the entire composition. The replicated shape in the “Benedictus” is a linear ascent rather than a pitch shape expansion. However, the

opening statement of the principle motive also serves as an initial impulse from which linear ascents at more global structural levels are generated.

Another common feature of all three works is that they seem to have been conceived with very careful consideration to pitch shape placement within the registral framework of the piece. In *Continuum*, the initiating dyad of the middle section is situated exactly in the middle of the piece's range. Additionally, the final sonority of the expansion that occurs across the first four sections articulates the lowest note of the piece while the final sonority of the last section articulates the highest note.

In the "Benedictus," registral centering takes place with respect to both local and global ranges with the most significant registral centering coinciding with the temporal midpoint of the work. Another important feature of the "Benedictus" is the crafting of three ranges of equal size for each section placed progressively higher in register. The simultaneous sounding of the outer boundaries of these local ranges acts like a signal for a motion to the next, higher register.

While the bagatelle does not contain notable instances of registral *centering*, it does exhibit careful registral *balancing* with respect to the central pitch axis. The median pitch trajectory graphs for sections A and B show an overall motion within each section from -4 to -1.5 and +4 to +1.5 respectively. Both sections contain equivalent spatial motion toward the central pitch axis from both above and below the axis. Also, as mentioned above, the highpoint in the cadenza is exactly balanced by the subsequent introduction of the octave doubling in the bass line at the opening of the final section. Finally, the median trajectory shows that the opening and closing sonorities of the piece

exhibit the same kind of registral balancing described above in the A and B sections. The opening is positioned at -4 while the close is positioned at 4.5.

Most of the research that engages with registral space relies on measurements, whether of contour or of interval, taken only with reference to the pitch shape itself. Since my new method quantifies all positive and negative space within a composition's range, it reveals not only how the pitch shape develops, but also how it moves within the work's registral framework. These analyses demonstrate that this perspective is helpful in understanding the design of a composition.

A third common feature I have discovered is the importance of negative space to the structures of these compositions. The concept of negative space in music carries with it some difficulties because it refers to what we are *not* hearing. If the composer does not specifically draw our attention to the negative space, we may not be aware of the absence of sound in a particular register. Each of these pieces uses different compositional means to draw attention to the negative space that is so significant to its spatial design.

In *Continuum*, the expansion over the first four sections gradually reveals to the listener a wide range of pitches. When the sound in this register disappears and is replaced by a cluster in a newly activated higher register, the listener becomes aware of the missing lower and middle register as well as the high cluster of the final section. Thus the lower negative space in the final section is held as an object in consciousness

I have shown how the formation of inner negative space in the "Benedictus" becomes a primary means of creating musical energy in the piece – an energy which finds release through the transition of musical activity to a new and higher register. The use of unison at the opening of each section establishes the unison sonority as a stable

sonority within the context of this piece, thus expansions away from the unison become marked for awareness. Additionally, the use of smaller expansions leading to a single larger expansion also help to create a feeling in increasing musical energy.

The importance of contiguous negative space to the articulation of form in the bagatelle has already been discussed at length. I believe the unusual voicing of harmonies in the opening A section draws the listener's attention to the inner negative space in the piece. The close spacing of the two lower voices in the low range, as well as their increasing registral separation from the soprano line create what would have been an unusual sonority around the time of the composition. While negative space is important in all three compositions, it serves different functions for each and is highlighted in different ways.

Above, I have listed three ways registral space is used to create meaningful structures in these three compositions. As in these pieces, self-similar structures, balancing of pitch shape within a piece's registral framework, and negative space could be significant aspects of structure in a great deal of music. Another similarity, however, exists among these pieces that is probably somewhat unusual: the overall spatial motion of each piece is a registral ascent.

As I have already discussed, ascents in pitch tend to be associated with increases in musical energy and dissipation of that energy is achieved through a consequent descent in pitch. Typically there must be some dissipation of musical energy for a composition to adequately draw to a close. The ascent at the end of each piece creates an interesting challenge for the composer because it affects the overall spatial balance and does not assist in the creation of closure in the work. As we have seen, each composer addresses

the problem differently - in a manner and to a degree that is influenced by the musical style of the piece.

From the above discussion, we can see that, not only can registral space be an important element in many types of music, but, because this method for analyzing registral space is not style-specific, it also allows for interesting comparisons of spatial motion among works written in different eras and perhaps even different cultures. This project also raises a number of questions for future research. The pieces analyzed were written for either one instrument or for voice. Analyzing chamber and orchestral music with this method would provide an interesting challenge, as the number of parts playing together typically would generate a texture with more positive space. It would also be fascinating to apply this method to the analysis of non-western music as norms concerning register vary across cultures. From this study, it is clear that spatial motion is an important aspect of our experience of music. My method provides a formal system for its analysis that views registral space in a new and meaningful way, revealing aspects of musical structure that might otherwise remain hidden.

BIBLIOGRAPHY

- Aluas, Luminata. "Visible and Audible Structures: Spatio-Temporal Compromise in Ligeti's 'Magyar Etüdok.'" *Tempo*, New Series, No. 183 (Dec., 1992): 7-17.
- Bernard, Jonathan W. "The Correspondence between Color and Sound Structure in His Music." *Music Perception: An Interdisciplinary Journal*, Vol. 4, No. 1 (Fall, 1986): 41-68.
- Bernard, Jonathan W. "Inaudible Structures, Audible Music: Ligeti's Problem, and His Solution." *Music Analysis*, Vol. 6, No. 3 (October, 1987): 207-236.
- Bernard, Jonathan W. "Ligeti's Restoration of Interval and Its Significance for His Later Works." *Music Theory Spectrum*, Vol. 21, No.1 (Spring, 1999): 1-31.
- Bernard, Jonathan W. "Messiaen's Synaesthesia: The Correspondence between Color and Sound Structure in His Music." *Music Perception: An Interdisciplinary Journal*, Vol. 4, No. 1 (Fall, 1986): 41-68.
- Bernard, Jonathan W. "Pitch/Register in the Music of Edgard Varèse." *Music Theory Spectrum*, Vol. 3 (Spring, 1981): 1-25.
- Bernard, Jonathan W. "Space and Symmetry in Bartók." *Journal of Music Theory*, Vol. 30, No. 2 (Autumn, 1986): 185-201.
- Bernard, Jonathan W. "Spatial Sets in Recent Music of Elliott Carter." *Music Analysis*, Vol. 2, No. 1 (March, 1983): 5-34.
- Bernard, Jonathan W. "Voice Leading as a Spatial Function in the Music of Ligeti." *Music Analysis*, Vol. 13, No. 2/3, Twentieth-Century Music Double Issue (July-October, 1994): 227-253.
- Bernard, Jonathan W. "Zones of Impingement: Two Movements from Bartók's 'Music for Strings, Percussion, and Celesta.'" *Music Theory Spectrum*, Vol. 25, No 1 (Spring, 2003): 3-34.
- Blackburn, Bonnie J. "Masses Based on Popular Songs and Somization Syllables." In *The Josquin Companion*, ed. Richard Sherr, 51-87. Oxford: Oxford University Press, 2000.
- Bonds, Mark Evan. "The Spatial Representation of Musical Form." *The Journal of Musicology*, Vol. 27, No. 3 (Summer, 2010): 265-303.
- Brinkmann, Reinhold. "In the Time of the *Eroica*." in *Beethoven and his World*. ed. Scott Brunham and Michael P. Steinberg. Princeton: Princeton University Press, 2000.

- Brothers, Thomas. "Vestiges of the Isorhythmic Tradition in Mass and Motet, ca. 1450-1475." *Journal of the American Musicological Society*, Vol. 4, no. 1 (Spring 1991): 1-56.
- Cambouropoulos, Emilios and Costas Tsougras. "Auditory Streams in Ligeti's *Continuum*: A Theoretical and Perceptual Study," *Proceedings of the Fourth Conference on Interdisciplinary Musicology (CIM08)* Thessaloniki, Greece, July, 2008.
- Clendinning, Jane Piper. "The Pattern-Meccanico Compositions of György Ligeti." *Perspectives of New Music*, Vol. 31, No. 1 (Spring, 1993): 192-234.
- Cogan, Robert and Pozzi Escot. *Sonic Design: The Nature of Sound and Music*. Englewood Cliffs, NJ: Prentice-Hall, Inc. 1984.
- Cone, Edward. "Beethoven's Experiments in Composition: The Late Bagatelles." in *Music: A View from Delft*. Chicago: The University of Chicago Press, 1989.
- Cooper, Barry. "A Creation in Three Phases: The Late Bagatelles." in *Beethoven and the Creative Process*. Oxford: Clarendon Press, 1990.
- Cooper, Barry. "Beethoven's Portfolio of Bagatelles." *Journal of the Royal Musical Association*, Vol. 112, No. 2 (1986-1987): 208-228.
- Deutsch, Diana and Richard C. Boulanger. "Octave Equivalence and the Immediate Recall of Pitch Sequences." *Music Perception*, Vol. 2, No. 1 (Fall 1984): 40-51.
- Deutsch, Diana. "Octave Generalization and Tune Recognition." *Perception and Psychophysics*, Vol. 11, 411-412.
- Eitan, Zohar. *Highpoints: A Study of Melodic Peaks*. Philadelphia: University of Pennsylvania Press, 1997.
- Fallows, David. *Josquin*. Turnhout: Brepols Publishers, 2009.
- Fallows, David. "L'homme armé." *Oxford Music Online* (accessed June 13, 2010).
- Fitch, Fabrice. "Hearing John Browne's Motets: Registral Space in the Music of the Eton Choirbook." *Early Music*, Vol. 36, No. 1 (Feb. 2008): 19-40.
- Hicks, Michael. "Interval and Form in Ligeti's *Continuum* and *Coulée*." *Perspectives of New Music*, Vol. 31, No. 1 (1993): 172-190.
- Johnson, Mark L. and Larson, Steve. "Something in the Way She Moves" – Metaphors of Musical Motion." *Metaphor and Symbol*, Vol. 18, No. 2: 63-84.

- Lakoff, George and Mark Johnson. *Metaphors We Live By*. Chicago: The University of Chicago Press. 1980.
- Lehrdal, Fred. "Tonal Pitch Space." *Music Perception: An Interdisciplinary Journal*, Vol. 5, No. 3. (Spring, 1988) 315-349.
- Long, Michael. "Symbol and Ritual in Josquin's 'Missa Di Dadi.'" *Journal of the American Musicological Society*, Vol. 42, No. 1 (Spring, 1989), 1-22.
- Lyle, Jean Alberts. *The Integration of Thematic Design and Tonal Structure in Josquin's Two Masses on 'L'homme armé.'* Thesis, University of North Carolina at Chapel Hill, 1980.
- Marvin, Elizabeth West and Paul A. Laprade. "Relating Musical Contours: Extensions of a Theory for Contour." *Journal of Music Theory*, Vol. 31, No. 2 (Autumn, 1987): 225-267.
- McDermott, Vincent. "A Conceptual Musical Space." *Journal of Aesthetics and Art Criticism*, Vol. 30, No. 4 (1972): 489-494.
- Morgan, Robert P. "The Concept of Unity and Musical Analysis." *Music Analysis*, Vol. 22, No. 1/2 (March-July, 2003): 7-50.
- Morgan, Robert P. "Musical Time/Musical Space." *Critical Inquiry*, Vol 6, No. 3 (Spring, 1980): 527-538.
- Morgan, Robert P. "Symmetrical Form and Common-Practice Tonality." *Music Theory Spectrum*, Vol. 20, No.1 (Spring, 1998): 1-4.
- Morris, Robert D. "New Directions in the Theory and Analysis of Musical Contour." *Music Theory Spectrum*, Vol. 15, No. 2 (Autumn, 1993): 205-228.
- Perkins, Leeman L. "Mode and Structure in the Masses of Josquin." *Journal of the American Musicological Society*, Vol. 26, no. 2 (Summer 1973): 189-239.
- Polansky, Larry and Richard Bassein. "Possible and Impossible Melody: Some Formal Aspects of Contour." *Journal of Music Theory*, Vol. 36, No. 2 (Autumn, 1992): 259-284.
- Reiprich, Bruce. "Transformation of Coloration and Density in György Ligeti's Lontano." *Perspectives of New Music*, Vol. 16, No. 2 (Spring-Summer, 1978): 167-180.

- Reynolds, Christopher. "Musical Evidence of Compositional Planning in the Renaissance: Josquin's "Plus nulz regretz." *Journal of the American Musicological Society*, Vol. 40, No. 1 (Spring, 1987): 53-81.
- Richart, Robert W. *György Ligeti: A Bio-Bibliography*. New York: Greenwood Press, 1990.
- Rochberg, George. "The Concepts of Musical Time and Space." , 78-136, In *The Aesthetics of Survival: A Composer's View of Twentieth-Century Music*. Ann Arbor: The University of Michigan Press, 1988.
- Rochberg, George. "The New Image of Music." *Perspectives of New Music*, Vol. 2, No. 1 (Autumn-Winter, 1963): 1-10.
- Rodin, Jesse. "Finishing Josquin's 'Unfinished' Mass: A Case of Stylistic Imitation in the 'Cappella Sistina.'" *The Journal of Musicology*, Vol. 22, no. 3 (Summer 2005): 412-453.
- Rodin, Jesse. "'When in Rome...': What Josquin Learned in the Sistine Chapel." *Journal of the American Musicological Society*, Vol. 61, no. 2 (Summer, 2008): 307-372.
- Roig-Francoli, Miguel A. "Harmonic and Formal Processes in Ligeti's Net-Structure Compositions." *Music Theory Spectrum*, Vol. 17, No. 2 (Autumn, 1995): 242-267.
- Rosen, Charles. *The Classical Style: Haydn, Mozart, Beethoven*. New York: W.W. Norton & Company, 1972.
- Rosen, Charles. *Sonata Forms*. New York: W.W. Norton & Company, 1988.
- Sawyer, F.H. "The Use and Treatment of Canto Fermo by the Netherlands School of the Fifteenth Century." *Proceedings of the Musical Association*, 63rd session (1936-1937): 97-116.
- Shepard, Roger N. "Geometrical Approximations to the Structure of Musical Pitch." *Psychological Review*, Vol 89, No. 4 (July 1982): 305-333.
- Solomon, Maynard. *Beethoven*. New York: Schirmer Trade Books, 1990.
- Steinitz, Richard. *György Ligeti: Music of the Imagination*. Boston: Northeastern University Press, 2003.
- Strunk, Oliver, ed. *Source Readings in Music History*. New York: W.W. Norton & Company, 1998.

Trochimczyk, Maja. "From Circles to Nets: On the Signification of Spatial Sound Imagery in New Music." *Computer Music Journal*, Vol. 25, No. 4 (Winter, 2001): 39-56.

Varèse Edgard. "The Liberation of Sound." In *Contemporary Composers on Contemporary Music*, eds. Elliott Schwartz and Barney Childs, 195-208. New York: Da Capo Press, 1998.