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Geometric pitch structure and form in "Deserts" by Edgard Varese.

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GEOMETRIC PITCH STRUCTURE AND FORM IN *DÉSERTS* BY EDGARD VARÈSE

By

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A Thesis Approved on

April 23, 2004

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DEDICATION

This thesis is dedicated to my wife

Carol Wilson Sprowles

and my two sons

Dennis Earl Sprowles, II

and

Aaron David Sprowles

without whose understanding and patience
this project would not have been possible.

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ABSTRACT

GEOMETRIC PITCH STRUCTURE AND FORM

IN *DÉSERTS* BY EDGARD VARÈSE

Michael David Sprowles

April 21, 2004

Edgard Varèse began composing *Déserts* in 1949 and completed it late in 1954. Scored for fifteen instruments, five percussionists and two tapes of organized sounds, *Déserts* comprises acoustic instrumental music and sections of electronically-organized sounds on magnetic tape meant to be inserted at three specific locations within the piece. The alternating sections create a continuous, seven-part form.

For a piece of music that is viewed by many as one of Varèse's greatest works, scholarly writing on *Déserts* has been sparse compared to studies of works by other prominent composers of the same time. Since Varèse's death in 1961 there have been only a handful of detailed analyses published. Previous analysts like Andrew Blyth and Malcolm MacDonald have referred to the instrumental portion of this work as a four-part structure, which is delineated formally by the insertion points Varèse selected for the interpolations of taped sounds.

This analysis will concentrate on the geometric constructs at work in *Déserts*. Initially, an analysis of the pitch structure will reveal distinct planes of sound comprised

of adjacent pitches. A consideration of these geometric planes based on trichords identified early in the work provide insight into Varèse's concept of "music as spatial – as bodies of intelligent sounds moving freely in space,"[1] since the elements of tension and release manifest themselves in figures as they collide (tension) and are repelled (release). Consequently, the collision and repulsion of pitch-planes together with the changing of the shapes (construction of new pitch planes) provide clear formal indicators in the instrumental portion of the work and reveal the acoustic portions of the work as a two-part structure.

[1] Edgard Varèse, "Spatial Music," in *Contemporary Composers on Contemporary Music,* ed. Elliott Schwartz and Barney Childs (New York: Da Capo Press, 1998), 204.

TABLE OF CONTENTS

PAGE

GEOMETRIC PITCH STRUCTURE AND FORM IN *DÉSERTS* BY EDGARD VARÈSE

INTRODUCTION

Edgard Varèse spent his creative life searching for new means of musical expression. He pursued rising technology in sound production through electronic instruments and recording techniques. He explored aspects of timbre in acoustic instruments, particularly in the area of percussion. More significantly, he came to think of music as "spatial – as bodies of intelligent sounds moving freely in space"[2] and formulated a new vision of musical form. In his concept, form is a result of the expansion of basic internal ideas over time, rather than a guide or framework within which to compose music.[3] No other composition in Varèse's oeuvre captures the last two of these innovations – spatial music and form as result – more effectively than *Déserts.* His pitch structure consists of geometric pitch-planes that change by shifting and rotating throughout the work, representing spatial constructs through sound. The planes collide and retreat, providing climax and repose. It is through the analysis of the collision and repulsion of these geometric pitch-planes that a form becomes evident in the instrumental portion: a two-part structure delineated by the transformation, collision and repulsion of the pitch planes.

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[2] Edgard Varèse, "Spatial Music," in *Contemporary Composers on Contemporary Music,* ed. Elliott Schwartz and Barney Childs (New York: Da Capo Press, 1998), 204.

[3] Edgard Varèse, "The Liberation of Sound," in *Perspectives on American Composers,* ed. Elliott Schwartz and Barney Childs (New York: W.W. Norton, 1971), 30.

Beginning in 1905 with an interest in the siren, Varèse explored new sounds in the acoustical medium, especially concentrating on percussion instruments, which he brought to the forefront of the musical texture rather than retaining them in their traditional roles of providing metrical or dynamic emphasis. Varèse's compositions in the 1920s, *Offrandes, Hyperprism,* and *Intégrales,* demonstrate a growing emphasis on the role of percussion. His only works for full orchestra, *Ameriques* and *Arcana* also from the 1920s, feature large percussion sections uncharacteristic of orchestral compositions of that time. These earlier works contain innovations in rhythm and musical time that culminated in the 1933 work scored entirely for percussion, *Ionisation.*

Not all of Varèse's works from the 1920s emphasize percussion. *Octandre* was premiered in 1924 and features seven wind instruments and a contrabass. Greatly influenced by the crystallography work of Nathaniel Arbiter, Varèse began to view musical form much like the process of crystallization where the internal structure, based on the smallest unit – the atom – extends into space, forming the defined crystal.[4] Varèse relates this scientific process to musical form in the following:

> There is an idea, the basis of an internal structure, expanded and split into different shapes or groups of sound constantly changing in shape, direction and speed, attracted and repulsed by various forces. The form of the work is the consequence of this interaction. Possible musical forms are as limitless as the exterior forms of crystals.[5]

In *Octandre,* this concept begins to materialize in the opening motive played by the oboe.

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[4] Varèse, "Rhythm, Form and Content," in *Contemporary Composers on Contemporary Music,* ed. Elliott Schwartz and Barney Childs (New York: Da Capo Press, 1998), 203.

[5] Ibid., 203.

A three-note figure comprised of two half-steps – the smallest interval commonly accepted at that time – represents the atom or the internal structure of the crystal form.[6] Varèse expands and transforms this figure throughout the brief three movements until coming to rest at the end on the three notes of the opening, now inverted and transposed up a tritone, transforming the internal structure of the crystal in the process.

In 1934, the composition *Ecuatorial* for brass, percussion and keyboard instruments (piano and organ) included two *Ondes Martenot*[7] and represents Varèse's first step toward combining acoustic and electronic instruments. Through relationships with electronic music pioneers Maurice Martenot and Leon Theremin, Varèse sought new instruments that did not simply generate noise but made it possible for a composer to designate specific pitches outside of the tempered scale in a continuous range.[8] Applications for grants to finance further research into electronic instruments in the 1920s and 1930s failed, and Varèse could not successfully pursue developing these

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[6] Jonathan Bernard's 1987 analysis refers to the opening as the micro-structure. See Jonathan Bernard, *The Music of Edgard Varese* (New Haven: Yale University Press, 1987), 98-9.

[7] Joel Chadabe, *Electric Sound: The Past and Promise of Electronic Music* (Upper Saddle River, New Jersey: Prentice Hall, 1997), 12. Chadabe describes the Ondes Martenot as being played using both hands. With the right hand "inserting a finger in a ring and pulling a ribbon left or right causing pitches to change correspondingly lower or higher." The left hand varies loudness and timbre by "manipulating various controls." Later Martenot added a keyboard that could be used independently or with the ribbon mechanism and a lever under the main instrument controlled by the right knee for "continuous timbral changes."

[8] Edgard Varèse, "The Electronic Medium," in *Contemporary Composers on Contemporary Music,* ed. Benjamin Boretz and Barney Childs (New York: W. W. Norton and Company, Inc., 1998), 207.

instruments further until the end of World War II when improved technology inspired a resurgence of interest in electronic music.[9]

In *Déserts* Varèse offers his greatest musical expression in all of the areas mentioned – timbre, electronics and form. The innovation in timbre is obvious in the alternating of acoustic music with electronic sections. The significance of *Déserts* lies in the new pitch structure Varèse employs and the effect of geometric figurations on the resulting form.

Existing Scholarship

Musicological studies

A thorough introduction to Varèse and his music can be found in a series of articles written by Varèse's associate Chou Wen-chung. For many years Chou studied with Varèse and is responsible for new editions of Varèse's work including the finished score of *Déserts*. Chou's article following Varèse's death in 1965 entitled "Varèse: December 22, 1883-November 6, 1965"[10] provides background on Varèse's life and compositional development. An article by Chou published in 1967 "Open Rather Than Bounded"[11] explains Varèse's views on musical space and sound masses. "A Varèse

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[9] Robert Morgan, *Twentieth-Century Music: A History of Musical Style in Modern Europe and America* (New York: W.W. Norton & Company, 1991), 307.

[10] Chou Wen-chung, "Varèse: December 22, 1883-November 6, 1965," *Current Musicology* 1, no. 2 (1965): 169-74.

[11] Chou Wen-chung, "Open Rather Than Bounded," *Perspectives of New Music* 5, no. 1 (1967): 1-6.

Chronology"[12] appears immediately afterward in the same volume and gives a timeline of important stages and events throughout Varèse's life. In 1966, Chou published "Varèse: A Sketch of the Man and His Music"[13] which yields important biographical information as well as analytical sections on *Intégrales* and *Déserts.*

More recently, an article by John D. Anderson explains scientific connections between physics and Varèse's musical aesthetics. His article "Varèse and the Lyricism of the New Physics"[14] refers to Varèse's concepts of spatial projection and sound masses, proposing scientific innovations of early twentieth-century physics – specifically the theory of relativity, x-rays, sub-atomic particles and quantum theory – that not only functioned as influences in Varèse's thought but also manifest themselves in his music.

"Varèse's Multimedia Conception of *Déserts*"[15] by Olivia Mattis provides an historical account of *Déserts* and, in particular, the unrealized visual portion of the work that Varèse had in mind at its inception. This part of *Déserts* never came to fruition and lingered as a point of frustration for the composer.

Analyses of *Déserts*

Previous analytical studies of *Déserts* have focused on the sections of acoustical music. In the analytical portions of his article, "Varèse: A Sketch of the Man and His

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[12] Chou Wen-chung, "A Varèse Chronology," *Perspectives of New Music* 5, no. 1 (1967): 7-10.

[13] Chou, Wen-chung, "Varèse: A Sketch of the Man and His Music," *The Musical Quarterly* 52, no. 2 (1966): 151-70.

[14] John D. Anderson, "Varèse and the Lyricism of the New Physics," *The Musical Quarterly* 75, no. 1 (1991): 31-49.

[15] Olivia Mattis, "Varèse's Multimedia Conception of Déserts," *Musical Quarterly* 76, no. 4 (1992): 557-83.

Music," Chou Wen-chung compares parts of *Intégrales* and *Déserts* demonstrating Varèse's technique of creating "layers of sound-masses."[16] Through transmutation of certain elements within the sound-masses, Varèse creates a continuously expanding musical organism.

Arnold Whitall's brief analysis from 1967 refers to a "process of clarification"[17] in which Varèse uses fewer materials as the piece progresses. In this article Whitall attempts to establish the idea that *Déserts* lacks any thematic or motivic elements and that it holds together through a series of clusters surrounding certain key pitches. Whitall looks to the longest pitches in the work to delineate form. Although incomplete by Whitall's own admission,[18] this analysis raised valid claims that fueled more detailed future analyses.

Jonathan Bernard, in his 1981 article "Pitch/Register in the Music of Edgard Varèse,"[19] treats the two elements of pitch and register in Varèse's compositional technique. Bernard cites only seven examples from *Déserts* to illustrate these elements. He constructs two graphic representations from the examples of small sections of the piece, specifically mm. 63-65 and mm. 1-22, and does not provide a detailed analysis of

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[16] Chou Wen-chung, "Varèse: A Sketch of the Man and His Music," 158.

[17] Arnold Whitall, "Varèse and Organic Thematicism," *The Music Review* 28 (1967): 311.

[18] Ibid., 315.

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

the entire work. In his 1987 book *The Music of Edgard Varèse,*[20] Bernard limits his comments to brief sections of *Déserts* and the use of percussion and the elements of rhythm and duration.

The most detailed analysis of *Déserts* to date appears in Andrew Blyth's 1986 article, "Pitch Structure and Process in Edgard Varèse's *Déserts.*"[21] Using set theory analysis, Blyth explains features that represent pitch groups in two categories: groups that form the continuation of a structure or process and those that are independent of any structure or process. These two elements work together to form a "continuing process of interaction and cumulative change."[22] This analysis also presents the only formal diagram of the complete acoustic sections.

Scope of this Study

The first chapter explains the concept of a geometric pitch-plane and how Varèse constructs them in *Déserts.* A pitch-analysis of the instrumental portion demonstrates how the pitch planes retain their integrity while seeming to rotate freely in musical space. Further analysis demonstrates their transformation and how the collision and repulsion of these planes create moments of climax and repose. Chapter 2 provides an analysis of the formal implications of the pitch planes in *Déserts.* An investigation of previous analyses reveals a limited understanding of the form as a four-part structure, articulated by the insertion points of the three interpolations. When the acoustic instrumental portion of

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[20] Jonathan W. Bernard, *The Music of Edgard Varèse* (New Haven: Yale University Press, 1987).

[21] Andrew Blyth, "Pitch Structure and Process in Edgard Varèse's Déserts," *Studies in Music* 20 (1986): 62-90.

[22] Blyth, "Pitch Structure and Process in Edgard Varèse's *Déserts*," 72.

Déserts is isolated as the single-movement work Varèse originally composed, and is analyzed using the pitch-planes, a two-part structure becomes evident that is not dependent on the presence or locations of the interpolations.

Chapter 3 presents the conclusions drawn from the pitch-plane and formal analysis substantiating the evaluation that Varèse's use of pitch-planes in *Déserts* (discussed in Chapter 1) demonstrates clearly his concept of spatial music, that of geometric shapes represented in sound, rotating and interacting with each other. Through their interactions, those of collision and repulsion, geometric shapes appear that delineate form (as discussed in Chapter 2) revealing the acoustic instrumental portion of *Déserts* to be in a two-part form.

CHAPTER I

GEOMETRIC PITCH STRUCTURE

Defining Pitch-planes

The concept of pitch-planes was inspired by Varèse's own words in a speech he gave in 1936 at Mary Austin House while residing in Santa Fe, New Mexico. When speaking of new instruments he related his conception of music:

> 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 on to other planes, moving at different speeds and at different angles.[23]

Here Varèse has made it plain that he thought of music as composed of objects in space, moving freely, colliding, retreating and fading out of sight at times. The visible, or in this case, the audible, portion of the plane is subject to the listener's perspective.

Pitch-planes are created using a core sound-mass[24] and surrounding the individual pitches of the sound-mass with its chromatic, upper and lower neighbors. For example, if

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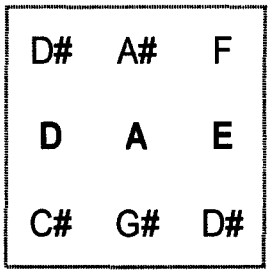
[23] Edgard Varèse, "New Instruments and New Music," in *Contemporary Composers on Contemporary Music,* ed. Benjamin Boretz and Barney Childs (New York: W. W. Norton and Company, Inc., 1998), 197.

[24] The phrase core sound-mass in this study refers to a group of specific pitches used as the basis of a pitch-plane rather than a cluster of pitches that are unspecific in shape, density and size.

one of the pitches of the core sound-mass were E, it would be surrounded by F on the upper side and D# (Eb) on the lower side. Consequently, a three-pitch core sound-mass becomes a nine-pitch plane as shown in Example 1.

Example 1: Construction of a Pitch-plane



The core sound-mass, D, A, and E, is shown in bold type. This plane can be shifted so that all, or only a few, of its pitches can be heard simulating rotation of the plane. The plane can drift in space far enough away so that none of it is audible,[25] an indication that the plane's relative position is changing as well. Furthermore, the plane's pitches may sound in a different register, indicating movement in a vertical direction. These aspects of construction and variance apply to pitch-planes with a core sound-mass comprised of up to the twelve pitches of the chromatic scale.

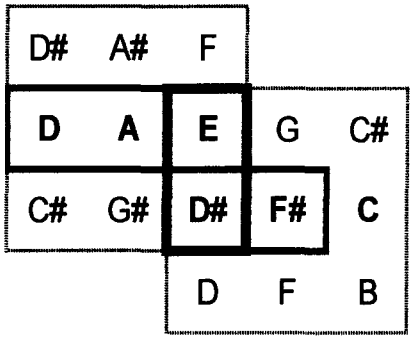
The stabilizing element for every pitch-plane is the intervallic structure of its core sound-mass. That is, if the core sound-mass consists of three pitches each separated by the interval of a third, that relationship is never altered. The audible pitches change as the plane rotates in space; however, when the entire core sound-mass is audible, it is in its original form.

[25] The terms audible and inaudible are used throughout this study to indicate that a pitch-plane is present and active or can no longer be heard yet, in its silence, the plane still exists in space and continues in motion as evidenced by the many instances of its reappearance in a changed form.

The concepts of climax and repose are consequences of multiple planes moving in space. In a defined space, freely-floating objects will certainly come into contact with each other. These contacts result in collisions and subsequent repulsions of the individual planes. Collision is obvious when common pitches between the two or more planes are audible. Common pitches can exist between the core sound-masses of the planes or the other pitches of the planes. By constructing a second pitch-plane, the concept of collision can be more easily demonstrated. Example 2 shows the construction of a second pitch-plane, based on the core sound-mass of D#, F# and C, and a collision between it and the pitch-plane constructed in earlier in Example 1.

Example 2: Construction of 2nd Plane and Collision of Two Pitch-planes

Pitch-plane 1



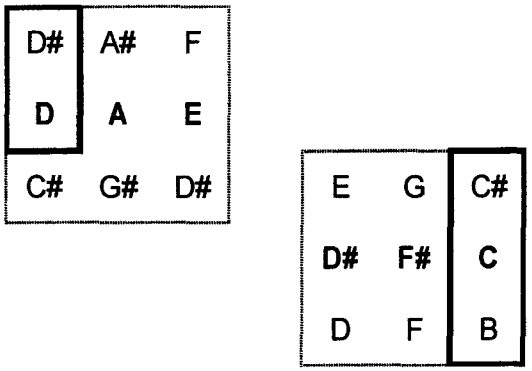
Pitch-plane 2

The light grey lines identify the individual pitch-planes and the solid lines indicate the audible portion of the respective planes, the core sound-mass of pitch-plane 1, D, A, E and the pitches E, D#, F# of pitch-plane 2. The common audible tones of E and D#, shown surrounded by bold lines, create a collision of the two pitch planes and the result is immediate repulsion. Repulsion is indicated when pitch-planes seem remote from one another, either in the number of pitches audible or in the specific pitches present. The planes rotate away from each other causing other pitches of the plane to become audible,

fewer pitches to be audible or causing the plane to completely disappear. In repulsion, no common pitches are audible between the planes. Therefore, collision and repulsion can effect the audible sonorities, density of texture and dynamics. Example 3 shows the same two pitch-planes in repulsion.

Example 3: Repulsion of Two Pitch-planes

Pitch-plane 1



Pitch-plane 2

The audible part of Pitch-plane 2, shown with the solid line, has no common pitches with the audible part of Pitch-plane 1, likewise shown with a solid line. Furthermore, the collision had a different effect on each of the two pitch-planes, since more pitches are audible in Pitch-plane 2 than in Pitch-plane 1 giving the impression that Pitch-plane 1 is further repelled than Pitch-plane 2.

Pitch-plane Construction in the Instrumental Music of *Déserts*

It is through the use of pitch-planes that Varèse's concept of "intelligent sound-masses moving freely in space"[26] becomes tangible. Throughout *Déserts* the rotation and

[26] Edgard Varèse, "Spatial Music," 204.

transformation of pitch-planes play a significant role in dynamics, density, timbre and musical form.

The focus of this section is on the pitch-planes and how they are manifest in the instrumental music of *Déserts*. The question of how the pitch-planes are indicators of form will be addressed in the next chapter.

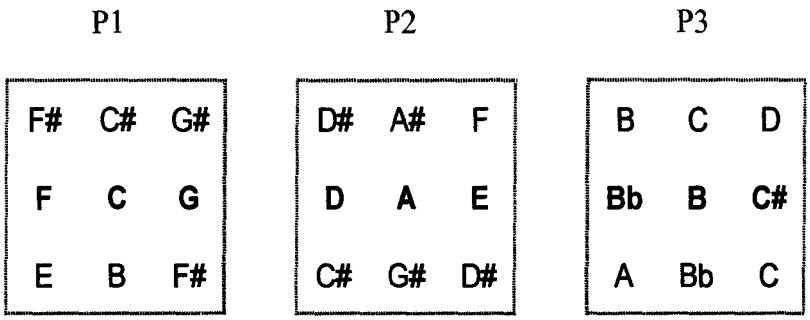
The opening six measures emphasize the interval of a 9th, specifically, the major 9th of F_4 and G_5. This initial interval represents the boundary pitches of the core sound-mass of pitch-plane 1 (P1). In m. 7 the third pitch of P1's core sound-mass C_5 sounds, forming the interval of a 5th with the first two pitches, thus completing P1. The integrity of P1's original form is maintained through m. 20.

In the last beat of m. 6 the boundary pitches, D_2 and E_3, of the core sound-mass of the second pitch-plane (P2) enter. Again, the interval of a 9th is the framework for P2 and the equal division of that interval, A_3 arriving in the horns and piano in m. 7 complete this new plane. Its existence is short-lived as it fades to inaudibility by the end of m. 13.

A new sonority arrives in m.14 in the form of a minor 9th, Bb_2 and B_3. The boundary pitches of the third core sound-mass are joined in m. 17 by the third member $C\#_4$. This introduces a new relationship, that of stacked 9ths, a major 9th on top of a minor 9th. The movement of this pitch-plane (P3) is noticed in m. 20 as the C# temporarily drops out of the texture.

By m. 21 the three core sound-masses have been established: P1 – F_4, C_5, G_5; P2 – D_2, A_3, E_3; and P3 – Bb_2, B_3, $C\#_4$. From these the three pitch-planes can be constructed. In Example 4 the three pitch planes are shown.

Example 4: Three Pitch-planes Established in mm.1-21.



The three planes share many pitches and between them and all twelve pitches of the chromatic scale are present. It is also worthy to note that the pitch-planes are all based on three-note core sound-masses totaling nine pitches placing additional emphasis on the number nine early in the piece. With the pitch-planes established, it can be shown how the individual planes rotate, advance, retreat, and, in some cases, disappear.

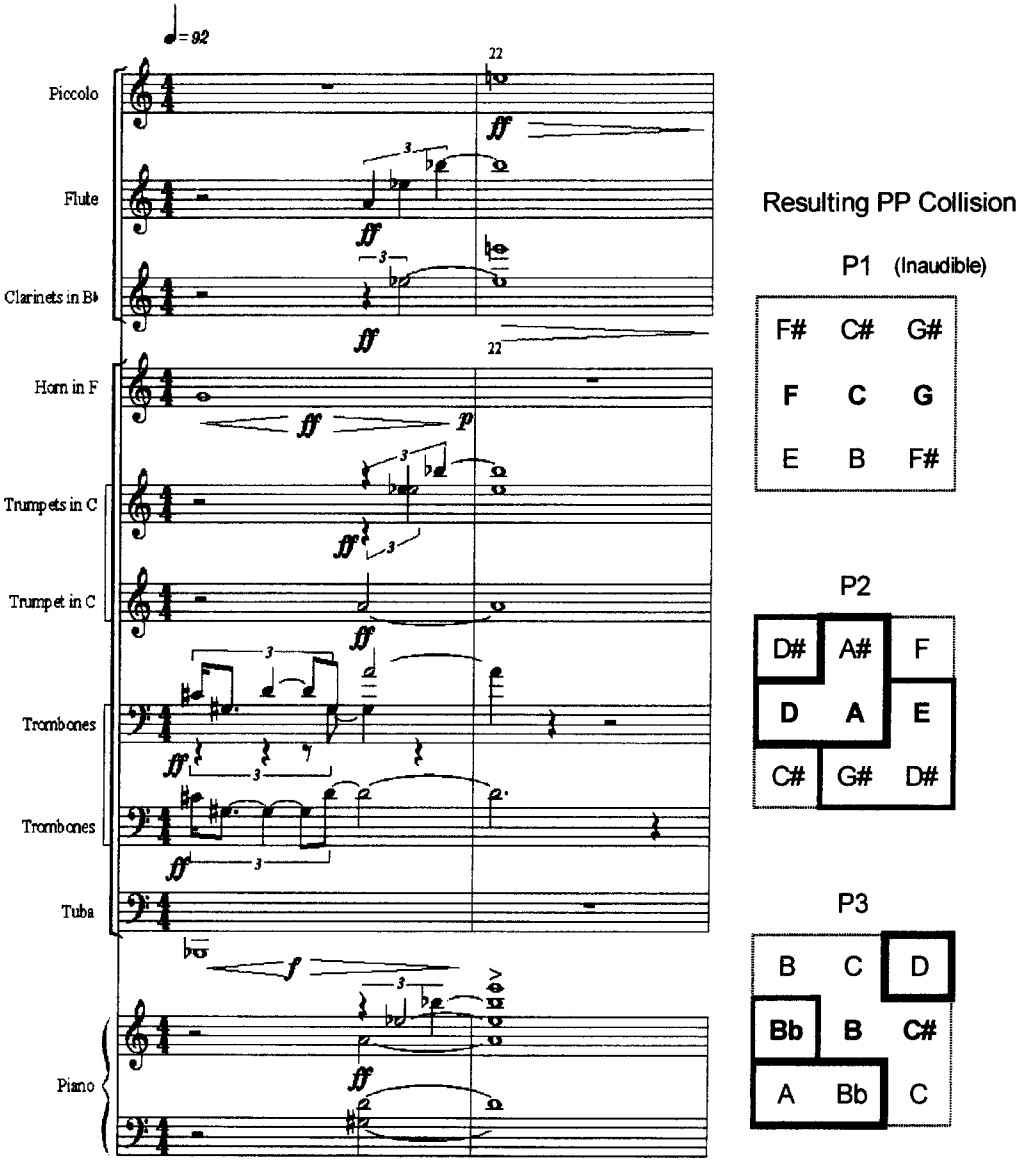
Pitch-plane Movement, Collision and Repulsion, mm. 1-117

Earlier it was noted that P2 disappeared from the texture in m. 14 shortly after its initial appearance in m. 6. This demonstrates motion on the part of P2 as it moves in and out of view. It is also worth noting that the pitches of these planes are not articulated simultaneously. From the opening P1 with only its boundary pitches sounding, all subsequent entries of the other pitch planes feature partial presentation of their pitch content. The point of attack is varied so that no sense of a steady, predictable pulse is portrayed to the listener, enhancing the shifting sensation created by the irregular chiming of the 9ths. This, coupled with the intermittent appearances of the third tone of each pitch-plane, creates a destabilizing effect on the otherwise stable 9ths.

The somewhat static environment of the first twenty measures is interrupted by the first significant transformation of the pitch-planes, resulting in a collision and

providing the first point of climax in the piece. Example 4 shows mm. 21-22 of *Déserts* and provides a diagram representing the corresponding collision of the pitch planes.[27]

Example 5: First Climax/PP Collision mm. 21-22



A sense of urgency is established in m. 21 as a new pitch, G# is introduced and motion is increased. A transforming P2, now including the two additional pitches of D# and A#

[27] Musical examples are condensed from the score and all instruments sound as written except piccolo which sounds an octave higher. Edgard Varèse, *Déserts,* (New York: Colfranc Music Publishing Corporation, 1959).

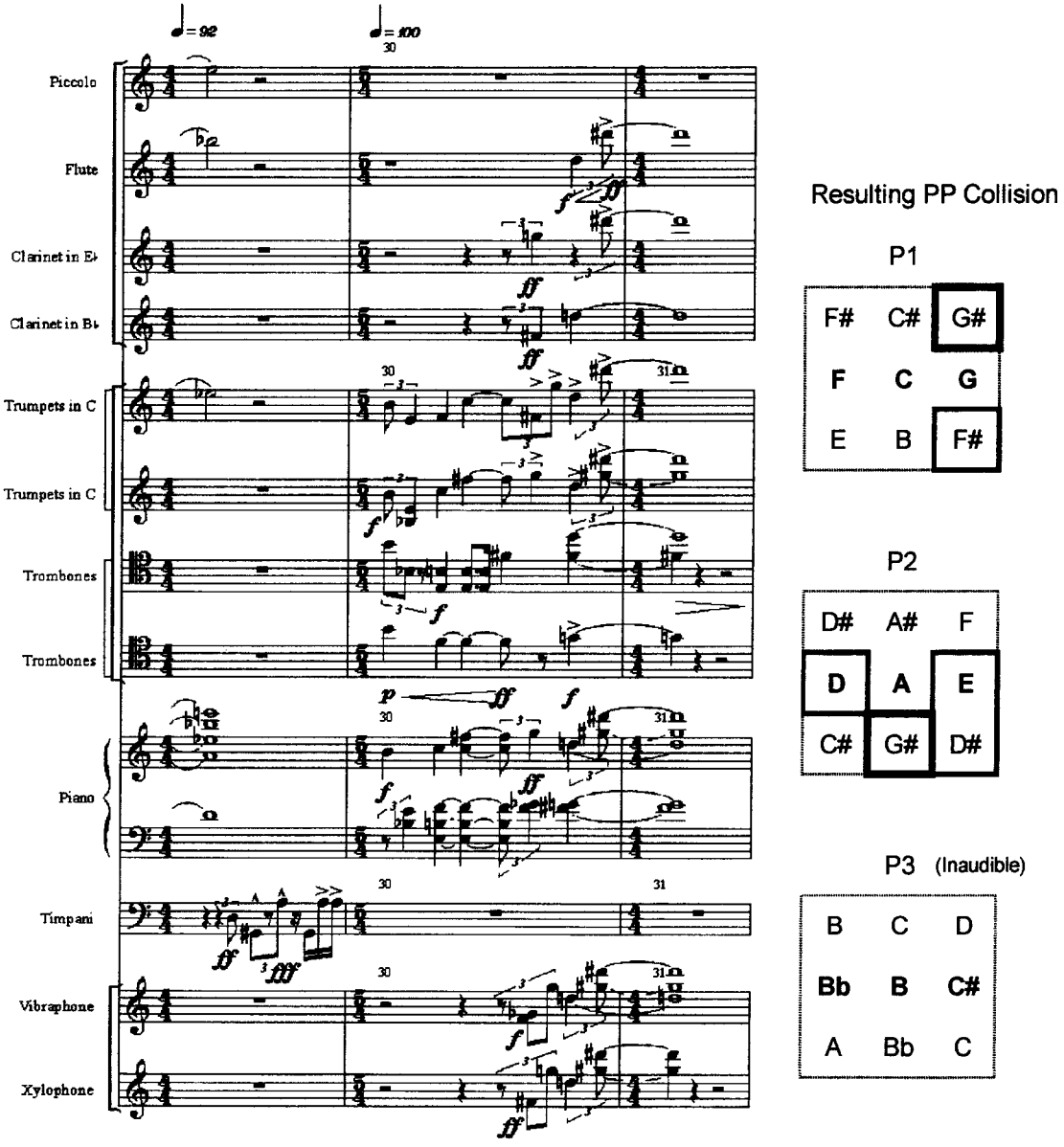
returns and collides with P3. The pitches A, A# (Bb) and D represent the point of collision between the two planes. All of the pitches involved preserve the integrity of the 9ths established in the opening measures of the piece. The boundary pitches of the two colliding planes, now E_6 in P2 and D_4 in P3 confirm the importance of the interval of a 9^{th} in the individual planes and their interactions even though they are two octaves apart. Also notable is the occurrence of doubled pitches in the two sounding planes, A# (Bb) in P3 and D# (Eb) in P2, in three voices while other pitches appear only in two voices. The fading G in the horns indicates a retreat to silence on the part of P1 and plays no role in the collision. The brief appearance of G# in m. 21 is significant, since it plays a substantial role in the next section that culminates in the second climax.

After the climax of m. 22 a thinner texture emerges. The pitches of the collision between P2 and P3 are left ringing while the planes themselves tumble away as suggested by the sharp insertions of different pitches from the two planes. The first sign of independence in the percussion section also occurs here. Until this point the percussion, principally the chimes and suspended cymbals, have assisted in the chiming progressions of the different pitch-planes. In m. 23 the timpani disturbs the quiet following the climax of m. 22, emphasizing again the importance of the G# and is followed by scatterings of percussion sounds, again devoid of pattern or pulse. P1 remains in an inaudible state throughout this section. In m. 29 the timpani violently announces the onset of the next climax, through the familiar G# and D of the first measure of transformation, m. 21.

The second climax, beginning in m. 29 and continuing through m. 31 contains greater motion and a wider dynamic range than the first. In m. 30 P1 returns sounding six of its pitches including the original core sound-mass of G, C, F. P3 has spun away

leaving only two of its pitches remaining audible, A and B. By the end of m. 30 these pitches, too, fade rendering P3 inaudible. P2 transforms, in m.30, from D and A# to D, D#, and G# in m. 31. Likewise, P1, after its reentry, rotates to reveal only three pitches, G#, F# and E. The result, caused principally by the bold reappearance of P1, and the subsequent fading of P3, is a collision between P1 and P2 in m. 31. As seen in Example 5, only a single point of collision occurs, the G# common between P1 and P2.

Example 6: Second Climax/Pitch-plane Collision mm. 29-31



In this example, as in Example 4 it is evident that once collision occurs between two pitch-planes an immediate thinning of the texture results, indicating repulsion. During the measure of transformation, m. 30, there are eleven audible pitches; however, immediately following the collision, only five remain.

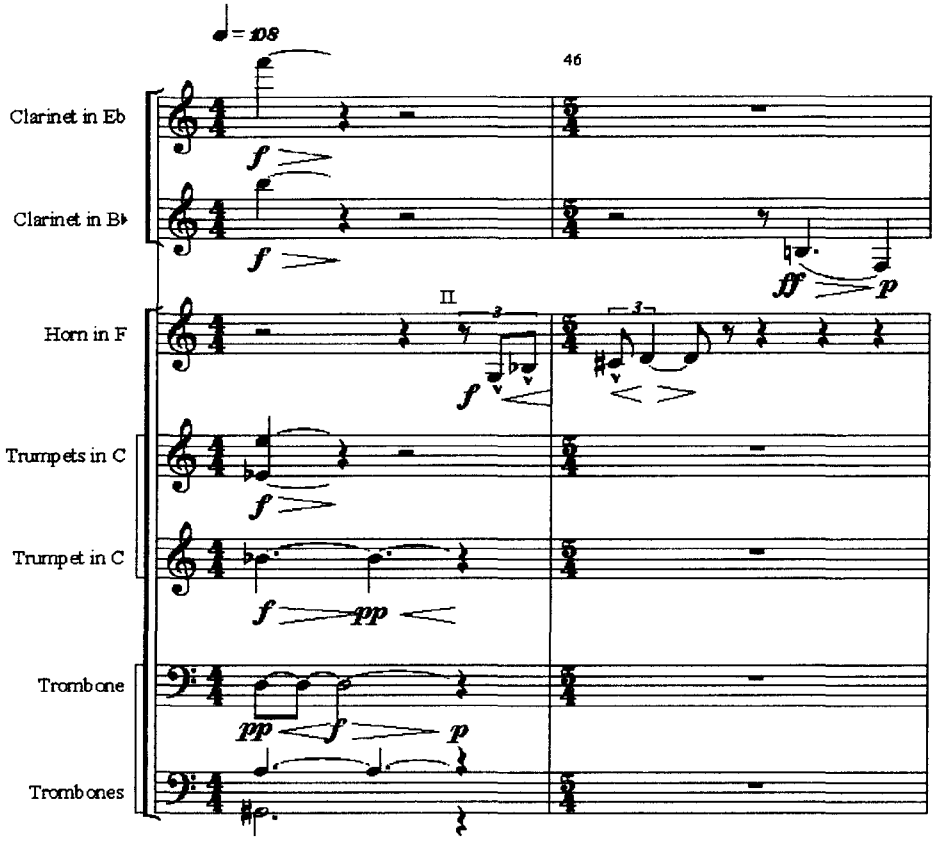
Proceeding beyond the climax at m. 31 is a continued thinning of the texture. The only pitches audible are the D and D# of P2 and the pounding C and B that announce the return of P3. P1 has faded from the texture midway through m. 32. In m.35 the timpani supplies two additional pitches in E and Bb. Their emphasis indicates a growth in the role of P2. P1 reenters at the end of m. 36 in the form of G and F#.

Just as the collision of pitch-planes has caused points of climax and subsequent repose in example 5 and 6, in m. 40 it is evident that emphasis of a single pitch-plane can provide a profound change as well. Where the disappearance of pitch-planes has demonstrated a reduction in sound in the measures following a climax, at m. 40 P1 and P3 have disappeared and exposed P2 in a violent movement to the front of the texture. This movement is accentuated by the vigorous, rhythmic figure in the piano and timpani. Immediately repulsed, P2 disappears and silence ensues until P1 reappears in m. 41 producing a pair of minor 9ths in its use of the pitches C and C#, F# and G.

The motion has slowed noticeably beginning in m.41. P1 dominates the texture from mm.41-43 with quiet disturbances of the shifting sound from a B and D of P3. The prominence of P1 fades, and in m.43 P2 returns in its original D, A, E form. P1 returns with a single audible note, F, midway through m.44. The addition of Bb to P3 and Eb (D#) to P2 prepares for the appearance of a new melodic figure in the last beat of m.45. This rising third is the result of the turning of the three audible pitch-planes so that only

four pitches can be heard between them: G of P1, D of P2 and Bb, C# of P3. Example 7 shows the emergence of these four pitches.

Example 7: Introduction of Rising Third, mm. 45-46

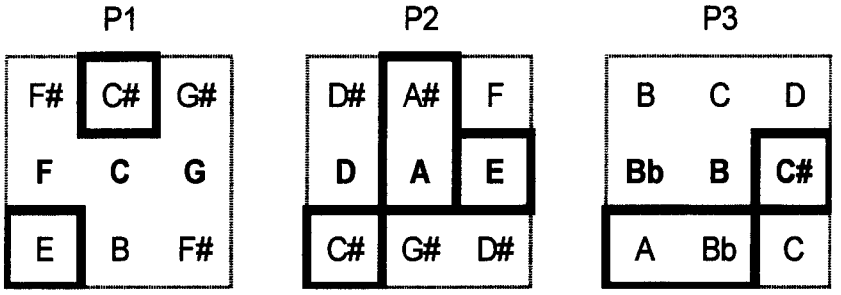


There is no collision evident, no emphasis of one pitch-plane, and therefore no climax. The movement from B to F in the last half of m. 46 lands on an F# in m.47 and is a continuous presence through m. 52. The function of this section is to prepare the pounding thirds in the timpani and tubas, P2 in mm. 48-52, which are the prevailing sonorities that lead to the next significant change in m. 54.

In m.54 the emphasis on the E octaves strikes the ear, as does the accented, chiming motion that was heard in the opening measures. As striking as it is, this is also the thinnest the texture has been since the beginning, as it comprises only four notes, E, C#, Bb and A. It is notable that these four pitches are common between the pitch-planes

in various ways. First, all four pitches are found in P2. The other pitch-planes exhibit two and three of the pitches, respectively: E, C# in P1 and C#, Bb, A in P3. This is the first instance of more than one plane colliding simultaneously. Example 8 shows this collision.

Example 8: Multiple Pitch-plane Collision



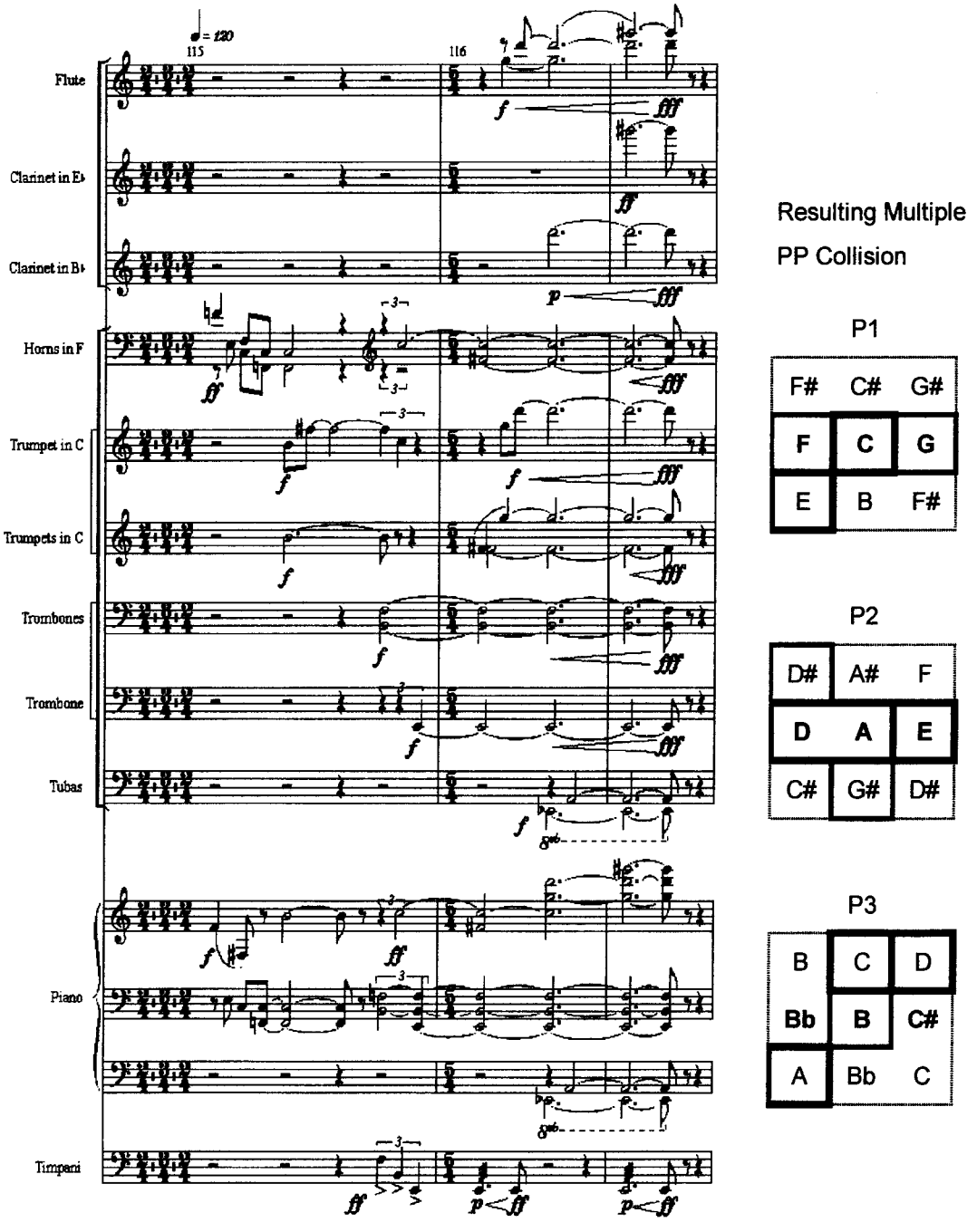
Once again the pitch-planes are identified with light grey lines, audible pitches are marked by a solid line, and the bold lines define collision points; however, all sounding pitches collide with other planes, therefore the only lines visible are bold. Points of collision occur between all three pitch-planes. It is also notable that this collision does not result in immediate repulsion and an accompanying sense of repose. To the contrary, this section from m. 54 through m. 56 features a continued interaction between the different planes. In fact, the motion increases in m. 57 with the same pitch content until repulsion begins and the individual planes begin to move independently once again in m. 59. As the pitch content changes in mm. 59-65, the reverberations of such an intense collision continue to have their effect as the sense of motion remains intact until m. 66 when the return of a thinner texture and less movement provide the expected repulsion; however, the dynamic level of mm. 67-70 suggests anything but a state of repose. Reposed is not sensed until m. 72 when the familiar D, G# of P2 in m. 23 reappears in a new register in the trumpets.

P2 and its D and G# are the central focus of rising and descending figures in mm. 75-77 and are also more subdued versions of the tumultuous rising figures in the transformational measures preceding the first two climaxes of the piece, m. 21 and m. 30. In m. 79 the emphasis on 9ths is heard as the audible pitches of the planes are F#, F, G in P1, Eb, E, G# A in P2 and C, C# in P3. In this instance the pitches of P1 and P3 sound as successive 2nds rather than 9ths while the music turns to its quietest moment in mm. 83-84 with the emergence of a solitary 9^{th}, B and C# found in P3. P1 and P2 are now inaudible. The addition of the C in m. 84 extends the existing 9^{th}, restating the intervallic structure of P3's core sound-mass, again forming a trichord comprised of stacked 9ths, this time, however featuring two minor 9ths.

In m. 85 the G#, F# of P1, the first entry is soon joined by a C from P3, and in m. 86, a D from P2. These four pitches continue to be the primary pitch content through m.92 when the G#, F# of P1 transforms into G and F in a much lower register. Likewise the C of P3 transforms into C# and the D of P2 fades out. B is added to P3 just in time for all audible planes to disappear. In the last beat of m. 93, the G#, D descending figure erupts once again in the timpani signifying eminent change. C# is added in m. 94 as the G#-D idea is transformed into a three-note, ascending 9^{th} of P2: C# to D divided by the G#. This figure has now become the focus, as a series of three-note ascending 9ths occupies mm. 94-102. They fade in dynamic intensity until m. 103 when A and Eb move to the forefront of P2 accompanied by unpitched percussion. The ascending C#, G#, D figure along with the A, Eb, (all of P2,) dominate the texture until the sudden appearance of Bb in m. 110, representing that the next step in the pattern of 9ths has been established in P2. The Bb is the sole pitch, other than the ringing C#, G#, D in the piano through m.

114 and the onset of the next pitch-plane collision. A climax that begins in m. 115, continues until m. 117. As seen in Example 9, it is by far the most dynamic collision to this point in the piece because it includes interaction between all three active pitch-planes.

Example 9: Third Climax/Pitch-plane Collision mm.115-117.



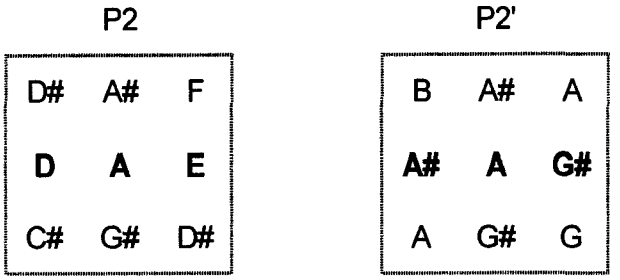
This is the first large-scale collision of all three planes. All of the ten pitches involved are common to at least two of the other planes, indicated by the bold lines surrounding the individual points of collision. Additionally, the core sound-masses of the three pitch-planes are present, with the exception of P3, whose lower and upper boundary pitches, Bb and C#, respectively, have been omitted, leaving only its central pitch, B, sounding in its original register.

The first section of this analysis covering mm. 1-117, demonstrated that pitch-planes representing geometric shapes, once established, rotate in three dimensions: side to side, front to back and up and down, causing interactions between the different planes. These interactions, defined as collision and repulsion, provide a distinct motion which propels the work toward a point of arrival. The planes move about freely in space and come into contact with each other, creating distinct climax points followed by immediate, subsequent repose. The intensity of the third climax in m. 117 supports the idea that building to a climax is a principal goal of the pitch-plane interactions.

Pitch-plane Transformation and Redefinition, mm. 118-127

It is immediately evident in m. 118 that the previous collision had decisive consequences. The pitches sounding in mm. 118-121 emphasize the interval of a 2^{nd} rather than the 9^{th} established as the focus in mm. 1-117. The opening motive in the horns immediately passed to the bass clarinet attests to this. What emerges is a verticalization of A, the central pitch of P2, and its chromatic upper and lower neighbors, Bb, and G#. This plane should not be viewed as a new plane, but rather as a transformation of P2. Example 10 shows the original P2 and its new shape P2'.

Example 10: P2 Transformed into P2'

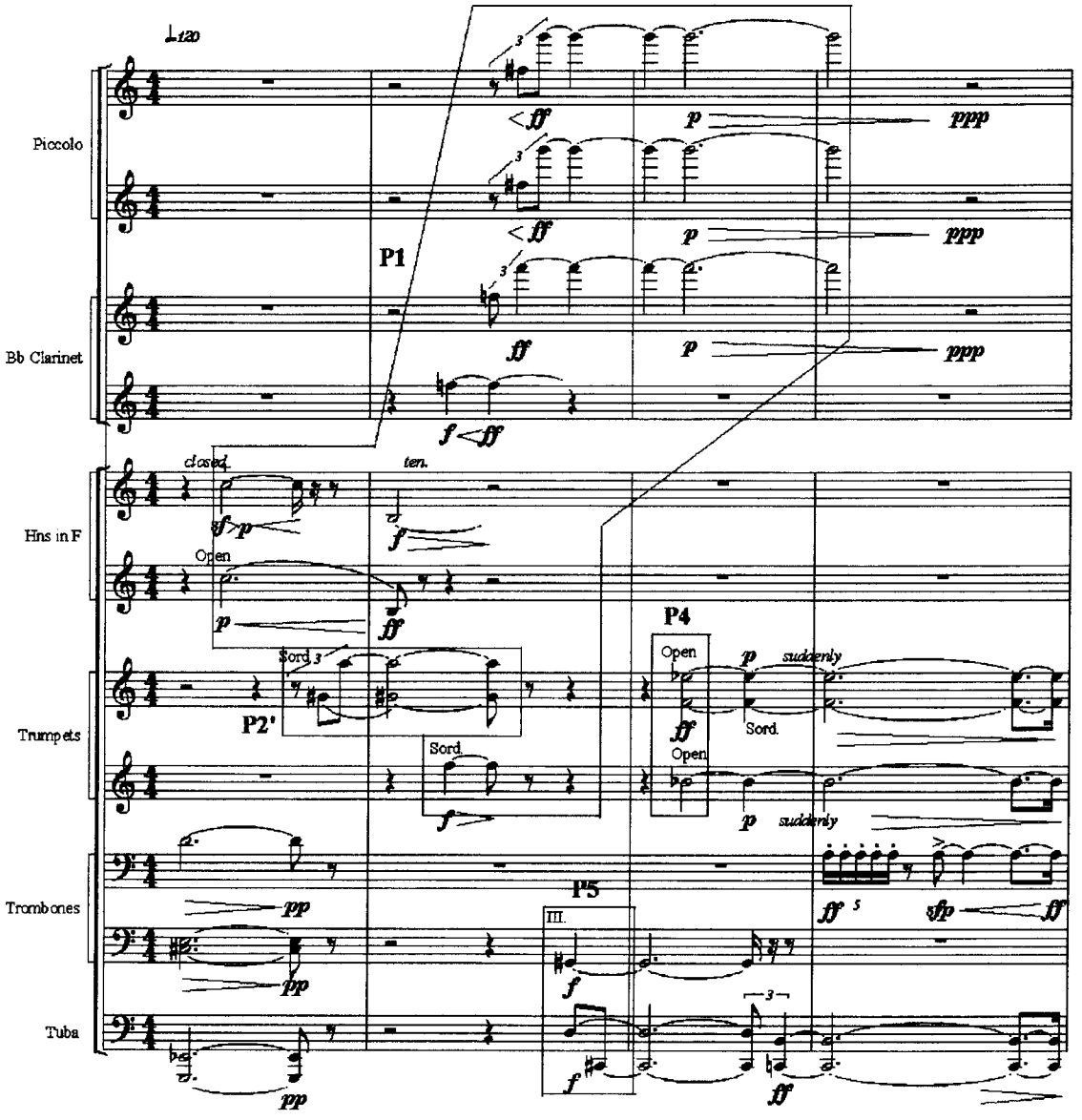


The three pitches, A#, A, and G# are found in the new pitch-plane in the horizontal axis as the core sound-mass as well as in the vertical axis around the central pitch, A. The symmetry of P2' around the pitch A is noteworthy, but so is the vastly narrowed range of the pitch-plane compared to its predecessor, P2. Whereas P2 spans an octave and a diminished 4th (C#-F), P2' spans only a major 3rd (G-B).

In m. 122 it is evident that P1 escapes from the collision unscathed since we find that the E, B, F and Gb (F#) fit into the pitch-plane. Further evidence of this exists in the ascending sequence of pitches beginning in m. 124 and culminating in the piccolos and clarinets in m.126.

The next five measures present a series of pitches that do not form a specific pitch-plane; rather, they are isolated pitches from two new pitch-planes that are the result of the dissolution of P3 and the transformation of P2. Just as was noted earlier in this analysis during the establishment of the first three pitch-planes, another period of development ensues where new pitch-planes are being defined. As shown in Example 11, it is clear that in mm.124-127 four pitch planes have been defined: P2' and P1 and two new planes P4 and P5.

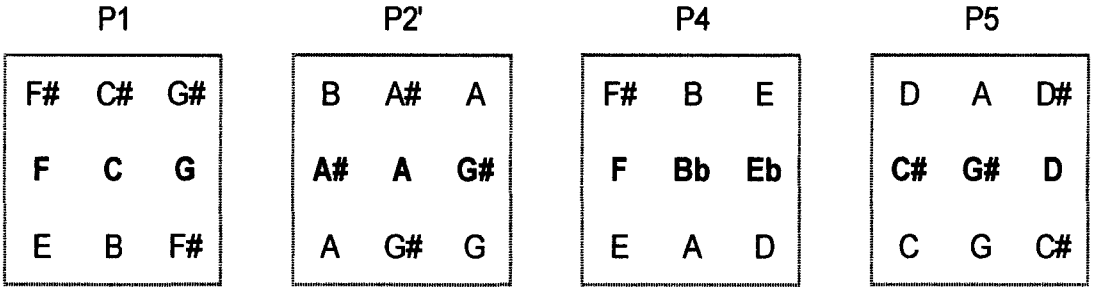
Example 11: Redefining Pitch-planes mm. 124-127



P4 is based on the core sound-mass of F, Bb, Eb. Like P2', this pitch-plane is narrower than the 9th-based planes appearing earlier in the work. Here the entire core sound-mass falls within the interval of a 7th. The central pitch of this plane is Bb which is also the central pitch of P3 when the double-pitches of P3 are considered. P5 is based on a familiar P2 motive, the G#, D, C# motive heard in the piano part just prior to the third climax in m. 117. The core sound-mass of P5, is also contained within the interval of a

7th. The quintuplet on the repeated A that emerges from the texture in m. 127 (as well as in m. 129 and m. 130) attests to the centrality of that pitch in the newly formed P2'. Example 12 shows the new configuration of interacting pitch-planes.

Example 12: New Pitch-plane Configuration, mm.118-127



The pitch A appears in all of the planes except the only remaining plane left unchanged by the collision in mm.115-117, P1. It is also notable that A was absent from the original plane P2.

In the opening measures of the piece, mm. 1-21, three pitch-planes were established by the introduction of trichords: two comprised of equally divided ninths and, a third of a minor 9th stacked on top of a major 9th. In mm. 118-127 a similar process occurs; however, the result is four pitch-planes that now represent the geometric shapes that are set in motion through sound.

The Function of New Pitch Planes, mm. 128-325

In mm. 128-131 there is a repetition of P4 and P5's core sound mass along with another A quintuplet that results in a rising passage, increasing in dynamics through m. 131. This ascending figure is reminiscent of early climaxes. Although it exhibits the widest range of any in the work, it is undercut by its brevity and its lack of dynamic power. Following this ascending figure the incessant A again rings out from Trombone 1

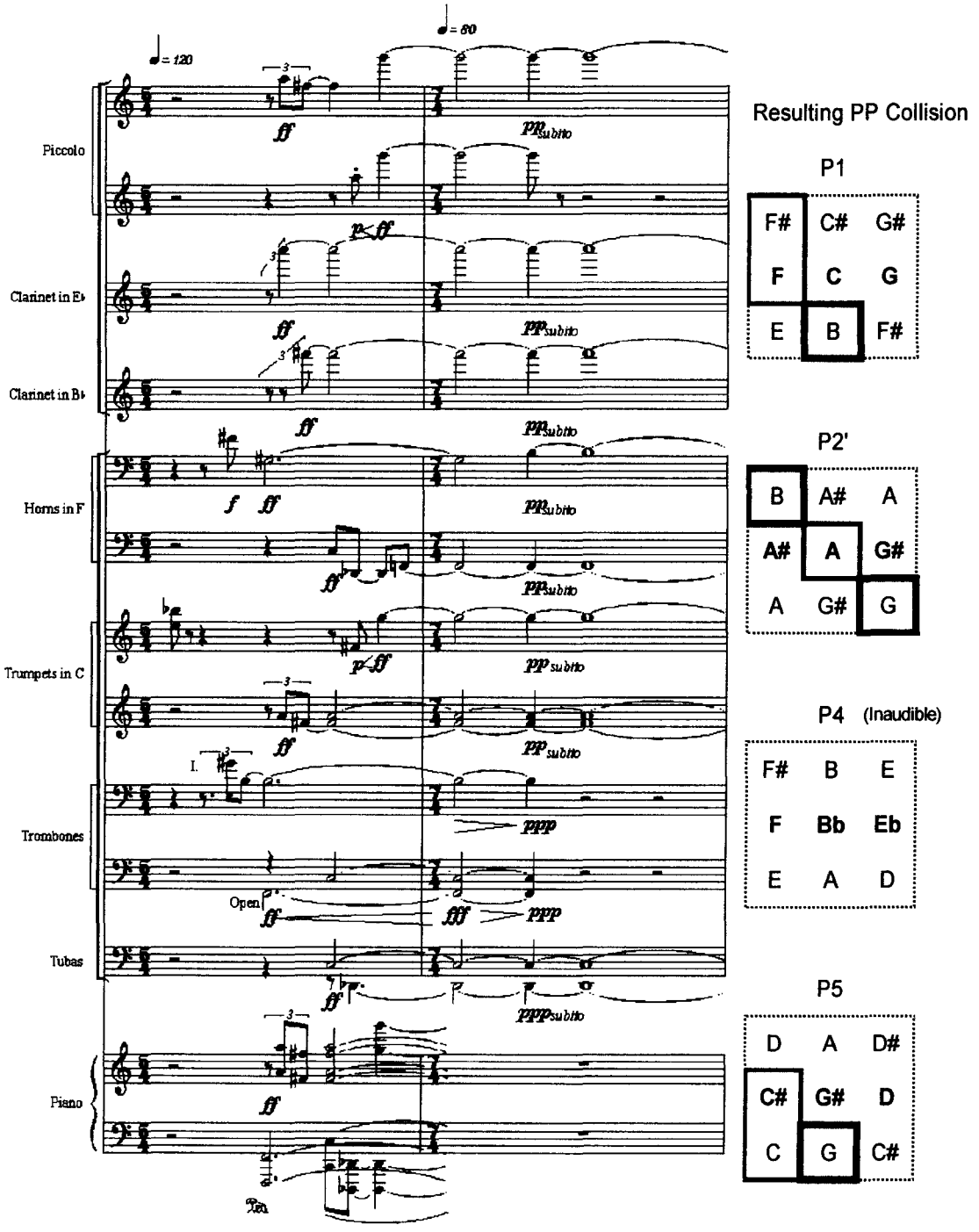
only to be interrupted by a quintuplet from Trombone 2 on Eb, one of the boundary pitches of P5.

A period of sparseness follows during which emphasis falls on the unpitched percussion that has appeared for the first time since m. 117. The pitch content consists of four pitches in the lower register, D, Bb, E and B from P4 with pulsations of a high F from P1. It is not until m. 137 that this sparse, nearly static texture is broken by surges of individual planes. In m. 137, it is P5, with the pitches Ab, Eb, A, C#, G and D that presses to the front of the texture. P5's appearance recedes by the end of m. 138 only to emerge again at the end of m. 139 and, once more recedes, yielding to more percussion sounds in m. 140. In m. 141 a new pitch, Bb, becomes the emphasis. The central pitch of P4 appears, emerging out of the texture, becoming the focus until it fades in m. 144.

P4 reclaims prominence in m. 146 as it is the only audible pitch-plane. The addition of Eb to the previous pitches of D, Bb, E and B expands P4's presence. The fortissimo entries of the horns, flutes and trumpets in mm. 146-148 show an emphasis on attack that has been absent in the slowly emerging pitch material since m. 117 and indicates that a change is near. The repetition of P4 intensifies through m. 148 in the crisply attacked material mentioned above. In m. 149 P2', (G, A, B) P5, (G, A, C, C#) and P1, in its core sound-mass form, (F, C, G) rotate and suddenly become audible. P4 is affected by the appearance of the other pitch-planes and rotates noticeably leaving only the B audible. What ensues in mm. 149-150 is the first significant pitch-plane collision and resulting climax of the work since m.117. The characteristic dynamic thrust of previous climaxes is evident as well as a full texture covering a vast range. As seen in Example 13, there are many shared pitches between the different planes with the

exception of P4 which has completely faded from the texture by the third beat of m.150. The B sustained in the horn part into m.151 represents the holding of the B present in a different pitch-plane, P2'.

Example 13: Fourth Climax/Pitch-plane Collision mm.149-150

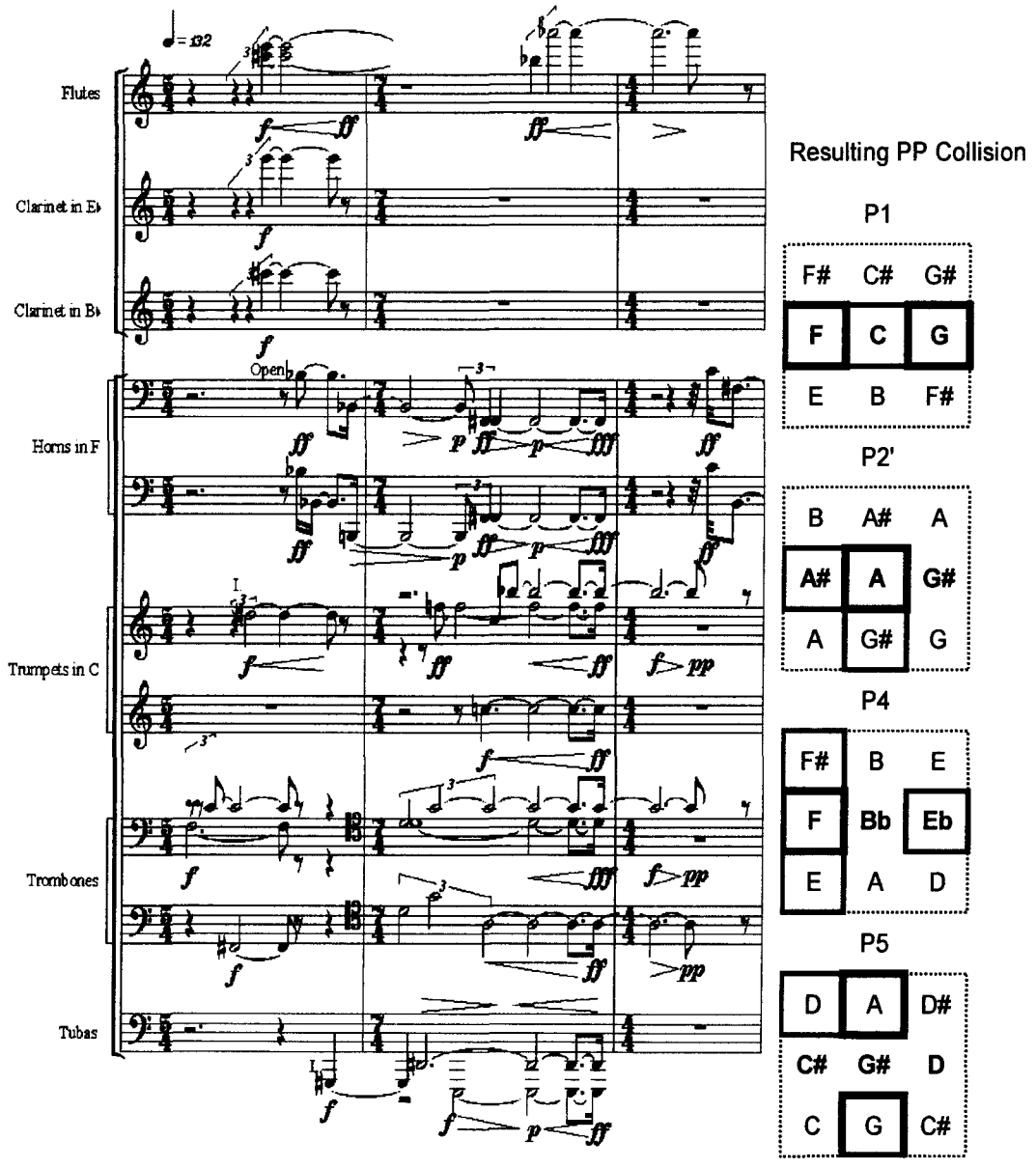


As in other points of climax, a sense of repose occurs immediately, the onset of which is seen in the sudden pianissimo markings midway through m. 150. This culminates in the first measures completely lacking in pitch content containing only unpitched percussion in m.153-155.

The interaction between four pitch-planes in mm. 128-155 results in less drastic moments of climax and repose. Perhaps due to the increased number of objects, the immediate repose after the first three climaxes seems to now be a slower process. Where the pitch-planes in mm. 1-117 rapidly rotated away, in mm. 128-155, sections of repose have become extended. After collision, the pitch-planes are quickly repelled; however, following the climax in mm. 149-150, complete repose is not achieved until five measures later in m. 155.

The P2' motive first encountered in m. 118 appears in m. 156. It is not alone in this instance and is joined by D, Bb, E of P4. P1 becomes audible once more as the pitch F invades and quickly expands to include C and C#. All pitches fade except for C and C#. This minor 9^{th} of C and C# has from the beginning been a P1 sonority, and now the pitches move back and forth as if being thrown at one another. This battle does not subside until m. 162 when it becomes evident that the C# was indeed part of P1; however, the C natural, the only of the two pitches remaining, is joined in m. 162 by D and G# making the three pitches part of P5. A, B, Bb and Eb appear briefly as P4 becomes audible, only to fade as the C versus C# battle is renewed. This time both individual members of different planes fade from view and a brief silence seems to build energy toward another climax found in mm. 165-167, seen in Example 14.

Example 14: Fifth Climax/Pitch-plane Collision mm.165-167



There is no large-scale collision in this case; single pitches common to different pitch-planes are evident, however. The P2' pitches, Bb, Ab, A collide with the A in the G, D, A pitches of P5. Additionally, the pitches of P4, F#, F, D#, E collide with P1's F, C, G, which, in turn collide with the G in P5. The resulting repulsion leaves only the pitch-plane P1 audible with the pitches C, G, and F#.

C# appears in m. 169 as a solitary member of P5 and acts as a harbinger of things to come as G# and D appear in m. 170 to complete the core sound-mass of P5. E and Eb of P4 are likewise present in m. 170 along with G and A from P2'. All pitches are eventually repulsed as the music subsides into silence for two beats of rests in m. 171.

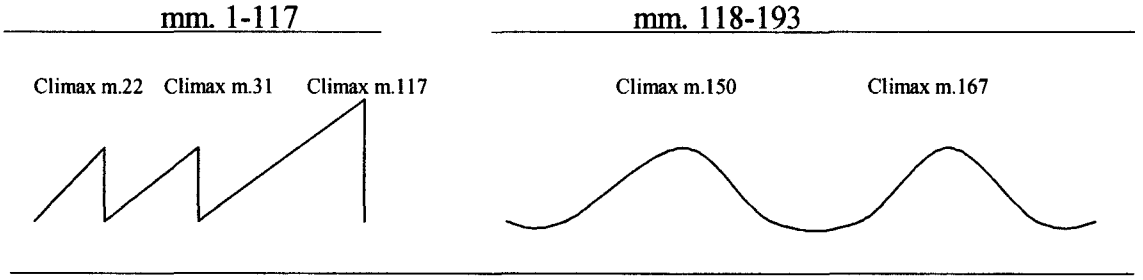
When the sound resumes in the last beat of m.171 the E and Eb of P 4 are still present, as are the G and A of P2'. The C of P1 has also reappeared alongside the D of P5, which finds its completion in m. 172 when the C# and G# return. The texture diminishes to reveal an emphasis on G# in the timpani and the piano in mm.173-174.

In m. 175, rhythmic figures emphasizing P4 (F, E, F#, Bb) pervade the texture through m.177 and the emergence of D and Eb in m. 177 provides a nearly full view of P4. The C# and G in the low register in m. 178 brings P5 back into the audible range along with a brief hint at the P2' ½-step motive first heard in m. 118, only G# and A this time reveals that pitch-plane's presence. But for the solitary C# of P5, silence prevails as all other pitch reference has been repulsed.

The lone C# is joined by G in m. 180 and is accompanied by another iteration of the P2' motive, G#, A. The C# continues to stand out and the P2' presence is felt by the repeated G, G# of mm. 182-184. In m. 185 a high Bb rings in from the trumpets at a dynamic of forte followed close behind by a B in the piccolo, a minor second indicating that P2' is still the prevailing audible plane. Db and D appear in the upper register bringing P5 to the fore along with unpitched percussion sounds in m. 187-189. C is added to the P5 group in m. 189 and B, Bb appear from P4. C fades from view and the four pitches, Db, D of P5 and B, Bb of P4 alternate as the dominant pitch until the high D unfolds from the texture as the lone sound at the fermata at the end of m. 193.

In the seventy-five measures following the large climax of m. 117 it is apparent that not only has the pitch material changed, but two other important changes have occurred. First, and perhaps most significant, is the change in the role of climax. Its role in mm. 1-117 is that of completion and reset. After each of the three climaxes (m. 22, m.31, and m.117), a period of repose occurs followed by a new building of tension toward the next point of climax. In mm.118-193, however, points of climax become agents of gradual change proceeding to a period of repose, an extended decline in dynamics and texture that is not complete until the dissolution of all pitch material. Secondarily, the motion of the pitch material in mm.118-193 is noticeably slower evidenced by the gradually emerging pitches, indicating that the rotation of the pitch-planes has slowed. Example 15 provides a graphic representation of the difference in motion and effects climax has on the contour of the two areas.

Example 15: Effect of Climax/Motion on Contour



The contour of the first area, mm. 1-117, appears as a saw-tooth wave depicting the abrupt drop in dynamics and texture following each climax, as well as the subsequent building toward the next climax. The shape of the second area, mm. 118-193, owing to its extended sections of repose, slower pitch motion and its dissolution of pitch-material prior to the building to another climax, is best represented by a sine wave.

After the slight pause created by the fermata, crisp attacks by the tubas followed by the horns occur on the pitches F#, Eb and E. It is not until the second half of m. 194, when the D of the previous measure returns in a much lower register along with F in the trumpets, that the pitch-plane becomes clear. D, Eb, E, F and F# are all from P4. In m. 196 P5 appears in the lower register with the pitches C# and D, an octave higher than the D of P4 in the previous two measures. P4 has rotated, leaving only B and Eb audible, and P1 is now present with the pitches G and Ab. A and Bb, appearing in the last beat of m. 196 and the first beat of m.197, respectively, belong to P2'. The Bb is heard above the remaining six pitches and is accompanied by loud percussion sounds. All of the six pitches belong in P1, and provides an abbreviated version of the P2' half-step motive twice before fading out, leaving the Bb alone drifting into silence.

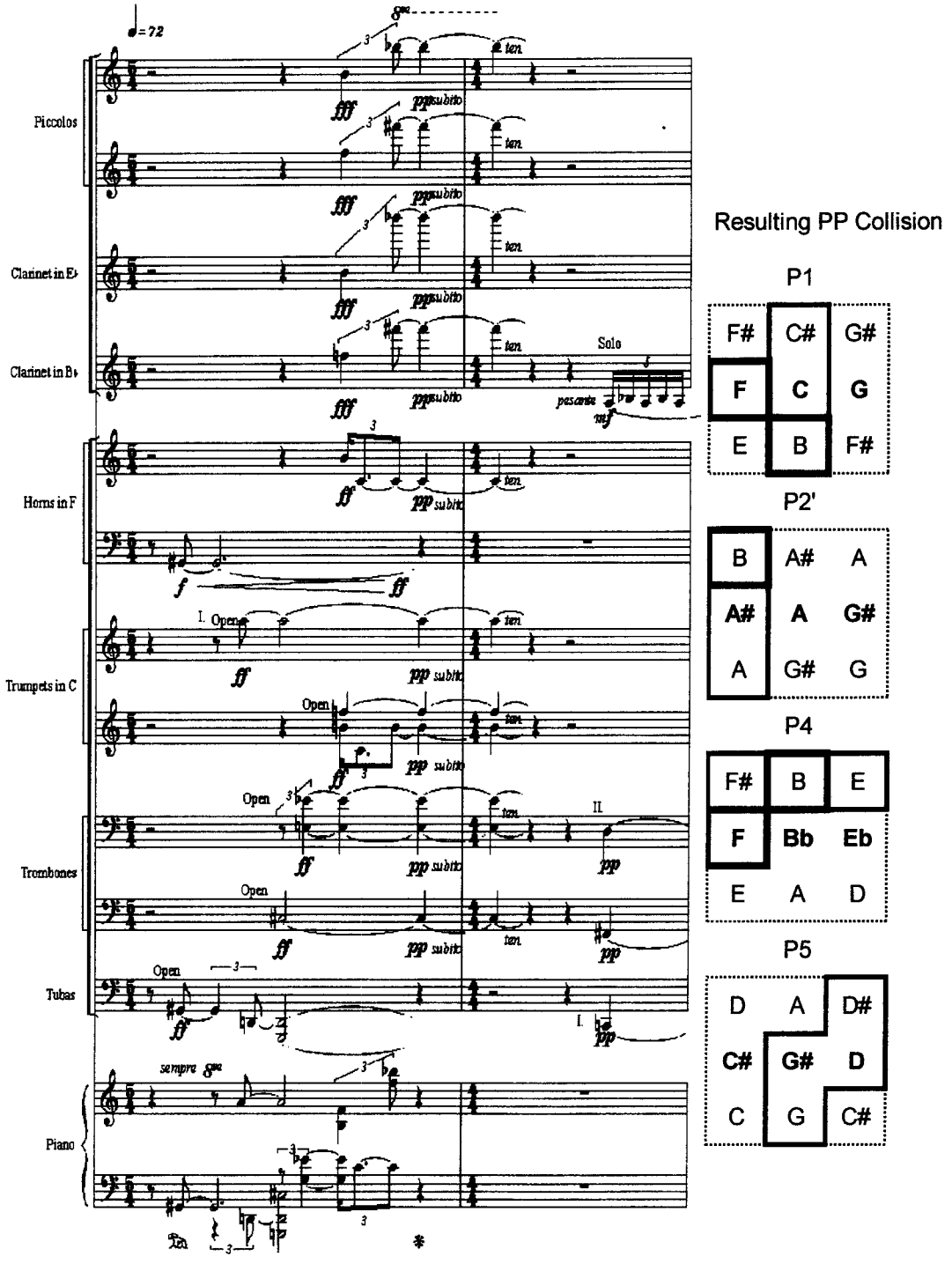
A period of sparse, single pitches and register-swapping follows in m.199 leading to a complete disappearance of the pitch-planes in m. 200. A second section of only percussion sounds occurs in mm. 200-203, and become barely audible by the end of m. 203.

The propensity of individual pitches moving to the front of the texture in this section (mm. 156-203), indicates that the pitch-planes have rotated to such an acute angle that the planes themselves are barely audible in contrast to the previous section, mm. 118-155, in which the presence of several pitches in different planes suggest a fuller view of the rotating pitch-planes.

The quiet is interrupted by a blaring, low G# from the tubas, horns and piano in m.204. The following rising figure is one of the most dynamic elements of the piece but, it is also one of the quickest repulsions. As can be seen in Example 16, this climax occurs

within the course of one measure. Additionally, the subsequent repulsion has occurred prior to the end of the same measure indicated by the hasty retreat to a pianissimo dynamic on beat four.

Example 16: Sixth Climax/Pitch-plane Collision, mm. 204-205



The prominence of the pitch B is notable; it is present in five parts (piccolo, Eb clarinet, trumpet, horn and piano) at the point of collision. But, upon repulsion, the parts quickly skip away except for the B in the trumpets. It is evident that a collision between three of the four planes has occurred with the B sounding in P1, P2', and P4. P1 also collides with P4 and the pitch F rendering P1 inaudible by the end of the repulsion. This collision represents the only one so far to include all twelve pitches of the chromatic scale. What remains after repulsion is the familiar A, Bb, G# motive of P2', C and D of P5 and the single F# of P4.

In m. 206, B and C in the trumpets along with the C# and G in the horns bring the return of P1 and P5, respectively. All planes then fade into silence broken by soft percussion sounds and a pulsating F# in the timpani.

P1 and P5 return in m. 210 in the same B, C and C#, G configuration prior to their fading in m. 207. Late in the measure D and Eb appear as P4 once again becomes audible. In m. 211 the texture thins. Only the B of P1 and P4's D and Eb remain. This sparseness continues in mm. 212 and 213 as P1 (F#, G, G#) alternates with P4 (Eb, E, F). By the end of m. 213, P1 has rotated and its pitches C#, C and F# are audible while P2' returns with the pitches A, Bb, B. Measures 215 and 216 consist of P4 pitch material with the second iteration in m. 216 is much more pronounced with louder dynamics. P2' reenters in m. 217 with G# and A just before all pitch material fades. In mm. 218-224, only soft percussion sounds are heard save one loud D from the timpani in m. 221, indicating repose as the pitch-planes rotate away.

In m. 225 the familiar P4 pitches F, E, Eb, D, B and Bb return; however, the D in the horns lies in a new register providing a preview into mm. 226 and 227 in which the

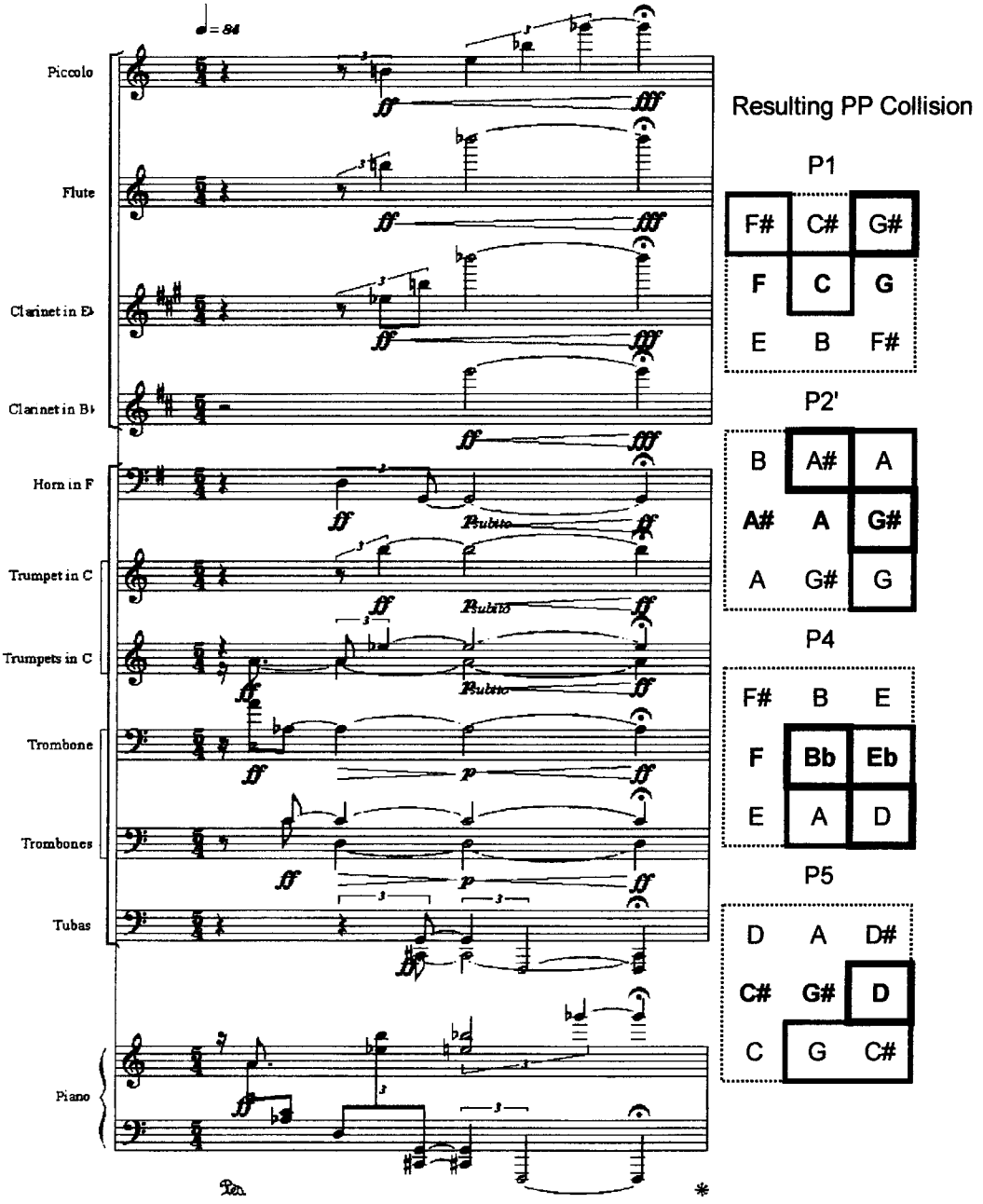
single D is emphasized in the horns, trumpets and trombones. Eb is added in the last beat and a half of m. 227 and a new plane becomes audible, P5. Bb, Ab, and A of P2' are heard in the clarinets and piano in m. 228 along with C, B, and C# of P1. P4 has faded out and the remaining audible planes, P1, P2' and P5 seem to freeze, as the only motion is that of soft, sparse, unpitched percussion sounds through m. 234, when, for the next two measures, the C# of P1 becomes the only audible pitch.

Measure 238 brings an emphatic return of P4 and its F, E, Eb, D, B and Bb combination. What appears to be a measure of transformation just prior to a pitch-plane collision occurs in m. 239; however, climax does not occur as the usual ascending motive is incomplete and all voices fall to pianissimo. Although in the following measures several planes are again simultaneously audible, no sense of climax is accomplished and no collision is evident.

C and Db of P5 are left ringing in m. 244 with interjected occurrences of P1 with G, F#, and P4's Bb, B. The single F# of P1 is left ringing in m. 247 as all sound fades to silence in m. 248. There is minimal motion of the planes in mm. 249-251 as the single pitch F# alternates with measured silence. At the end of m. 251 a faint sound from P2' is heard but quickly yields to the F#, this time in a different register, two octaves higher. The F# returns in m. 254 and is accompanied by the P2' pitches only to – once again – yield to silence in m. 256. The motion intensifies as the two planes become more active, although they are still quite soft. At m. 266 the P2' pitches have faded entirely and all that remains is the F#. All pitch material is absent as the soft percussion sounds provide the backdrop for the complete dissolution of pitch or rhythm.

Measure 270 features another climax resulting in a twelve-note chord. This seventh climax of the work represents a large-scale return of pitch-planes. Beginning with A, ascending and descending to include a range from F_1 to Gb_7, P1, P2', P4 and P5 are once again audible. As seen in example 17, the point of collision between these planes is the pitch Bb, doubled in the flute and Eb clarinet.

Example 17: Seventh Climax/Pitch-plane Collision, m. 270



The fermata at the end of this climax renders the element of time somewhat undefined. The Bb exists in only two of the planes, P2' and P4; however, common tones between the other audible planes, demonstrate other collision points. The most drastic dynamic drop of the piece occurs immediately following this climax.

Rustling noises from the snare drum pervade the texture in mm. 271-273. The calm is disturbed by a familiar group of pitches from P4, E, Eb, A, Bb and D. (The earlier version of this group included F instead of A.) Once again, only percussion sounds are heard in m. 275 but this occurrence is quite loud in preparation for the heavily articulated chords that are heard in m. 276. These chords feature the P4 group and an added pitch C, perhaps signaling that a new plane has rotated into view. The last five beats of m. 277 have no pitch elements and are driven by loud percussion sounds.

The emphasis on F and G in the opening half of m. 278 indicates that P1 has returned and answers any question raised by the lone C of the previous two measures. An ascent in the treble voices featuring the pitches of P2' – G, G#, A, and P4, E, B, and Bb – seems to prepare for a climax; however, before any lower voices enter the dynamic quickly fades to pianissimo leaving only E in the piano and horn against an Eb in the vibraphone moving into m. 280.

The original P2' half-step figure has been transposed lower and is heard in the vibraphone. Its pitches, G, Ab(G#), F#, are no longer part of P2'; the figure appears in the plane P1 which dominates the texture until the appearance of E, Bb, A from P4 in the timpani of m. 283. A single F emerges in the xylophone in m. 284 quickly followed by another iteration of the half-step motive, cut short this time by the interruption of a

pounding G in the timpani. This is followed by another half-step figure in the bass clarinet in m. 286 again interrupted by the quiet, deliberate G in the timpani.

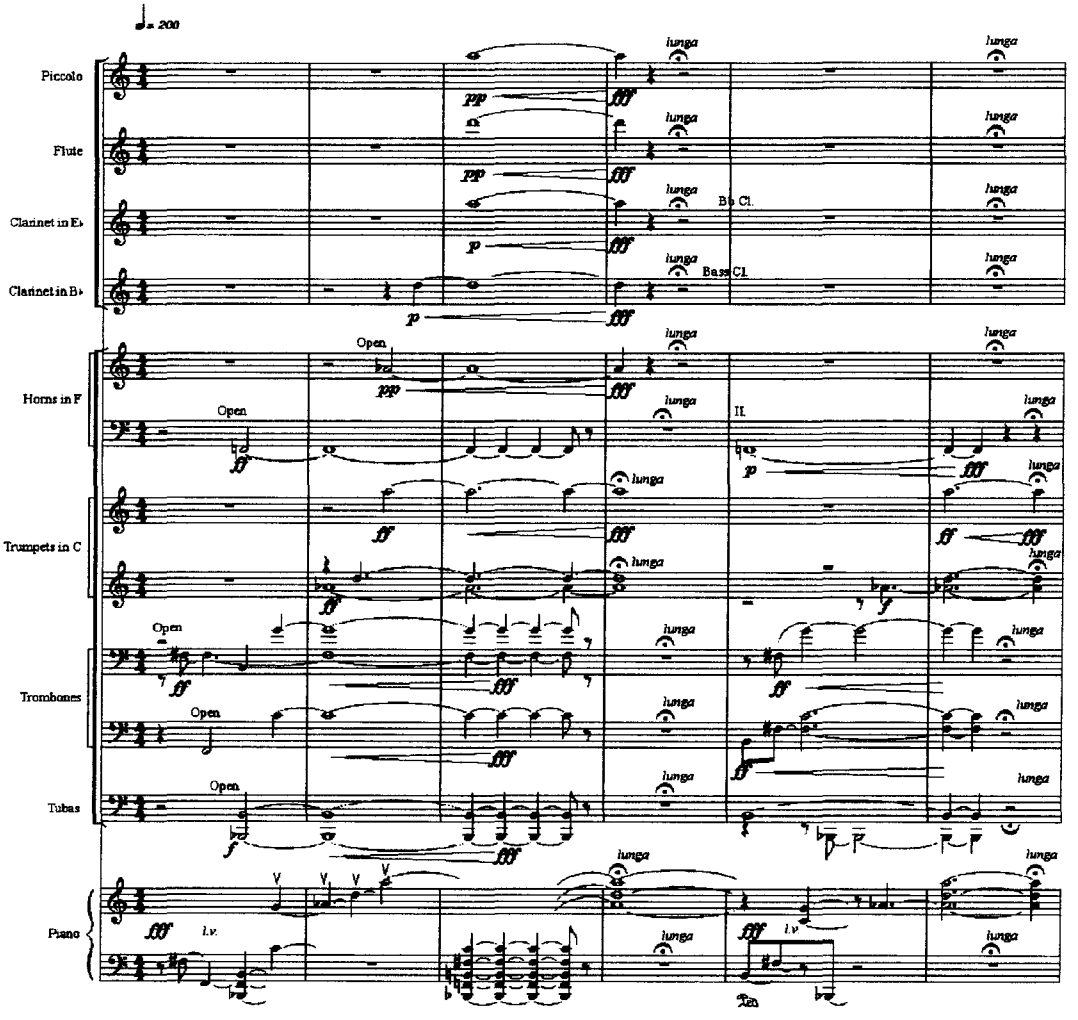
Another rising figure commences in m. 287 signaling the onset of another climax, once again cut short. The only pitches left at the end of this brief swell are B and F of P1. The pitches G, Bb, B(Cb), and A offer the half-step figure once again from its familiar starting point in P2'. At the end of m. 289 Eb is added along with F and F# in m. 290 representing P4. A fading of the planes follows and D_5 becomes the emphasis reaching its loudest in m. 294 before fading to soft, unpitched percussion sounds.

Abrupt entries of B and Bb begin a section emphasizing the interval of a ninth. The B and Bb belongs to P4 while a battle is underway between the G, F# of the timpani and the G, F natural of the xylophone within the same plane, P1. The conflict between the two ninths continues to intensify through m. 303 releasing their energy into the final climax beginning in m. 304.

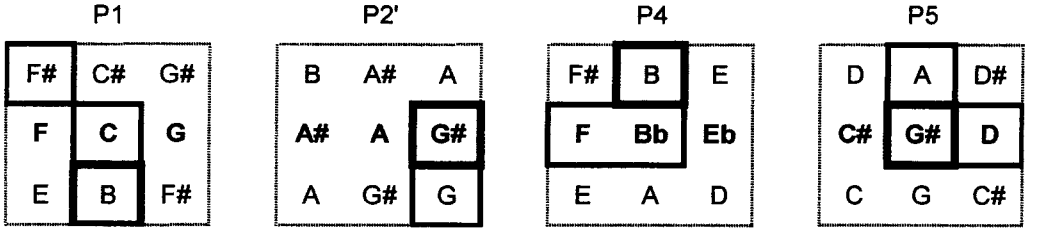
The longest transformation of any climax in the piece, this climax lasts from m. 304-307 and causes a secondary climax immediately following it in m. 308-309. There are nine pitches audible with collision occurring in all four active planes. The pitches are stacked in overlapping ninths and reveal the following pitch-plane configuration: P1- B, F# and C; P2'- G, Ab(G#); P4- Bb, F and B; P5- Ab(G#), D, A. It is notable that the only half-step in this configuration occurs in the center of the texture, verifying the centrality of the P2' pitch-plane in the last two-thirds of the piece. After the first climax, only P5 and its pitches Ab, D, and A, remain audible while all other planes have been repelled. Immediately, another build-up begins in m. 308, but this climax is a repercussion of the first. It features the same pitches and corresponding planes; however, the lower

dynamics, due principally to a thinner texture and the lack of high-register wind instruments decrease the impact of this climax. As in the first climax, the only remaining pitches upon repulsion are the Ab, D and A of P5. Example 18 shows the immediately successive climaxes of m. 304-309 and the resulting pitch-plane collisions.

Example 18: Eighth and Ninth Climaxes/Pitch-plane Collisions, mm. 304-309



Resulting PP Collision



The bass presence is not as strong in the second climax in mm. 308-309. The lower register of the piano part has fewer notes. Additionally, the disappearance of the winds from the upper register creates a reduction toward the center of the texture where the G-Ab half-step lies.

Out of the silence in m. 310 emerge combinations of ninths. A new pair of half-steps, B, C, and C#, D, which have previously been heard as ninths, also surface. The interval B, C occurs only in P1, while C#, D belong exclusively to P5. Eb_4 of P4 appears in m. 312 as the lowest pitch in the texture. Silence in m. 315 is disturbed by the reappearance of the Eb which is joined by E in m. 317 and Ab, G, now as a ninth in P5 rather than the half-step of P2'. It is these sonorities that close the work and come to rest as the final sonority a unison Eb_4.

This pitch-plane analysis of the acoustic instrumental sections of the piece, demonstrates the rotation of specific geometric shapes, in three-dimensional space. Points of climax and repose have been demonstrated as the shapes interact with each other in the piece. Collision between the individual planes and groups of planes provide the sensation of climax, while the immediate repulsion exhibited by the subsequent decrease in motion, dynamics and texture indicate sections of repose.

CHAPTER 2

FORMAL ANALYSIS OF *DÉSERTS*

Previous Conceptions of Form in *Déserts*

Previous formal analyses of *Déserts* have approached the work from a traditional standpoint. Andrew Blyth's analysis in his article "Pitch Structure and Process in Edgard Varèse's Déserts"[28] attempts to contain this landmark work within set-theory analysis as established by Allen Forte.[29] Blyth's analysis represents the most in-depth study of *Déserts* to date and yields potential insight into the core pitch material used by Varèse; however, his confinement of the pitch-related processes within specific pitch-class sets provides a view of only the most fundamental pitch elements at work in *Déserts.* Of greater concern is Blyth's resulting formal delineation based principally on the insertion points for the interpolations of taped sounds. This method of delineating form is far too straight-forward for Varèse. It must be recalled that the instrumental music of *Déserts* was composed as a single movement prior to the composition of the taped sounds. The insertion points for the interpolations, although they have an obvious effect on the form when the taped sections are included, were not intended to be formal or structural indicators within the instrumental work as it stands alone.

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[28] Blyth, "Pitch Structure and Process in Edgard Varèse's Déserts."

[29] Allen Forte, *The Structure of Atonal Music* (New Haven: Yale University Press, 1973).

More recently, Malcolm MacDonald's analysis of *Déserts* in his book *Varèse: Astronomer in Sound,* only begins to discuss two items that most analysts have avoided: 1) the relationship of the instrumental sections to the interpolations, specifically, occurrences in the taped sections of emphasized, common intervals and motives in the instrumental part, and 2) the development of sound planes. MacDonald describes the opening bell-like major ninths as "grave, poised hieratic music – two 'planes' proceeding at first in parallel – (having) many long-range structural consequences."[30] The suggestion that the intervals are part of a plane, a geometric figure seems to go hand-in-hand with Varèse's own comments regarding the pitch material of *Déserts'* instrumental music:

> ...the intervals in the instrumental sections, though they determine the constantly changing and contrasted volumes and planes, are not based on any fixed set of intervals such as a scale or series.[31]

Regarding form, MacDonald also separates the instrumental sections according to the position of the interpolations, dividing the work into seven distinct sections. This method works relatively well when the interpolations are included as they represent significant points of change; however, without the interpolations this tendency to simply classify the instrumental part as a four-part structure divided at the points of insertion does not agree with the geometric constructs at work in *Déserts.*

Using the pitch-plane method discussed in Chapter 1, this analysis will focus on three significant elements in the form of *Déserts*: the role of pitch-planes as formal delineators through collision and repulsion; the significance of the interval of a ninth in

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[30] Malcolm MacDonald, *Varèse: Astronomer in Sound* (London: Kahn and Averill, 2003), 348.

[31] Varèse, "The Liberation of Sound," 30.

determining the overall form of the instrumental portion; and, the revealing of geometric constructs that support the view of *Déserts* as a two-part structure.

To begin with, Example 19 shows a formal diagram of *Déserts* as a two-part instrumental work delineated by pitch-plane collisions and repulsions.

Example 19: Formal Diagram of Instrumental Portion of *Déserts*

Part A

m. 1	m. 22	m. 31	m. 41
Establishment of Pitch-planes P1:F,C,G; P2:D,A,E; P3:Bb,B,C	**1st Climax** P1 inaubible Collision between P2,P3	**2nd Climax** P3 inaudible Collision between P1,P2	Noticeable thinning of texture and slowing of motion.
Sub-division 1 Chiming 9ths, two central climaxes followed by decline representing repulsion of pitch-planes.			

m. 54	(m. 82)	m. 117
Multiple Pitch-plane collision resulting in structural change. Collision between P1 and P2; P2 and P3	Insertion point of 1st Interpolation	**3rd Climax** Most powerful and convincing. Collision between all three active pitch-planes, P1, P2, and P3.
Sub-division 2 Chiming figure transformed into octaves, emphasis on 9ths, opposite motion of Sub-division 1. Complete decline occurs in the middle, m.82 and rises to 3rd climax.		

Part B

m. 118	m. 132	m. 146	m. 156	m. 168	m. 194
Introduction of 1/2 step motive, pitch-planes redefined. P1, P2', P4 and P5.	After small climax sparse texture Percussion returns	P4 emphasis. **4th Climax** in m.150. Collision P1, P2', P5	Return of 1/2-step motive, **5th Climax in** m. 165-167. Collision P1, P2' P4, P5	Emphasis continues on C and C#. Core sound mass of P5. Rotation of different planes. D of P4 emerges in m. 193.	Renewed emphasis on 9ths. 1/2-step motive returns **6th Climax** m.204-205. Collision P1 P2', P4
Sub-division 1 New pitch planes as a result of collision in m. 117. Late in section repulsion closes unlike collision on Sec. A.			**Sub-division 2** Return of 1/2-step motive in P2'. Features two climaxes separated by sections of repose.		

Example 19: Formal Diagram of Instrumental Portion of *Déserts* (cont'd)

Part B (cont'd)

m. 206	m. 225	m. 238	m. 263
Return of 1/2 step motive. P1 and P5 emphasized. P4 fades in and out	2nd Interpolation	Low register pitches emphasizing P4 leads to ascending/descending figure. Emphasis on F#.	3rd Int. **7th Climax** m.270 Collision P1 P2', P4, P5
Sub-division 3 Return of 1/2 step motive. Ascending figures alternating with unpitched percussion. Loud interjections alternate with subdued sections. Closes with climax at end.			

m. 271	m. 288	m. 311
Begins with unpitched percussion, expanded chiming figure emphasizing 9ths. Impression of 1/2 step motive.	1/2 step motive returns in P2' Emphasis on D, alternating m9th and M9ths. **8th Climax** m.304-306, **9th Climax** in m.308-309. Repeating collision P1, P2', P4 and P5	Coda section with emphasison m9ths. Comes to rest on Eb of P4 as all others fade.
Sub-division 4 Begins with percussion rather than 1/2 step motive. Motive is present later on connecting with rest of section. Most intense climaxes before coda section.		

As seen in the above diagram, pitch-planes, their interaction with each other as they rotate in space, and their transformation as a result of this interaction are fundamental to the resulting form of *Déserts.*

Pitch-planes as Formal Indicators

It is easy to accept the form of *Déserts*' instrumental music as a four-part structure. After all, the composer divided the work into sections by inserting the interpolations of organized sound at specific, structural points in the work. To gain further insight into the form of this piece requires an approach that accords with the composer's idea of spatial music. An analysis of the pitch content defined as pitch-planes provides insight into *Déserts* as an instrumental work with its own integrity before the interpolations were added.

The single most important formal element involved in pitch-plane analysis is the concept of collision, an interaction between different planes that both results in significant structural change and introduces the sensations of climax and repose. Without exception, significant points of climax are attained when a rising figure emanates from the middle register, expands to cover a range of five, or in some cases six octaves and culminates in a loud, dynamic thrust. The collision points of the pitch-planes discussed previously are the point of departure for this analysis of form in the instrumental portion of *Déserts.*

In the first section – Part A – three pitch-planes are developed in mm. 1-21 of sub-division 1 each based on the interval of a ninth. In the first two pitch-planes, P1 and P2, the core sound-mass is constructed of a ninth dissected by the fifth, forming quintal-trichords. The third pitch-plane comprises stacked ninths, a major ninth above a minor ninth. The three planes exist in space and begin to move independently as the chiming gives way to staggered attacks. In the middle of the first sub-division, two climaxes occur (m. 22 and m. 31) within ten measures of each other. Initiated by a rising figure originating in the middle register and expanding upward and downward in range, the first climax is the result of a collision between P2 and P3. This climax is followed by long, sustained notes in the upper register interrupted by abrupt interjections from the clarinets and timpani which counteract any suggestion of stasis or lack of motion. Nine measures later, another rising figure emerges, signaling an additional climax. An obvious change has occurred as a result of the first collision and now different pitch-planes are involved, P1 and P2. Immediate repose is delayed as ninths in the upper register are offset by equally loud ninths in the lower register. The thinning of the texture, however, creates

enough contrast with the section of collision that a decline is suggested. Motion slows as the texture continues to become thinner. Persistent, violent eruptions in the timpani continue to disrupt a sense of calm until m. 41 when a closing section of repose commences.

The next area of Part A, referred to as sub-division 2, begins in m. 54 with the initial chiming motive that is revised to emphasize the octave. This is also an example of a pitch-plane collision; however, here the collision results in the appearance of a distinct new sub-division rather than providing a sense of climax or closure. The collision of P1, P2 and P3 at this point demonstrates that collision forces significant change in the work whether that change is one of structure, climax or repulsion. The familiar interval of a ninth resurfaces in m. 59, lending a sense of stability and cohesiveness. Individual pitches begin to emerge from the texture. The octave E's and the repeated tones G# in m. 59, and the G natural in m. 66 give this section a different identity from sub-division 1. This sub-division reaches complete repose in m. 82, near the middle of the sub-division; notably, it is the insertion point for the first interpolation of organized sound.

In contrast to previous formal analyses of *Déserts,* the above-noted decline does not represent the end of one section and the beginning of another; quite to the contrary, it represents the middle of the second sub-division. Measure 83 begins a steady increase in density and dynamics. Starting with a sparse texture featuring dynamic swells as if different parts of the pitch-planes were rotating in and out of view or audibility, rising figures interrupt, simulating the move to a climax that never reaches fruition. These smaller rising figures propel the work toward the ultimate climax of Part A at m. 117. This is the largest, most dynamic climax of the work so far and the silence at the end of

the measure demonstrates the dissolution of all previously established pitch material. For the first time in the work all three active pitch-planes are involved in the collision, P1, P2 and P3.

Where the overall shape of sub-division 1 moves toward climax, additional climax and a subsequent decline, sub-division 2 displays the opposite tendency. The dynamic restructuring of the chiming motive, caused by the collisions between P1/P2, and P2/P3 at the beginning of the sub-division, is a major event signified by the increased dynamics and stronger articulation. What follows is a general decline in density and dynamics that continues through m. 82. A rebuilding that begins in m. 83 drives the section to its ultimate destination, the rising figure beginning late in m. 115 and culminating in the huge climax of m. 117.

Where Part A uses pitch-plane collision to establish its form, the second part of *Déserts* instrumental music uses climax and repulsion, together to provide shape to the sub-divisions. The driving force with regard to formal delineation in Part B is the half-step motive that appears in m. 118 in the horns and bass clarinet. The recurrence and transformation of this motive provides this section a sense of cohesiveness. The pitch-plane collisions and subsequent repulsions are not events that begin or end sub-divisions; rather, they are elements of climax and repose that shape the internal measures of the individual sub-divisions.

A strikingly new motive emerges in the beginning of the first sub-division of Part B and is the direct result of the massive collision in m. 117 that essentially reconfigures the pitch-planes. Only P1 of the original planes is left unaffected by the collision. P2 is transformed from a plane constructed using ninths to one that contains minor seconds.

The fact that the new core sound-mass is a rotation of a vertical manifestation of P2 makes it still very much a product of the original P2; hence it is referred to as P2'. The other planes constructed in the opening measures of Section B bear no resemblance to previous planes and are, therefore, referred to as P4 and P5. P5 is constructed around a core sound-mass based on an equally divided ninth and P4 is constructed of a core sound-mass based on a minor seventh equally divided into fourths.

Brief rising figures in the upper register (m. 121, m. 124-125, and m. 131 for example) and a greater emphasis on specific pitches of individual pitch-planes (A in mm. 127-130 and Bb in mm. 141-145) characterize this first sub-division. It opens with a loud burst, notably missing the rising figure before it falls short of a true climax followed by a sparse texture accompanied by a new emphasis on percussion sounds. A sparse texture develops indicating that the planes have rotated so that little is audible. The second part of this sub-division comes to rest on a single pitch, G_2 in m. 145. P4 is the primary pitch-plane beginning in m. 146 until the rising, expanding figure begins in m. 149 leading to the fourth climax of the work. An immediate drop in dynamics indicates repulsion; however, here the texture, unlike that in previous climaxes, is still relatively dense. The decline due to repulsion is demonstrated by the disappearance of the pitch content. Soft percussion sounds bring sub-division 1 of this section to a close. Here the role of repulsion has changed. It now closes the section rather than existing simply as the result of a collision and acting as a prelude to another climax.

The return of the half-step motive in the bass clarinet in m. 156 begins the second sub-division of Section B. In this sub-division the earlier, brief emphasis on individual pitches are transformed into extended passages emphasizing single notes. The C# is

notable in m. 158 and is quickly juxtaposed with a C natural in the piano and xylophone. The battle for dominance between the two culminates in an extended rising, expanding figure that becomes the fifth climax late in m. 166. Emerging from the texture is the C natural of the previous battle; repeated in the trumpet it serves as the indicator that a new part of sub-division 2 has begun.

The prominence of C in the texture is invaded by new sounds as the core sound-mass of P5, C#,G#, D, appears just before a diminuendo to silence in m. 171. Crisp attacks in the horns and flutes bring the return of the ninth sonority breaking the silence. In m. 178 an imitation of the half-step motive appears but remains incomplete; a recurrence of the motive in m. 180, and another in m. 184, confirms the importance of this motive to the entire section. An obvious close of this sub-division occurs with the fermata in m. 193 on a single D_6 of P4.

A renewed emphasis on ninths emerges in m. 194 as sub-division 2 progresses. The half-step motive returns transposed down a step in m.197 but now it is part of a different pitch-plane, P1. A measure featuring pitches passed between different registers in m. 199, coupled with little percussion activity create almost a sense of stasis and all pitch material fades out, allowing unpitched percussion to control the texture until the sixth climax of the piece begins in m. 204. The period of repulsion following this climax is comparatively brief this time as the half-step motive returns at the end of m. 205 ushering in a new sub-division.

The half-step motive accompanied by statements of P1 and P5 quickly fades to quiet percussion sounds in mm. 208-209 as sub-division 3 begins. Rising figures yield to quiet instrumental sounds contrasted with loud sounds from the lower register. Another

passage of unpitched percussion seems to indicate the close of a section, but it is interrupted by the return of the loud, lower register sounds. Because this is the insertion point of the second interpolation, earlier analyses of the work mark m. 225 as a point of structural articulation despite the fact that it is a continuation of the ideas in the measures preceding the unpitched percussion. Measure 225 only functions as a formal indicator when the interpolations are included.[32]

After the dynamic return of the timpani, an emphasis on D_4 arises as it emerges as the only pitch in mm. 226-227. C and C# are once again prominent, this time as the boundary pitches of the pitch content. C# is first exposed and then fades to reveal more sharply accented low register sounds together with the persistent timpani, launching the final portion of sub-division 3.

A rising figure emerges following the loud, low-register announcement of m. 238 but falls short as a point of climax. F# surfaces in m. 244 as a focus pitch of P4 and is joined by B and Bb. The single F# rings out of the texture as other pitches of P4 continue to rotate into view. Only the F# remains in mm. 261-263. After m. 263, the third interpolation is inserted; however, the third sub-division does not close until the soft unpitched percussion sounds have had their say and the seventh climax has powerfully and abruptly occurred.

The final sub-division of Part B comprises three parts. It begins without the familiar half-step motive that has begun all previous sub-divisions of this section; the

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[32] The assumption that m. 225 is a formal indicator when the interpolations are included is still a speculative evaluation, as a case could be made that there is a seamless connection between m.224 and the beginning of the second interpolation. Likewise, the timpani in m.225 seems more an extension of the ending portion of the second interpolation than the onset of a new section.

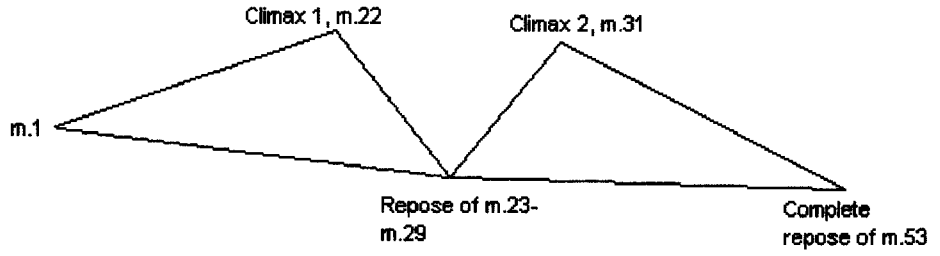
swelling snare rolls are the first sign that a change has occurred. The pounding of the timpani and the single D in the horns, however, provide an important connection with the previous sub-divisions. The return of the transposed half-step motive in m. 280 and its restatement in m. 281 confirm that this sub-division is indeed part of Part B. A rising figure in m. 287 signifies the approach of a climax, but yields, instead, to another statement of the half-step motive in m. 288 beginning the middle portion of the final sub-division and the closing section of the piece. The solitary D returns in m. 292 just before the irregular unpitched percussion sounds take control in m. 294. In m. 296 a battle ensues much like the C and C# battle of Sub-division 2. This battle is not between two pitches but between two intervals: the minor 9^{th}, G, F# of the timpani and the major 9^{th}, G, F natural of the xylophone, a conflict within the same pitch-plane, P1. The conflict intensifies and the final series of climaxes begins in m. 304.

The expansive rising figure beginning in m. 304 is the longest of the work and the resulting climax, a collision of all four active pitch planes features the longest, largest dynamic swell. After a brief pause, a smaller version of the previous climax, narrower in range and less dense occurs. The central half-step (G, Ab) of the transposed half-step motive found in the 3^{rd} trumpet and 1^{st} trombone occurs squarely in the middle of the texture and is the only half-step present in both concluding climaxes. This double-climax represents the final two climaxes of the work and results in the most extended period of repulsion as well. Measure 310 is silent and the remainder of the work, during which the pitch-planes are completely repulsed, can be viewed as a coda. The cessation of all motion allows the final pitch, Eb to emerge in the closing measure

Geometric Shapes in the Form of *Déserts*

In a review of the formal diagram in Example 16[33], certain shapes become evident in the sub-divisions and portions of those sub-divisions. The first sub-division, for example, exhibits two important characteristics – a rising motion toward the two central climaxes in m. 22 and m. 31, and a subsequent general decline producing a shape much like a pair of triangles hanging in space yet connected at the ends. This is graphically represented in Example 20.

Example 20: Triangular Configuration of Sub-division 1, Part A

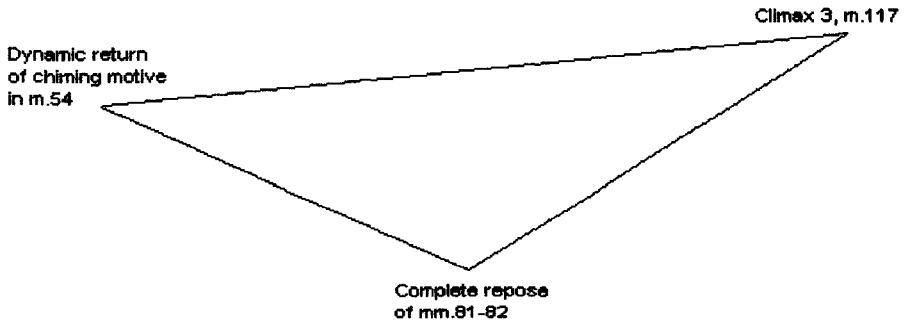


The repose of mm. 23-29 serves in the visual diagram as a connecting point of the two triangles. Additionally, the beginning of the first triangle, m. 1, has greater height than the repose of m. 53 and it therefore, seems higher in space.

Sub-division 2 of Part A, likewise exhibits a triangular shape; however, it is a single triangle featuring directional motion contrary to that of Sub-division 1 as shown in Example 21.

[33] See pages 38-39.

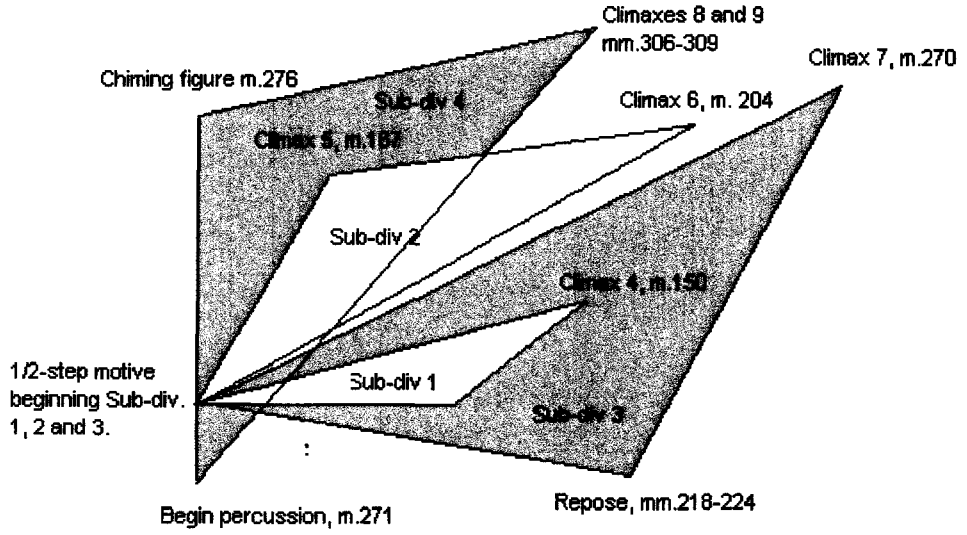
Example 21: Triangular Configuration of Sub-division 2, Part A



It is notable that where Sub-division 1 creates two distinct triangles that overall move from medium dynamics to disappearing ones, Sub-division 2 forms a single, larger triangle whose complete motion is from loud to louder.

What occurs in Part B reflects Varèse's notion that music develops from a very basic element, expanding and growing to transform into a new entity. From the same starting point, that of the half-step motive in m.118, Varèse constructs what appears, when diagramed, as overlapping triangles. These separate triangles expand outward from the same point of origin, and, with the exception of Sub-division 4, create the effect of an ever-changing, repeated configuration, shown in Example 22.

Example 22: Overlapping Triangular Configuration of Part B



Sub-division 4 is the only one that does not begin with the half-step motive, and, consequently, begins with a higher dynamic level since its opening features the swelling rolls in the snare drum. The high point of the entire configuration is the double climax at the end of Part B in mm. 306-309. The extended repulsion of mm. 310-325 is represented by the side of the triangle that returns to the silence that began the sub-division just before the entry of the percussion in m. 271.

There are likewise geometric configurations represented in the points of insertion for the interpolations. Although the interpolations are not the focus of this discourse, proof that geometric principles operate there as well is evidenced by the first insertion point. Varèse specifies in the score that the "1st interpolation of organized sound enters on the 4th beat of bar 82."[34] This identifies the distance from the beginning of the work to the first interpolation as 81.75 measures. The hypotenuse of a right isosceles triangle of sides 81.75 is 115.6 where the rising figure begins leading to the third climax in m.117.

[34] Edgard Varèse, *Déserts* (New York: Colfranc Music Publishing Corporation, 1959): Instrumentation page.

CHAPTER 3

CONCLUSIONS

Pitch-plane Analysis and Form

The primary goal of this analysis has been to examine the acoustic instrumental portion of Edgard Varèse's *Déserts* from a geometric perspective, viewing the contents of the work as a series of rotating objects in three dimensional space. To facilitate this, a new method of analysis called Pitch-plane analysis was used. The development of the pitch-planes began with the observation of the importance of the number 9 within the work.[35] The propensity of major and minor 9^{ths} led to an analysis that used planes of 9 pitches. The planes were created using three pitches that form a trichord based on the interval of a 9^{th}. The initial trichords form the core sound-mass of the pitch-plane. The planes are completed by surrounding the trichord of each core sound-mass with chromatic upper and lower neighbor tones resulting in three, nine-pitch planes.

The logic behind this analysis is substantiated by the fact that each pitch and combination of pitches can be identified within the three initial planes. Furthermore, the formal sections delineated by the use of this analysis concur with recurring motivic ideas and logical divisions of the music into units based on the number 9 as is detailed in Chapter 2.

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[35] Details of the significance of the number 9 are treated in the Appendix, pages 63-64.

This analysis reveals *Déserts* as a multifaceted work containing innovations in form and pitch structure. The previous tendency generally found in overview treatments of the work to view it solely as an innovation in acoustical music combined with electronically generated sound can now be expanded to recognize these other innovations. *Déserts* features a new method of musical organization in its formal development and through its ever-changing, rotating and shifting planes of sound provides concrete evidence that music can be understood by means of a spatial metaphor, as objects existing and interacting in space and is no longer limited to the limitations as seen in the forms or the analysis of the past.

In the descriptive analysis Chapter 1 it was shown how, through the use of pitch-planes, the music appeared as Varèse intended it: floating and independent planes of sound. The rotation of the planes was demonstrated by the shifting complexes of audible pitches. Pitch-planes rotate in and out of view (become audible) they appear, disappear and change pitch combinations. In some cases the planes rotate at such an acute angle that only a single pitch is audible. Important concepts of climax and repose have been shown as collision points between the different planes. These collisions and subsequent repulsions became important indicators of structural changes as well as initiators of climaxes.

In Chapter 2 the analysis of form demonstrated how the pitch-planes, and their rotation, interaction, collision and repulsion work to delineate structure and the form of the work. Distinct formal indicators become evident between the A part and B part. The A part, driven by the interval of a 9th and structural change caused by collision of pitch-planes stands in contrast to the B part, the form of which is largely delineated by

occurrences of a half-step motive. The concept of collision and repulsion of pitch-planes takes on a new role in the B section as individual sections are not considered complete until an extended period of repulsion has occurred. Geometric constructs depicted by sections of the work additionally support and provide a visual representation of the geometric constructs found in the form of *Déserts.*

The interaction of pitch-planes, the significance of the number 9, and the geometric constructs provide a view of *Déserts* previously unavailable. It allows for an understanding of the work that is aligned with the composer's view of music in space. By demonstrating the rotation of the planes of sound that Varèse envisioned, the true form – one that considers the instrumental work removed from the interpolations and their individual insertion points – can be discerned, that of a two-part instrumental composition.

Opportunities for Further Research

This analysis has focused on elements of pitch and form. By devising a method of analysis more appropriate to the thoughts of the composer, new ideas of pitch organization and form have been discovered.

There are areas that can be explored further. In this study, the interpolations of organized sound have been largely ignored and only the points of insertion have been mentioned. An analysis of the interpolations with regard to form is needed. Likewise, the impact of the interpolations on the form of the entire work was not addressed. Although the deterioration of tape over a course of years and the variance in speed of early tape

recording devices makes a pitch analysis impractical, if not impossible, structural analysis of the aural events within the interpolations could prove relevant.

More aligned with this study is a need for research into the role that the percussion plays in the instrumental music of *Déserts.* It is too easily relegated to that of an accompanimental force or a device for emphasis. However, Varèse, certainly did not think of percussion in this way, as evidenced by his *Ionisation* for percussion.

On a more detailed scale, the role of register and dynamics within *Déserts* seems to be of significance. In his quest for new sound, Varèse's use of dynamics and register is like no other composer of his time; he creates interesting new sonorities through shifting instrumental combinations and registral transformation, especially in his acoustic instrumental music. *Intégrales, Octandre* and *Ecuatorial* come immediately to mind. These concepts of register and dynamics should be explored in *Déserts.*

Déserts represents a turning point in musical development by its combination of electronic and instrumental music, its use of geometric structures as pitch material and geometric constructs of form. *Déserts* is the beginning of a movement in music off of the page into the three-dimensional realm of space.

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APPENDIX

OCCURRENCES OF THE NUMBER NINE

IN THE FORM OF *DÉSERTS*

The interval of the ninth permeates *Déserts,* and the number nine plays a significant role in determining structural changes. This becomes particularly evident in transitional areas and also is manifest with regard to insertion points for the interpolations of taped sounds.

The effect of the number nine is noticeable early in the work. The first two pitch-planes, P1 and P2, have been established and fade out in m. 13, the number of semitones in a minor 9^{th}, and nine measures later in m. 22, the first climax occurs. Exactly nine measures after the first climax, the second climax occurs in m. 31. Nine measures after this the timpani ecstatically proclaim a major change in the texture with the heavily accented notes in m. 40. The first sub-division comes to a close and a new version of the chiming motive appears in m. 54 the product of six and nine. Later in Sub-division 2 the original pitches F, G reappear for the first time since transforming into other pitches in the plane in m. 81, the square of nine. Finally, the largest climax of Part A at m. 117 confirms the importance of nine; 117 being the product of nine and thirteen.

Incidences of nine as a formal indicator in Part B are prevalent as well. The overall length of the section, 207 measures (mm.118-325), represents another multiple of nine since 207 is the product of 9 and 23. The opening sub-division of Part B begins with

13 measures in which the new pitch-planes are defined, mm. 118-131. The fourth climax of the piece, in m.150, occurs 18 measures after the completion of this section. The first incidence of all pitch material fading leaving only unpitched percussion sounds occurs in m. 154, 36 (9 x 4) measures into Part B. Additionally, the return of the ½-step motive in m. 156 is 39 measures (the product of 13 and 3, the square root of 9) from its first appearance after the climax of m. 117.

The distance between the climax/repulsion combinations of Part B also demonstrates the influence of 9. From the completed repulsion of climax 4 in m. 152 to the onset of climax 5 in m. 165, thirteen measures have transpired. The distance between the completed repulsion of climax 5 in m. 170 and the completed repulsion of the sixth climax, in m. 206 is 36 measures, yet another multiple of 9. The insertion point of the second interpolation is at m. 225, the product of 9 multiplied by 25. Climax 7, the abrupt one with immediate repulsion created by the fermata, occurs in m. 270, the product of 9 and 30. The last portion to be initialized by the ½-step motive occurs in m. 288, 9 multiplied by 32, and 18 (9 x 2) measures later the largest climax of the work, the first of the double-climaxes, occurs.

Finally, owing to Varèse's well-documented penchant for the study of acoustics, it must be noted that the final Eb, exposed in the closing measures of the work also demonstrates a connection with the number 9 and the interval of a 9^{th}: considering the Eb as the fundamental, the 9^{th} partial is F, the lower boundary pitch of the core sound-mass of the initial pitch-plane, P1.

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