MODELS OF OCTATONIC AND WHOLE-TONE INTERACTION: GEORGE CRUMB AND HIS PREDECESSORS

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A bifurcated view of pitch structure in early twentieth-century music has become more explicit in recent analytic writings. Elliott Antokoletz, for example, describes "two extremes of tonal orientation" represented on one side by Schoenberg and his followers, and on the other by a diverse group of composers that includes, among others, Bartók, Debussy, Scriabin and Stravinsky.[1] An axiomatic characteristic of Schoenbergian expressionism is the studied avoidance not only of triadic tonality, but also of the chordal constructions associated with common-practice harmony. Composers outside the Viennese circle, notwithstanding their general lack of interstylistic congruence, were not similarly self-conscious about the retention of these traditional sonorities and allowed their harmonies to migrate freely between tonally focused, tonally ambiguous and non-tonal progressions.

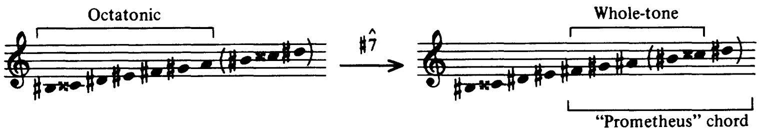
For this repertoire that is neither consistently tonal in a conventional sense, nor designedly atonal, the importance of referential pitch-class collections such as the octatonic and whole-tone "scales" is well documented. Studies that explore in some depth the functions of octatonic and whole-tone materials in early twentieth-century music tend to follow one of two lines of inquiry. The first involves the relationship between one of these collections and an overarching tonal structure, treating the octatonic or whole-tone elements as chromatic inflections or tonally deviant intrusions within a diatonic framework.[2] The second approach focuses more specifically on the special properties and applications of the individual collections themselves.[3]

The interpenetration of octatonic and whole-tone elements has rarely received attention as a discrete phenomenon, despite the fact that it occurs more than sporadically in the repertoire. The subject usually arises only as an isolated by-product of some more generalized approach to pitch structure. Antokoletz, for example, discusses octatonic and whole-tone interaction in combination with diatonic elements as they relate to cyclic interval projections in Stravinsky's ballets.[4] Richard Parks's analysis of Debussy's *Feuilles mortes* (*Préludes,* Bk. 2, no. 8) classifies pitch-class sets according to the octatonic, diatonic, whole-tone and chromatic "genera" (collections and subsets) that intermingle throughout the piece.[5] Similarly, Kip Wile's essay on Stravinsky's *Scherzo fantastique* elaborates upon earlier octatonic-diatonic interaction studies by concentrating on various types of combinations and juxtapositions of whole-tone, diatonic, octatonic and chromatic collections.[6]

George Perle's discussion of Scriabin's Preludes, op. 74 adopts a more entangled explanation of transformations between referential pitch collections.[7] In the fifth prelude, for example, what Perle designates the "master scale" is a seven-note octatonic segment which, with its seventh degree raised, possesses itself of a five-note whole-tone segment (example 1). Perle subsequently extricates from the scale the whole-tone pentachord plus one "odd" note to reveal Scriabin's "mystic" or "Prometheus" chord.[8]

Theoretical writings intended to establish nineteenth-century precedents for twentieth-century practice have in some cases derived both the octatonic and whole-tone collections from linear harmonic successions based on octave-partitioning interval cycles.[9] None of these studies, however, makes any specific claims for the direct association of these collections in compositional applications.

Many of George Crumb's compositions exhibit extensive octatonic–whole-tone interplay, certain aspects of which have their origins in the works of earlier twentieth-century composers. His successful combination of octatonic and whole-tone materials to construct



Example 1. Perle's derivation of referential collections in Scriabin's *Preludes,* op. 74.

larger musical units—often complete pieces or movements—transforms their earlier usage as experimental features of tonally transitional works into viable paradigms for post-tonal composition.[10] By concentrating on their interaction, the present study seeks to augment what is currently understood about the role these collections play as diatonic alternatives in works from the early part of the century, to identify some procedures that serve as precedents and help to provide a historical basis for Crumb's compositional practice, and finally, to illustrate Crumb's extension and application of those procedures in a piece from *Makrokosmos,* Volume I in which octatonic and whole-tone elements are structurally and motivically intertwined.

I

As abstract constructions, the octatonic and whole-tone collections share properties and subsets that facilitate their confederation as reference sets. The adaptability of either collection as a deviant element in tonal writing derives principally from the large number of diatonic scale segments and traditional chordal sonorities it contains. The first three notes of a major scale, for example, are equivalent to a three-note [0,2,4] segment of a whole-tone scale, and the first four notes of a minor scale—[0,2,3,5]—coincide with one of four tetrachordal segments of a scale-ordered octatonic collection.[11] Therefore the transfusion of linear voice-leading progressions and motives from a diatonic to either an octatonic or a whole-tone context permits some degree of continuity even where the underlying harmonies undergo a radical change in character. Often more important, however, are the traditional harmonic constructions associated with functional tonality that also exist as octatonic or whole-tone sonorities. Table 1 lists these sonorities, first as trichordal or tetrachordal set types, then by their traditional names, and indicates the number of occurrences of each in the whole-tone and octatonic collections, and in the [0,1,3,6,7,9] hexachord (also known as the "Petroushka" chord), an octatonic subset that operates as a referential collection in a number of the passages

Table 1
Traditional Sonorities as Octatonic and Whole-Tone Subsets

Subsets			Number of Occurrences in Larger Collections		
set label	prime form	familiar name	Whole-Tone (6-35): [0,2,4,6,8,10]	Octatonic (8-28): [0,1,3,4,6,7,9,10]	"Petroushka" chord (6-30): [0,1,3,6,7,9]
3-8	[0,2,6]	V^7 (5th omitted) or $ø^7$ (3rd omitted)	6	4	2
3-10	[0,3,6]	° triad	0	8	4
3-11	[0,3,7]	M triad/m triad	0	8	2
3-12	[0,4,8]	$^+$ triad	2	0	0
4-24	[0,2,4,8]	$V+^7$	6	0	0
4-25	[0,2,6,8]	Fr+6 or $V^{7}_{\flat 5}$	3	2	1
4-26	[0,3,5,8]	mm7	0	4	0
4-27	[0,2,5,8]	V^7 or $ø^7$	0	8	2
4-28	[0,3,6,9]	°7	0	2	1

discussed below.[12] The whole-tone and octatonic collections have comparatively high degrees of symmetry (12 and 8, respectively), and all three of the larger collections (including the [0,1,3,6,7,9] hexachord) are transpositionally symmetrical at the tritone (T_6). In addition, any whole-tone subset that is found in the octatonic collection also occurs in the "Petroushka" hexachord.

Table 2 presents the three forms of the octatonic collection and the two forms of the whole-tone collection in a rotational array that illustrates pitch-class invariance between them.[13] Virtually every exposition of the octatonic scale describes its construction (in addition to the alternating half-step, whole-step pattern) as the combination of two diminished-seventh chords or [0,3,6,9] set types.[14] For purposes of the present discussion, however, it is advantageous to view an octatonic collection as a union of two "French sixths," or [0,2,6,8] tetrachords, at T_3 or T_9. Because these two tetrachords belong to different whole-tone hexachords that are mutually exclusive in pitch-class content, an octatonic collection is not intrinsically allied with either whole-tone set. The connected circles in table 2 denote pitch classes shared between octatonic and whole-tone sets, demonstrating that an octatonic collection contains four pitch classes from each form of the whole-tone collection. The rectangles in table 2 indicate pitch classes belonging to one whole-tone and two octatonic sets. Whereas any two of the octatonic forms share a [0,3,6,9] tetrachord, the two tritones in that tet-

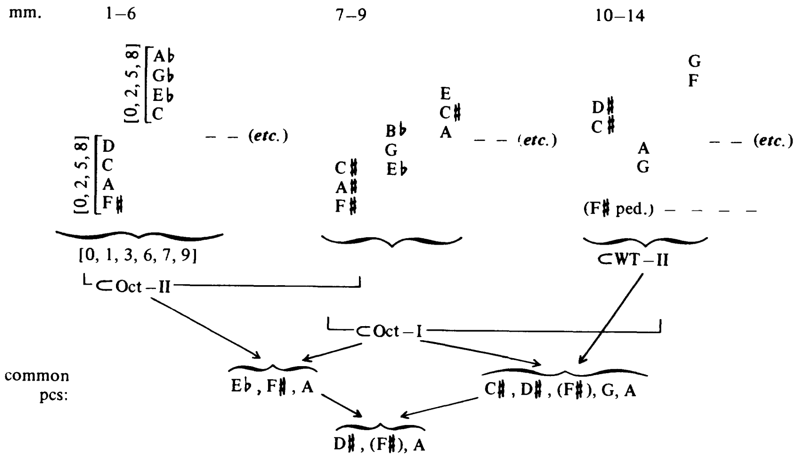
Table 2
Pitch-Class Invariance Between Octatonic and Whole-Tone Forms

pc numbers	0	1	2	3	4	5	6	7	8	9	10	11
Oct-II	C		D	D#		F	F#		G#	A		B
WT-II		C#		D#		F		G		A		B
Oct-III		C#	D		E	F		G	G#		A#	B
WT-I	C		D		E		F#		G#		A#	
Oct-I	C	C#		D#	E		F#	G		A	A#	
WT-II		C#		D#		F		G		A		B
Oct-II	C		D	D#		F	F#		G#	A		B
WT-I	C		D		E		F#		G#		A#	
Oct-III		C#	D		E	F		G	G#		A#	B
WT-II		C#		D#		F		G		A		B
Oct-I	C	C#		D#	E		F#	G		A	A#	
WT-I	C		D		E		F#		G#		A#	
Oct-II	C		D	D#		F	F#		G#	A		B

rachord are members of opposing whole-tone forms, so that any two octatonic sets and a whole-tone set contain a single tritone as a common element. These shared elements provide a compositional incentive for "modulations" from one collection to the other, or between different forms of the octatonic collection.

The opening of Debussy's *Ce qu'a vu le vent d'Ouest,* from the first book of *Préludes,* illustrates this kind of interaction. The first fourteen measures, given in example 2, consist of three segments. The first begins with an arpeggiation of a dominant six-five type construction ({F♯,A,C,D} or [0,2,5,8]), which is expanded by the addition of a [0,2,5] trichord ({E♭,G♭,A♭},) at measure 3. The E♭ on beats two and four coincides with and incorporates the C of the lower arpeggio in a way that partitions the composite [0,1,3,6,7,9] hexachord—an Oct-II

Example 2. Debussy: *Ce qu'a vu le vent d'Ouest,* mm. 1–14.



Example 3. Octatonic and whole-tone elements in *Ce qu'a vu le vent d'Ouest,* mm. 1–14.

subset—into paired [0,2,5,8] tetrachords at T_6.[15] As indicated in example 3, the collection shifts at measure 7 to Oct-I (absent the C), expressed as a compound line in parallel major triads on F♯, E♭ and A.[16] The "roots" of the triads form a pitch-class link with the preceding hexachordal subset of Oct-II and also with the WT-II set (with B omitted) established subsequently in measures 10–14. Oct-I and WT-II share the [0,2,6,8] tetrachord {C♯,D♯,G,A}.[17] The tritone A–D♯/E♭ is the common element in all three sets, and it receives special emphasis as a melodic gesture as well in measures 7–9 and 10–14. The F♯ that lies outside WT-II carries over as a pedal from the first two segments of the passage.[18]

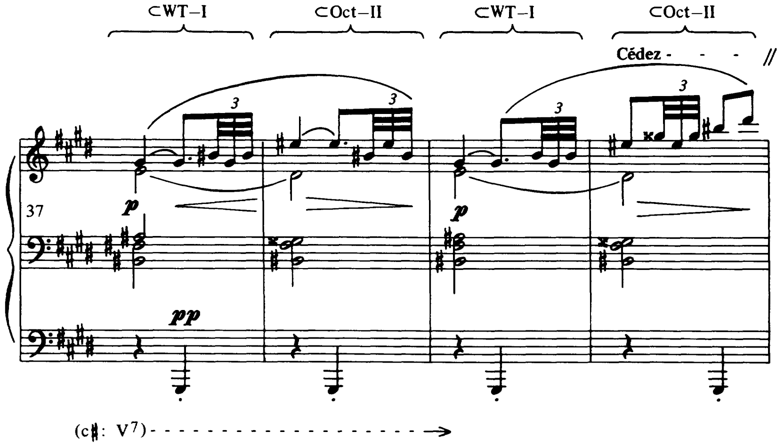
The juxtaposition of contrasting collections often relies on the retention of common tones for musical continuity. Passages based on octatonic and whole-tone oscillation are normally tangential to underlying tonal structuring, but in exceptional circumstances they may serve to reestablish or reinforce functional relationships. Debussy's prelude *Feuilles mortes* implies a tonality of C♯ minor through its key signature of four sharps, its concluding C♯ major harmony (a kind of "Picardy third"), and the chromatically colored C♯ harmony (C♯[7] with a "split third" and added minor ninth) that appears at or near the beginning of all three statements of the opening thematic idea at measures 1–5, 15–18, and 41–46 (see, e.g., measure 15 in example 4). As Parks states, however, "the role of harmony and voice leading as tonal determinants is conspicuously weak. . . ."[19] Even the opening theme

Example 4. Debussy, *Feuilles mortes,* mm. 15–28.

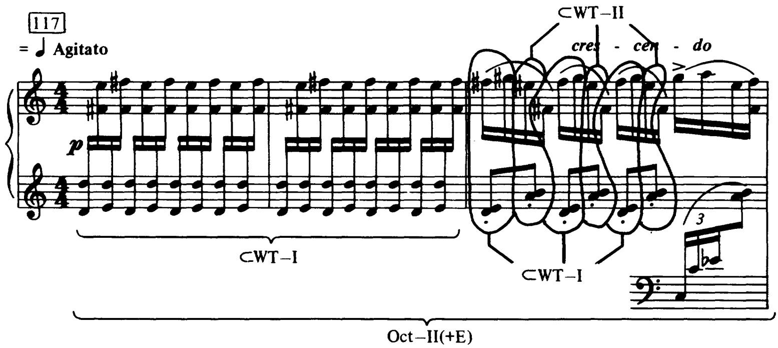
is more octatonic than tonal, and specific octatonic and whole-tone forms dominate a large portion (mm. 19–31) of the middle section. The restatement of the opening thematic material shown at the beginning of example 4 dissolves via a descending line that sets up WT-I at measure 19, and an Oct-I passage supplants the WT-I material at measure 25. The pitch content of measures 15–18 fluctuates first between different forms of the octatonic collection, and then between octatonic and whole-tone collections in measures 17–18, failing to project a single, unifying referential set. The mustering of WT-I pitch-classes in measures 21–24, and subsequently those belonging to Oct-I, provides two contrasting areas of comparative stability despite the absence of a specific tonal focus. The only pitches in the excerpt that do not belong to the indicated whole-tone and octatonic sets are the sixteenth-note chromatic passing tones in measures 17–24 and the G♯ pedal that underlies the Oct-I passage beginning at measure 25 (the notes enclosed in parentheses in example 4).

Measures 37–40, which immediately precede the final statement of the opening theme, realize the potential tonal associations of the octatonic and whole-tone collections (example 5). Here the pitch content alternates in successive measures between WT-I and Oct-II subsets. The retention of G♯, B♯ and F♯ throughout the passage, and the placement of G♯ as a harmonic anchor in the low register, simulate a retransition based on dominant prolongation that sets up the final statement of the opening material and the return of C♯ as a focal harmony.[20] The shared [0,2,6] trichord {G♯,B♯,F♯} functions in these measures not only as a unifying element that recalls and accelerates the pendular exchange between the contrasting collections, but also as the essential skeleton of a dominant seventh harmony. (See the first entry in table 1.)

The model of octatonic and whole-tone interaction expressed in these two Debussy preludes is based on the alternation of contrasting sonorities. Linkage between discrete collections results from the retention of shared pitch classes and, in measures 37–40 of *Feuilles mortes,* through harmonic prolongation. A passage from the fourth tableau of Stravinsky's *Petroushka* comprises a different sort of exchange in which octatonic collections accrue from the rapid alternation of opposing whole-tone subsets. Example 6 shows the first three measures of the Mummers' dance at No. 117 of the score. (This and the following two score excerpts are taken for convenience from the 1921 piano transcription.) The D, E, and F♯ are remnants of a preceding diatonic collection that initiate a WT-I subset. Successive eighth-note pulses in measure 3 shift back and forth between WT-I and WT-II subsets of Oct-II until the last beat, where the remaining Oct-II pitch classes enter and establish the preeminence of the



Example 5. *Feuilles Mortes,* mm. 37–40.



Example 6. Stravinsky: *Petroushka* No. 117, mm. 1–3.

octatonic collection. The subordination of the whole-tone collection is not absolute, however, because one note (E) of the WT-I subset does not belong to Oct-II. This blurring of octatonic and whole-tone elements continues as the pattern in measure 3 ascends in a sequence of essentially parallel motion through Oct-III and Oct-I. The pattern maintains the original whole-tone divisions so that at each level in the sequence there is always one note that lies outside the prevailing octatonic set.

At No. 118, all hints of the whole-tone sets evaporate, giving way to a complete and unadulterated Oct-II passage in which the bass line descends scalewise beneath a continuously repeated chord in the upper parts (example 7). The reconsolidation of pitch-class content at No. 119 abolishes Oct-II in favor of a hexachord that is closely associated with WT-II—C, D♭, E♭, F, G, A, or a "mystic chord" set consisting of a five-note whole-tone segment with an appended alien pitch class (example 8). Parallel trichords in the upper and lower parts progress in contrary motion by whole steps, unfolding a complete WT-II in the outer voices. The shift at No. 119 is rhythmically, texturally and dynamically abrupt, but the retention of three pitch classes in the upper parts (E♯/F, B♯/C and A) provides a connection that makes the sonority at the point of transformation sound like a new harmonic setting for the upper voices. The more dramatic change in the referential collection becomes apparent only with the symmetrical expansion of the new vertical construction. Both the octatonic collection at No. 118 and the whole-tone collection at No. 119 arise out of preceding material. The continuity of the music derives in part from the retention of common elements, and in part as a result of the eventual codification of distinct collections from the jumbled composite at No. 117.

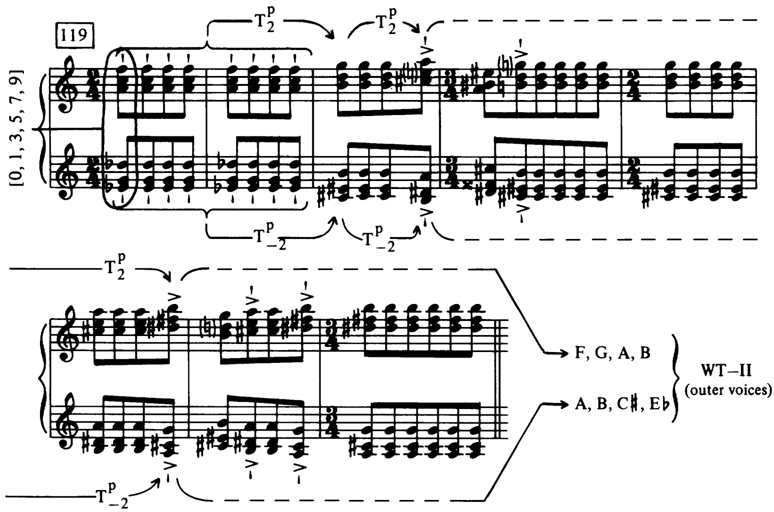
II

Octatonic or whole-tone writing is frequently associated with the use of transpositional patterns, as evidenced in portions of the preceding examples. The whole-tone collection that unfolds in the outer voices of example 8, for instance, is the result of a transpositional scheme based on contrary motion in whole steps. Whereas the cardinality of the set (i.e., the number of discrete pitch-classes it contains) varies, the even-numbered transpositions ensure the consistent WT-II allegiance of all the notes except the middle note of the upper trichord, which always belongs to WT-I.

The compositional potential of the transposition operation is more profound as it relates to the interplay between octatonic and whole-tone sets, because different levels of transposition may have a similar or contrasting effect on the two collections. The octatonic collection has four degrees of transpositional symmetry, whereas the whole-tone collection has six. Table 3 shows the results of all possible levels of transposition on one form of each collection, and the information it provides leads to the following corollaries:

1. T_0 and T_6 preserve the form of an octatonic *and* a whole-tone set.
2. T_3 and T_9 preserve octatonic form but *not* whole-tone form.
3. T_2, T_4, T_8 and T_{10} preserve whole-tone form but *not* octatonic form.
4. T_1, T_5, T_7 and T_{11} alter both octatonic *and* whole-tone form.

Example 7. Petroushka No. 118.



Example 8. Petroushka No. 119, mm. 1–8.

Table 3
Octatonic and Whole-Tone Form Under Transposition

Collection/Form		Transposition		Resultant Form
Oct-I	@	$T_{0,3,6,9}$	=	Oct-I
Oct-I	@	$T_{1,4,7,10}$	=	Oct-III
Oct-I	@	$T_{2,5,8,11}$	=	Oct-II
WT-I	@	$T_{0,2,4,6,8,10}$	=	WT-I
WT-I	@	$T_{1,3,5,7,9,11}$	=	WT-II

Complete octatonic or whole-tone sets often ensue from patterns based on successive transpositions of one of their subsets.[21] Whether the particular form of the collection remains constant, however, depends on the transpositional pattern employed. For smaller constructions that are subsets of both types of collections, it is the transpositional scheme that determines which of the collections, as well as which form of a collection, is projected in a specific passage. The two examples from Scriabin's piano works discussed below give evidence of the structural role of the transposition operation as it pertains to octatonic and whole-tone interaction.

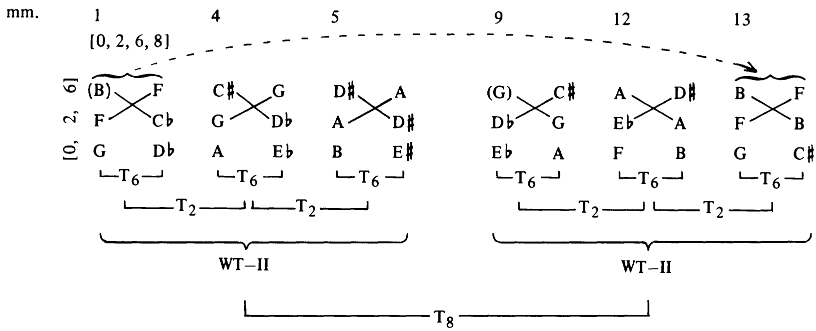
The Etude, op. 65, no. 3 proceeds in two registral strata, separated according to staves. The first sixteen measures, given in example 9, illustrate the nesting of transpositional patterns that characterizes much of the piece. The principal harmonic unit in this section is an incomplete "mystic" chord—a [0,1,3,5,7] pentachord composed of a four-note whole-tone segment plus one additional pitch class—that occurs on almost every beat in various transpositions. (The first beat of m. 1, e.g., is E, F, G, A, B.) The pitch-class content of the lower stratum, or left-hand part, consists of a series of [0,2,6] trichords that express WT-II through a complex of interlocking transpositional patterns (example 10). Tritone transpositions of the opening sonority on the second beats of measures 1–3 alternately reorder the upper two notes of the lower trichord (F–B) and yield a new pitch class (D♭) in the bass. The full-measure unit moves in a sequential pattern with restatements at T_2 beginning at measure 4 and measure 5, producing a complete WT-II in the bass line. Measures 9–16 restate the material of measures 1–8 at T_8, reproducing in measures 13–16 the pitch classes from the first beat of measure 1 to achieve a kind of sectional closure.

The even-numbered transpositions of the [0,2,6] trichord on the lower stratum continue throughout most of the piece, with the exception of T_9 relationships at measures 30–31 and 44–45 that create a section in which the lower stratum converts to WT-I. The odd-numbered transpositions do not return until the coda (mm. 95–102), where a series of T_3 and T_9 progressions of the trichord express a complete Oct-III set ({B,C♯,F}→T_3→{D,E,G♯}→T_9→{C♭,D♭,F}→T_9→{G♯,A♯,C𝄪} →T_9→{F,G,B} etc.).

The whole-tone structure of the lower stratum preceding the coda is the product of selective transpositions and is not attributable to the basic [0,2,6] trichord itself. Even the initial T_6 pairing in measures 1–3 does not conclusively establish WT-II as the principal referent because the composite [0,2,6,8] tetrachord is also an octatonic subset.[22] In this etude the summary role of the coda is limited to its connection with the isolated T_9 relationships at measures 30–31 and 44–45 (the only other odd-numbered transpositions in the piece). Its primary function is the realization of the octatonic potential of measures 1–3, in contrast with the rest of the piece, which exploits only the whole-tone implications of the opening.

A transpositional complex projects octatonic and whole-tone elements simultaneously in the opening measures of Scriabin's Piano Sonata No. 9, op. 68—the "Black Mass" (example 11). The pitch content of the first four measures grows out of two-voice counterpoint that emphasizes WT-II (example 12). The upper voice descends chromatically from B while the lower voice outlines two tritones: G–C♯ followed by F–B. These melodic progressions result in a quasi-voice

Example 9. Scriabin: Etude, op. 65 no. 3, mm. 1–16.



Example 10. Nested transpositions in op. 65 no. 3, mm. 1–16 (lower stratum).

exchange at the beginning of the second measure: the chromatic line arrives on G concomitantly with a transfer of the B in the lower voice to the higher octave, replicating the original dyad. A second statement of the progression, transposed down by a tritone, also begins on the downbeat of measure 2. As a consequence of the symmetrical property of the tritone, paired pitch classes of the lower voice in measure 2 recur in reverse order: the two pitch classes involved in the voice exchange of the first statement are nested at the center of the line in the second statement, and vice versa. Both patterns are repeated in the next two measures, concluding on the first beat of measure 5. These pitches (F, G, B, C♯) that frame the contrapuntal structure, and all the other notes in measure 1–4 except for the apparent passing notes in the descending chromatic line, are members of WT-II. The [0,2,6,8] tetrachord formed by the principal structural notes, however, also belongs to Oct-III, as do the pitch classes of the first two dyads in each contrapuntal progression.

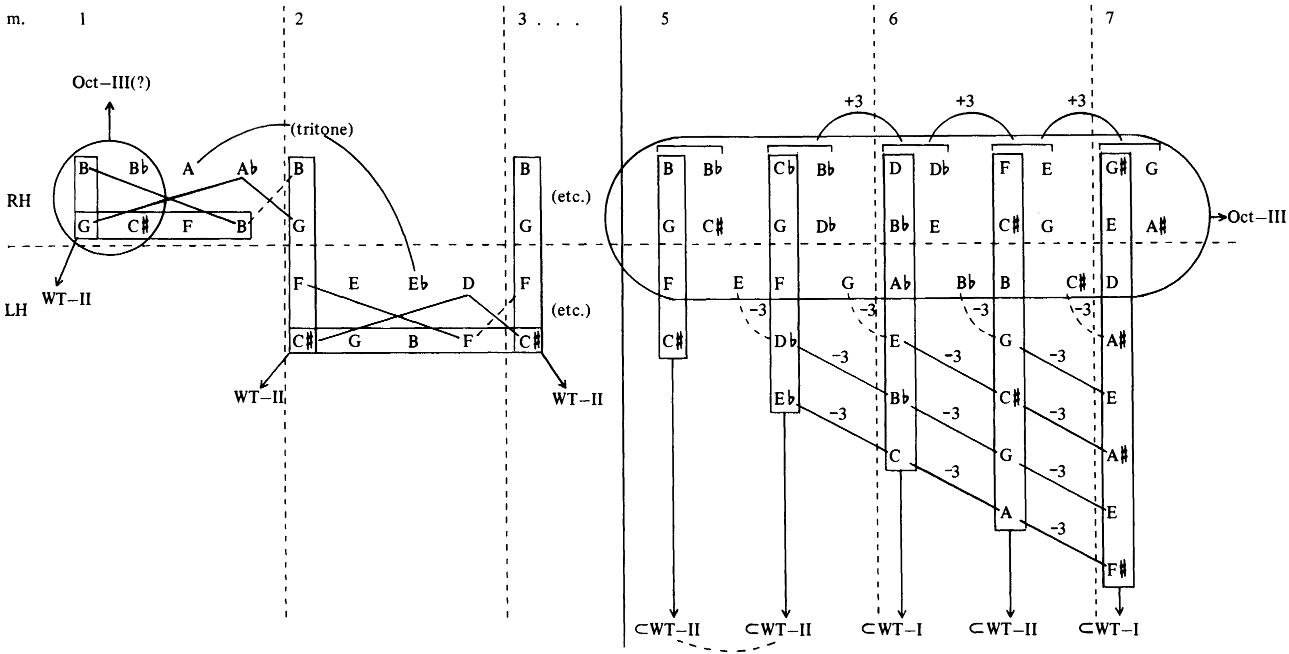
Measures 5–7 expound on both the whole-tone and octatonic implications of the first four measures. The original dyad-pair rises sequentially in a T_3 pattern beginning on the first beat of measure 5 to produce a complete Oct-III, and the voice on the middle staff in measures 5–6 unfolds the same set in scalar form, concluding with the D on the downbeat of measure 7. The descending arpeggios, which incorporate the off-beat pitches of the scalar progression in the middle voice, increase in size by one note in each successive statement, and the pitches in the arpeggios combine with corresponding dyads on the upper staff to produce alternating WT-II and WT-I sonorities. The pattern cadences on the second beat of measure 7 with an E♭ minor harmony over A in the bass. This sonority introduces a new motivic idea based on Oct-I; a restatement of the new motive at T_4 reestab-

Example 11. Scriabin, Piano Sonata No. 9, op. 68, mm. 1–13.

lishes Oct-III, and in measure 11 an altered version of the opening theme returns.

The salient feature of the structural complex in measures 5–7 is that similar transpositional projections in contrary motion generate the contrasting collections. The ascending T_3 sequence in the upper parts preserves the Oct-III form, whereas the expanding arpeggiations based on a descending projection of the same interval (T_9) fluctuates between the two whole-tone forms.[23]

For either the octatonic or whole-tone collection, the number of degrees of inversional symmetry (four and six, respectively) equals



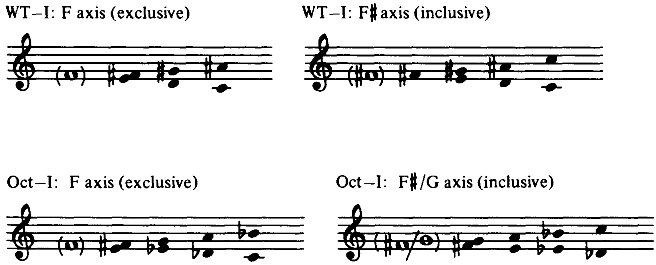
Example 12. Piano Sonata No. 9, op. 68: Pitch structure, mm. 1–7.

that of transpositional symmetry. The nature of the inversional axes, however, is not the same for both collections. Any axis in a whole-tone set is always located on a specific pitch class, but the axis of an octatonic set may also be positioned between two pitch classes; and whereas the projection of a whole-tone collection around an axis may be inclusive or exclusive of the axis note itself, an octatonic projection always includes the notes of the "split" axis and excludes the single-note axis, as illustrated in example 13.

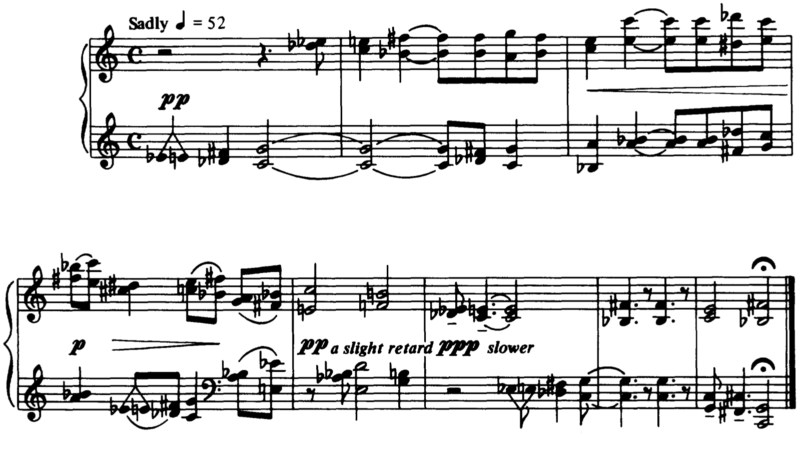
The transpositional schemes in No. 119 of *Petroushka* and measures 5–7 of the "Black Mass" sonata (examples 8 and 11–12) are symmetrically conceived, but they do not involve the uniform distribution of pitches around an axis. Among non-Schoenbergian composers of the early twentieth century, Bartók is the one best known for his use of inversionally symmetrical constructions.[24] Perhaps surprisingly, however, Bartók seems not to have developed an interest in the integration of these collections at any level, although octatonic and, to a lesser extent, whole-tone elements were important to him as pitch-structural resources. Models of the interaction of octatonic and whole-tone material within a framework of axial symmetry occur only later in the century—not only in George Crumb's works, but also in those of his composition teacher, Ross Lee Finney.

Finney (b. 1906) adopted what was for his time a conservative approach to composition, embracing neither the Schoenbergian atonal aesthetic nor the antiestablishmentarian avant-garde of the post-World War II period. He occasionally experimented with serial procedures but did not eschew traditional tonal sonorities. Although his music has not been addressed in the theoretical literature, he merits some attention as a possible link between composers of the early twentieth century and those of the post–avant-garde.

Finney's predilection for melodic permutation and symmetrical constructions is evident in his didactic piano works such as the *32 Piano Games* and the *24 Inventions.* The Invention No. 20, "Double Mirrors," is given in example 14. Its pitch content consists of two linear strains of dyads, each of which revolves around a shifting axis of symmetry (example 15). From the beginning through the first beat of measure 3, the axis of the lower staff ("LH") is E♭4/E4, whereas the axis of the upper parts ("RH") is D5. As the dyads expand and contract, the intervallic patterns around the axes initiate a complete octatonic collection (Oct-I). Wherever the axes shift, it is almost always by tritone, so that paired pitch classes around the point of symmetry remain constant, but with their relative positions reversed. (This feature is apparent in the shift on the first beat of measure 3, where the upper axis changes from D5 to A♭5 and the C and E exchange places.)

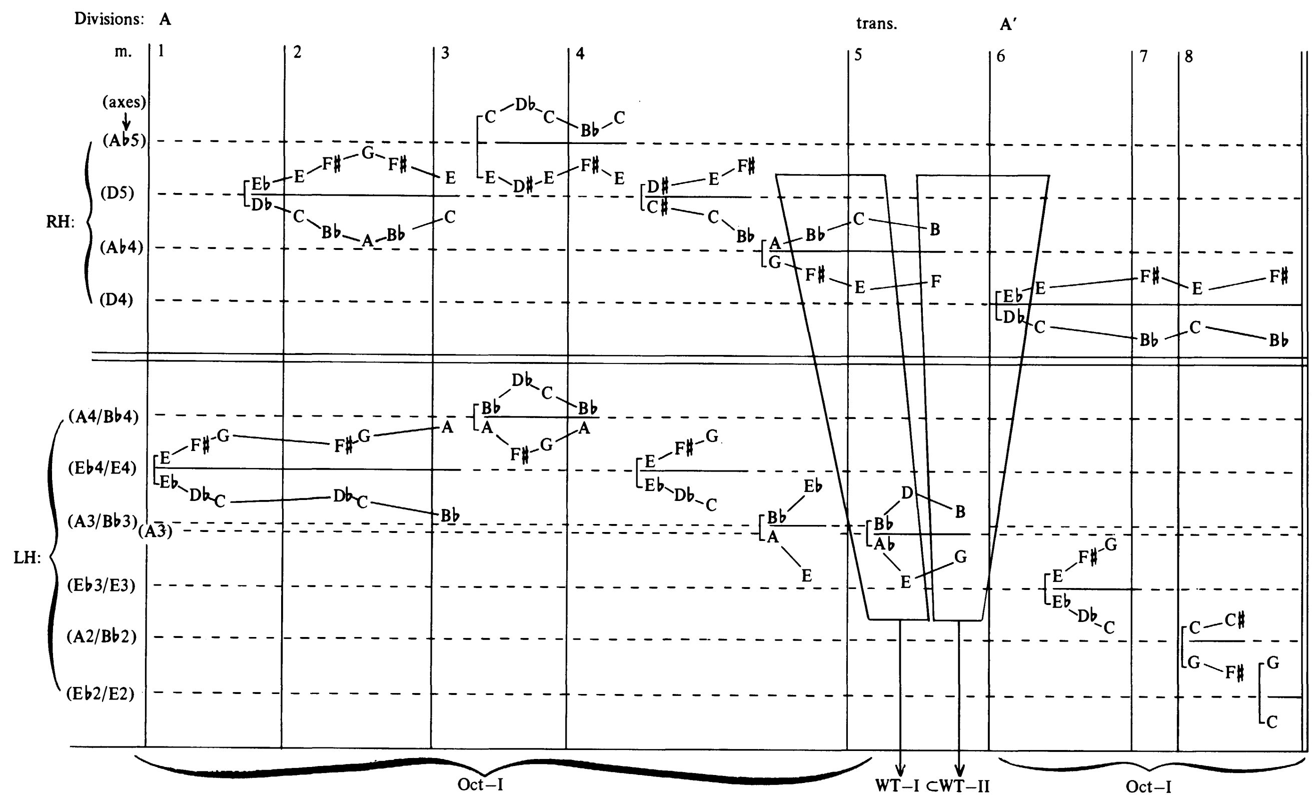


Example 13. Two types of inversional axes for octatonic and whole-tone collections.



Example 14. Finney: "Double Mirrors" from *24 Inventions.*

An exceptional shift occurs in measure 5, where the lower axis drifts downward by a quarter-step to A3. At this point the dyads projected on the lower staff combine with those on the upper staff to produce whole-tone, rather than octatonic, sonorities—first WT-I, then WT-II. The whole-tone sets overlap the surrounding Oct-I pitches by one dyad on either side of measure 5, but only in the upper voices, which are organized throughout the piece around specific pitch-class axes; the split axes of the lower voices cannot generate whole-tone constructions. The temporary dislocation of the lower axis also helps to delineate the formal sections of the piece because at measure 6 the opening material returns, this time with the upper voices leading. The resulting arrangement is a kind of simple binary form with the first



Example 15. Pitch structure in "Double Mirrors."

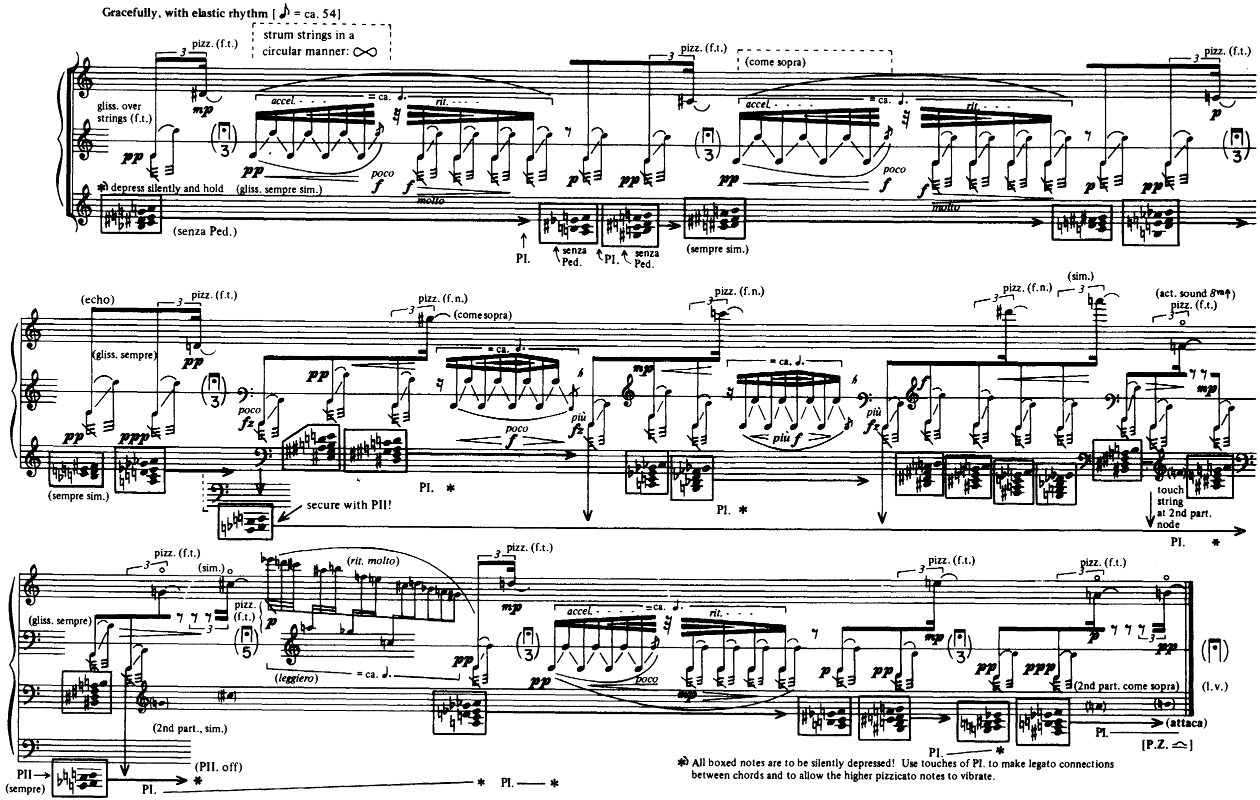
section (*A*) merging into a transitional figure in measure 5, which is succeeded by an abbreviated reprise (*A′*) in measure 6–8. A supporting aspect of form in "Double Mirrors" is its implied C major tonality. C major triads occur at the beginning of measure 2, the end of measure 3, and on the third beat of measure 4. The tonality is reinforced by the implied dominant seventh harmony at the end of measure 5 that immediately precedes the return of the theme, and by the final harmony, which is also based on C with two coloristic added notes (♭7 and ♯4).

III

The importance of symmetry and transpositional projections in George Crumb's works can hardly be overstated. Crumb routinely achieves clarity through the manipulation of a limited number of pitch constructions within some large-scale symmetrical progression. The larger progressions, in turn, are meticulously devised to emphasize specific pitch classes through invariance, recurrence and registral placement, resulting in a network of motivic relationships that contributes to the integrity of the musical structure. Contrast within individual pieces or movements frequently depends on the interplay between opposing types of referential collections. In "Music of Shadows (for Aeolian Harp)" from *Makrokosmos,* Volume I, contrast is based almost entirely upon octatonic and whole-tone interaction. This piece also incorporates to some extent all the procedures employed in his predecessors' "models" examined above.

The notation of extended modes of performance gives the score a characteristically complicated appearance (example 16). Its pitch content, however, is reducible to a few basic components. The principal constructions are the boxed chords that begin on the lower staff and continue throughout the piece. These notes are articulated in the manner of an autoharp, with the keys depressed silently and the pitches sounded by strumming over the strings inside the piano. Another chord enters in the lower register near the beginning of the second system and extends through several rearticulations to the five-second fermata on the third system. Some individual *pizzicato* pitches on the upper staff are interspersed between the strummed chords, and the only other type of gesture is the series of *pizzicato* notes immediately following the five-second fermata.

The series of boxed chords on the principal stratum consists of only three types of constructions. The first is an octatonic subset, specifically the [0,1,3,6,7,9] "Petroushka" hexachord generated by the superimposition of two [0,2,5] trichords (e.g., B♭–C♯–D♯ and E–G–A in the first chord); the second is a five-note whole-tone segment. These two chord types occur at various transpositional levels until the



Example 16. Crumb: "Music of Shadows (for Aeolian Harp)," *Makrokosmos* Vol. I No. 7.

middle of the second system, where a series of nine [0,1,3,6,9] pentachords begins. The pentachords resemble the original hexachord with one note omitted. The sonority on the lower stratum is an invariant [0,1,6,7] tetrachord, also an octatonic subset.

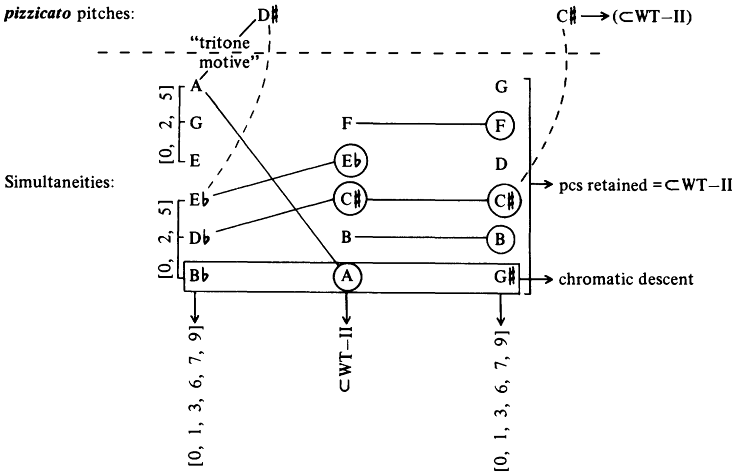
The ostensibly irregular miscegenation of pitch materials in "Music of Shadows" poses three "enigmas" that are addressed in the analysis below: 1) the structural basis for the particular pattern and transpositional levels of the octatonic and whole-tone subsets that form the chord succession of the principal stratum; 2) the reason for the omission of one member of the hexachord to produce the pentachordal octatonic subset used in the central portion of the piece; and 3) the function of the invariant tetrachord in the lower register. The solutions to these enigmas are closely linked to the overall form of the piece as determined by certain concealed pitch-structural relationships and motivic connections.

Example 17 divides the chord succession into five formal units in a ternary arrangement: an introduction consisting of the first three chords; an *A* section consisting of the next five chords; *B,* the first four chords of the middle section; *B′*, the remaining seven chords of the middle section; and *A′*, the final five chords which follow the five-second fermata and the short transitional figure on the third system. The procedure in this piece that "explains" the fist two enigmas concerns the retention of certain pitch classes between adjacent chords in the succession as well as, in some sections, the disposition of pitches in the lowest voice around an axis of symmetry. In the introduction, for example, three of the six pitch classes in the first chord are retained in the second chord (the A, C♯ and E♭ circled on the first graph of example 17). The third chord retains the B, C♯ and F from the second chord. All these notes belong to WT-II, as do all the pitches of the second chord and the two *pizzicato* notes on the upper staff. The process established in this passage also includes the chromatic descent from B♭ to G♯ in the lowest voice—an idea which is composed out on a larger scale in the rest of the piece. A third structural feature exposed in the introduction is a motivic idea expressed by the melodic motion from A (the highest pitch in the opening chord) to D♯ (the first *pizzicato* note), designated the "tritone-motive" in example 17.

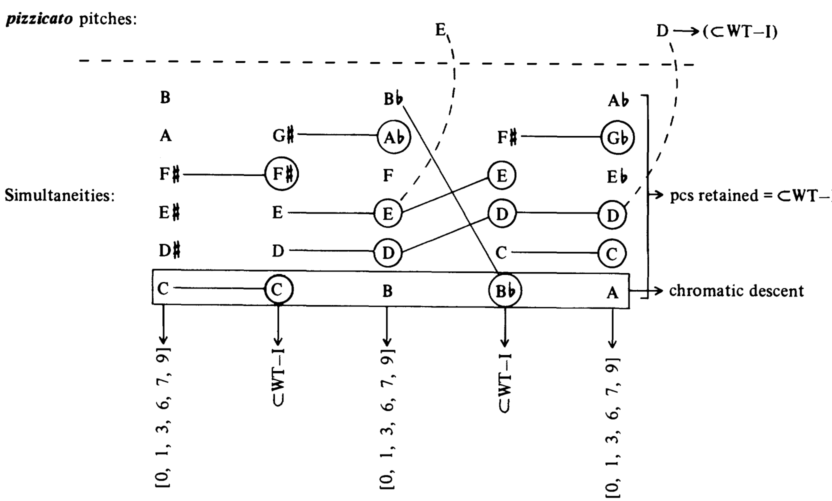
Section *A* continues the process of retaining in successive chords pitch classes belonging to a single whole-tone set; but here the pitch classes emphasized in this manner, plus the *pizzicato* notes and the two whole-tone chords in the group, are members of WT-I. This section also contains a chromatic descent in the lowest voice, this time from C to A.

The descending chromatic line is interrupted by the middle section, in which all but the first two chords of the principal stratum are

INTRODUCTION

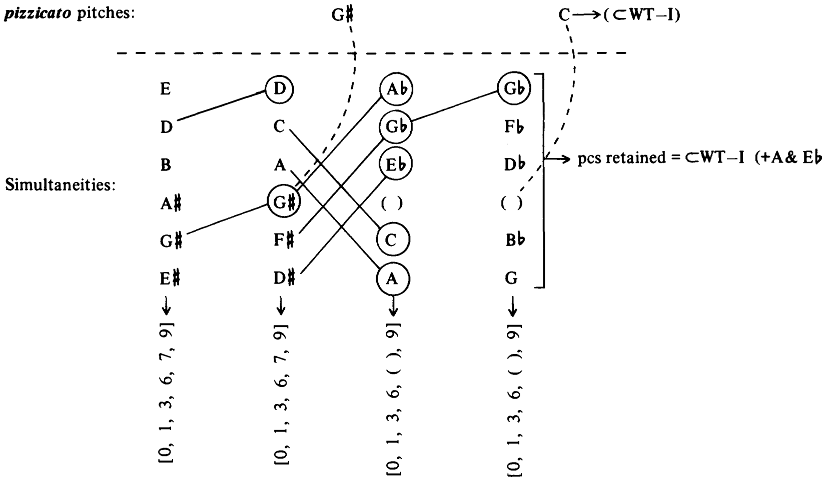


SECTION A

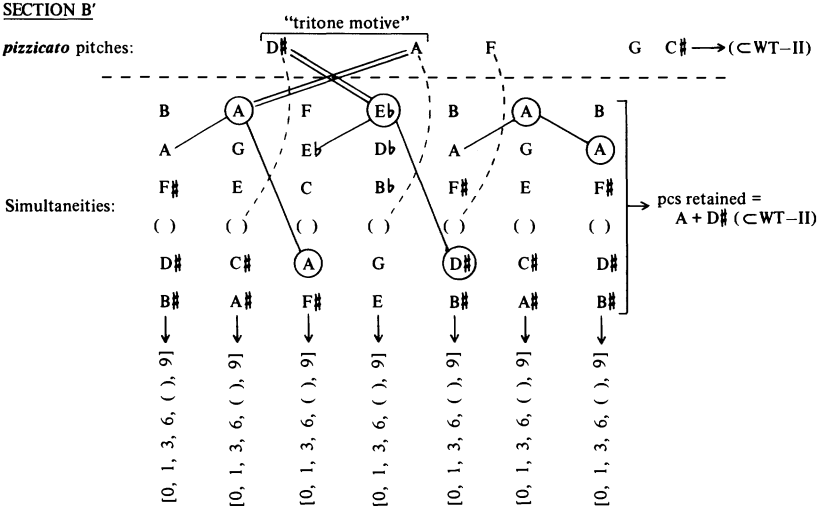


Example 17. Pitch structure in "Music of Shadows."

SECTION B

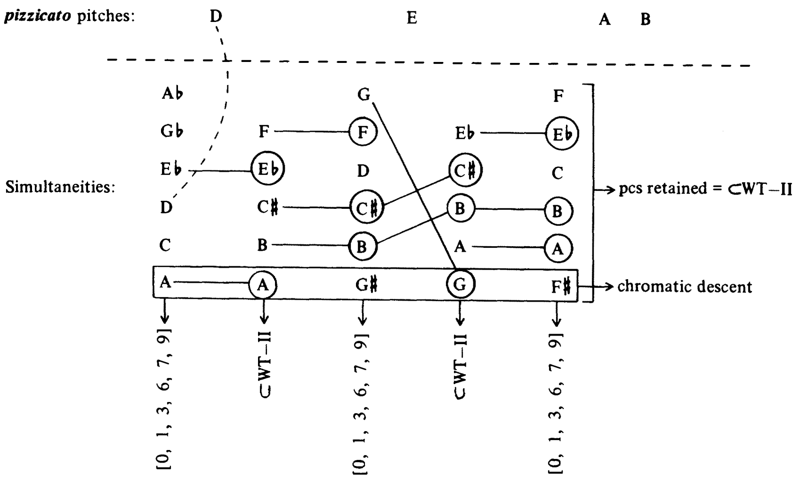


SECTION B′



Example 17 (continued)

SECTION A′



Example 17 (continued)

pentachordal relatives of the opening hexachordal sonority. The first four chords of this passage (section *B*) follow a procedure similar to that of the preceding groups: the *pizzicato* notes and most of the pitch classes shared between adjacent chords are members of WT-I, but A and D♯ from the opposing WT-II also appear in both the second and third chords. In the *B′* group the emphasis shifts back to WT-II, but with the specific limitation that only the pitch classes of the tritone-motive are retained in successive chords. The A and D♯/E♭ are highlighted as *pizzicato* notes in the upper register, forming the melodic climax of the piece, and are also part of a voice exchange between the uppermost pitches of the chords that immediately precede each of them. This emphasis on the tritone-motive offers one explanation for the shift in the middle section from hexachordal to pentachordal octatonic sonorities: the inclusion of the "missing" notes would result in the retention of pitches other than A and D♯ within the succession.

Section *A′* marks a return to the two types of sonorities used earlier in the piece and resumes the chromatic descent of the lowest voice initiated in section *A*. The continued descent forms an expanded version of the arrangement in the introduction. The *A* group descends from C to A, and the *A′* group extends the progression to F♯, with A as the axis of symmetry and the point of interruption for the complete progression.

These compositional procedures provide solutions to the first two enigmas in "Music of Shadows:" first, the retention of whole-tone–related pitch classes between alternating octatonic and whole-tone sonorities within sections; second, the symmetrically arranged chromatic descent of the lowest voice in the outer sections; and third, the elaboration of a central motivic idea—the A–D♯ tritone—which becomes a climactic feature in the middle section. The answer to the final enigma concerning the independent sonority on the lower stratum also has a connection to the large-scale structure of the piece. The first chord in section *A* and the last one in section *A′* are tritone-related, and because this hexachord is symmetrical at T_6, they have the same pitch-class content. These chords, which frame the main body of the piece as well as the larger chromatic descent in the lowest voice, are the only ones in the piece that contain all four pitch classes (F, G♭, B, C) of the pedal sonority from the middle section. The additional notes that complete the hexachord are the A and D♯ of the pervasive "tritone-motive," thus fortifying the close correlation between motivic structure, form and pitch-class invariance on all three textural strata.

The octatonic and whole-tone elements in "Music of Shadows," as with many of Crumb's works, are distinctive in their emancipation from any enlarged diatonic context. At the same time, descriptive labels such as "chromatic" or "atonal" are too general to account for the pitch-structural orientation of the piece. The interpenetration of these referential collections is not without precedent, but Crumb's specific approach is unique in its elevation of existing techniques to the level of independent procedures capable of generating motivically unified, complete musical structures. This kind of procedural expansion exemplifies Crumb's adaptation of traditional models that include not only referential collections, but also characteristic sonorities (such as the [0,1,6,7] tetrachord so common in Bartók) and organizing principles (for example, isorhythm and mensuration canon), as well as direct musical quotations. The ascendancy of aggregate-based atonal and serial methods during the mid-twentieth century may have temporarily relegated these symmetrical referential collections to a subordinate role, but recent works by a number of composers provide evidence that the compositional opportunities offered through interaction between octatonic, whole-tone, and related sonorities such as the "Petroushka" and "Prometheus" chords, were not exhausted in the early part of the century. Crumb in particular has developed clear and aurally accessible models for the integration of two, and sometimes more, non-diatonic reference sets that stand on a par with diatonic and chromatic writing within the broader spectrum of his eclectic harmonic language.

NOTES

1. Elliott Antokoletz, *Twentieth-Century Music* (Englewood Cliffs: Prentice-Hall, 1992), p. viii.
2. See, for example, Arthur Berger, "Problems of Pitch Organization in Stravinsky," *Perspectives of New Music* 2/1 (1963): 11–42 where the term "octatonic" originates; the analysis of Villa Lobos' *Chôros* No. 10 in Antokoletz, *Twentieth-Century Music,* pp. 230–236, which deals with the combination of diatonic and octatonic sets; and Pieter van den Toorn, *The Music of Igor Stravinsky* (New Haven and London: Yale University Press, 1983), the most extensive octatonically-based study of music by a single composer. James Baker, *The Music of Alexander Scriabin* (New Haven and London: Yale University Press, 1986), pp. 1–43 passim, explores the functional role of whole-tone subsets (in particular the "French sixth" or $V_{\flat}{}^{7}_{5}$ construction) and prolongations. Arnold Whittall, "Tonality and the Whole-Tone Scale in the Music of Debussy," *Music Review* 36/4 (1975): 261–271, discusses whole-tone sonorities that contrast with diatonic passages as a kind of "expanded tonality."
3. Studies that concentrate on octatonic usage include Michael Eckert, "Octatonic Elements in the Music of Luigi Dallapiccola," *Music Review* 46/1 (1985): 35–48; Allen Forte, "Debussy and the Octatonic," *Music Analysis* 10/1–2 (1991): 125–169; and especially Richard Cohn, "Bartók's Octatonic Strategies: A Motivic Approach," *Journal of the American Musicological Society* 44 (1991): 262–300, which includes a thorough abstract study of the collection. A discussion of whole-tone collections and subsets as they are employed in some of the music under consideration here appears in Simon Harris, "Chord Forms Based on the Whole-Tone Scale in Early Twentieth-Century Music," *Music Review* 41/1 (1980): 36–51; see also Roy Howat, *Debussy in Proportion: A Musical Analysis* (Cambridge: Cambridge University Press, 1983), pp. 46–63, in which the analysis of *L'Isle Joyeuse* deals with the interaction of diatonic, whole-tone and "acoustic" (♯4/♭7) scales in relation to proportional divisions.
4. Antokoletz, "Interval Cycles in Stravinsky's Early Ballets," *Journal of the American Musicological Society* 39 (1986): 578–614.
5. Richard Parks, *The Music of Claude Debussy* (New Haven and London: Yale University Press, 1989), pp. 77–87.
6. Kip Wile, "Communication and Interaction in Stravinsky's *Scherzo fantastique* (1907–1908)," *Indiana Theory Review* 13/1 (1992): 87–112; see especially the discussion of his examples 3 and 4 on pp. 99–104.
7. George Perle, "Scriabin's Self-Analyses," *Music Analysis* 3/2 (1984): 104–109.
8. Ibid., p. 117. Perle goes on to state that this sonority "serves as . . . the closing chord of [Berg's] *Wozzeck* and as the principal referential collection of the work as a whole." Bryan Simms, *Music of the Twentieth Century* (New York: Schirmer Books, 1986), pp. 40–41 also notes the use of this collection by various early twentieth-century composers, referring to it as the "nearly whole-tone hexachord."
9. See Gregory Proctor, *The Technical Bases of Nineteenth-Century Chromatic Tonality* (Ph.D. diss., Princeton University, 1978); Richard Taruskin, "Chernomor to Kaschei: Harmonic Sorcery, or Stravinsky's 'Angle'," *Journal of the American Musicological Society* 38 (1985): 72–142; and Richard Bass, "Liszt's

Un sospiro: An Experiment in Symmetrical Octave-Partitions," *Journal of the American Liszt Society* 32 (1992): 16–37.

10. For two analyses of complete pieces that demonstrate to some degree the structural significance of octatonic and whole-tone elements in Crumb, see Richard Bass, "Sets, Scales and Symmetries: The Pitch-Structural Basis of George Crumb's *Makrokosmos* I and II," *Music Theory Spectrum* 13/1 (1991): 1–20.
11. The role of the [0,2,3,5] "minor" tetrachord as an octatonic element in Stravinsky's music is explored in depth by van den Toorn.
12. The familiar set labels given here for reference are from Allen Forte, *The Structure of Atonal Music* (New Haven and London: Yale University Press, 1973). Set labels, prime form (or normal order) and other set-theoretical expressions are explained in various texts. See, for example, John Rahn, *Basic Atonal Theory* (New York: Longman, 1979) and Joseph Strauss, *Introduction to Post-Tonal Theory* (Englewood Cliffs: Prentice-Hall, 1990).
13. Any labelling of the scale-forms is somewhat arbitrary in light of the symmetrical and therefore non-hierarchic nature of the collections. The system adopted here assigns the first numeral (I) to the scale that begins on the lowest-numbered pitch class(es), hence {0,2,4...} = WT-I and {1,3,5...} = WT-II; also, {0,1,3...} = Oct-I, {0,2,3...} = Oct-II, and {1,2,4...} = Oct-III. Both van den Toorn, pp. 50–51 and Antokoletz, *Twentieth-Century Music,* pp. 232–233 employ different numbering systems for the octatonic forms.
14. See, for example, Berger, p. 20n and, more recently, Cohn, "Bartók's Octatonic Strategies," p. 262n.
15. The opening of this prelude seems to be a transparent reference to the Coronation Scene from Mussorgsky's *Boris Godunov.* The identical pitch-class content of the two passages, as well as the partitioning of the composite sonority as two [0,2,5,8] tetrachords with a shared tritone, makes this relationship particularly plausible. The principal distinction between the two is that Debussy superimposes one tetrachord onto the other, whereas in the *Boris Godunov* scene the two alternate above a pedal consisting of the shared tritone. The first mention of this connection in the literature on Debussy seems to be in Forte, "Debussy and the Octatonic," pp. 156–7, unless that is what Robert Orledge, "Debussy's Piano Music: Some Second Thoughts and Sources of Inspiration," *Musical Times* 122 (1981): 27 refers to when he describes this prelude as "Musorgskian."
16. Richard Cohn, "Properties and Generality of Transpositionally Invariant Sets," *Journal of Music Theory* 35/1 (1991): 21 (referring to his ex. 4, p. 24) proposes a different partitioning of the opening 6-30 hexachord as a pair of T_6-related 3-7 trichords [0,2,5] in mm. 5–6, and then expresses the next 6-30 hexachord (beats 2–4 of m. 8) as a pair of T_6-related 3-11 trichords [0,3,7] (E♭ major and A major). Whereas Cohn's goal is to demonstrate multiple transpositional combinations of T_6-related pairs for this hexachord (combinations that also include [0,1,3] and [0,1,4]), his segmentation of the score does not take into account the well-delineated musical groupings (i.e., the F♯ that belongs to the *lower* tetrachord in mm. 1–6 and the F♯-major triad slurred together with the E♭ and A triads in mm. 7–9).
17. Harris, p. 41 discusses the French-sixth sonority as a whole-tone element occurring in five short passages over the course of the piece, noting that another

whole-tone construction—the augmented triad—does not appear in any of them. His observation that in this repertoire "the two chords never seem to be associated" can, in passages similar to the ones under consideration here, be attributed to the dual octatonic/whole-tone affiliation of the French sixth as opposed to the more exclusively whole-tone identity of the augmented triad.

18. Although the composite sonority in measures 10–14 is the same type as the "Prometheus" chord or "nearly whole-tone hexachord," the musical context justifies a view of the F♯ as a pedal that extends from the beginning of the piece through measure 24, instead of an essential member of the scale as Perle has it in his analysis of a similar construction in Scriabin's Op. 74. (See notes 7 and 8 above.)
19. Parks, p. 83.
20. Ibid., pp. 83–85. Parks's comments pertaining to tonal referents in the piece take into account only pitch-class invariance ("quantitative" emphasis) and textural or dynamic assertion ("qualitative" emphasis), thereby ignoring the implied functional harmonies in these measures. Similar omissions are noted in Douglass Green, review of Parks, in *Music Theory Spectrum* 14/2 (1992): 217.
21. Of particular relevance here are the discussions of "fertile" and "potent" sets based on partitioning subsets in Cohn, "Bartók's Octatonic Strategies," pp. 266–272.
22. The role of [0,2,6] and [0,2,6,8] as elements shared between octatonic and whole-tone collections is noted also in Wile, pp. 99–101, and Antokoletz, "Interval Cycles," pp. 582–587.
23. Forte, pp. 117–119 uses this passage to demonstrate his theories of set-relations (K and Kh complexes, plus R and R_p relations). Some of the findings in the present study (e.g., the octatonic set 8-28 and the projections in contrary motion based on interval class 3 shown at the bottom of his ex. 110) may be inferred from Forte's analysis; his partitioning of the score, however, does not encourage an understanding of these measures in terms of octatonic and whole-tone contrast.
24. See, for example, George Perle, "Symmetrical Formations in the String Quartets of Bela Bartók," *Music Review* 16 (1955): 300–312; Jonathan Bernard, "Space and Symmetry in Bartók," *Journal of Music Theory* 30 (1986): 185–201; and the analyses of two pieces from *Mikrokosmos* in Cohn, "Bartók's Octatonic Strategies," pp. 272–279.

Works Cited

Antokoletz, Elliott. "Interval Cycles in Stravinsky's Early Ballets." *Journal of the American Musicological Society* 39 (1986): 578–614.

———. *Twentieth-Century Music.* Englewood Cliffs: Prentice-Hall, 1992.

Baker, James. *The Music of Alexander Scriabin.* New Haven and London: Yale University Press, 1986.

Bass, Richard. "Sets, Scales and Symetries: The Pitch-Structural basis of George Crumb's Makrokosmos I and II." *Music Theory Spectrum* 13/1 (1991): 1–20.

———. "Liszt's *Un sospiro:* An Experiment in Symmetrical Octave-Partitions." *Journal of the American Liszt Society* 32 (1992): 16–37.

Berger, Arthur. "Problems of Pitch Organization in Stravinsky." *Perspectives of New Music* 2/1 (1963): 11–42.

Bernard, Jonathan. "Space and Symmetry in Bartók." *Journal of Music Theory* 30 (1986): 185–201.

Cohn, Richard. "Properties and Generality of Transpositionally Invariant Sets." *Journal of Music Theory* 35/1 (1991): 1–32.

———. "Bartók's Octatonic Strategies: A Motivic Approach." *Journal of the American Musicological Society* 44 (1991): 262–300.

Eckert, Michael. "Octatonic Elements in the Music of Luigi Dallapiccola." *Music Review* 46/1 (1985): 35–48.

Forte, Allen. "Debussy and the Octatonic." *Music Analysis* 10/1–2 (1991): 125–169.

———. *The Structure of Atonal Music.* New Haven and London: Yale University Press, 1973.

Green, Douglass. Review of *The Music of Claude Debussy,* by Richard Parks. *Music Theory Spectrum* 14/2 (1992): 214–221.

Harris, Simon. "Chord Forms Based on the Whole-Tone Scale in Early Twentieth-Century Music." *Music Review* 41/1 (1980): 36–51.

Howat, Roy. *Debussy in Proportion: A Musical Analysis.* Cambridge: Cambridge University Press, 1983.

Orledge, Robert. "Debussy's Piano Music: Some Second Thoughts and Sources of Inspiration." *Musical Times* 122 (1981): 21–27.

Parks, Richard. *The Music of Claude Debussy.* New Haven and London: Yale University Press, 1989.

Perle, George. "Symmetrical Formations in the String Quartets of Bela Bartók." *Music Review* 16 (1955): 300–312.

———. "Scriabin's Self-Analyses." *Music Analysis* 3/2 (1984): 101–122.

Proctor, Gregory. *The Technical Bases of Nineteenth-Century Chromatic Tonality.* Ph.D. diss., Princeton University, 1978.

Rahn, John. *Basic Atonal Theory.* New York: Longman, 1979.

Simms, Bryan. *Music of the Twentieth Century.* New York: Schirmer Books, 1986.

Strauss, Joseph. *Introduction to Post-Tonal Theory.* Englewood Cliffs: Prentice-Hall, 1990.

Taruskin, Richard. "Chernomor to Kaschei: Harmonic Sorcery, or Stravinsky's 'Angle'." *Journal of the American Musicological Society* 38 (1985): 72–142.

van den Toorn, Pieter. *The Music of Igor Stravinsky.* New Haven and London: Yale University Press, 1983.

Whittall, Arnold. "Tonality and the Whole-Tone Scale in the Music of Debussy." *Music Review* 36/4 (1975): 261–271.

Wile, Kip. "Communication and Interaction in Stravinsky's *Scherzo fantastique* (1907–1908)." *Indiana Theory Review* 13/1 (1992): 87–112.