Aspects of compositional realization in Xenakis’s pre-stochastic and early stochastic music

Ron Squibbs
Department of Music, University of Connecticut, U.S.A.
ronald.squibbs@uconn.edu - http://www.uconn.music.edu/Faculty/Squibbs_R.htm

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In the preface to the score of Metastaseis (1953-54), Xenakis indicates that certain of the work’s features prefigured aspects of stochastic composition, the approach that he would adopt in Pithoprakta (1955-56) and subsequent works. While there are good reasons to contrast the serial procedures that underlie certain passages in Metastaseis with the stochastic approach taken in later works, there are also significant points of contact between Xenakis’s compositional realization of both approaches. These points of contact include harmonic contexts, both within a given work and between works, and specific techniques for managing the flow of musical events in the rhythmic domain. Throughout this brief inquiry, emphasis is placed on the musical effectiveness of Xenakis’s solutions to the compositional problems posed by the non-serial atonal, serial, and stochastic approaches that followed one another in close proximity in his early works. While his pioneering efforts in the development of stochastic composition remain a source of fascination in themselves, along with his particular syntheses of ideas from both architecture and music, there appear to be eminently practical musical reasons for some of the compositional choices that Xenakis made in his early music. This presentation hopes to uncover a few of these practical reasons as a stimulus toward further thought about the immediacy of the impact produced by Xenakis’s music, as well as about its enduring effectiveness.

The sound masses in Xenakis’s orchestral works present considerable difficulties for musical analysis. The simple enumeration of their pitch contents is laborious and rather uninformative, except as a starting point for further analysis. The sheer number of events in some of these sonorities may lead one to dismiss any attempt at pitch or pitch-class reduction as an arbitrary analytical exercise that violates the spirit of the music. Contextually sensitive consideration of pitch and pitch-class relations among particularly salient pitches within Xenakis’s sound masses can, however, reveal the existence of a surprising degree of harmonic coherence just beneath the musical surface. Such coherence does not exist apart from the musical surface, but in fact supports it and may support its perception as a comprehensible whole. Awareness of this structural coherence may, in turn, lead to a more focused perception of the details of individual sound masses as well as of the relations among different sound masses. Analysis along such lines may also lead to a greater appreciation of the relations between sound masses and other types of textures in Xenakis’s music, such as passages of melodic or polyphonic writing.

An example of this analytical approach to sound masses is shown in Figure 1, which displays the boundary pitches of the sound mass at the beginning of Metastaseis for orchestra (1953-

![Figure 1. Boundary pitches in the sound masses at the opening of Metastaseis, versions B and A](image-url)
There are two versions of Metastaseis: the revised “B” version was published by Boosey and Hawkes in 1967 (Xenakis 1967), and the original “A” version has recently been published, also by Boosey and Hawkes (Xenakis 2009). The B version features a complement of 46 strings, while the A version has a string section of 52 players. In both versions, there is a single player to a part in the opening sound mass, and in much of the rest of the work as well. Also in both versions, all of the string players begin on G3 and then move, by glissandi at varying rates of speed, to positions within a chord of 46 notes (version B) or 52 notes (version A). Despite the differences in instrumentation, the boundary pitches of the sound masses in both versions are similar. The outer boundaries are formed, in each case, by E1 and A#6. An inner boundary is formed in Metastaseis B by a one-octave gap that opens up symmetrically from the G3 at the work’s opening. This gap is significantly larger than the gaps between other pairs of adjacent pitches in the sound mass and thus calls attention to itself analytically, and perhaps perceptually as well. The interior gap in the sound mass in Metastaseis A is narrower, but it also opens up some space near the center of the mass, within the same octave in which the gap is found in Metastaseis B. Taken together, the pitch classes of the boundary pitches in Metastaseis B form a member of set class (sc) 4-28 in Forte’s labelling system. In traditional tonal nomenclature, the members of sc 4-28 are known as diminished seventh chords. A member of a distinct, but similar set class, sc 4-27, is formed by the pitch classes of the boundary pitches in the sound mass in Metastaseis A. This set class contains half-diminished seventh chords and major-minor (or dominant) seventh chords. The member of sc 4-27 in the figure is a half-diminished seventh chord.

![Figure 2. Metastaseis B and A, boundary pitches of opening sound mass and chord at end of part 1](image)

To the extent that one considers the boundary pitches to have any perceptual importance at all, it is perhaps remarkable that Xenakis should have chosen to frame this particular sound mass within a diminished seventh chord—whether fully or only half-diminished—since diminished seventh chords are loaded with associations from the mainstream of 18th- and 19th-century European classical music, particularly associations having to do with dramatic intensity (e.g., Sturm und Drang). References to the structural and stylistic characteristics of European classical music may not be entirely out of place here for, as Xenakis wrote in the preface to the score of Metastaseis B, “The Metastaseis [dialectical transformations] are a link between classical music (which includes serial music) and ‘formalized’ music which the composer was obliged to introduce into composition.” (Xenakis 1967, preface.) Of greater relevance to the current project, however, are the compositional contexts that Xenakis created within his own compositions. One of these contexts is illustrated in Figure 2, which shows the boundary pitches of the sound masses at the beginnings of Metastaseis B and A, respectively, followed by the four-note chord with which the first part of the work ends in both versions. The four-note chord emerges gradually out of a glissando from another chord over the course of mm. 86.104. On both sides of the figure, G3 is followed by G#3. Simultaneously, E1 moves up to
E2. These voice-leading motions provide a local context for an overall motion from an isolated G3 at the beginning of the work to an isolated G#3 at its end (not shown in the figure). Perhaps not surprisingly, the isolated G#3 is approached in a reversal of the work’s opening gesture, from a sound mass whose lower boundary pitch is E1. Thus, the semitonal shift from G3 to G#3 that spans the entire work is not merely an incidental detail, but is a component of a harmonic transformation that is prepared by events in the work’s first part.

In addition to what it reveals about local voice leading, the annotated graph in Figure 2 demonstrates that there are connections between Xenakis’s harmonic practice in Metastaseis and the symmetrical pitch-class collections, or Modes of Limited Transpositions, that were frequently used by Xenakis’s teacher, Messiaen, and so named by him (Messiaen 1956). The pitch classes of the boundary pitches of the opening sound mass in Metastaseis B, in combination with the pitch classes of the four-note chord at the end of part 1, combine to form a member of sc 7-19. In Metastaseis A, the combination of the pitch classes in both sonorities forms a member of sc 7-7. Each of these seven-pc sets is a subset of a single member of sc 8-9, {1234789T}, which is a form of Messiaen’s Mode 4. The connection between these particular subset classes and sc 8-9 is particularly strong, since every subset of any member of sc 8-9 is either a member of sc 7-19 or of sc 7-7. Although Xenakis would express a preference for asymmetrical pitch collections in his theoretical writings and later compositional practice (Xenakis 1992), a number of symmetrical pitch-class collections may be found in Metastaseis. Of the set classes whose members are labelled in Figure 2, the members of 4-8, 4-28, and 8-9 are symmetrical.

The use of symmetrical pitch-class collections in Metastaseis is not limited to the string parts alone. The brass passage in mm. 61-87, shown in a condensed score in Figure 3, references three of Messiaen’s Modes of Limited Transpositions. This passage, which is superimposed upon the first sound mass in the strings, is the same in the two versions of Metastaseis. The annotations on the condensed score show that the brass passage begins and ends with a member of sc 7-19. This is, in fact, the same set—not merely a member of the same set class—that was used in the strings to frame the first part of Metastaseis B. The relationship between this member of sc 7-19 and the member of sc 7-7 used in the strings in Metastaseis A is indirect, as before, since the two sets are most closely related through their shared membership in the same member of sc 8-9. The slight harmonic differences between Metastaseis A and B indicate that the B version is not simply an arrangement of the same composition for reduced instrumental forces, but also shows some rethinking of aspects of the work’s harmonic structure. From this perspective, the harmonic structure of Metastaseis B appears to be more sharply focused than that of Metastaseis A. The central portion of the brass passage presents a member of sc 8-25, which is equivalent to Messiaen’s Mode 6. Further, the pitch classes of the entire passage are contained within a single member of sc 10-6, which is equivalent to Messiaen’s Mode 7.

The precise identities of the pitches in the brass passage are obscured slightly by the use of glissandi, flutter-tongue, and quarter-tone inflections, but comparison of the condensed score...
with the original brass passage shows that the harmonic foundation illustrated in the condensed score is fairly discernible in the music’s actual setting. In fact, the resemblance between the condensed score and the actual brass passage is closer than that between the reduced score of the sound masses in the strings and the actual passages in which they occur. This is because the brass passage does not feature a proliferation of inner voices within the envelope provided by the boundary pitches, as do the sound masses for the strings.

Although the disposition of the inner voices in the sound masses for the strings results in the formation of asymmetrical pitch sets, the analysis presented here reveals that the outer-voice frameworks of the masses (particularly in Metastaseis B) make use of symmetrical pitch-class sets, such as were used by Xenakis’s predecessors, including Messiaen.³ It stands to reason that, as he began to formulate the harmonic and textural ideas that were uniquely his own, Xenakis would rely in part upon foundations that were firmly established in past compositional practice. The presence of such easily identifiable harmonic features in the early music facilitates comparisons among different sections of the same work, as demonstrated in the connections that have been made here between the sound masses for the strings and the brass passage within the first part of Metastaseis.

The prominent presentation of the ten-note Mode 7 (sc 10-6) in the brass passage may hold a clue as to why, at the beginning of the serial passage in part 2 of Metastaseis (mm. 105-50), Xenakis chose to present only ten-note segments of the twelve-tone row on which that section is based. It is, in fact, a simple matter to posit a transformational relationship between the member of sc 10-6 that is used in the first part of Metastaseis and the member of chromatic sc 10-1 that supplies the pitch classes for the ten-note row segments used at the beginning of the work’s second part.⁴ Each member of sc 10-6 contains two members of chromatic sc 5-1 at a transposition of 6 semitones (T6) from one another, while each member of sc 10-1 contains two members of sc 5-1 such that the second is at T5 from the first (or, equivalently, such that the first is at T7 from the second). The relationships between the particular members of set classes 10-6 and 10-1 is such that the first chromatic pentachord of sc 10-1 is at T5 from that of sc 10-6, while its second pentachord is at T4 from that of sc 10-6. In terms of their intrinsic properties, the members of sc 10-6 are significantly more symmetrical than those of 10-1: the members of sc 10-6 are transpositionally and inversionally symmetrical under two operations each, while those of 10-1 are inversionally symmetrical under a single operation and are transpositionally symmetrical only under the trivial identity operation, T0. Thus, it is as if, in moving harmonically from part 1 to part 2 of Metastaseis, Xenakis effected a transition from the highly symmetrical harmonic realm of Messiaen’s music (at least with respect to the framing sonorities for his sound masses) into the more open-ended, less symmetrical realm in which he would work for the remainder of his career.
A more concrete and more localized transformational relationship connects the end of part 1 to the beginning of part 2. This is shown in Figure 5, where the pitch classes in the four-note chord in the strings at the end of part 1 are shown to transform into the pitch classes of the four-note melody that appears at the beginning of part 2, in mm. 105-08 in Violin I 1. The combination of these two four-note sets produces a member of sc 6-7, which is equivalent to Messiaen’s Mode 5, thus providing yet another connection between *Metastaseis* and the symmetrical pitch-class collections favoured by Messiaen.

![Figure 5. Metastaseis, pitch-class contents of four-note chord at the end of part 1](image)

The pitch classes in the ten-note segment that forms the basis for mm. 105-50 are shown in Figure 6. They are shown in the order in which they appear in the first presentation of the segment, but the registers of the actual pitches have been compressed so as to fit into a single staff for ease of reference. The four-note melody that is used to begin part 2 of *Metastaseis* is shown at the head of this segment. Within the first section of part 2, Xenakis cycles through the twenty-four possible permutations of a set of four elements taken four at a time. The cycling through of these permutations is coordinated with the twelve distinct transpositions of the ten-note segment. The order of the transpositions, in turn, is determined according to the interval successions of a rotated form of the complete twelve-tone row from which the ten-note segment was derived. The ordered pitch-class succession of the complete row is <329T801E7645> and the succession of pitch-class intervals, beginning from the fifth position of the row (at pitch class 8) and wrapping around to the fourth position, is <0453ET897612>. Substituting each of these integers for n in Tn produces the succession of transpositions that Xenakis used in this passage. The linking of twenty-four permutations and twelve transpositions means that each transposition is heard twice before the process moves on to the next one. The complementary six-note segment at the tail of the ten-note segment is used to accompany each transformation of the four-note segment at its head. Although there are seven hundred twenty permutations of a set of six elements taken six at a time, only twenty-four are selected. Thus, the permutational process on the ten-note segment is effectively controlled by the operations on the four-note segment at its head.

![Figure 6. Metastaseis, pitch-class contents of ten-note segment used at the beginning of part 2](image)

The timbre of this passage is relatively homogenous since it is written for solo string instruments, but within this relative homogeneity the four- and six-note subsegments of the ten-note segment are differentiated by several means. These means include rhythm, register, and the subtle timbral differences among the various members of the family of string instruments. Thus, from a unitary concept—permutations and transpositions of a ten-note segment—a polyphonic texture is generated. A similar approach would be taken in the
composition of Xenakis’s early stochastic music. For the sake of comparison, a brief excerpt from one of Xenakis’s early stochastic compositions is shown in Figure 7. The excerpt shows three measures of the violin parts from *Analogique A* for nine string instruments (1958). *Analogique A* is the acoustic component of the hybrid acoustic/electroacoustic work *Analogique A + B*. *Analogique B* consists of a recording of clusters of extremely brief sinusoidal sounds and stands as an early example of granular synthesis (Di Scipio 2005: 2). In the combination of *Analogique A + B*, the synthesized sounds are interpolated between, or superimposed upon, the work’s instrumental sections. *Analogique A* provides a logical basis for comparison with mm. 105-50 of *Metastaseis*, since the instrumentation throughout *Analogique A* is essentially the same as in the excerpt from *Metastaseis*. In both cases, the members of the string family that are used are violins, cellos, and basses. The instruments are grouped into trios by instrumental type. Within the trios the individual instrumental parts perform three, four, or five divisions of the beat. These differing divisions of the beat produce a metrical grid that ensures a degree of rhythmic independence among the parts.

![Figure 7. Series of “screens” used in the composition of *Analogique A*](image)

In serialism, the composition of musical textures proceeds from the specific to the general, but the opposite is true in stochastic composition. In order to manage the potentially endless succession of randomly generated pitches and time points in stochastic composition, boundary conditions need to be established in order for the composer to be able to control the general features of the resulting musical surface. In *Analogique A*, Xenakis chose to regulate the flow of events by means of filters, or “screens,” as shown in Figure 8. The combination of pitch ranges, dynamics, and density (average number of sounds per beat) ensures that none of the screens A-H has the same global properties. A palpable division between groups of screens results from differing uses of the registers: screens A-D make use of adjacent pitch ranges in the outer registers, while screens E-H make use of overlapping middle registers (at levels I-III) plus an adjacent upper-middle register (at level IV). In the compositional realization of *Analogique A*, the order of the screens was randomized, as was the order of the individual notes contained within the boundaries defined by the screens. Some sections, however, feature repetitions of a single screen. One such section begins in m. 15, from which the excerpt in Figure 7 was extracted. This section makes use of screen A only.

The relationship between the four levels of the screens in Figure 8 and the three groups of instruments in *Analogique A* (violins, cellos, basses) is not self-evident, but a consideration of practical constraints, combined with careful study of the score, suggests some plausible relations between concept and realization. To begin with, the ranges of the instruments place some limitations on which groups may realize which ranges of pitches. In screens A-D, levels I and II would need to be realized by cellos and basses. Level III could be realized by cellos, the outer registers, while screens E-H make use of overlapping middle registers (at levels I-III) plus an adjacent upper-middle register (at level IV). In the compositional realization of *Analogique A*, the order of the screens was randomized, as was the order of the individual notes contained within the boundaries defined by the screens. Some sections, however, feature repetitions of a single screen. One such section begins in m. 15, from which the excerpt in Figure 7 was extracted. This section makes use of screen A only.
indistinguishable in the score. With respect to rhythm, the use of a metrical grid based on the simultaneous subdivision of the beat into three, four, and five parts results in the availability of twelve time points within each instrumental group. Within each beat there are ten distinct time points, since each group of subdivisions contains the downbeat.

With the foregoing in mind, it becomes possible to interpret the structure of the excerpt in Figure 7 with greater clarity. In the excerpt, the range of the instruments is from B5 to A6, the dynamic level is ff, and the density is high. Thus, the excerpt is evidently a realization of screen A, level IV. Examination of the full score (not shown) indicates that levels II and III are shared by the cellos, and level I is realized by the basses. In addition to pitch range, dynamics, and density, further differentiation among the levels is achieved by means of modes of articulation. These differences are not accounted for in the description of the compositional process (Xenakis 1992: 98-103), but are evident in the score. In the passage from which the excerpt in Figure 7 was extracted, the violins (level IV) perform with mutes (sourd), the cellos (levels II and III) perform arco normale, and the basses (level I) perform pizzicato. The actual density of each beat within level IV of screen A may be read from the score excerpt simply by counting the number of notes within each half-note beat or, alternatively, by subtracting the number of rests from twelve. Each of the beats in the excerpt contains ten notes, with the exception of the first beat of the third measure, which contains eight. Over the course of the passage, the average number of notes per beat more closely approximates nine, which is the average density shown for screen A, level IV in Figure 8. For groups of instruments playing single notes, divided into trios with twelve possible time points per beat, nine notes per beat is near the maximum practical density.

Implicit in Xenakis’s realization of the screens is the use of two probability distributions: the exponential distribution for the calculation of intervals between time points and the linear distribution for the calculation of intervals between pitches (Xenakis 1992: 323-27). Generating functions based on these distributions are used to produce the notes, which represent the endpoints of the calculated intervals for time and for pitch. The output of these functions is characterized by irregular variations in the intervals between time points and pitches. Since Xenakis used chromatic sets in his early stochastic music, minimal pitch intervals are expressed as repeated pitches or as chromatic steps, while larger intervals are expressed as diatonic steps or as leaps. The time intervals work similarly, with larger gaps between time points being filled in with rests. This simplifies the notation and ensures that the players may be given parts in which simple divisions of the beat occur throughout. Presumably Xenakis generated notes according to a given average density and then distributed them among the individual parts within the instrumental groups, approximating the time values so as to conform to the temporal grid. Where the density is relatively high, as in the excerpt in Figure 7, the prevalence of rests on the beats suggests that Xenakis wished to avoid the accents that would likely have occurred if the players were to have frequently doubled or tripled articulations on the beats.

Because of the convergence of factors involved in bringing the concept of the screens in Analogique A into compositional realization, the appearance of the score may give the somewhat misleading impression that the music consists of a series of motivic transformations following one another in rapid succession. The presence of rests in the parts, especially in the upper parts in Figure 7, suggests a natural segmentation of the musical surface into motives such as may have been used by freely atonal or serial composers. Considering just the first two measures in the Violin 1 part in Figure 7, the segmentation reveals the following: an arpeggiation of a D minor triad; an arpeggiation of the root, fifth, and seventh of a B half-diminished seventh chord; a member of set class 3-4; and an arpeggiation of an F# diminished triad. These “motives” appear, however, in the absence of a context in which they can be said to act as elements within a succession of systematic motivic transformations. The addition of Violin 2 and 3 to the analysis increases the number of distinct pitch classes per beat to between seven and ten, with the resulting sets showing varying degrees of chromaticism. Inclusion of the cello and bass parts (not shown) adds either an additional pitch class or none at all, along with repetitions of pitch classes that are already in the violin parts.

Some of the sets that appear in the violin parts in Figure 7 are members of set classes that were found to be significant in Metastases, such as sc 10-1 (first beats of mm. 15 and 16) and sc 8-25 (second beat of m. 16), but in Analogique A these occurrences evidently result from
the algorithmic process of composition, presumably not as a matter of compositional design. Pierre Schaeffer is known to have criticized Xenakis’s approach to stochastic composition, asserting that, "[O]nce certain sonic results are obtained through intensive work, you intervene in the results to render them as interesting as possible by editing" (Matossian 2005: 148). The degree of editing, if any, that Xenakis may have applied to the output of his compositional algorithms, is unknown. In order to challenge Schaeffer’s contention that editing may have been necessary in order to create musically viable results, an alternative rendering of the violin parts from mm. 15-17 of Analogique A is shown in Figure 9. This example was produced by the author, using the algorithm described in Xenakis 1992: 323-27. The alternative rendering bears at least a superficial resemblance to Xenakis’s original, due in part to a general avoidance of simultaneous attacks on the beats, as in Figure 7. There are some subtle differences, however. For example, there are more pitch-class repetitions within the beats of the alternative rendering than there are in the original. As a result, the number of distinct pitch classes per beat varies from five to nine, rather than the seven to ten in the original. Whether the greater degree of chromaticism in the original is the result of possible differences in the pitch algorithm, or is the result of editing, is unknown. In general, however, the unedited output of the algorithm in the alternative rendering in Figure 9 demonstrates that it is possible to produce similar results to Xenakis’s without editing. Ultimately, it may be that Schaeffer’s critical attitude toward Xenakis’s compositional process in his stochastic music could have resulted from a limited understanding of the practicalities of algorithmic composition. It is understandable that such considerations may have been difficult to characterize in words at that time, given the then very recent development of such a compositional approach.\footnote{11}

**Figure 9.** Passage for violins, modelled after Analogique A, mm. 15-17

Despite the similarities in compositional realization between the serial passage in Metastaseis, mm. 105-50, and the stochastic music used in Analogique A, there are significant differences in their compositional contexts. Among these differences is textural density. The density of the music in the passage from Metastaseis varies, but averages around five notes per beat. In Analogique A, the density remains between fourteen and sixteen notes per beat throughout. (Since the tempo of the two works is the same, their densities are directly comparable.) In the next passage within the serial portion of Metastaseis, mm. 151-201, however, the density suddenly increases to a level similar to that found in Analogique A. This jump in density turns out to be a stage in a process of increasing textural density that continues through the following section, leading to the work’s climax. In Analogique A, however, the relatively high density is a characteristic of a steady state that persists throughout the work, and therefore does not participate in the building up of climaxes or in the block-like juxtaposition of contrasting sections—characteristics that are found in a large number of Xenakis’s works, both before and after Analogique A. Further, because the taped sound grains that constitute Analogique B are of such a different nature sonically from the string sounds in Analogique A, they add variety to the musical surface but remain so distinct from the acoustic sounds that they do not result in the generation of a more massive-sounding texture. An additional difference is in the relative sizes of the ensembles between the two works—nine strings for Analogique A versus the large string ensemble plus brass, winds, and percussion in Metastaseis—a factor that limits the power and the degree of contrast available within the smaller ensemble used in Analogique A. It is well known that the reception of Analogique A + B
was problematic (Matossian 2005: 147-51), and it may be that factors such as the size and composition of the ensemble, and the fairly steady textural density, may have figured into the work’s difficult reception. Perhaps as a result of some of these technical features, the work has a lightness and charm that is somewhat unusual in Xenakis’s oeuvre. By way of contrast, the sequel to *Analogique A + B*, *Syrmos* for 18 (or 36) strings (1959), demonstrates that the concepts underlying the former work could also be applied to massed sonorities, with spectacularly dramatic results.

This study has made use of relatively small samples from only two among a much larger number of works that could have been chosen for comparison, but the implications of the provisional findings that have been presented here may provide the basis for further comparisons among works from various stages of Xenakis’s compositional development. Perhaps most striking among the findings of this study has been the degree and the precision of the harmonic control that is evident just beneath the surface of the sound masses in the first part of *Metastaseis*. The similarities in the realization of his serial and stochastic procedures is also striking, and suggests a greater degree of gradual continuity in Xenakis’s compositional development than may appear to be the case, based on the evidence of the composer’s writings and according to much of the previous scholarly and critical writing on his music. Now that the distinctiveness of Xenakis’s contribution to compositional practice in the second half of the twentieth century has been firmly established, it may be possible (and even desirable) to move further in the direction of contextualizing his work through additional comparative studies. Such studies, if they prove to be insightful, may help to normalize the position of Xenakis’s work within the history of the twentieth-century avant garde and may thereby stimulate a broader discussion of his work within the scholarly literature.

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**References**


**Notes**

1. In the A version, Viola 12 does not perform a glissando, but remains stationary on G3, which it sustains into the 52-note chord.
2. See Forte 1973. Pitch classes are labelled by integers 0 to 11, where C = 0. Following a notational convention in Straus 2005, the integer 10 is abbreviated here as T and 11 as E. Curly brackets ({})) indicate that order (temporal or otherwise) is not a structural property of the set. For ease of reference, the contents of unordered sets are presented in normal form and are listed in ascending pitch-class order.
3. A recent example of such an association is the film *Charisma X – Iannis Xenakis* (Xirou 2008), in which the sound mass from the opening of *Metastaseis B* is used to accompany documentary footage of combat, along with a voice-over description of the traumatic effect of Xenakis’s experiences in Greece during World War II.
4. The members of sc 4-8 are inversionally symmetrical, while the members of set classes 4-28 and 8-9 are both inversionally and transpositionally symmetrical.
5. Varèse, who is often cited as a precursor to Xenakis in the composition of sound masses, also made use of symmetrical pitch-class collections in some of his music. The opening sections of *Intégrales* (1925), for example, feature clear articulations of set classes 9-12 and 8-9. (These set classes are equivalent to Messiaen’s Modes 3 and 4, but Varèse’s use of them predates the codification of Messiaen’s system of modes.) Although Bernard 1987 analyzes Varèse’s music mainly in terms of transformations upon trichords in pitch space, Morris 1995 demonstrates the utility of considering both pitch- and pitch-class-space perspectives in the analysis of Varèse’s music.
6. As with the brass passage, this passage (mm. 105-50) is identical between the two versions of the work. It is unnecessary, therefore, to affix A or B to the work’s title when referencing this excerpt.
7. The use of angle brackets (< >) here indicates that order is a structural property of the set whose elements are listed between the brackets.
8. For more information on the permutational and transpositional processes in mm. 105-50 of *Metastaseis*, see Baltensperger 1996, Solomos 2001, and Barthel-Calvet 2003. The latter contains a transcript of Xenakis’s analytical commentary on the work.
9. The only exception to the division of the instrumental groups into trios occurs in m. 146 of *Metastaseis*, where cellos 4-6 are added to the ensemble.
10. It appears that judgments regarding the purity or otherwise of algorithmic composition have softened in the more than fifty years that have passed since Xenakis’s first stochastic compositions were produced. In a recent book, Dmitri Tymoczko characterizes his algorithmic compositions this way: “Typically, I augment [the] algorithmic passages with music composed intuitively producing a final product that blends the human and the inhuman.” (Tymoczko 2011: 24.) Xenakis apparently worked similarly in some of the computer-assisted “ST” compositions, including *Atrées*, in which, according to Matossian, “[h]e used seventy-five per cent computer material, composing the remainder himself.” (Matossian 2005: 208).