ALLEN FORTE

PITCH-CLASS SET ANALYSIS TODAY

Introduction

It appears that during the past twenty years pitch-class set analysis has become quite widely accepted, particularly in the United States. Indeed, a recent observer has described this type of analytical theory as 'normal'.[1] Although it is not possible to determine whether this is a fair assessment, pitch-class set analysis does seem to be more 'normal' now than it was fifteen years ago. This positive view was not always widely represented, nor is the pitch-class set theoretic approach universally accepted, as will be evident when I quote from reviews of *The Structure of Atonal Music* and *The Harmonic Organization of The Rite of Spring* later on.[2]

Although I am well aware of the contributions of others to this general area of music research, I will restrict my remarks here primarily to my own work and to work closely related to it. In justification of this egocentric but, I trust, not self-serving position, I remind you that I have been described on occasion as a 'pioneer', a designation which conjures up a vision of Daniel Boone in a coonskin cap, axe in hand, making his way through the wilderness of Kentucky, rather than that of an academic clad in a T-shirt and seated at a typewriter in an air-conditioned room in southern Connecticut.

The plan of my paper is as follows. First I shall discuss the scope and domain of pitch-class set theory and analysis and review some interesting recent applications. I shall then examine some of the major criticisms of pitch-class set analysis in an effort to clarify and possibly rebut. Although some of those criticisms may have lost validity (as indicated by the vitality and diversity of ongoing and recent work), others are still extant and continue to be expressed, hence deserve serious consideration. In conclusion I shall do some analysis in connection with a discussion of problems of segmentation in atonal music. And finally, I shall outline what I see as interesting future prospects for pitch-class set analytical techniques.

The Scope and Domain of Pitch-Class Set Analysis

In confronting the question of the scope and domain of pitch-class set analysis,

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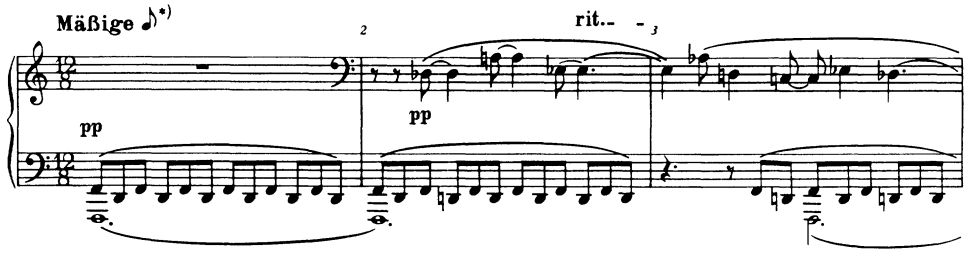
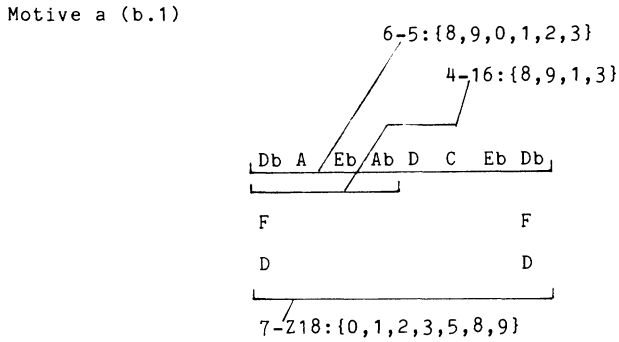


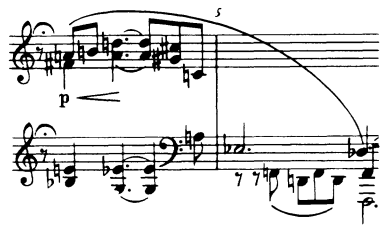


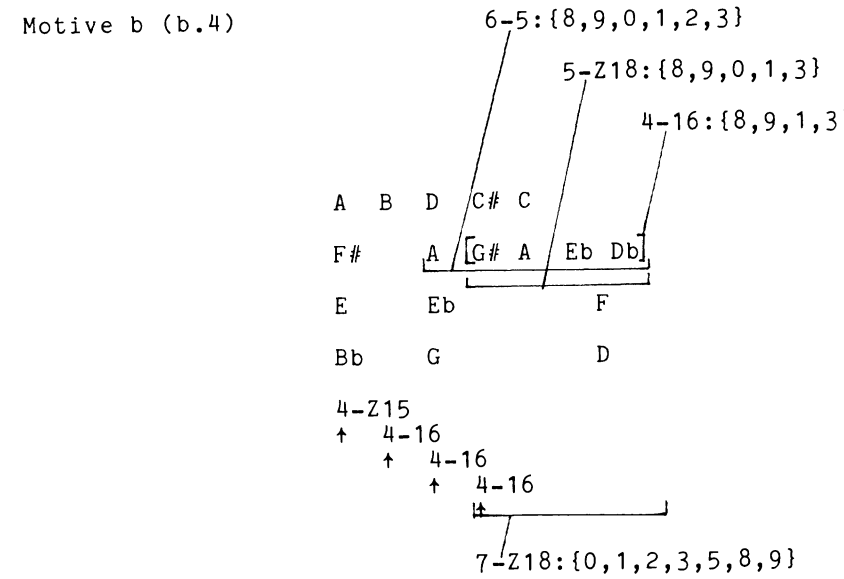
it seems appropriate to begin by asking whether the use of the procedures of set analysis is, in any sense, obligatory. The answer is straightforward: Certainly not. I need only mention Wallace Berry's excellent study, *Structural Functions in Music*, which includes much material on atonal music (the normative repertory of application), but makes no use whatsoever of pitch-class set theory.[3]

In similar fashion, Jonathan Bernard's fine research on the structure of the music of Varèse[4] does not invoke pitch-class set theory, nor does Christopher Hasty's innovative and valuable study of the general problem of segmentation in non-tonal music make extensive use of it.[5] And Douglas Jarman has managed to write an excellent book on the music of Alban Berg without invoking any of the apparatus of pitch-class set theory.[6]

There are, however, published studies in which pitch-class set analytical techniques could have been useful, if only by relating seemingly disparate musical configurations. A case in point is illustrated in Ex. 1, which presents the

Ex. 1–cont.





opening music of Schoenberg's Op. 11, No. 2, in score at the top with some analytical material placed below it. Reinhold Brinkmann has commented upon these adjacent passages as follows:

> The procedure of developing every configuration out of one kernel is also used in this piece. The point of departure of all the derivation is the opening

> section, with its two themes or motives, exposed right at the beginning, which have a close connection to one another. They may be referred to as a and b.[7]

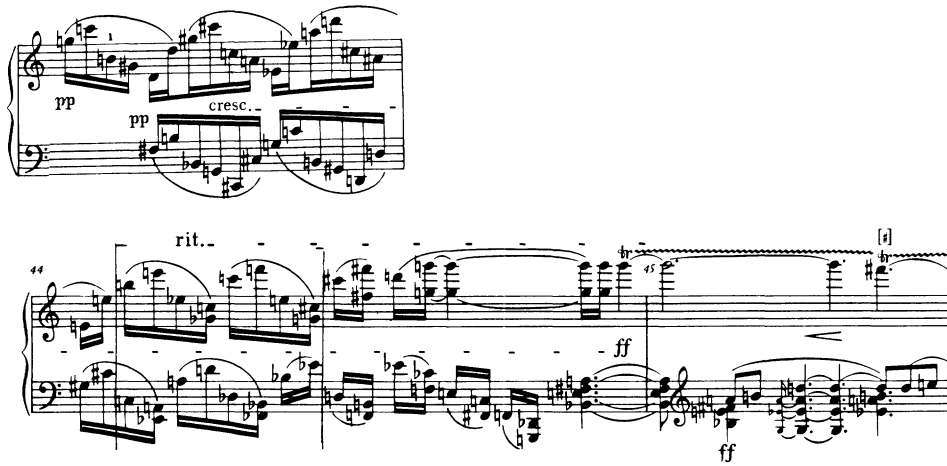
This particular observer does not tell us, however, anything specific about the 'close connection'. There are, in fact, explicit structural relations between a and b, as indicated on Ex. 1. There is a hint of this in the fact that both a and b end with the dyad E♭–D♭. But the correspondence does not end with that common dyad, for the final hexachord in b is the same, with respect to pitch class, as the upper voice melody of a: set 6–5. Thus, when the ostinato figure D–F returns at the end of motive b, the entire opening set, a form of 7–Z18, is repeated, in 'unordered' form, creating a miniature aba form, so typical of Op. 11, and providing a lucid instance of Schoenberg's 'developing variation'.

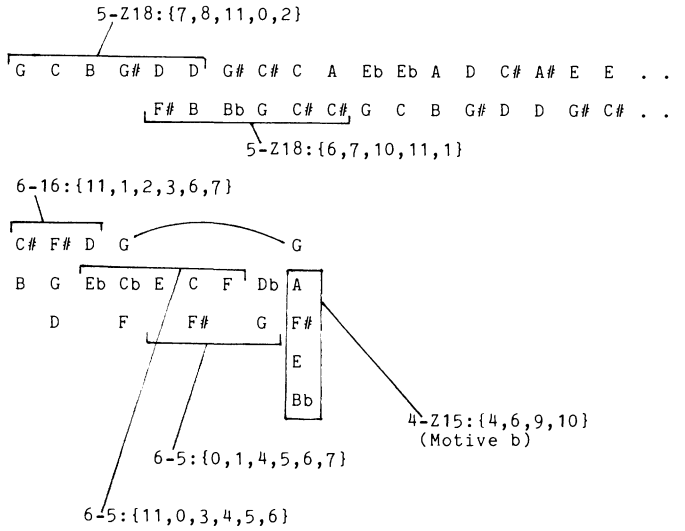
There are other significant correspondences between motives a and b in Ex. 1. The first linear tetrachord in a is set 4–16: [D♭–A–E♭–A♭]. This then recurs as the last linear tetrachord in motive b, reordered as [G♯–A–E♭–D♭]. Set 4–16 also appears in the vertical dimension, as shown in the second part of Ex. 1 by the up arrows. But perhaps the most interesting correspondence between the two parts has to do with pitch-class set 5–Z18, which, because of the redeployment of 6–5, now occurs as the inner-voice succession G♯–A–E♭–D♭ in motive b. This analytical observation is relevant to the immediate contexts, motives a and b, since 5–Z18 is the complement of the large set, 7–Z18, which comprises the entirety of motive a, as shown in Ex. 1.

As but one instance of the further significance of pitch-class set 5–Z18 in the composition, Ex. 2 gives a partial reading of the canonic passage that begins in b. 43. There we find set 5–Z18 as the head motive of the canon. In this role it reflects the large harmonic grouping of the opening music, to which it relates as complement (to be more precise, as a transposition of the inversion of the literal complement of 7–Z18 in its first manifestation). Indeed, the relation of this music to the opening music of the movement becomes even more explicit as the return of the b motive in b. 46 nears. As shown at the end of the letter- name and numerical representation below the musical excerpt in Ex. 2, motive b is prepared by the reappearance of pitch-class set 4–Z15, in its original disposition. Most extraordinary, however, is the recurrence of hexachord 6–5, the hexachord of motive a just prior to this. Again, the two forms of 6–5 in this passage are displayed in letter-name and numerical notation at the bottom of Ex. 1. More elusive, because of the absence of explicit intervallic or rhythmic cues, is the appearance of 6–16 in this context, a reference to one of the primary hexachords in the first movement, specifically, to the hexachord which first appears as the two left-hand trichords at the beginning of that movement (see Ex. 4c on p. 43).

As for the domain of pitch-class set analysis — the music to which it might be appropriately applied — I am tempted to say that it is determined by 'common sense'. At the same time, one must realize that common sense is often overrated

Ex. 2





as a guideline; one person's common sense is another's folly. (The same applies to Schenkerian analysis: one would hardly expect to find Schenkerian graphs of Japanese koto music, yet they exist.[8]) Pitch-class set analysis was developed with a specific musical repertoire in mind, the atonal (non 12-tone) music of the first part of the twentieth century. Now, however, it has been applied in unexpected ways, for example, to some of the music of Bartók, in Paul Wilson's

extended study, or to the transitional music of the later 19th century.[9] In my own recent work, which involves studies of the innovative music of Liszt, I have found the concept of the unordered pitch-class set to be of considerable value. More will be said about applications of pitch-class set analytical techniques in the next section of this paper, which is devoted to that topic.

Recent Applications

As I have just suggested, recent applications of pitch-class set theory and analysis are highly diversified, ranging over a wide field of research activities. I shall discuss, briefly, several of these.

Martha Hyde's recent detailed study provides a radically new view of Schoenberg's twelve-tone music, dealing with the supposed anomalies and irregularities criticized by earlier writers. Among other achievements, Hyde shows 'how Schoenberg uses the harmonies of the basic set to integrate two-or-more simultaneous dimensions of harmonic structure'.[10] In analysing the harmonies of the basic set and the music from which it is derived, she uses pitch-class set nomenclature and defined relations to demonstrate that Schoenberg incorporated many of his atonal procedures into his twelve-tone music in specific ways. In the process, she provides a detailed and convincing exegesis of Schoenberg's two important writings, 'Composition with Twelve Tones' and 'Vortrag/12TK/Princeton'.[11]

Working with a somewhat different musical repertory, Jeff Pressing, an American composer, jazz pianist and ethnomusicologist living in Bundoora, Australia, has written an extremely interesting essay entitled 'Pitch-Class Set Structures in Contemporary Jazz', which presents extensive analyses and theoretical material on such familiar works as Thad Jones's 'Big Dipper' and John McLaughlin's 'The Dance of Maya'.[12] Also somewhat unexpected was the paper which Alan Chapman delivered at the recent Yale Conference on the Music of Kurt Weill (Autumn 1983), which impressively demonstrated the relevance of pitch-class sets to the music of that composer, relating his choice of harmonic materials to the music of the avant-garde composers of his time, notably to that of Schoenberg.[13]

One of the finest of the recent studies to employ pitch-class set analysis is Paul Wilson's as yet unpublished work on music from Bartók's middle period, 1908–1922, with concentration on the Three Etudes for Piano, Op. 18, completed in 1918, and the Improvisations on Hungarian Peasant Songs, Op. 20, completed in 1920. The study begins with the following statement:

> Béla Bartók's music is generally regarded as representing traditions separate from those which gave rise to the classic atonal music of the Second Viennese School. But Bartók was not unaware of that school or its music, and for a period in his career he composed works which embodied his own understanding of atonal pitch organization and structure.[14]

Large-scale studies in progress at the present time which employ pitch-class set analysis include Philip Russom's work on the music of Maurice Ravel, which promises to delineate in novel fashion the harmonic procedures of that composer and to deal with a number of problems which his music has presented to students in the past, such as the matter of centricity (to use George Perle's term) and the interpretation of scalar structures and such familiar harmonic constructs as the 'ninth chord'.[15]

However, it will be difficult to match Janet Schmalfeldt's tour de force, which entailed a complete pitch-class set analysis of Berg's *Wozzeck*.[16] Douglas Jarman's trenchant review in the *Times Literary Supplement* states:

> The real contribution which this book makes to the literature on *Wozzeck* lies less in its attempts to arrive at some overall conclusions about the musical language of the opera than in the extent to which it provides a more detailed study than has previously been available of the motivic structure of many passages.[17]

It seems to me that the reviewer misses a major point of Schmalfeldt's study, which is that unordered pitch-class sets, as motives in large and small, comprise the organization of the work in its pitch aspects. These pitch-class sets occur in multiple harmonic and melodic configurations in a work which is one of the most remarkable achievements of modern music. Schmalfeldt's analytical techniques are sufficiently powerful to enable her to generalize. An especially fine instance of this is her characterization of the 'family of origin' sets, sets which belong to the *persona* of *Wozzeck* and 'provide the fundamental pitch-structural matrix of the opera'.[18]

Richard S. Parks's ongoing large-scale study of the music of Debussy also employs pitch-class set analytical procedures, together with other methods. Parks's approach is well represented in his recent article, 'Pitch Organization in Debussy: Unordered Sets in "Brouillards" ', in which he examines musical configurations in that work in considerable detail, concluding:

> To a rather large extent, Debussy's music (of which 'Brouillards' may be considered typical) reveals, in its pitch resources, combinations which exhibit characteristics lying beyond traditional notions of harmony, voice-leading, and a referential tone and sonority (tonic).[19]

With the reader's indulgence, I will include my study of Stravinsky's *The Rite of Spring* as another instance of an investigation of larger scale (although lilliputian, compared to Schmalfeldt's work). This resulted from a plan of long standing to analyse a major work by using pitch-class set analytical techniques to provide a picture of its overall organization. Those familiar with the study will recall that standard pitch-class set constructs, that of the set complex, in particular, underwent modification in the final stages of the presentation of the study, which attempted to synthesize the analyses of the individual movements.

Despite my fondest hopes, however, the study was not received with unanimous approval. In an extensive review, Richard Taruskin, after some laudatory comments, concludes: 'But it seems to me that Forte's application of his method, at least in this case, is unnecessarily restrictive and one-sided, and has concealed as much about *The Rite of Spring* as it has revealed'.[20] The author's main complaint is that the pitch-class set analysis disregards features of the music which he views as exemplary of ordinary 'functional' tonality. He presents, for instance, an alternative reading of the music of the Ritual of Two Rival Tribes at R60 (Ex. 3a) and comments:

> If . . . one looks at the passage from the point of view of functional harmony (and pretty simple functional harmony at that, allowing Stravinsky his fair share of double inflections and added sevenths), there is no problem. The combinations in the middle of measures one, two, and four are the result of linear functions (accented passing tones), with parallel doubling at the major third. . . . The shift of tonal center, involving a progression to the submediant, is standard Russian fare.[21]

What suggests a tonal analysis of the passage, of course, is the scalar melody, which can be regarded as a segment of the B major scale — a fact of which I am aware. This use of diatonic materials in *The Rite of Spring* is hardly unusual. Stravinsky, however, invariably does something unusual in his setting of such 'commonplace' melodies, in this case harmonising the melody with tetrachords which appear frequently in other parts of the music.[22] The reviewer's analysis (Ex. 3b) is heavily dependent upon the 'double inflections' and 'added sevenths' in which he asks the reader to indulge the master. Thus, the chord labelled I in b. 1 of Ex. 3b is a very peculiar creature: a tonic with no root, two kinds of thirds, and, presumably, an 'added seventh' (A). The other readings of 'functional' harmonies in Ex. 3b reveal similar problems, all of which have the same source: *ad hoc* analytical techniques. If we accept as valid this reading of 'functional' harmony in *The Rite of Spring*, an important historical discovery ensues: that Stravinsky studied the wrong functional harmony textbooks. I will not pursue these points further here, but will return to a similar instance of an attempt to force a tonal reading of some kind upon, in that case, an atonal composition, at which point I will make a few additional observations.[23] Finally on *The Harmonic Organization of The Rite of Spring*, however, I quote a reviewer of perspicacity, judgement and taste:

> [The] book is of capital importance because it provides the long-awaited analytical means with which Stravinsky's harmonic system can be understood and at the same time throws new light on his mind, showing, for instance, that what seemed to be most immediate was often most reflective.[24]

To return to a final example of current work involving pitch-class set analysis, I want to cite a particularly interesting extension, which is its use in

Ex. 3

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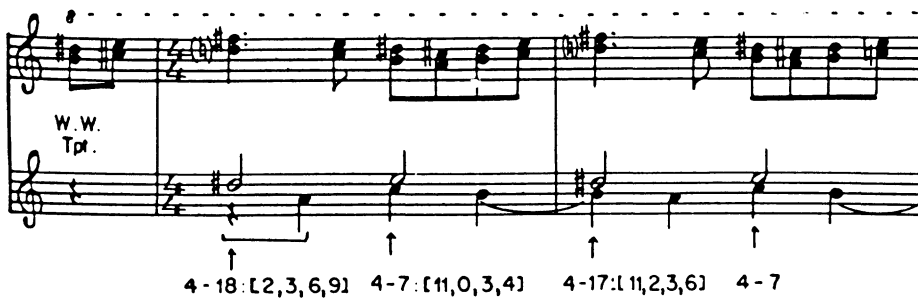

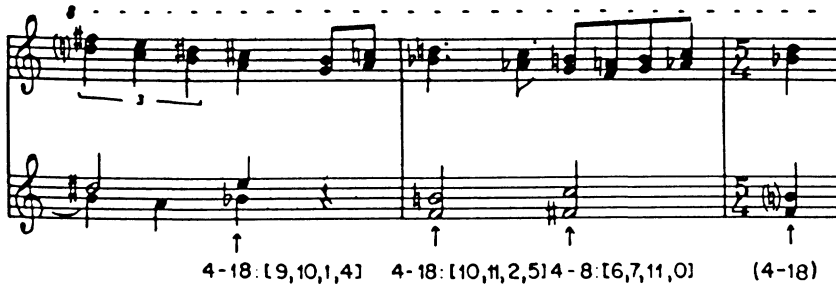

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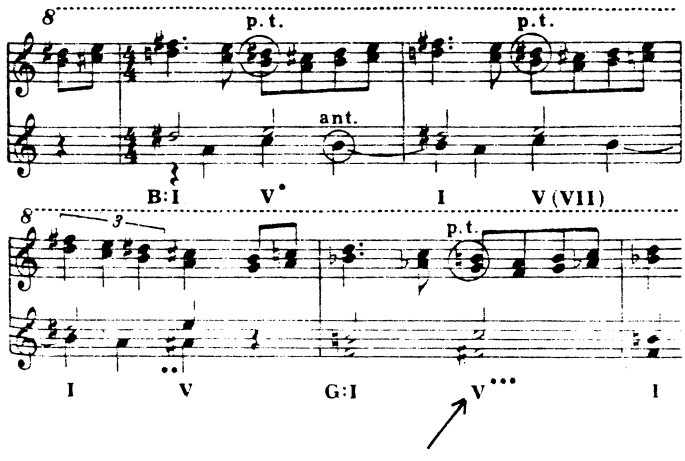


conjunction with Schenkerian or quasi-Schenkerian linear methods. James M. Baker has provided a convincing and original instance of this type of work in his article, 'Schenkerian Analysis and Post-Tonal Music', in which he sets forth cogent criteria for executing an analysis of this type and then illustrates his views in a study of a late tonal work by Alexander Scriabin, entitled 'Enigme'. Baker concludes by saying:

> Although 'Enigme' . . . constitutes perhaps Scriabin's furthest extension of implicit tonality in the music of his transitional period (1903–1910), tonal forces are nevertheless responsible in large part for the overall coherence of the work. At the same time, the retention of whole-tone elements participates in the prolongation of the dominant function, while other nontonal relationships, in particular those based on complementation, are important in establishing structural bonds between the contrasting sections of the piece.[25]

The diversity of applications suggested by these few studies, out of many, demonstrates that unordered pitch-class set analysis, far from locking individual analysts into a rigid interpretation or being limited to a small repertory of music — specifically, the music of the Viennese atonal school — offers a flexible resource, one which, when properly interpreted, produces new and interesting results.

Some Critical Views of Pitch-class Set Analysis

Since it first appeared on the scene in 1964,[26] and, in particular, since the publication of *The Structure of Atonal Music* in 1973, unordered pitch-class set analysis has received a good deal of critical attention, perhaps more than it needed, I have felt on several occasions. I would now like to review some of that criticism, excluding from this brief survey the detailed essays by Benjamin, Browne and Regener, not because they are unworthy of serious consideration — far from it — but because they are not reviews in the usual sense, but articles that used *The Structure of Atonal Music* in large part as a point of departure for presentation of the authors' own ideas.[27] In the course of this review I hope to touch on certain issues of a general nature, issues involving contemporary theory and analysis which transcend the immediate object of attention, unordered pitch-class set analysis.

Pitch-class set analysis has been criticized as being too abstract, too formal. An important case in point is the set of sets known as the 'Z-collections'. It will be recalled that two pitch-class sets in the Z relation have the same total interval content, but are not related by transposition or inversion. Each member of the pair is called the 'Z-correspondent' of the other. Why is it necessary to make the distinction between the members of such pairs, when they are intervallically equivalent? One outraged commentator has even described such sets as '. . . specialties of the music theory department of Yale University', in an apparent effort to banish these sets forever to the Arcadia of Southern

Connecticut, 'flushing' them, as it were, from the pristine streets of New York City.[28] The simple answer to George Perle's criticism is that Z-related sets help to explain harmonic usages in a wide variety of non-tonal repertories. Indeed, they are often well-nigh indispensable. For example, the hexachord 6–Z29 often occurs in the context of Stravinsky's octatonic music, yet it is not to be found in the octatonic scale. However, its Z-correspondent, 6–Z50, is a component of that scale. Without knowing the relation between 6–Z29 and 6–Z50, the former appears to be an anomaly.[29]

The musical evidence in the atonal repertory that supports the Z-pairs is overwhelming in sheer quantity. To take as an example the work with which our exasperated critic was concerned, Berg's *Wozzeck*, we find that set 5–Z18 represents the Drum Major, while its Z-correspondent, 5–Z38, is associated with Wozzeck's hallucination, and set 4–Z15 is one of Marie's tetrachords, while its Z-correspondent, 4–Z29, represents the Doctor. Other Z-pairs are 6–Z17 and 6–Z43, both connected with the Doctor (especially in Act 1, scene 4, the passacaglia), 6–Z19 and 6–Z44, representing Marie and Wozzeck together, and 6–Z25 and 6–Z47, linking Wozzeck, Marie and the Captain, with the latter set predominant in the drowning scene. The musical-dramatic significance of many of these combinations is discussed at length by Schmalfeldt, and it would be presumptuous to attempt to relate her detailed discoveries here.

While rejecting the Z-related sets, our critic apparently does not fully understand the nature of the relationship, as indicated by the following comment:

> That the 'z-relationship' [*sic*] exists between the two hexads of the tone row of Schoenberg's Third Quartet does not imply an awareness of this property on the composer's part, since this relationship is present between the two hexads of *every* twelve-tone collection [my emphasis].[30]

The latter statement is not true. By definition Z-related hexachords are complementary hexachords which cannot be related by transposition or by inversion. Furthermore, the importance of these hexachords is indicated by the fact that of the fifty hexachords in the twelve pitch-class set universe, thirty are of the Z variety.

Misunderstanding of the notion of 'equivalence' as it pertains to the Z-related pitch-class sets, the hexachords in particular, persists in the professional literature. In *The Structure of Atonal Music* equivalence of two pitch-class sets is defined as follows: '. . . two pc sets will be said to be equivalent if and only if they are reducible to the same prime form by transposition or by inversion followed by transposition' (p. 5). This is not the same thing as saying that any two sets with the same total interval content will be regarded as equivalent. Yet a recent reviewer perpetuates the confusion. Jarman expresses doubts about two of the criteria upon which musical relations (according to pitch-class set theory) are presumed to exist. The first of these is '. . . the belief that any two collections which, while being distinct in pitch

content, share the same total interval content . . . are equivalent. . . .[31] Whatever his disagreement might be with this assumption, it is not a disagreement with the definition of pitch- class set equivalence as expressed in *The Structure of Atonal Music*, which is based upon the pitch-class content of a set and not its total interval content.

Occasionally critics have said that the procedures and concepts of unordered pitch-class set analysis derive from 12-tone theory and are therefore inappropriate when applied to non-twelve-tone music. For example, Richard Swift's recent extended article on the 12-tone aggregate contains the following observation: 'That aggregate composition may well be a viable means of approach to the analysis of much twentieth-century music has not failed to attract the attention of some theorists'. To this statement is attached a footnote: '*The Structure of Atonal Music* (Yale, 1974 [sic]), is a recent attempt to force such aggregates into a twelve-tone theoretical mold'.[32] Clearly there is a misunderstanding here. Unordered pitch-class set theory was not developed within 'a twelve-tone theoretical mold', but was derived independently and inductively through the intensive study of a good deal of music. Indeed, as I indicated earlier in my comments on the work of Martha Hyde (p.34), pitch-class set analysis illuminates 12- tone music. The ordered set concepts of 12-tone theory are only peripherally relevant to the study of music in which the unordered set is the basic structural unit.

Some critics have said that when music is analysed using techniques of unordered pitch-class set analysis important aspects of that music, such as timbre, may be overlooked or ignored. The complaint is specious, of course. However transparent this ploy of the critic may be — and, of course, music analysis is not its exclusive field of application — it has tempted more than one. For example, a review of *The Structure of Atonal Music* in a French periodical criticized the use of a reduced score of Schoenberg's Five Pieces for Orchestra, Op. 16, third movement, because the analysis was then focused solely on pitch, whereas, in the reviewer's words, '. . . the basis of this piece is a timbral ambiguity . . .'.[33] Now, everyone knows that timbre is a fundamental component of Schoenberg's Op. 16, third movement. What the analysis in *The Structure of Atonal Music* revealed, however, is that the work is canonic throughout; the canonic structure is concealed by the timbral surface, but unambiguous. The same reviewer complains about the use of a reduced score for the 'Danse sacrale' movement of Stravinsky's *The Rite of Spring*, claiming that what he terms the 'global structure' of the music is 'assured . . . by rhythm'.[34] Here the practical requirements of presenting a quasi-score of a large segment of music dictated the omission of rhythmic notation, inviting criticism of the type levelled by this writer. However, the criticism is justified insofar as *The Harmonic Organization of The Rite of Spring* did not discuss rhythmic features of the music; indeed, it explicitly excluded them from systematic consideration, as might even have been suggested by the very title of the book.

The extent to which one can generalize about non-tonal musics is a matter of

some disagreement. There are those who feel that the term 'atonal' has only a limited applicability. For example:

> Atonality thus roughly delimits a wide range of compositional practices whose only features are the absence of the normative and interrelated procedures of tonality and of the basic concept of serialism. It remains to be seen to what extent atonality is a useful or relevant musical category.[35]

This view, like the comment on the absence of rhythmic analysis cited earlier, reflects the current state of research on twentieth-century music in general and early twentieth-century music in particular. Here the authors say it remains to be seen, and that is certainly true. Much work remains to be done. However, a considerable amount of relevant analytical work has been completed in recent years — much of it after the article from which I extracted the quotation was written — and this work strongly suggests the existence of a 'common practice' in the early twentieth century, a practice which incorporates a large and varied repertory of non-tonal music that is not coextensive with the atonal works of Schoenberg and his students. Even that repertory, the atonal music of the 'second Viennese school', has been inadequately understood with respect to its historical position. Reviewing *The Structure of Atonal Music*, one writer has observed:

> It will be argued by some that to apply set theory to, for example, Schoenberg's Little Piano Piece, Op. 19/6 is to falsify its 'free' nature and reduce it to a mere anticipation of a twelve-tone composition. On the contrary, however, Forte's system clarifies what is unique about the music, and the indissoluble complexity and coherence of those works which he examines in detail have never been more convincingly demonstrated. In particular, the sense in which their freedom contrasts with the principles of tonal past and twelve-note future can be precisely defined.[36]

To move along to another issue, and one that will undoubtedly continue to generate considerable heat in the future, I summon forth with some reluctance the two-headed monster whose name is 'Tonal oder Atonal'.

There are many, perhaps very many, who believe that non-tonal, in particular, 'atonal' music is a misperception, that all music is, in some sense, tonal. To apply pitch-class set analytical techniques to atonal music is then *ipso facto* illegal at worst and suspect at best. This view may take a mild and mediating form, as expressed in the following quotation from Jim Samson:

> An analytical approach to 'atonality' should begin rather [i.e., not as does *The Structure of Atonal Music*] by accepting a wide range of interacting functions in an oeuvre where tradition and innovation are inextricably interwoven and where emphasis lies as much on the *exploration* of new resources as on their organization.[37]

Although I am not totally unsympathetic to this point of view, which may, indeed, have some merit in certain transitional works by Schoenberg, Scriabin and others, I believe that atonality represents an historical fact that determines analytical priorities. The very name with which this musical development was supplied by some unknown critic, with its connotations of 'amusical', 'agnostic', even 'atheistic', has encouraged an ultraconservative stance. This extreme view is well represented by Will Ogdon, author of a recent study of Schoenberg's Op. 11, No. 1, a beleaguered and somewhat petulant tonalist who writes as follows near the beginning of his essay:

> The competition among those willing to venture diverse opinions on the tonality of Opus 11 is lively, to say the least, while the scornful, led by George Perle and Alan [sic] Forte, offer motivic and set analysis in the place of tonal interpretation.

The author of this study is extremely prone to irritation:

> It is also irritating to read the work of reputable theorists [i.e., Perle and Forte] who do not bother to discuss structural relations and functioning in Opus 11 even though they abstract various note sets.

Now, while I do not wish to speak for George Perle — he is quite able to represent himself, as he has amply demonstrated over the years — I will point out that both Perle and I used the beginning of Op. 11, No. 1, to illustrate specific points, not intending to provide complete analyses which would have led to considerations of 'structural relations and functioning'.[39]

I did publish, however, a relatively comprehensive pitch-class set analysis of Op. 11, No. 1, in the same issue of the journal in which the study by this unreconstituted tonalist appeared. (I hasten to add that he had not seen my analysis at the time he prepared his, nor did I read his until it was published.) With the idea that it would be interesting, and, I trust, not overly irritating, to compare representative portions of the tonal and the atonal analyses, I have provided excerpts in Exs 4b and 4c.

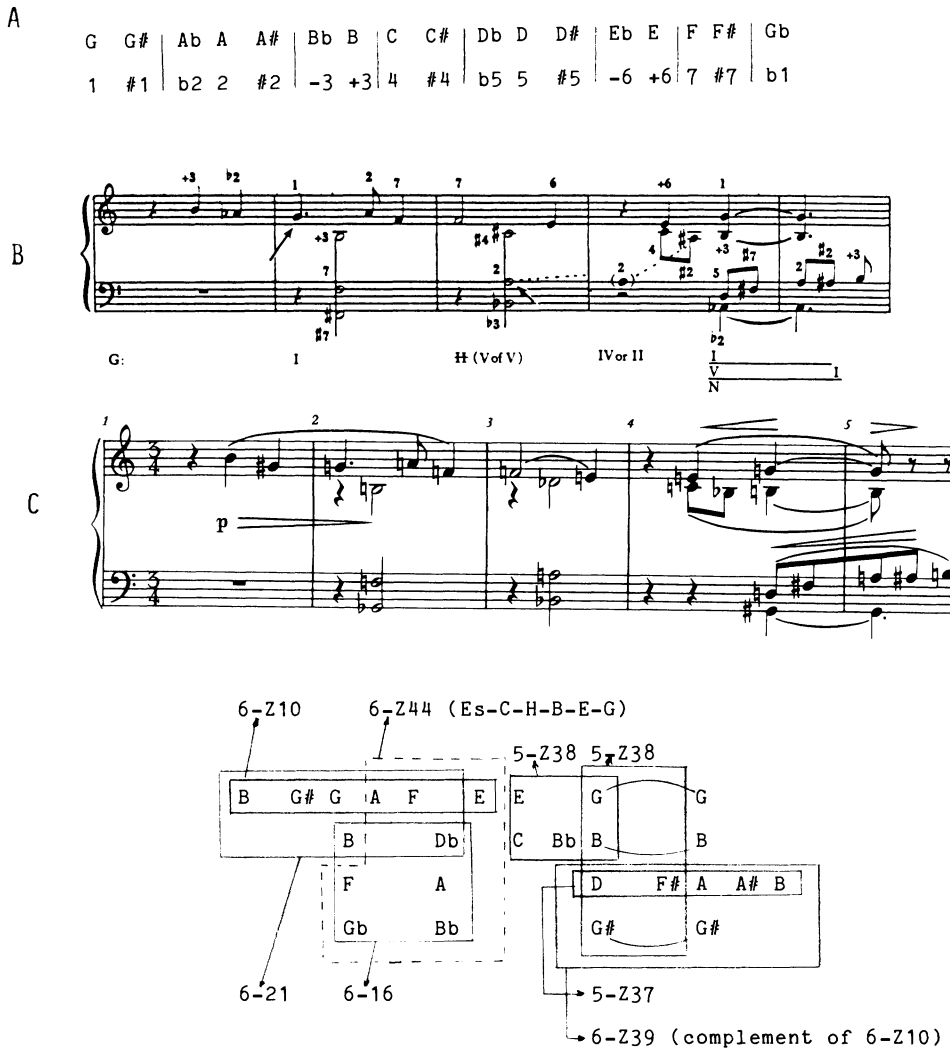
Before I comment upon these, I would like to establish in an informal way what I take to be three reasonable and straightforward criteria which any analytical undertaking should satisfy: (1) completeness; (2) consistency; (3) testability. By 'completeness' I simply mean that all components of the pitch structure be included in the analysis. By 'consistency' I mean that the analytical procedures be applied consistently, without introducing *ad hoc* methods. And by 'testability' I mean that different analysts using the same method would produce results that intersect in significant ways. The latter criterion is, of course, worthy of far more extensive discussion than can be accorded it here. Ogdon apparently feels that it is of no importance, for he welcomes, or so it seems, 'diverse opinions'. Whether Op. 11, No. 1, is in E minor, Phrygian mode, or E♭ is of no concern, as long as it is 'tonal'.

In order to read the tonal analysis and compare it with the atonal (pitch-class set analysis) of the opening music of Op. 11, No. 1, it is necessary to understand the author's symbols on his example. Melodic placement within the G scale, which the author contends is 'the prime tonal axis' of the theme[40], is symbolized according to the table in Ex. 4a. Arrows in his analysis (Ex. 4b) 'point to harmonic roots' (p. 171). Pitches may be renotated to clarify the 'voice leading', by which the author means scale-degree tendencies or something of the kind. Thus, the second note in the upper-voice melody, G♯, is rewritten as A♭ and in this way 'clarifies the tonal priority of G in measure 2 . . .' (p. 172). Similarly, the inner-voice D♭ in b. 3 of Ex. 4b is renotated as C♯, thus becoming scale degree ♯4, with leading-note implication. These notational changes encroach upon the criterion of consistency, since there are no rules for determining when and how they should be made. The analyst does, however, make the same change from G♯ to A♭ in the bass of b. 4 and in the upper voice of b. 1, thus preserving the notational correspondence between A♭ and B which form interval class 3, providing a link between the two moments in the music.

Let us now read the tonal analysis of the opening of Op. 11, shown in Ex. 4b. I have combined the analyst's Exs 1 and 4 from the published article in order to show the same span of music as shown in the first part of my Ex. 5 in the published article, a span which he regards as a unit, as do I. The upper voice of this analysis describes a descending path from scale degree +3 to scale degree 6, then skips upward from scale degree 6 to scale degree 1. Accompanying this melody are the functional harmonies indicated by the Roman numerals below the staff in Ex. 4b: I–II altered (V of V) and I. How I is formed by the pitches that comprise this measure is not explained. In particular, the function of F♯ in this constellation, especially as it relates to its uninflected counterpart, F, is left shrouded in mystery, nor is the designation of roots buttressed by theoretical argument. (In this connection, it is perhaps worth noting that a Hindemithian would call B the root here, since it is the root of the best interval, the fifth.) The harmonic progression is most peculiar, especially the succession V of V to I. What became of the dominant? Although the author could have evoked 'elision', availing himself of an escape hatch always at hand to the shrewd analyst, he does not do so, nor does he offer any explanation for this progression. Finally, the progression ends on I in bs 4–5, but a I that is different, with respect to pitch content, from the I in b. 2. This second I is not unequivocal, as indicated by the three levels of symbols below the lower stave in bs 4–5, which are described by the author as a 'cubist cadence' (p. 172). I will not quote or attempt to paraphrase his explanation of this remarkable formation, since it is highly condensed material which is difficult enough to follow when read from the printed page.

It would be hard to imagine a reading of this music that differs more from the tonal reading just surveyed than the pitch-class set reading shown in Ex. 4c. In Ex. 4c, the full music notation is given at the top, in its original form, without enharmonic substitutions, and below that is a letter-name diagram correspond-

Ex. 4



ing to the music notation, with pitch-class set components indicated by boxes to which are attached set names. Perhaps the most basic difference between this reading and the tonal reading is the way in which the music is segmented. Instead of following the bar-by-bar segmentation of the tonal reading, this

interpretation adopts a simpler strategy: the upper voice of bs 1–3 is taken to be one musical unit, the accompanying lower parts another. The upper part then presents the hexachord 6–Z10, a favorite of Schoenberg's, while the accompanying parts sum to 6–16. Analytical proof that this is the correct way to segment the opening — with respect to its hexachordal components — is amply provided by the rest of the piece, where both hexachords recur in multiple forms. Indeed, repetition, Schoenberg's 'developing variation', is the basic musical process in this composition.

Bars 4–5 (Ex. 4c) again segment naturally into upper and lower parts. The lower parts present a new hexachord, 6–Z39 (F♯–G♯–A–A♯–B–D, in normal order). Remarkably, this set class is the complement of set-class 6–Z10. Thus, the accompaniment of the consequent phrase derives from the melodic theme of the antecedent phrase by complementation (followed by transposition, with t=8). I do not wish to suggest here, nor did I do so in the article, that Schoenberg was thinking in such systematic terms at this early pre-12-tone stage; however, he certainly knew about complementation and interval content, even in the most traditional terms. The relation may be 'abstract', but it is nonetheless real. Later in this paper I will offer a brief demonstration of ways in which complement-related sets may be associated in more immediate ways.

The upper parts of bs 4–5 present the pentad 5–Z38, which also has multiple manifestations in the subsequent music. In fact, it is immediately replicated, as shown in Ex. 4c, by the configuration consisting of F♯–G–G♯–B–D (normal order), an inverted transposition (specifically, IT6). The two forms of 5–Z38 intersect in the dyad G–B, a significant axis interval because of its role as a major component of the initial melodic gesture and, in this context, as part of the durationally and rhythmically distinct trichord, from the bass up, G♯–B–G, which is identical, with respect to pitch class, to the first melodic trichord. I offer this analytical observation to the author of the tonal analysis in support of his G-tonality thesis; note, however, that I am giving him not a complete triad, but only the lower third of a major triad. He will no doubt have little difficulty in locating the required additional element.

Other features of the set structure of the opening music may be mentioned briefly. First, the hexachord 6–21 is a component here, and this subsequently surfaces as the upper-voice melody of the music that begins in bs 9–11, where it has the same rhythmic shape as 6–Z10 in the opening phrase. Set 5–Z38 is strongly associated with the pentad 5–Z18, discussed in connection with Exs 1 and 2, since it is the Z-correspondent of that set, hence has the same total interval content. Set 5–Z37, the tenor melody of bs 4–5, foreshadows its complement, 7–Z37, which is expressed at the very beginning of the development section, where among its principal constituents are 6–Z10 and 6–16, the principal foreground components of the opening music, as I have indicated. And finally, in this opening music of Op. 11, No. 1, we find, as we do in all the music after the 1905 songs of Op. 6, Schoenberg's signature, Es–C–H–B–E–G, here transposed up six semitones, for Schoenberg almost

never presented the hexachord in its literal form.

I submit that the pitch-class set reading (which shows only one level of set structure and is not intended to be a 'finished' analysis) is complete, in the sense that no pitch components are omitted, and consistent, in the sense that *ad hoc* methods were not brought into play. It also observes the criterion of testability, since any trained analyst using pitch-class set procedures in the entire piece will come up with results similar to those presented here.

To continue with my survey, I note that some observers have felt that the procedures of pitch-class set analysis are too mechanical and the concepts too complex. While I agree, in principle, that an analysis should not be overly complicated in its effort to elucidate the music, I find it difficult to understand objections to elementary theoretical statements that are required for analytical work. Consider the following excerpt:

> And so we arrive at the following paragraph of gobbledegook: 'The total interval content of a pc set is represented by the interval vector, an ordered numerical array that displays the number of intervals of each class. . . .'

Anthony Milner continues: '(If this book was not written with the aid of a computer it should have been)'.[41] The reference to 'a computer' is, of course, disparaging, and it is assumed that the reader will share the reviewer's negative opinion of such devices.[42] My only response to such comments is to speculate upon the habitat of the writer during recent years. In this case it seems likely that he has been dwelling under a very large rock in Outer Mongolia. Surely everyone knows that many people now routinely work with computing devices — a topic to which I will return briefly at the end of this paper — a paper which, as I will now reveal, was written with the aid of a computer! Here we have another instance in which, as I have learned, music theory and analysis can be highly charged with emotion, especially when ideas are presented which threaten cherished beliefs and well-ingrained points of view.

In a similar vein, it has been asserted that pitch-class set analysis does not deal with compositional process and is only remotely related to music. In a review of *The Structure of Atonal Music* entitled, amusingly, 'The Rules of Scrabble', an anonymous writer frames his critique within the arena of international relations: 'What sets the American approach apart . . . is its total lack of concern for how the composer works or what he may intend his music to express. . . .' Further along, the reviewer enlarges the historical perspective, exclaiming: 'We are witnessing from a distance a Puritan backlash against European musical developments since the war'. Then, in an ecstatic mixture of geological and culinary metaphors, he proclaims:

> Not content to regard music as only that which is notatable, Professor Forte further reduces the field of his investigations to a gritty deposit of notes from which instrumentation, accentuation, rhythm, tessitura, tempo, dynamic, even sequence have been boiled away.[43]

Perhaps this is the time to say, once and for all, that no book on analytical theory can cover all the ground that needs to be covered in the analysis of an individual work. That *The Structure of Atonal Music* does not deal exhaustively with 'instrumentation, accentuation, rhythm', and so on, does not imply that its author regards these aspects as 'unimportant'. Were I to take such criticisms seriously, I would immediately seek employment as an operator of heavy equipment in the north of Alaska. I dismiss them, however, as being shallowly rhetorical, as unworthy of prolonged consideration. Moreover, the question of 'compositional process' as it relates to analysis is knotty at best (even when the composer is his own analyst), and one which can hardly be dismissed in a casual way, as did our reviewer. The extent to which any analytical process corresponds to compositional process will always be moot to a considerable extent, I feel, especially in the absence of strong evidence concerning compositional method, as is the case with atonal music. However much one might deplore the fact that Schoenberg did not have the privilege of studying *The Structure of Atonal Music* at the time he composed his first path-breaking works around 1908, it is, nevertheless, a fact.

Concluding Remarks

Where, then, does unordered pitch-class set analysis stand today? Have all the negative opinions been laid to rest? Does nothing remain to be done? I have already suggested my general responses to these questions at several points in the foregoing discussion. More specifically, in answer to the first of these questions, it is clear that although pitch-class set analysis has been utilized in a variety of fruitful ways by a number of different individuals, there are those who have absolutely no use for it whatsoever, for various reasons.

If one seeks a general reason for the explicitly negative responses, however, there is a thread that runs through them, a misperception that results from the failure to disengage theory from analysis in an appropriate way and at appropriate moments. A dichotomy that seems to me to be basic in this area of music research, and one that I will express in the simplest terms, is this: Music theory is abstract; music analysis is concrete. The power of a theory resides in its ability to provide a general background against which an analytical statement may be measured. While a theory may suggest a range of significant analytical interpretations at various levels of structure, including the level of minutest detail, it must still preserve its generality and its aloofness from any particular musical expression. Much of the criticism of pitch-class set analysis is based upon a confusion of these two facets of the study of musical structure, the one theoretical, the other analytical. Even at the simplest level the progression from theory to analysis has sometimes been ignored. One reviewer of *The Structure of Atonal Music*, for example, complained: 'The "name" still tells nothing about the set except its size and its position on a list. That's acceptable to a computer, perhaps'.[44] Of course — the derogatory reference to 'a computer' quite aside — set names were deliberately designed to be abstract and neutral. Nothing could

have been worse than to have burdened set names with descriptors of particular attributes, such as indications of special subsets they might contain, a strategy that has often been adopted.[45]

In going from abstract theory to the particulars of analysis, the analyst must decide precisely how much of the theoretical apparatus to apply and how to interpret it so that it fits the immediate musical situation. Clearly, this depends upon individual judgement. I might decide to stress complement-related hexachords, as in my analysis of the opening of Schoenberg's Op. 11, No. 1, presented earlier, since I know that this feature is important through the music in a variety of ways that have to do directly with the surface components. Another analyst using pitch-class set methods would discover many of the same structures but might decide at some point not to emphasise the complement relation or to deal with sets of magnitudes smaller than six. Still another approach — say, via the concept of the 'basic cell' — might yield totally different results, perhaps not involving the hexachord as a set at all. The evaluation of such 'alternative' analyses, is, of course, a matter for professional cogitation and judgment.

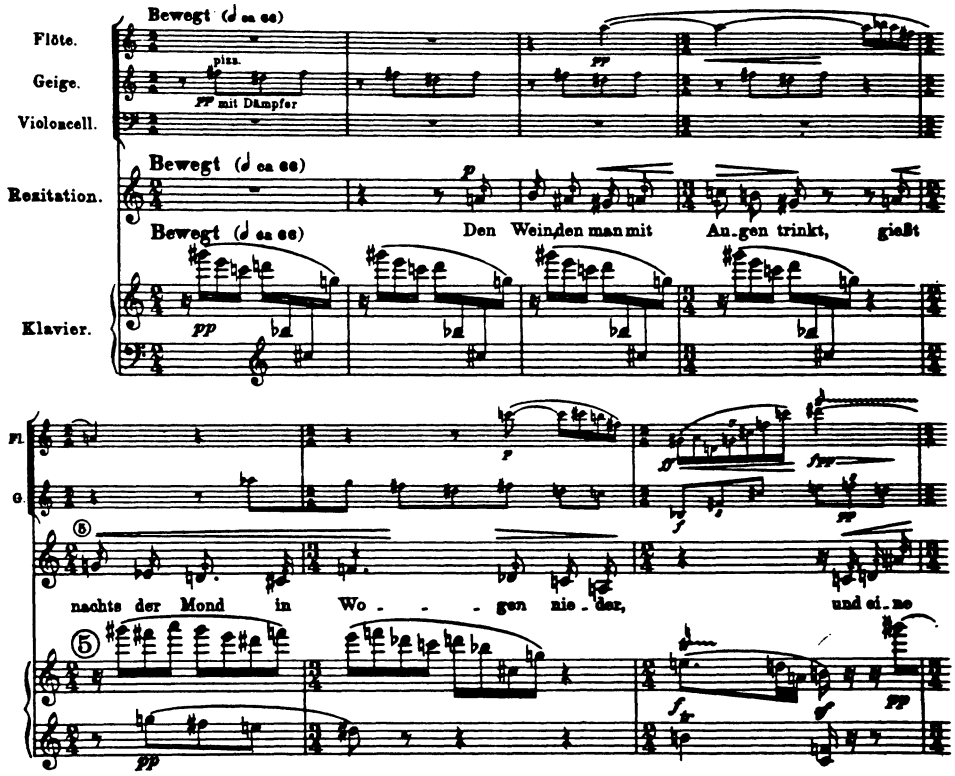
I would now like to deal with some important residual considerations, including problems in pitch-class set analysis — or, more precisely, problems raised by pitch-class set analysis — and possible new directions, in response to the question I raised above as to whether there remains work to be done.

First, I would like to deal with the general problem of the interpretation of analytical results obtained by performing certain basic operations in pitch-class set analysis, in particular, the operation of set identification.

Set identification, simple as it appears to be, usually engages a number of more complex analytical decisions, primarily in the domain of segmentation: the determination of those musical units that are to be regarded as structural. Thus, in the analytical process set identification and segmentation are inevitably intertwined. General rules of segmentation are hard to come by, although guidelines, based upon experience with the music of a particular composer, are always available to the hardened analyst. Perhaps Schoenberg's atonal music still offers the most difficult cases.

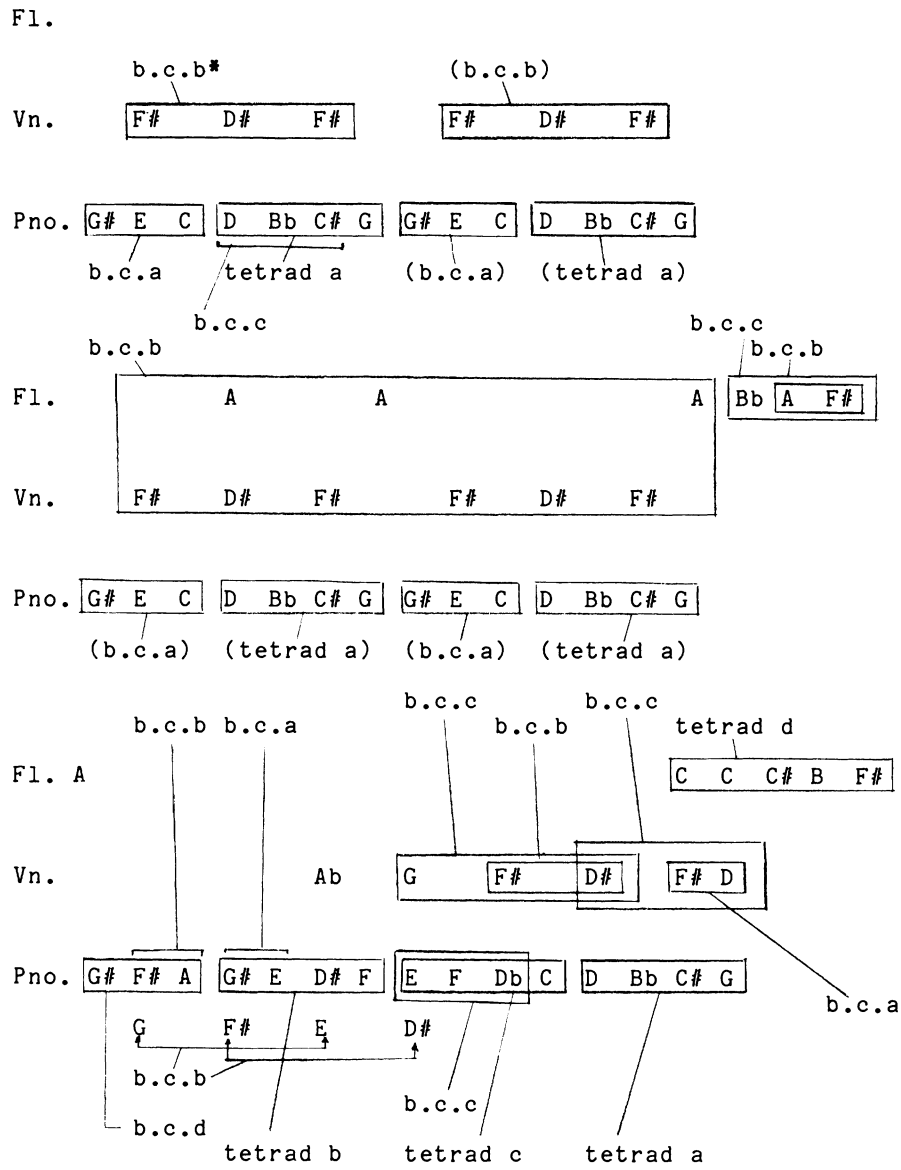
A brief excerpt from the first piece of *Pierrot lunaire* will serve to illustrate this point (Ex. 5a). Ex. 5b (p. 50) provides an analysis based upon the notion of basic cell, a pitch-interval unit which serves in a motivic capacity and in other capacities in the work to provide unity and continuity.[46] Thus, the first basic cell, marked b.c.a, is the augmented triad in the piano configuration which is repeated four times in the opening music. Basic cell b (b.c.b) is the ostinato-like dyad F♯–D♯ played by the violin.[47] Basic cells larger than the dyad or trichord are labelled tetrads on Ex. 5b. For instance, the first of these, tetrad a, comprises the last four notes in the seven-note piano figure (7–28). With the entrance of the flute in b. 3 on A, basic cell b, the minor third, is now doubly represented, while the succession consisting of basic cell a and tetrad a continues beneath it in the piano part. The tail of the flute line in bs 4–5 incorporates basic cell b as A–F♯(–A). The trichord here is basic cell c,

Ex. 5a



transposed up eight semitones. Further analytical justification of this reading is provided by the recurrence of this trichord type (3–3) — not the literal trichord — twice in the violin line that begins at the end of b. 5 on A♭, where the original form of basic cell b, F♯–D♯, in register, serves as an axis in this symmetrical construct within a hexachordal figure. As the basic cell analysis proceeds, however, certain difficulties begin to creep in. There occurs a new tetrad in the piano in b. 5, corresponding, with respect to position, to tetrad a in b. 1. This is labelled tetrad b. Notice that it contains basic cell a in its original form, G♯–E. In the piano in b. 6 a new tetrad appears, labelled tetrad c. It is connected to the previous basic cells, however, since it contains basic cell c (transposed). (It should also be observed that the tetrad is of the same type as the tetrad (4–7) formed by interlocking forms of basic cell in violin, bs 5–6, pointed out in the previous discussion.) Finally, still another tetrad appears on

Ex. 5b

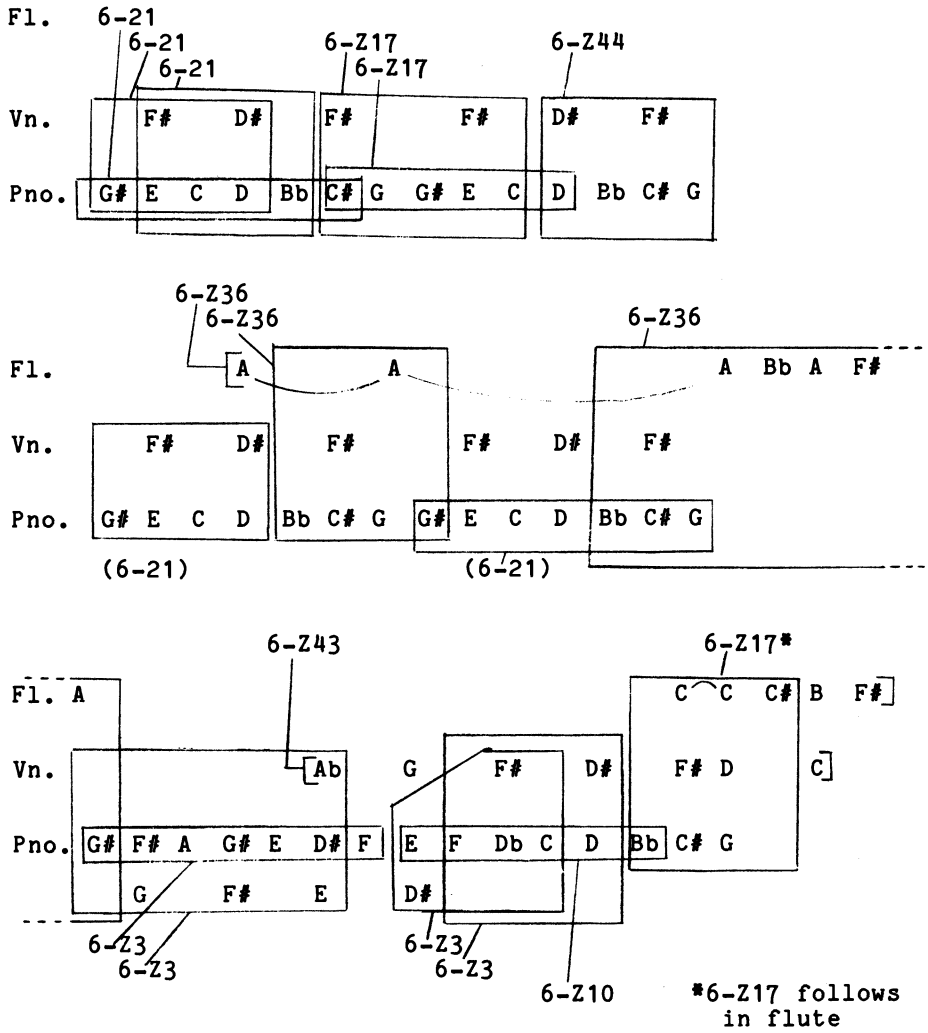


*b.c. means basic cell

the scene, labelled tetrad d, the end of the flute figure in b. 6. It will be difficult to fit these features into a completed analysis of the entire movement.

This basic cell analysis, other features of which are indicated on Ex. 5b, but will not be discussed, is effective and interesting as far as it goes, but it does not show the 'background' features which govern the movement as a whole. Ex. 5c

Ex. 5c



attempts to do that and in the process allows for a segmentation that is a good deal more flexible than the primarily 'foreground' segmentation of the basic cell analysis. This segmentation is justified by reference to an analysis of the entire movement, in a way which I will indicate further along. It proceeds from some basic observations. For example, both the flute and violin present hexachords — set-class 6–Z36 in flute and set-class 6–Z43 in violin — a strong hint that the hexachord is the fundamental unit in this music. Segmentation of the piano figure does not follow the rest-determined procedure of the basic cell analysis (Ex. 5b), but in view of the circular nature of the line — due to the immediate repetitions — permits a different reading. Also the analysis in Ex. 5c takes into account that the instruments interact and combine in various ways. Thus, if we read the first hexachord formed by piano and violin, this proves to be set 6–21. The same set class is represented by the first hexachord in piano alone, and again as the second hexachord formed by the two instruments. The opening music is therefore saturated with the sound of this special hexachord, one of the 'almost whole-tone' hexachords.[48] Hexachord 6–Z17 follows 6–21 in the piano as indicated on the example. The relation between this hexachord and its complement, 6–Z43, as it occurs in the violin line in bs 5–6 will be shown in connection with Ex. 5f (p. 55). Finally, in the opening music a form of 6–Z44 appears, a hexachord which subsequently assumes an important role in the music, together with its complement, 6–Z19.

After the onset of flute on the sustained A (b. 3), which begins the linear statement of hexachord 6–Z36, there is an echoing accompanimental occurrence of the same set, formed by all three instruments. The same set recurs beginning with B♭ in piano in b. 4. Here the two forms of 6–Z36 connect exactly by means of what was called basic cell c in Ex. 5b: the trichord F♯–A–B♭. In this analysis the trichord gains considerable significance because it is read in the context of a set which is fundamental throughout the movement. The upper part of the piano configuration in b. 5 now has a completely different aspect. It is read as 6–Z3, the complement of 6–Z36. The reading is supported by a criterion as yet unvoiced, one so 'simple' that it might be overlooked or taken for granted: the criterion of repetition. In the case of Schoenberg, it can surely be claimed that repetition is a fundamental musical process in all his music, not repetition in the obvious sense, but repetition of the most artistic and subtle kind. Here 6–Z3 is represented not only in the piano line but by the segment formed by the entire piano part and the first note of the violin line, which is the same pitch class as the first note in the right hand of the piano. (In this short excerpt I have deliberately suppressed many other occurrences of the basic hexachords in order to avoid presenting an overly complex analysis which would divert attention from general issues.) As shown on the example (Ex. 5c), 6–Z3 is represented twice more.

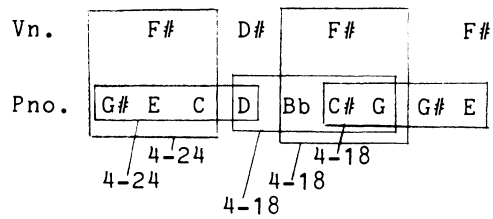
As 6–Z43 is completed in the violin part, its complement, 6–Z17, occurs as a segment formed by all the instruments. Just before this, hexachord 6–Z10 appears as the first hexachord in the right hand of the piano, b. 6. Again, this is a hexachord the functions of which — with respect to its complement as well as to

the other hexachords in the movement — become clear in the subsequent music.

Whereas the basic cell analysis shown in Ex. 5b was developed in a light-hearted, spontaneous and 'contextual' manner, the analysis shown in Ex. 5c is about as spontaneous as a cooking lesson on television, in which the instructor shows, step by step, the ingredients and combinations, knowing full well that the completed dish is safely in the oven and ready to be photographed at the end of the programme. In a similar way, the reading of the sets in Ex. 5c is conditioned by a detailed completed analysis of the entire movement, presentation of which in this setting would most certainly result in massive indigestion. I will say, however, that the movement is based upon exactly six hexachords — not an insignificant number in Schoenberg's case — together with their complements.[49] Of these, two of the most important are given in the opening music: the 'almost whole-tone' hexachord 6–21 and the 'almost chromatic' hexachords 6–Z3 and 6–Z36. The sixth hexachord, 6–Z13, incidentally, does not appear until b. 8, where it is the basis of the canon there. As will be obvious now, segmentation in Ex. 5c is strongly determined by repeated occurrences of these six fundamental hexachords. A segmentation of this kind, which seems to be especially appropriate in the case of Schoenberg's atonal music, but may be applicable elsewhere, may be termed a 'top-down' segmentation, as distinct from the 'bottom-up' segmentation illustrated by Example 5b.

It should be clear that the two types of segmentation are not mutually exclusive. Ex. 5d illustrates this: What was called tetrad a in the basic cell

Ex. 5d

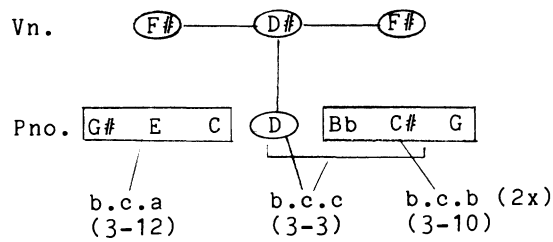


analysis (Ex. 5b) is identified in Ex. 5d as set 4–18, the prime form of which is [0,1,4,7]. Not only does 4–18 occur in the horizontal plane here, but it is also formed as a segment by piano and violin combined. As shown in Ex. 5d, it also occurs a third time, again in the horizontal plane, linking b. 1 and b. 2. The other aspect of tetrachordal organization shown in Ex. 5d is the dual occurrence of set 4–24, two transpositionally-related forms which share basic cell a, the 'augmented triad'. This tetrachord is prominent throughout the movement, for example in b. 10, where it sets the text word 'Horizont', a bit of word painting which exploits the symmetric and stable properties of the whole-tone tetrachord.

Ex. 5e provides a further refinement of the tetrachordal analysis in Ex. 5d, approaching the treatment of individual pitch classes which would be essential

to a relatively complete analysis. This example focuses upon b. 1, ignoring the elaborate overlapping structures of the previous segmentations. It divides the seven-note piano figure into two trichords, the first and the last, leaving D in the middle, a symmetric position which it occupied in the tetrachordal analysis in Ex. 5d as well. In this reading, D is connected to the rhythmically symmetric component basic cell b (that is, rhythmically symmetric with respect to the seven-note piano figure) to form basic cell c. This division of the seven-note piano figure reveals basic cell a again in contrast to basic cell b. Here it is represented twice, becoming a 'diminished triad', a representative of set class 3–10, to use the jargon of unordered pitch-class set theory.

Ex. 5e

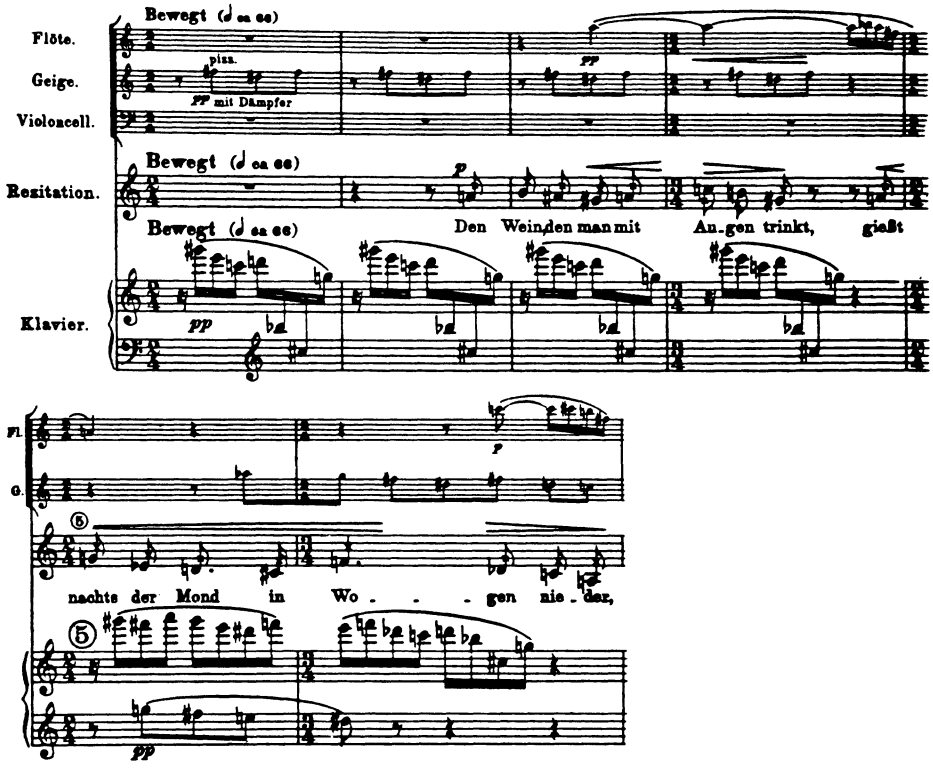


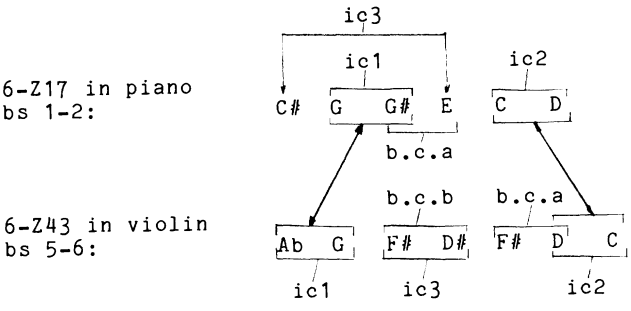
In the final example, Ex. 5f, correspondences between Z-related hexachords are displayed in demonstration of the significance that such relations may exhibit — but do not necessarily always exhibit — at the level of detail. Exact pitch-class correspondences are indicated by double-headed arrows that join the two dyads. Thus, the two Z-correspondents are associated strongly by interval classes 1 and 2. Interval class 3 in 6–Z43 is matched, however, not by an adjacency in 6–Z17, but by the non-contiguous C♯ and E. Basic cell components, the 'major third' from basic cell a and the 'minor third' of basic cell b, are shown on the example as well.

In conclusion, I express my regret that it is not possible here to cover all the subtopics that come to mind in connection with the general topic, 'Pitch-class Set Analysis Today'. These include the question of 'aural relevance', which is closely associated with the important matter of ear-training pedagogy — especially important in the case of early twentieth-century atonal music, with its rich harmonic vocabulary and intricate structures, of which the music of Schoenberg is surely the most complex representation.

I would like to say a word, however, about future prospects for the use and development of pitch-class set analysis. First, a recent technological development offers interesting possibilities for research. I speak of the advent of the microcomputer, which renders computational facilities accessible to any scholar who is interested enough to learn how to use them. Many aspects of analysis may undergo considerable development by virtue of the existence of this technology and its interactive capabilities. One can envision, for example, a

Ex. 5f





powerful set-complex analyser with artificial intelligence aspects. Second, there remain to be investigated many more general and interesting questions, such as the definition of 'centricity' in, for example, the atonal music of the Viennese classicists. Finally, there is much music still to be studied using pitch-class set methods. Two repertories come to mind: (1) the transitional music of the late 19th century, a repertory to which I referred at the beginning of this paper, and (2) more recent music that might be studied in a fruitful way via pitch-class sets and relations.

NOTES

1. Matthew Brown, 'Conference Report', *Music Analysis*, Vol. 3, No. 1, March 1984, pp. 91–5. In this report on the Sixth Annual Meeting of the Society for Music Theory at Yale (November, 1983), the author writes of the 'great diversity in subject matter', then goes on to say that '. . . there was considerable conformity in method — to some degree or other, the vast majority of papers drew upon Forte's theory of unordered sets and Schenker's theory of tonality'.
2. Allen Forte, *The Structure of Atonal Music* (New Haven: Yale University Press, 1973). Idem., *The Harmonic Organization of The Rite of Spring* (New Haven: Yale University Press, 1978).
3. Wallace Berry, *Structural Functions in Music* (Englewood Cliffs: Prentice-Hall, 1976).
4. Jonathan Bernard, 'Pitch/Register in the Music of Edgard Varèse', *Music Theory Spectrum*, Vol. 3, 1981, pp. 1–25.
5. Christopher Hasty, 'Segmentation and Process in Post-Tonal Music', *Music Theory Spectrum*, Vol. 3, 1981, pp. 54–73.
6. Douglas Jarman, *The Music of Alban Berg* (Berkeley: University of California Press, 1979).
7. Reinhold Brinkmann, *Arnold Schönberg: Drei Klavierstücke Op. 11: Studien zur frühen Atonalität bei Schönberg* (Wiesbaden: Franz Steiner, 1969), p. 98: 'Das Verfahren, alle Gestalten aus einem Kern zu entwickeln, findet auch in diesem Stück Anwendung. Ausgangspunkt aller Ableitungen ist der Eröffnungsabschnitt mit seinen zwei gleich am Beginn exponierten Themen bzw. Motiven, die untereinander wieder engen Konnex haben. Sie mögen mit a bzw. b bezeichnet.'
8. David Loeb, 'An Analytic Study of Japanese Koto Music', *The Music Forum*, Vol. IV, 1976, pp. 335–95.
9. Paul F. Wilson, 'Atonality and Structure in Works of Béla Bartók's Middle Period' (Yale University: Ph.D. dissertation, 1982), and James M. Baker (see n. 25 below).
10. Martha M. Hyde, *Schoenberg's Twelve-Tone Harmony: The Suite Op. 29 and the Compositional Sketches* (Ann Arbor: UMI Research Press, 1982), p. 11.
11. Arnold Schoenberg, 'Composition with Twelve Tones (1)', in *Style and Idea*, ed. Leonard Stein (New York: St Martins Press, 1975), and Claudio Spies, 'Vortrag / 12TK / Princeton', *Perspectives of New Music*, Vol. 13, No. 1, Fall – Winter 1974, pp. 58–136.
12. Jeff Pressing, 'Pitch-Class Set Structures in Contemporary Jazz', *Jazz Forschung*, Vol. 14.
13. Alan Chapman, 'Crossing the Cusp: The Schoenberg Connection', Kurt Weill Conference, sponsored by The Music Library of Yale University and the Kurt Weill Foundation for Music, New Haven, Connecticut, 2–5 November 1983.

14. Paul Wilson, *op. cit.*, p. i.
15. Philip Russom, 'Structural Levels in Post-Tonal Music as Exemplified in Works by Maurice Ravel', Dissertation-in-progress, Yale University.
16. Janet Schmalfeldt, *Berg's Wozzeck: Harmonic Language and Dramatic Design* (New Haven: Yale University Press, 1983).
17. Douglas Jarman, *Times Literary Supplement*, 20 January 1984, p. 56.
18. Schmalfeldt, *op. cit.*, p. 121.
19. Richard Parks, 'Pitch Organization in Debussy: Unordered Sets in *Brouillards*', *Music Theory Spectrum*, Vol. 2, 1980, pp. 119–34: p. 134.
20. Richard Taruskin, Review of *The Harmonic Organization of The Rite of Spring*, *Current Musicology*, No. 28, 1979, pp. 114–29.
21. *Ibid.*, p. 123.
22. Taruskin is inaccurate or misleading when he states: 'He finds the chord marked with an arrow in Example 3 "anomalous" and lets it go at that' (*ibid.*, p. 123). What I wrote was: 'Set 4–8 remains somewhat anomalous here because it does not fit into the similarity scheme [which had been discussed], but its relation to 5–6 (mentioned above) will be recalled' (Forte, *Harmonic Organization . . .*, p. 59).
23. It should be pointed out that nowhere in *The Harmonic Organization of The Rite of Spring* is it stated that the work is atonal.
24. Robert Craft, 'Craft on Forte', *The Musical Quarterly*, Vol. 64, No. 4, October 1978, pp. 524–35.
25. James M. Baker, 'Schenkerian Analysis and Post-Tonal Music' in *Aspects of Schenkerian Theory*, ed. David Beach (New Haven: Yale University Press, 1983), p. 179.
26. Allen Forte, 'A Theory of Set Complexes for Music', *Journal of Music Theory*, Vol. 7, No. 2, Fall–Winter 1964, pp. 136–83.
27. The three reviews of *The Structure of Atonal Music* to which I refer are: William Benjamin's in *Perspectives of New Music*, Vol. 13, No. 1, Fall–Winter 1974; Richmond Browne's in *Journal of Music Theory*, Vol. 18, No. 2, Fall 1974, pp. 390–415; Eric Regener's in *Perspectives of New Music*, Vol. 13, No. 1, Fall–Winter 1974, pp. 191–212.
28. George Perle, Communications section of *Journal of the American Musicological Society*, Vol. 35, No. 2, Summer 1982, pp. 373–7.
29. See Allen Forte, 'Harmonic Syntax and Voice Leading in Stravinsky's Early Music' in *Stravinsky: Centennial Essays*, ed. Jann Pasler (Berkeley: University of California Press, 1985).
30. The row hexads are 6–Z46 and its complement, 6–Z24. See Jan Maegaard, 'Schönbergs Zwölftonreihen', *Die Musikforschung*, Jhrg. 29, Heft 4, 1976, pp. 385–424. Maegaard takes this to be the main row and refers to two variants, his Nos 86 and 87 (p. 389, *ibid.*), both of which have the same unordered hexachordal content, viz., 6–Z49/6–Z28.
31. Douglas Jarman, Review of Janet Schmalfeldt, *op. cit.*, *Music & Letters*, Vol. 65, No. 3, July 1984, pp. 294–6. On p. 295 he refers to 'recent *JAMS* exchanges', by which he apparently means George Perle's communication in response to Martha Hyde's review of his book (see n. 28).
32. Richard Swift, 'Some Aspects of Aggregate Composition', *Perspectives of New Music*, Spring–Summer 1976/Fall–Winter 1976, pp. 236–48.
33. Dennis Collins, Review of *The Structure of Atonal Music*, *Revue de Musicologie*, Vol. 61, No. 1, 1975, pp. 143–5: '. . . alors que le fondement de cette pièce est une

ambiguité de timbres . . .' (p. 144).

34. *Ibid.*, p. 144: 'Meme atrophie de la partition de la "Danse sacrale", où cette structure globale est assurée, de toute évidence, par le rythme'.
35. George Perle, Paul Lansky, 'Atonality', *The New Grove Dictionary of Music and Musicians*, Vol. 1, p. 673.
36. Arnold Whittall, Review of *The Structure of Atonal Music*, *Tempo*, No. 109, June 1974, pp. 41–3.
37. Jim Samson, 'Schoenberg's "Atonal" Music', *Tempo*, No. 109, June 1974, pp. 16–25.
38. Will Ogdon, 'How Tonality Functions in Schoenberg's Opus 11, Number 1', *Journal of the Arnold Schoenberg Institute*, Vol. 5, No. 2, November 1981, pp. 169–81: p. 169.
39. See George Perle, *Serial Composition and Atonality* (Berkeley: University of California Press, 1962), pp. 10–16, and Allen Forte, 'Sets and Nonsets in Schoenberg's Atonal Music', *Perspectives of New Music*, Vol. 11, No. 2, Fall–Winter 1972, pp. 43–64.
40. Ogdon, *op. cit.*, p. 170.
41. Anthony Milner, 'Botanizing on music', *Records and Recordings*, Dec. 1979, pp. 128–9, a review of *The Harmonic Organization of The Rite of Spring*, with many references to *The Structure of Atonal Music*. As penance for this intemperate outburst, I suggest that Mr Milner be required to memorise Article Quatrième, Chapitre Huitième, Livre Premier of Rameau's *Traité de L'Harmonie Reduite à ses Principes Naturels* (Paris: 1722), 'De l'Accord de la Septième . . .', an eminent contribution to the ancient and honourable tradition of gobbledegook in music theory.
42. At the end of his vitriolic review, Mr Milner states: 'Perhaps the most favourable comment that can be made on the book is that it serves as the most compelling argument against the use of computers in musical analysis that has yet appeared'. He refers to *The Harmonic Organization of The Rite of Spring*. In point of fact, although I have written many computer programs in connection with analytical and theoretical studies, that book was executed entirely by hand methods, save for an electric typewriter and a high-tech electric eraser.
43. Anonymous review of *The Structure of Atonal Music*, *Times Literary Supplement*, 8 March 1974.
44. Richmond Browne, *op. cit.* (n. 27), p. 406.
45. See, for example, Douglas Jarman, *The Music of Alban Berg*, p. 54, where 4–19 is described as 'a minor triad with an added major seventh'.
46. The notion of 'basic cell' is, of course, George Perle's. See his *Serial Composition and Atonality*, pp. 9–10.
47. I have omitted the *Sprechstimme* from the analysis. If, however, its pitched notation is taken at face value, then it fits into the pitch-class set analysis without difficulty — indeed, supports it — here and throughout the work.
48. Set 6–34, the Wozzeck hexachord, is another 'almost whole-tone' hexachord. Set 6–21 is the opening thematic hexachord in Berg's String Quartet, Op. 3 (1909–10).
49. These hexachords are: 6–Z3/6–Z36, 6–Z10/6–Z39, 6–Z13/6–Z42, 6–Z17/6–Z43, 6–21, 6–Z19/6–Z44. Only 6–21 is its own complement.