The Association of Music Theory Students at Columbia and the Music Department

Present

THEORY
and
VARÈSE

A Symposium in Celebration
of the Composer's Centennial
April 6, 1984

Sulzberger Parlor, 3rd floor, Barnard Hall (117th St. and Broadway)

1:00-3:00 PM First Session: Papers dealing with specific pieces by Varèse: Equatorial and Density 21.5.

3:30-5:30 PM Second Session: Key Paper read by Professor Jonathan Bernard of Yale University:
"Varèse: Rhythm and Duration"

Informal reception to follow

Participants: Professors Patricia Carpenter and George Edwards of Columbia University, Professor Jonathan Bernard of Yale University, Jeffrey Kresky, William Patterson College, Gregory J. Sandell, Eastman School of Music.

ALL ARE WELCOME!

Gregory J. Sandell

SET CONSTRUCTS IN EDGARD VARESE'S ECUATORIAL

The application of set theoretical structures to pitch organization in the last few decades has produced striking insights into the music of the first half of the 20th Century. Analytical research into composers such as Bartok, Ives, Schoenberg, Stravinsky, and Webern has shown that the devices of equivalence under transposition and inversion, similarity based on interval class content and inclusion, pitch class invariance, complementation, and aggregate completion often play fundamental roles in the surface and structural organization of their music. This paper shows that the music of Varèse, while strikingly different from all of these composers, likewise possesses an organization which may be explained from this perspective; yet, as we might expect, so too are Varèse's methods of implementing these devices strikingly different. I will attempt to describe a facet of Varèse's unique method of pitch organization by means of what I have termed "set constructs," and for this I have chosen his Ecuatorial (1934). The paper will be divided into two parts: first an explanation of the analytic approach, followed by an analysis of selected passages of Ecuatorial.

An inquiry into a musical work by means of set classes is inevitably burdened by a surfeit of numerical data. Looking at a piece whose harmonic language comes from no apparent point of

origin, one can either haphazardly circle collections of notes and identify them, or with sufficient ambition (perhaps with the aid of a computer), even identify every conceivable collection of notes; in any case, lying yonder is the difficult task of defining some method of selectivity in order to interpret this data meaningfully.

The Set Complex theory of Allen Forte (whose set-class labels I use in this paper)[1] defines one process of selectivity by filtering out of the given data a web-like network of sets which are in elaborate inclusion relationships to one another. Out of this falls a single set class, the Nexus Set, which acts as a focal point for the work. By viewing the work through the lens of the Nexus Set, so to speak, all the other segmented set classes fall into varying degreees of clarity and obscurity, and the work obtains a certain harmonic profile.

In the present paper a different method of analytic selectivity is proposed which uses three set-class constructs, which I call "cluster/6," "cycle/1," and the all-interval tetra-chord 5 as the focal points of the work in question. While inclusion relationships do determine much of Ecuatorial's local pitch activity, there are many sets whose relationships function in terms of property rather than inclusion; that is, the degrees of clarity and obscurity in Ecuatorial are defined by the possession of specific attributes rather than the relation to

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[1] Allen Forte, The Structure of Atonal Music; New Haven and London: Yale University Press, 1973.

a single set. One might say that the segmentation process is governed by a well-formedness rule which allows only certain strings of pitches to be admitted as structurally important.

The first two constructs are essentially geometric entities. The first is called the "cluster-tritone" construct, hereafter abbreviated as "cluster/6." Please turn to example 1. This construct is defined as any chromatic set-class of cardinality two or above plus one or more tritones appended to any or all of its members; in the example we see the chromatic SC 3-1 with tritones appended to all of its members, and SC 4-1 with tritones appended to only one of its members. The complete family of cluster/6 sets of cardinality six and smaller is shown in example 2. We will be devoting much of our attention to the cluster/6 shown in example 3, that is, SC 4-5, as it is not only the most frequently occurring cluster/6 set, but is by and large the dominant set-class of Ecuatorial.

The second construct, one which acts as a contrasting counterpart to cluster/6, is called "cyclic set with half-step appendage," or simply, "cycle/1." Example 4 shows the essential features of this construct. A "cyclic set" is defined as a chain of two or more directed intervals of identical size---that is, they cycle back to their point of origin if the series continues. When a single half-step, or interval class 1 ("ic(1)") is appended to the extreme end of the set (either the upper or

lower end) it becomes "cycle/1." A variant on this construct is the "second order" cycle/1 set shown in example 5, in which half-step appendages are found at spots other than the extreme members of the cycle.

The third construct is the all-interval tetrachord, SC 4-Z15 or SC 4-Z29 (prime forms: 0146 and 0137); these sets are primarily associated with a recurring passage throughout Ecuatorial, shown in example 6. In the expressive scheme of the piece, this passage acts as sort of a "subsidiary theme": it always is more lyrical and tranquil (note the text) than the highly-charged passages in whose neighborhoods in appears. Perhaps even more important is the contrasting role it plays in the structural scheme of the work, owing to its very different intervallic makeup with respect to the other two constructs. As we can see by the interval vectors of the sets in example 7, the interval content of the cluster/6 sets ~~are~~ is naturally always weighted toward ic(1). Likewise, cycle/1 sets will of course have a preponderance of interval classes of which the parent cyclic set consists. The SCs 4-Z15 and 4-Z29 have no such interval-class weighting, for, as all-interval tetrachords they ~~alive~~ have equal distributions of interval-classes. Hence, these set-classes act as a foil for the other two constructs, both in their abstract properties and in the context of the passages which they represent.

only in one occurrence

What does this actually mean?

Let us turn now to the music itself and see how the first two of these constructs operate as elements of contrast to one another. Example 8 gives a reproduction of the score for measures 1-39. In the interest of conserving space, the percussion parts and all tacet parts have been excised from this example. This excerpt shows how one of the constructs, cluster/6 or cycle/1, can control an entire passage to the exclusion of the other. First I will consider measures 1-21, to which we will now listen. You will notice that there is a sketch-like reduction of the pitch material of this passage in example 9. (play example)

The passage focuses almost exclusively on the dominant set-class of the work, SC 4-5 (0126) and its subsets. Subset 3-1, is of course the opening melodic figure of the work, and the figure which dominates this entire passage (each appearance of the motive has been enclosed by parenthesis in the sketch). Two other subsets of SC 4-5 are the single interval-class 1, in the form of either a major seventh or minor ninth (see square brackets), and the tritone, which most noticeably participates in the "falling tritones" motive heard twice in this passage. Though apparently microscopic, each of the appearances of these small subsets play a role in articulating complete SC 4-5s, as I will now explain.

Several SC 4-5s occur (or unfold) in direct temporal succession, or as simultaneities:* see nos. 2, 3, 7, 12, 15, and 18. The remaining SC 4-5s on the other hand---nos. 1, 5,

* Please refer to the numbers the left of beams or directly beneath verticalities on the sketch in example 9

6, 9, and 10---span more remote temporal distances, as one can see from the longer beams in the sketch. In each case, an interval of a major seventh or minor ninth (or a single note) of extended duration[2] is what articulates the connection between the temporally remote subsets: for example, the extended E# of trumpet 2, mm. 4-7 closes the SC 4-5 left incomplete by the opening three notes of the piano; and the minor ninth E#-F# of trumpets 1 and 2, sustained through mm. 5-7 initiates a SC 4-5 which is not completed until the arrival of E-Bb in the "falling tritones" of mm. 12 (trombones 3 and 4).

Part of a ninth only

As innocuous as it appears, the "falling tritones" passage has tremendous significance in Ecuatorial. Consisting as it does, of a stationary ic(1) against chromatically descending tritones (see example 10) the resultant combinations can produce two and only two possible four-note sets: SC 4-5, which we have just seen, and SC 4-12, which is a representative cycle/1 set of the work. Statistically speaking, this is rare: of all possible combinations of pitting one interval class against another, in which one remains stationary and the other moves about (there are 21 possible combinations), only one other has so low a fertility rate; all others produce between three and five non-equivalent set classes.[3] For this reason, it can

"representative" meaning what? It's a "second-order" cycle/1

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[2]The purpose of the open note-heads in the sketch is to indicate the notes of extended duration, not to indicate structural weight.

[3]The other intervallic combination which produces only two four-note verticalities is ic(3) and tritone; the resultant verticalities are, curiously, SC 4-Z15 and 4-Z29.

Well, it could also be the case that these set-class congruities are actually by products of another kind of structure.

be no accident that the verticalities produced by this particular interval pairing result in the most important cluster/6 set of the work, SC 4-5, and a representative cycle/1 set, SC 4-12. This passage, which occurs many times throughout the work, is in a sense the archetypal "seed" of Ecuatorial, whose chromosomes, as it were, contain the essential information for its design and harmonic structure.

This surface event which I have titled "falling tritones" is only one of may details in Ecuatorial's rich "thematic" or surface structure, whose varying recurrences cue beginnings or indicate closings of formal sections, either by continuous repetition within a single section or by solitary appearances spanning long stretches of the composition. Because time limitations do not permit me to provide an account of Ecuatorial on this level, I will only point out that surface and structure do not operate independently; that is, the articulation of form that results from thematic activity is intimately related to and often synchronous with the various changes in set construct dominance.

Immediately following mm. 1-20 is a sudden change of focus from cluster/6 constructs to cycle/1 constructs. Although the events here are not as exclusively oriented towards this construct as we have seen with cluster/6, cycle/1 does for the most part control mm. 21-39. (play example)

The explosive event played by the brass in measure 21 is a remarkably paradigmatic demonstration of this construct,

exemplifying in this case a primarily linear usage of cycle/1 sets. Here in example 11, a segmented reduction of m. 21, I will again refer to the numbers identifying the different pitch collections. Sets consisting of stacked fourths with appended half-steps appear in nos. 1, 3, and 5; the remaining three, nos. 2, 4, and 6, consist of stacked major thirds (augmented triads) with appended half-steps. Some of the more interesting cycle/1 sets contained in the remainder of the passage are illustrated in example 12: 12(a) and (b) show sets with stacked minor thirds as the cyclic component, and 12(d) shows a whole-tone scale as the cyclic component. The timpani part shown in 12(c) demonstrates a particularly clear usage of a second-order cycle/1 set.

It might be asked to what extent does Varèse employ the "classic" atonal techniques---those mentioned at the beginning of this paper---in his music? While I make no claim that Varèse's music is as clearly informed by a set theoretic model as are the early atonal works of Webern and Schoenberg, nevertheless the various transformations and relationships of and among sets are continuously in operation in Ecuatorial. Example 6 already showed an explicit articulation of the relationship between the Z-related pairs 4-Z15 and 4-Z29. A later, more embellished appearance of this theme, shown in example 13, indicates by its use of SC 4-Z15's complement, 8-Z15, that clearly on some level Varèse's compositional

here complementation is invoked

one instance, however, is no reliable indication

craft included complement relations as a means of elaborating a set class. Example 14 shows a similar use of complementation employed in a passage which we all recognize as very characteristic in Varèse's style: an explosive event for full ensemble which begins on a single note and rapidly expands into the registral extremes, ending on a sustained, vertical mass of sound. (play example) Here we see in this instance the now-familiar SC 4-5 immediately embedded into its complement; other familiar set constructs are shown in the more detailed segmentation of the passage, shown below.[4] As a final demonstration of complement relations, I submit for your later examination the duet for Ondes Martenot which occurs in mm. 47-53, shown in example 15. The segmentations of this passage shown in the following example reveal how the full panoply of cluster/6 sets virtually saturates the horizontal axis of this passage, complete with multiple-overlappings and complement embeddings; surely this is one of the most remarkable passages in Ecuatorial. (play example)

Although this study of Ecuatorial focues mainly on abstract pitch-class phenomena, one cannot ignore the special role played by the voice. Generally speaking, throughout the whole of the work the voice explicitly articulates linear presentations of all three set constructs, as shown in example 17. One partic-

[4] This passage appears several times throughout the work; the additional detail shown here summarizes the basic features which are common to all appearances.

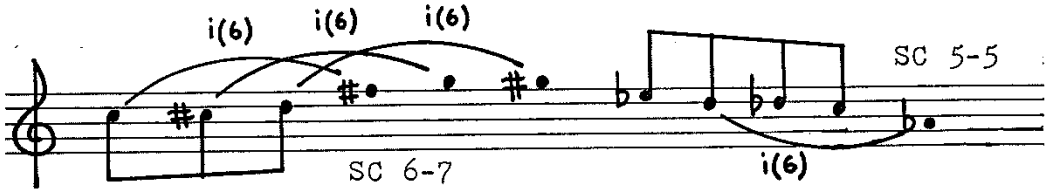
not the same passage each time

ular passage, however, shows the voice playing a fascinating role in the service of another "classic" atonal technique, aggregate completion. In order to illustrate this I must first explain what I call "space filling." The entry of the voice at measure 59 shifts the focus to smaller cluster/6 constructs: the reduced-size cluster/6 set 3-5, and the cluster feature as an independent element---that is, chromatic sets without the tritone appendages. This latter phenomena is exemplified in the many chromatic "wedges" sung by the voice, one of which appears in the next passage I will discuss in example 18. Here we see a series of space-filling figures by piano and voice which fill the chromatic whole (or aggregate) with the exception of pitch class {2}. The subsequent entry of the voice, beginning with new thematic material and a new line of text, provides exactly this missing pitch-class as its first note, thereby completing the aggregate. Three measures following, the identical situation occurs with respect to the Ondes Martenot parts, as shown in example 18(b). The two instruments gradually fill the aggregate, but leave pitch class {11} absent; again, it is this pitch class which the voice provides as the first note of its next phrase. These two aggregate-completing passages provide a lucid demonstration of the synchronicity between surface/thematic features and structural/set theoretic materials. The voice in measures 59-91 reinforces the regularity of its own phrases by providing completion pitch classes to aggregate left

incomplete in its own part and those of other instruments. Thus, for Varèse aggregate completion appears to be an indicator of beginnings rather than endings.

In conclusion, I hope to have shown that a less abstract approach to set theory may be appropriate in dealing with Edgard Varèse's music. By using a class of property sets which are identifiable primarily by their geometric configurations, we may have come to a closer understanding of Varèse's own geometric descriptions of his music.

Example 1. Cluster/6 sets.



Example 2. Cluster/6 sets.

*SC 3-5 (016)
*SC 4-9 (0167)

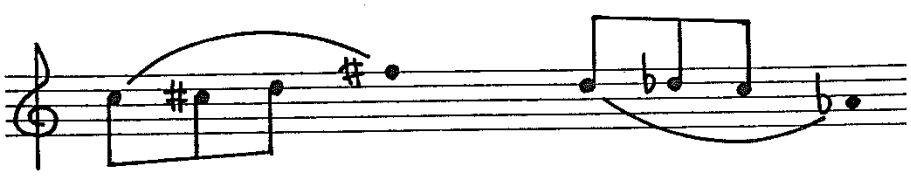
*SC 4-5 (0126)
*SC 4-6 (0127)
*SC 5-7 (01267)
SC 5-15 (01268)
*SC 6-7 (012678)

*SC 5-4 (01236)
*SC 5-5 (01237)
*SC 6-5 (012367)
*SC 6-38/6 (012378)
SC 6-41/12 (012368)
SC 6-42/13 (012369)

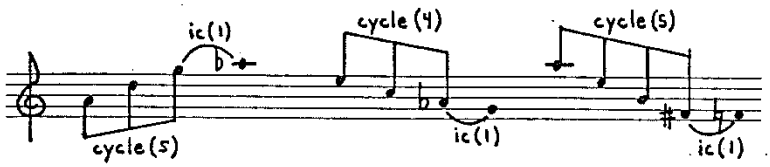
SC 6-2 (012346)
*SC 6-36/3 (012347)
*SC 6-37/4 (012348)

*common throughout Ecuatorial

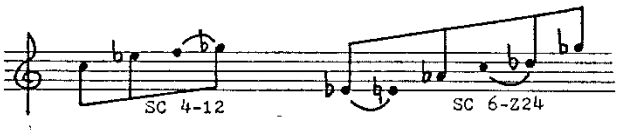
Example 3. Cluster/6 SC 4-5



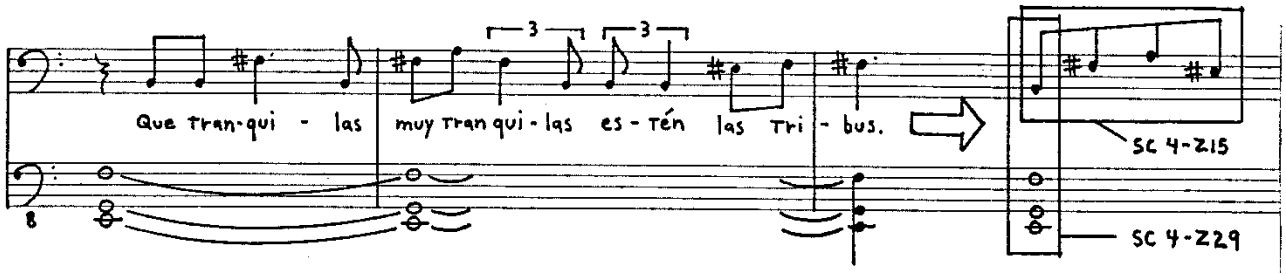
Example 4. Cycle/1 sets.



Example 5. Second order cycle/1 sets.



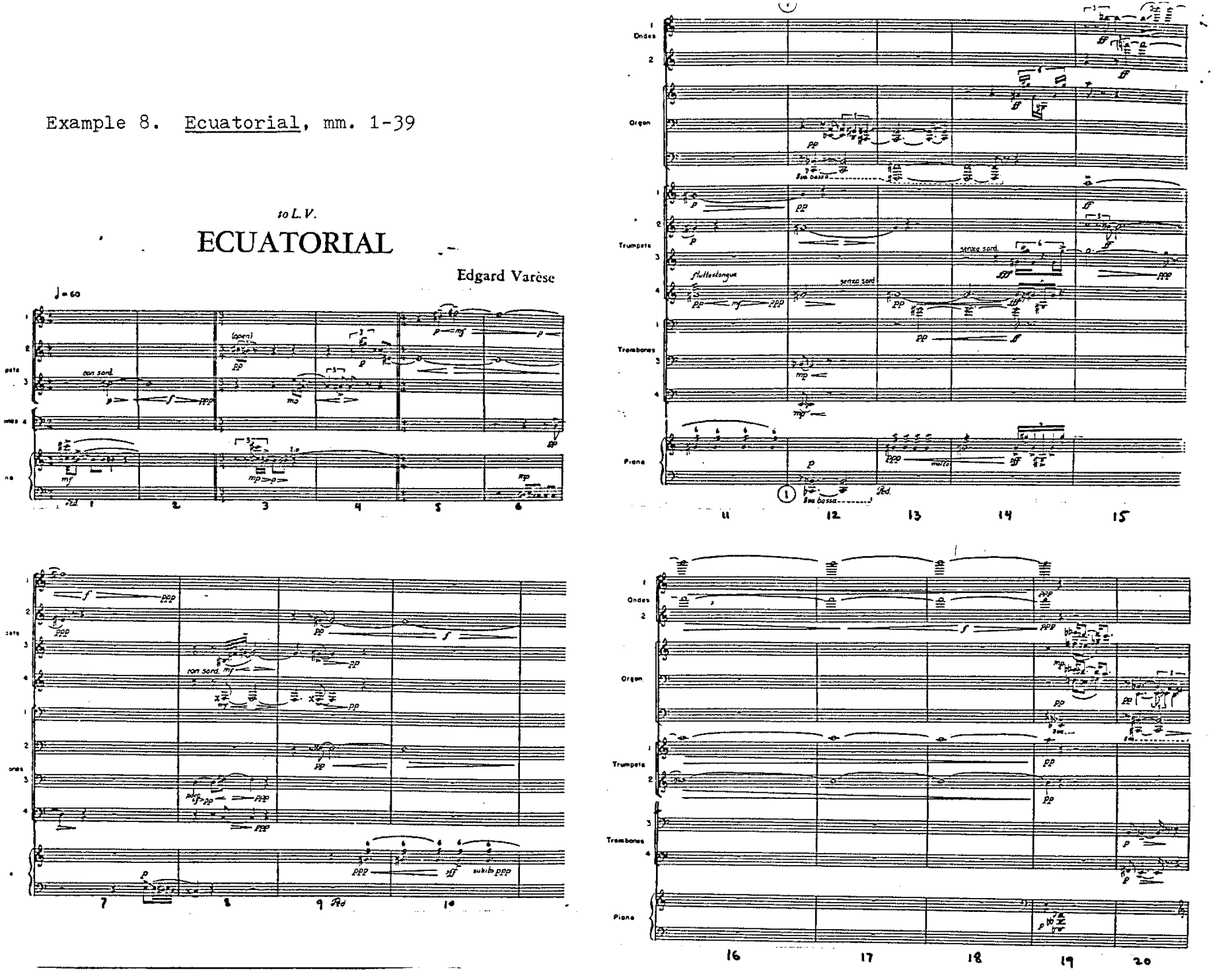
Example 6. SCs 4-Z15 and 4-Z29. Ecuatorial mm. 80-82.

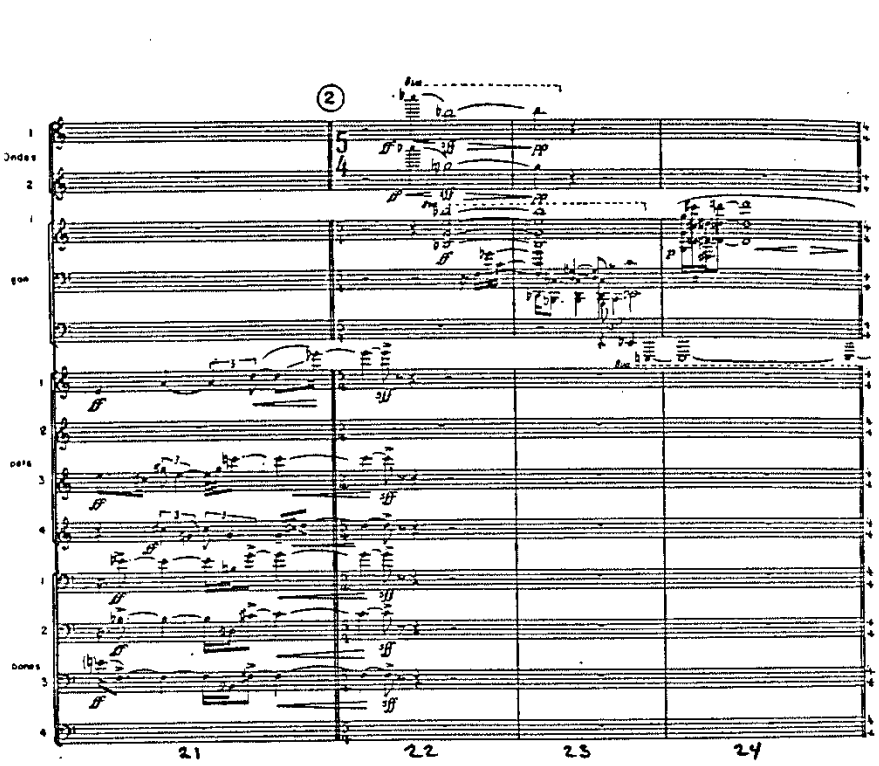


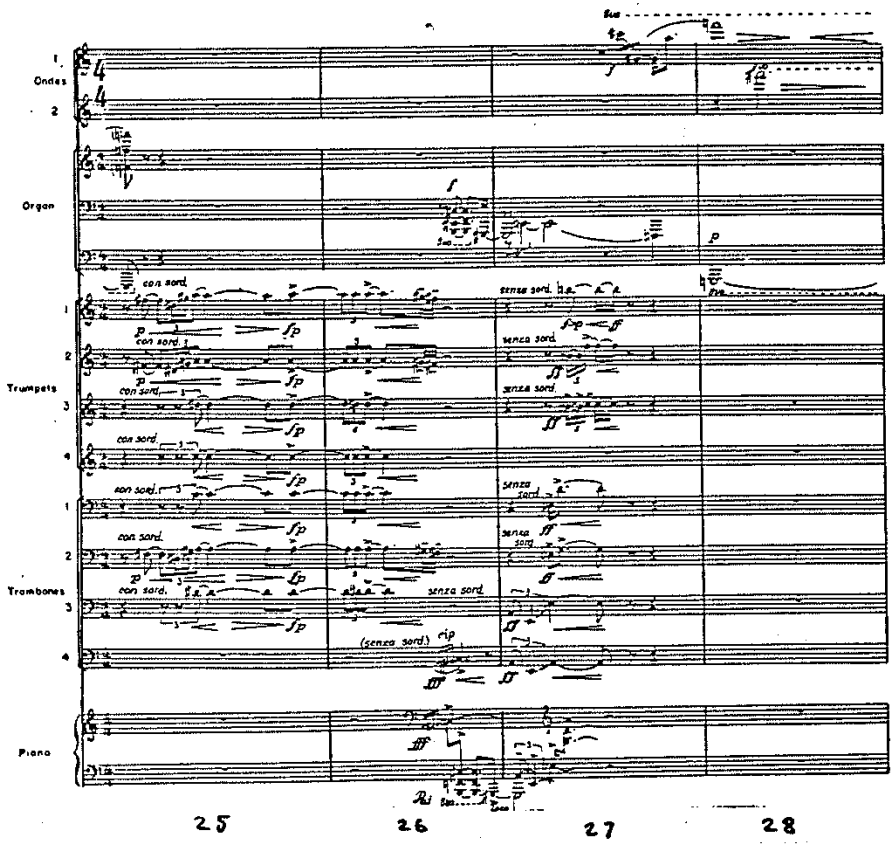
Example 7. Examples of vectors for the three set constructs.

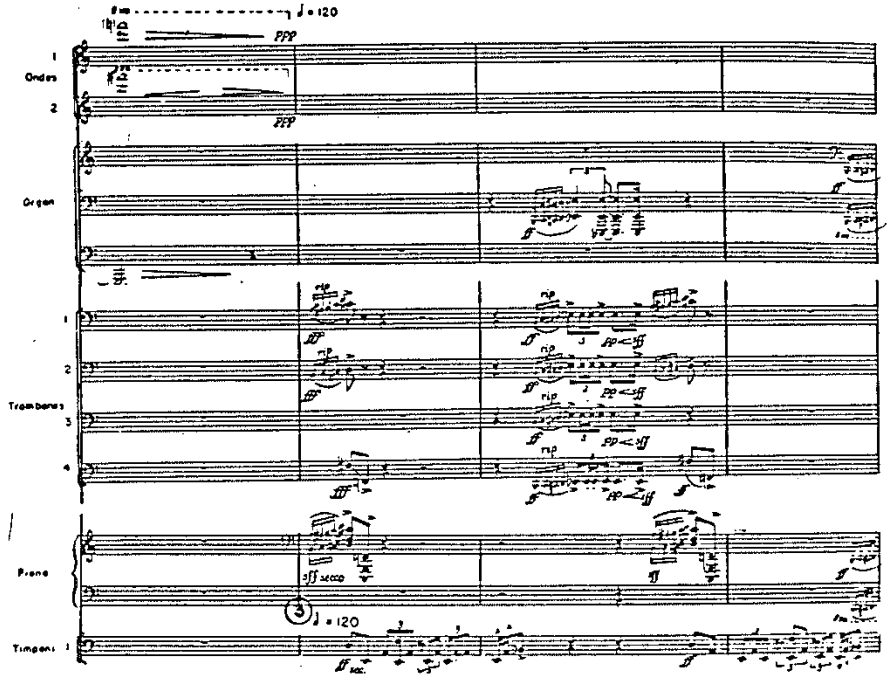
construct	set class	prime	vector
	5-4	(01236)	[322111]
cluster/6	6-5	(012367)	[422232]
	6-Z36	(012347)	[433221]
	5-14	(5072/1) i(5)	[221131]
cycle/1	4-19	(480/1) i(4)	[101310]
	6-27	(013469) i(3)	[225222]
all-interval tetrachord	4-Z15	(0146)	[111111]
	4-Z29	(0137)	[111111]

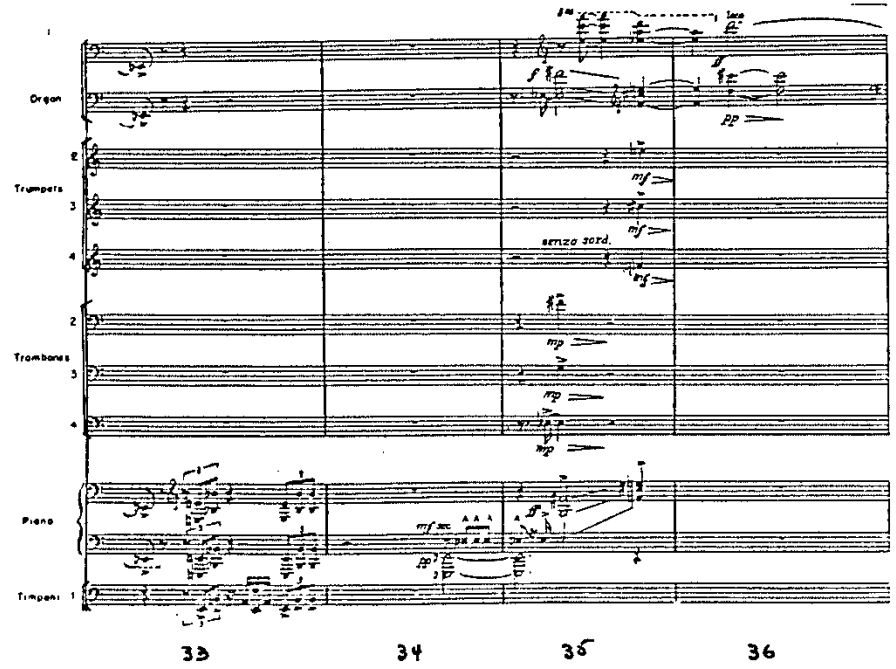
Example 8. Ecuatorial, mm. 1-39

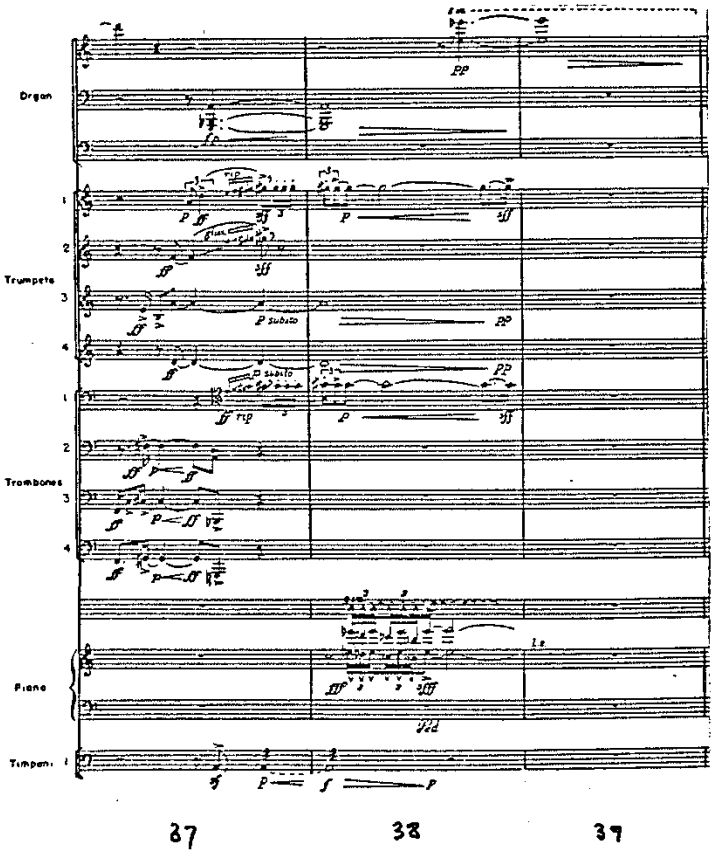



2
Ondes
Orgue
Trumpets
Trombones
Piano
21
22
23
24

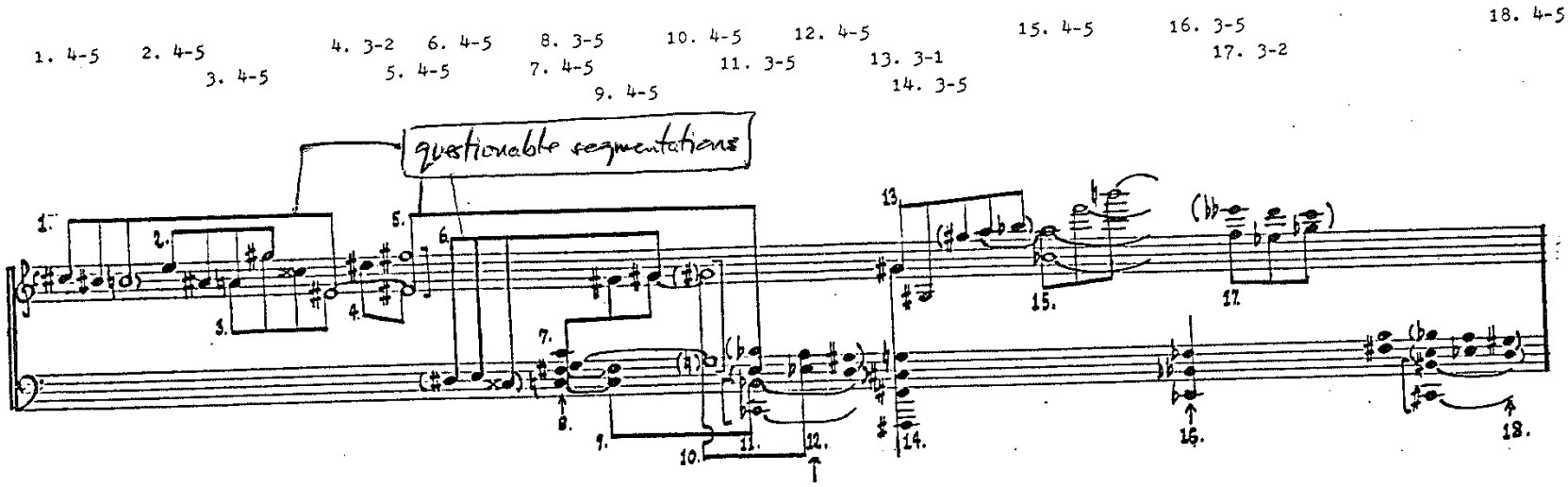

Ondes
Organ
Trumpets
Trombones
Piano
con sord.
senza sord.
(senza sord.)
25
26
27
28


Ondes
Organ
Trombones
Piano
Timpani
29
30
31
32


Organ
Trumpets
Trombones
Piano
Timpani
senza sord.
33
34
35
36

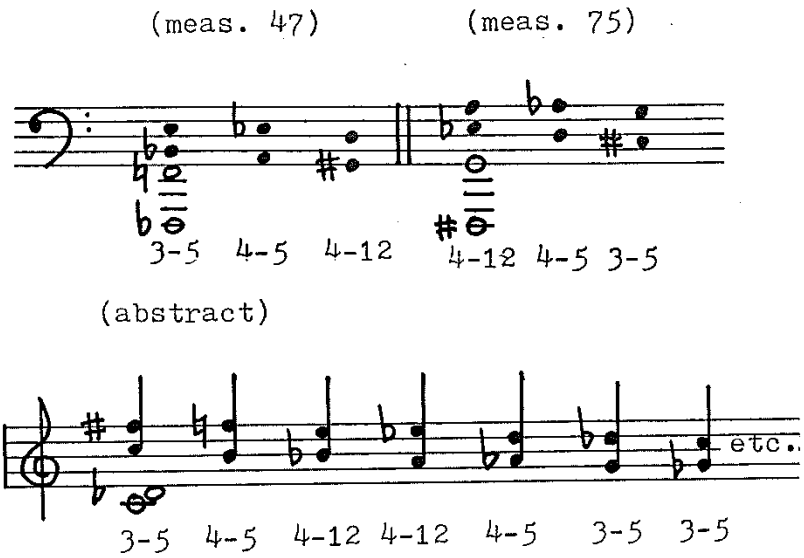

Organ
Trumpets
Trombones
Piano
Timpani
37
38
39

Example 9. Sketch of mm. 1-20.

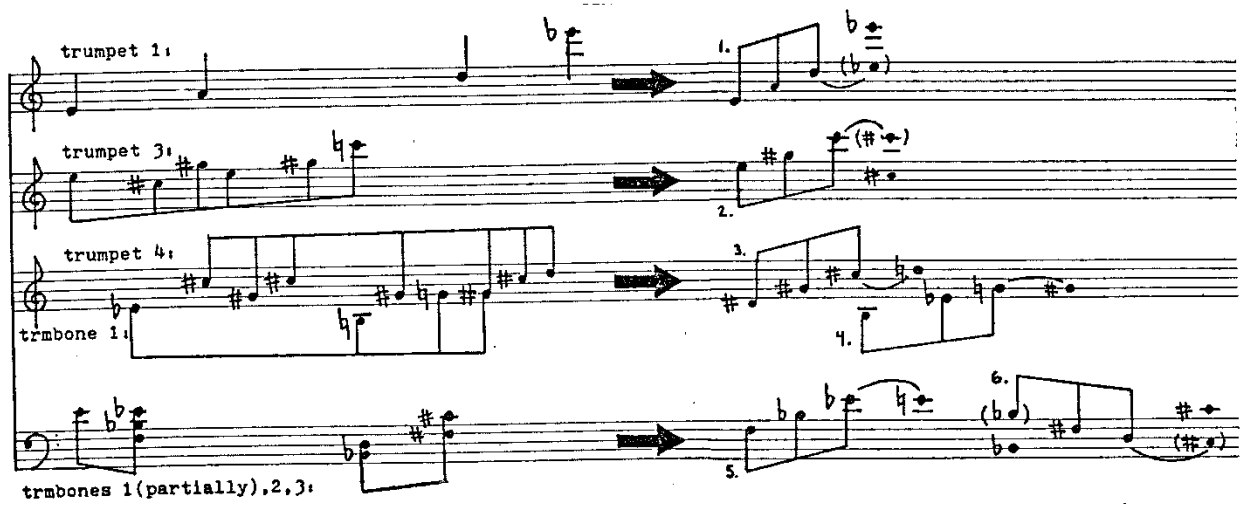


SC 4-5: 1,2,3,5,6,7,9,10,12,15,18
SC 3-5: 8,11,14,16
SC 3-1: see parenthesis
ic(1) : see square brackets

Example 10. "Falling tritones."

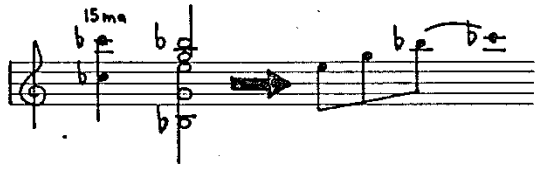


Example 11. Cycle/1 sets in measure 21.

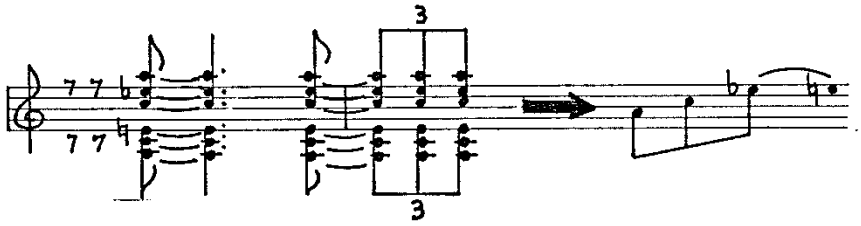


Example 12. Cycle/1 sets in mm. 22-39.

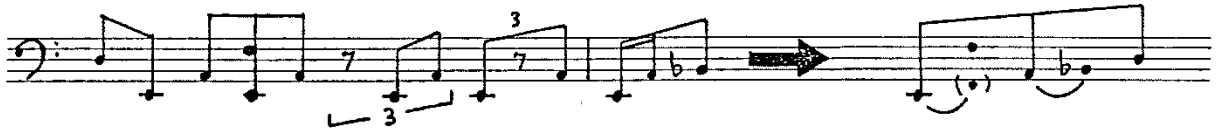
a) measure 22: ondes, organ



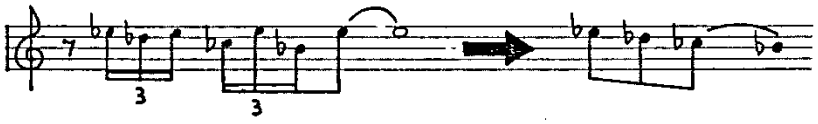
b) measure 25: brass, organ



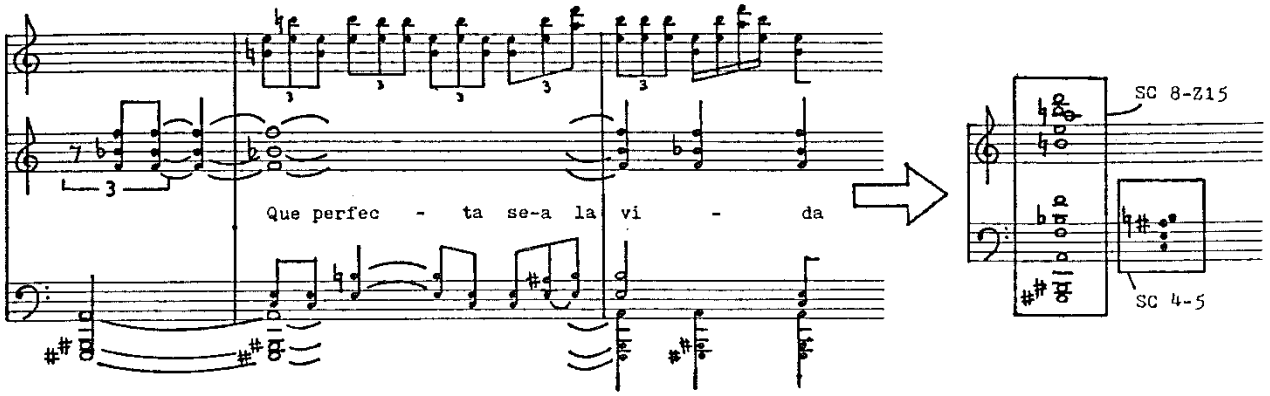
c) measures 30-31: timpani 1



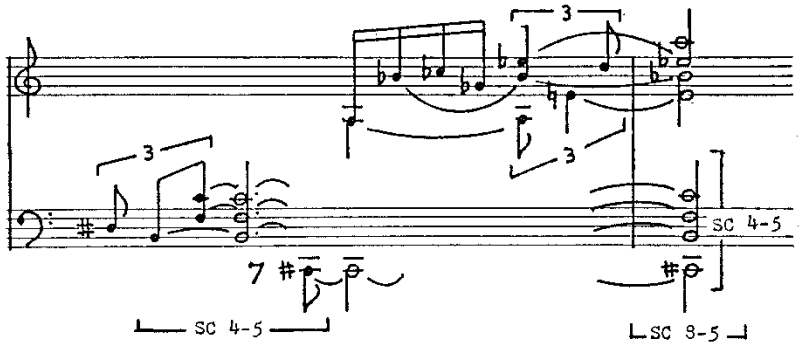
d) measure 38: piano



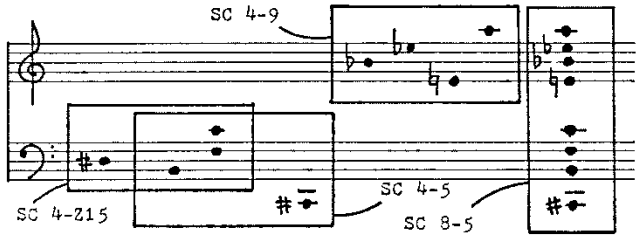
Example 13. Complementation of SC 4-Z15 (cf. example 6).
Measures 87-89: piano, brass, organ, voice.



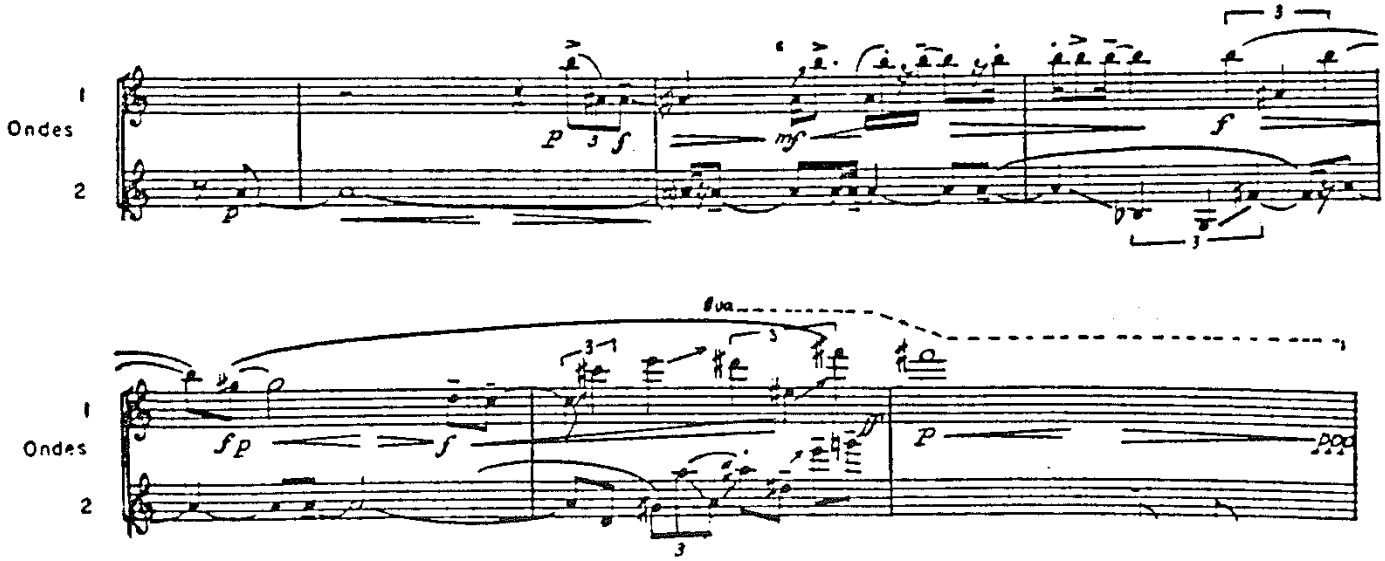
Example 14. Complementation of SC 4-5. Measures 45-46: piano, brass, organ.



(additional detail)

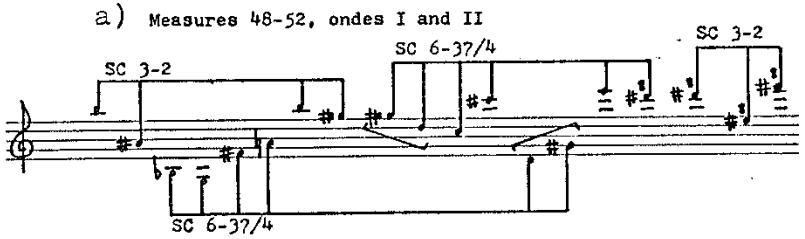


Example 15. Duet for Ondes Martenot, mm. 47-53.

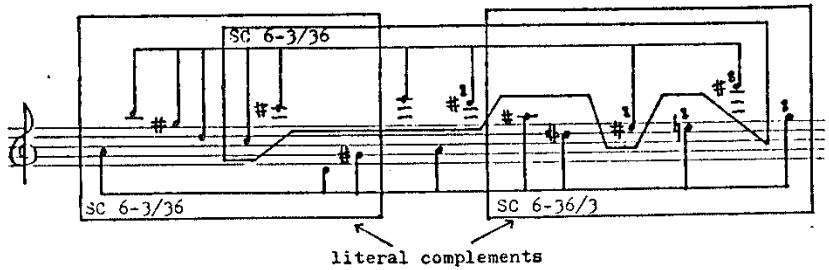


Example 16. Cluster/6 sets in the Ondes Martenot duet, mm. 47-53.

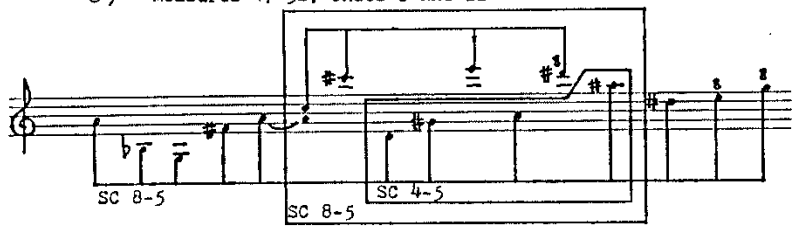
a) Measures 48-52, ondes I and II



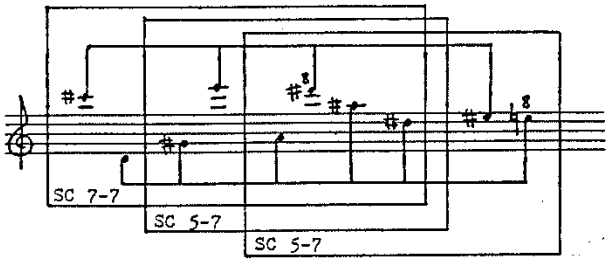
b) Measures 47-52, ondes I and II



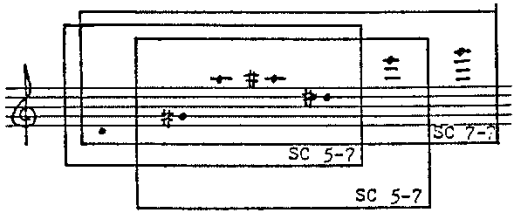
c) Measures 47-52, ondes I and II



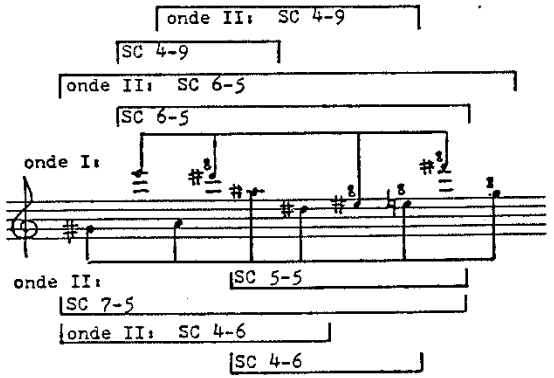
d) Measure 52, ondes I and II



e) Measure 52, onde II

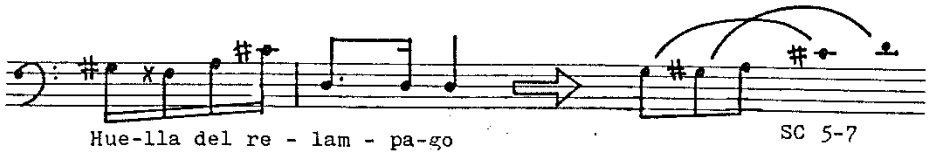


f) Measure 52, ondes I and II

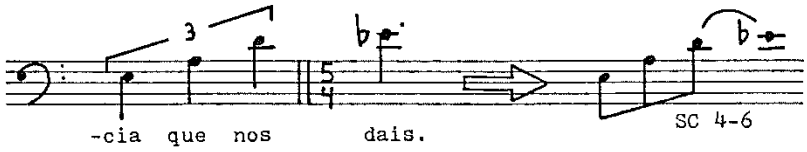


Example 17. Use of set constructs in the voice.

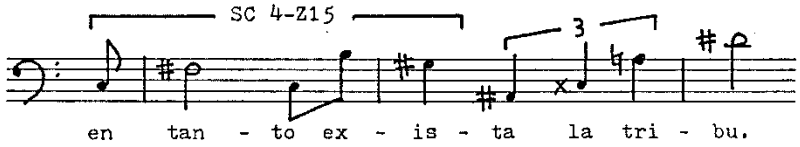
a) mm. 99-100



b) mm. 90-91

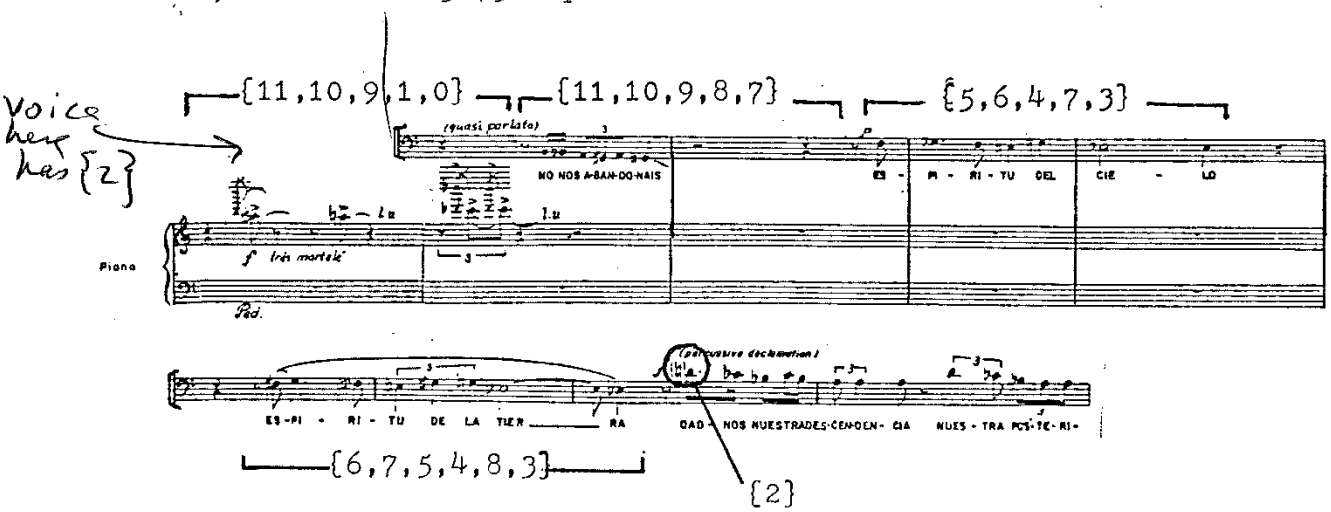


c) mm. 237-239

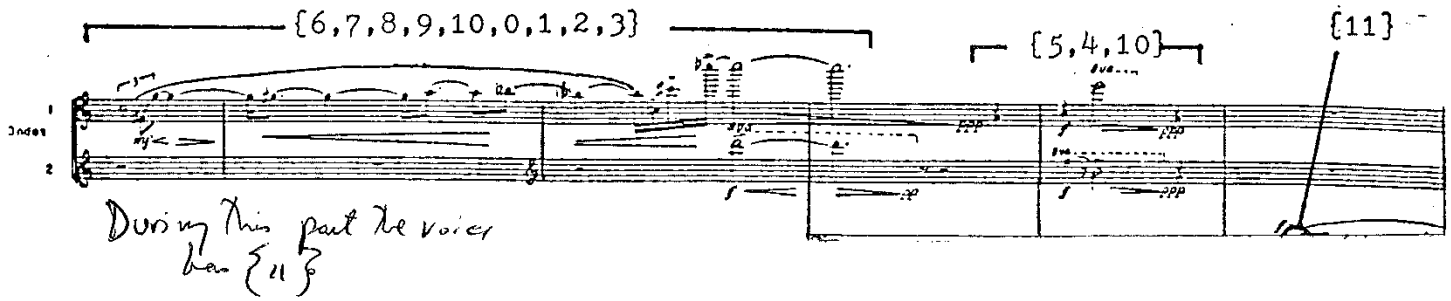


Example 18.. Aggregate completions by the voice.

a) Measures 65-73: piano and voice.



b) Measures 75-80: ondes and voice.



Sandell paper

What conceptual link exists between cycle/1, cluster/6, and all-interval tetrachords? Why would one want to group them other than to cover a large number of possibilities?

Why did you exclude sets ~~greater~~ larger than ~~cardinal 6~~ hexachords from cluster/6 and smaller than tetrachords from cycle/1?

How does complementation work in this context?
* PARTLY EXPLAINED

→ Segmentations involving sustained notes – is anything that comes along during the sustention potentially admissible?

Why are you interested in ~~E~~ equatorial?

2nd-order cycle/1: how many in all?