THE COMPOSER'S FLAIR: *ACHORRIPSIS* AS MUSIC

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ABSTRACT

This study examines aspects of the structure of Xenakis's *Achorripsis*, using the fully notated score as its point of departure. Some of the analytical techniques used in this study are adapted from methods for the prolongational analysis of atonal music developed by Fred Lerdahl in his book *Tonal Pitch Space*. As part of this approach, a hierarchical grouping structure is proposed for the sections in *Achorripsis*, corresponding to Lerdahl's method of time-span analysis. In addition to the time-span analysis, a pitch-reduction model is proposed, taking into account both the registral extremes and the most frequently repeated pitches in the individual sections and groups of sections. The time-span and pitch-reduction perspectives are considered along with the cumulative densities of the sections to suggest a fruitful strategies for a conceptual organization of the experience of listening to *Achorripsis*. The conclusion contains suggestions toward the possible extension of this method for the analysis of other stochastic works by Xenakis.

1. INTRODUCTION

Xenakis's *Achorripsis* for 21 instruments (1956-7), like far too many of the seminal works of the twentieth century, has been written about much more frequently than it has been performed. It was performed a little more than half a dozen times between 1958 and 1965, the latter performance resulting in the recording by which most people know the work today.[1] Despite its relative obscurity in the repertoire, *Achorripsis* is mentioned in virtually every book by or about Xenakis and in several articles as well. It is even featured in a standard textbook on the history of twentieth century music [5]. The items within the literature on *Achorripsis* tend to focus on one or more of the following: the work's compositional process [1] [2] [10], its importance within the history of algorithmic composition [7] [8] [9], and criticism and aesthetics [3]. Despite the frequent mentions of the work elsewhere, the most important written account of *Achorripsis* remains Xenakis's lengthy description of its compositional process in the first chapter of *Formalized Music* [10]. After providing a detailed description of the ways in which the laws of probability have been applied to the composition of this work, Xenakis turns his attention to the perception of the finished work:

> Let us now imagine music composed with aid of matrix [of probabilities] (M). An observer who perceived the frequencies of events of the musical sample would deduce a distribution due to chance and following the laws of probability. Now the question is, when heard a number of times, will this music keep its surprise effect? Will it not change into a set of foreseeable phenomena through the existence of memory, despite the fact that the law of frequencies has been derived from the laws of chance?
>
> In fact, the data will appear aleatory only at the first hearing. Then, during successive rehearings the relations between the events of the sample ordained by "chance" will form a network, which will take on a definite meaning in the mind of the listener, and will initiate a special "logic," a new cohesion capable of satisfying his intellect as well as his aesthetic sense; that is, if the artist has a certain flair. [10:37]

This article differs from previous studies of *Achorripsis* by taking as its point of departure the composer's invitation to explore the inner logic of the finished composition. This study, therefore, is primarily about the experience of listening to *Achorripsis* and about organizing that experience through the application of some basic analytical methods. The methods used here are adapted from Fred Lerdahl's work on the analysis of extended passages of atonal music [4].

[1] *Achorripsis* was recorded by the Ensemble Instrumental de Musique Contemporaine de Paris under Konstatin Simonovitch in 1969. The original LP recording has recently been reissued on compact disc Edition RZ 1015/16.

2. TIMBRE AND DENSITY

The probability matrix for the distribution of timbres and densities in *Achorripsis* appears to have achieved the status of a visual icon for Xenakis's first venture into thoroughly (i.e., multi-leveled) stochastic composition for instruments.[2] Although Xenakis originally generated the matrix as a visual aid to help him organize the compositional process, it may also serve as a guide to the listener, with some important qualifications. The matrix shows how instrumental groups representing seven different timbres are coordinated with respect to time and density. Density in the context of Xenakis's stochastic music refers to the average number of sounds per unit of time. It is thus a quantitative indicator of the relative thickness or thinness of the texture within a given section of music. The temporal structure of the work is simple, consisting of twenty-eight sections, each of which is approximately fifteen seconds in duration (making for a total duration of seven minutes). Thus, it is possible to track the instrumental groups and the density, one section at a time, as one is listening to the work. Guided listening by this method allows one to anticipate general features, such as rises and falls in density (including the climactic accumulation of densities in the twenty-fifth section), as the work unfolds in time. One thing that is not clear from the matrix, however, is the exact composition of the instrumental groups. Also, unless one is quick at doing addition in one's head, the cumulative density of each section is not easy to read from the matrix. In the interests of clarifying the nature of the music as heard, both of these issues are addressed below. In addition, some comments are offered regarding the nature of the compositional process within the instrumental groups. The issues that are detailed in this section provide a foundation for the construction of an analytical interpretation of the work in the following section.

The top row of Table 1 shows the instrumental groups as they are labeled in Xenakis's probability matrix for *Achorripsis*. The exact composition of the groups, derived from the score, is shown in the columns below each label. Most remarkable is the fact that the "flute" category contains no flute at all, but rather one member of the flute family (piccolo) plus two members of the clarinet family (E-flat and bass). Also remarkable is the absence of violas in the string section. The strings migrate freely among three articulations—arco, pizzicato, and glissando—depending on the density and on the number of string articulations represented within a given section of music. In the probability matrix each of these articulations is treated as a distinct instrumental group. In general Xenakis's choice of instruments is notable for the extremes of register represented in most of the groups. In this respect the instrumentation of this, his first mature composition for chamber orchestra, may have been influenced in part by the preference for timbral clarity and registral extremes in the instrumentation of the chamber orchestra works of Varèse, with whom Xenakis had worked closely in conjunction with the Paris premiere of *Déserts* for twenty instruments and tape in 1954. The percussion section in *Achorripsis* is certainly smaller than that found in Varèse's works, but its inclusion within the chamber orchestra setting is certainly suggestive of a possible influence of Varèse upon the younger composer.

instrumental group:	**flute**	**oboe**	**brass**	**percussion**	**strings (arco, pizz., gliss.)**
	piccolo	oboe	trumpet 1	xylophone	violin 1-3
	E-flat clarinet	bassoon	trumpet 2	wood block	violoncello 1-3
	bass clarinet	contrabassoon	trombone	bass drum	double bass 1-3

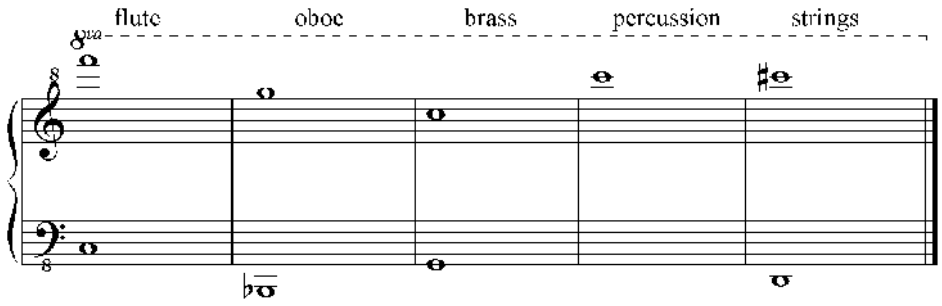
Table 1: Instrumentation in *Achorripsis*

The ranges within each instrumental group are shown in Example 1. With the exception of the percussion group, which contains only one pitch—C8 in the xylophone—the pitches within the other groups are distributed fairly evenly within each group. As the example implies, the registral extremes of a given section of music depend upon the instrumental groups that are active within that section.

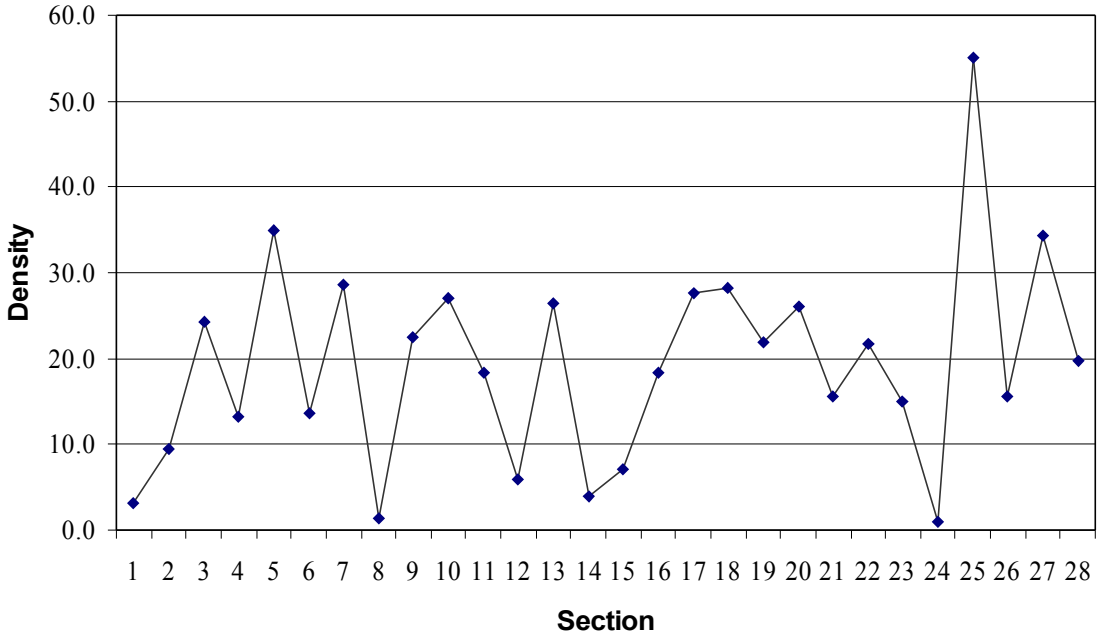
The probability matrix consists of 196 cells arranged into 7 rows, one for each of the instrumental groups (including three separate groups for the different articulations in the strings), and 28 columns, one for each of the approximately 15-second sections of music. The arrangement of cells within the matrix is determined according to the Poisson probability distribution so that 89 cells are occupied and 107 are left empty. The occupied cells contain from 1 to 4 events each, an event being defined as a passage of music for a specific instrumental group whose average density is 5 sounds per measure. A given cell may therefore contain, on average, between 5 and 20 sounds per measure. Furthermore, a given column may contain between 0 and 6 occupied cells. Thus, the range of cumulative densities within the sections of music varies greatly from near 0 to over 50 sounds per measure. A graph of the cumulative densities within the sections is shown in Example 2. While the graph shows that the density is very low in sections 8 and 24, the probability matrix indicates that there are no events in these sections. The score shows, however, that

[2] The matrix appears on p. 28 of *Formalized Music* [10] and has been reproduced in several other readily available sources on Xenakis's music, and therefore is not shown here.

Xenakis composed passages of minimal density for these sections, presumably so that the work would not sound as if it had come to a premature conclusion.



Example 1: Ranges within Instrumental Groups



Example 2: Cumulative Densities within Sections in *Achorripsis*

Measures of density provide only a very abstract indication of the musical events that occur within a section. Working from the average densities per instrumental group per section, Xenakis's method for stochastic composition prescribes that one determine the attack time and pitch of each note within a group, using separate probability distributions for each characteristic, thus imitating the effect of independent, random successions of intervals in the dimensions of both time and pitch. In the case of *Achorripsis*, no pitch intervals were required for the percussion instruments, for the woodblock and bass drum are unpitched and the xylophone was assigned a pitch of C8 for each attack. The pitches for the string glissandi were handled differently from those for the other pitched instruments: each glissando required the determination of a beginning and ending pitch, the latter being a secondary result of randomizing the duration, direction and "speed" of a given glissando line. After being determined numerically, the attack times were given approximate realization by being fitted to a temporal grid consisting of triple, quadruple, or quintuple divisions of half-note beats at a relatively slow, steady tempo (52 M.M.). With three instruments to a group, each one potentially playing according to a different division of the beat, considerable rhythmic complexity was attainable for the ensemble while the individual parts remained relatively simple. Pitches were determined in the following manner: starting from a randomly chosen point at the beginning of each section, subsequent pitches were determined by randomizing the size and direction of the pitch intervals within the range of the given instrumental group. The pitches appear to have been first distributed over the entire range available to each instrumental group, following which the individual pitches were

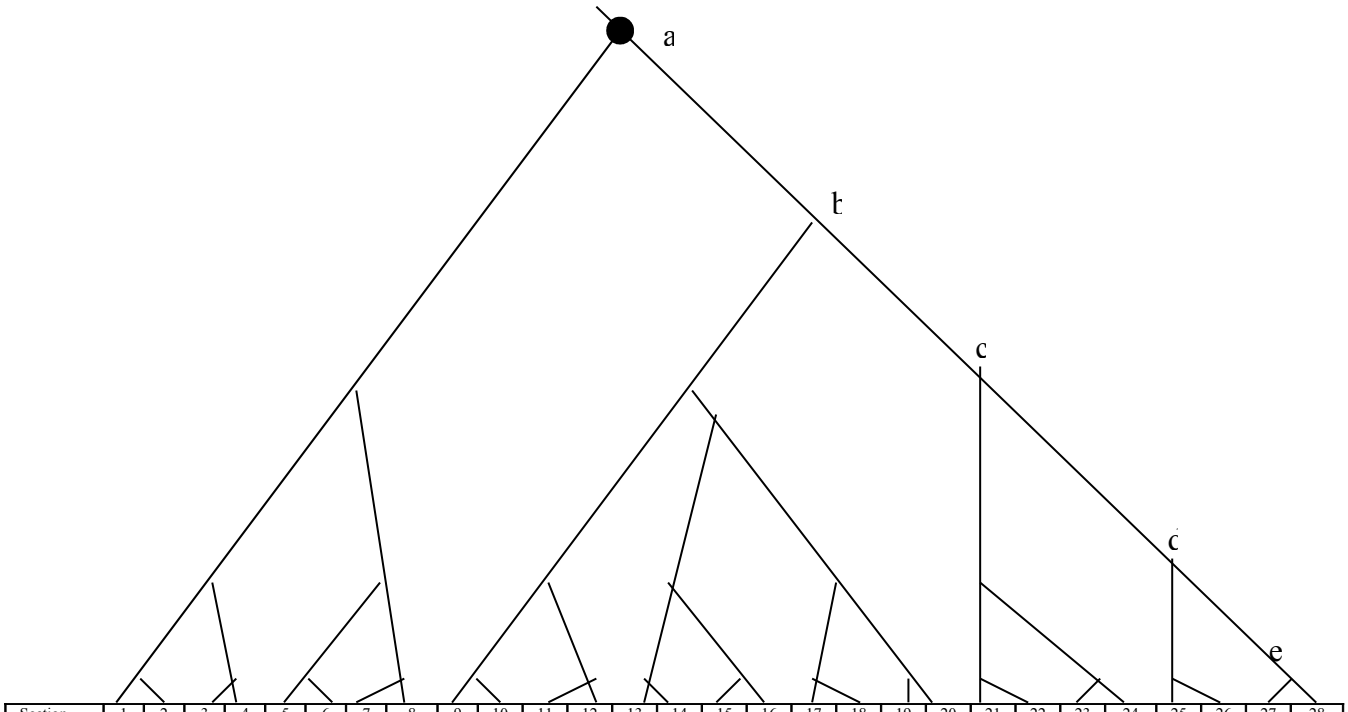
assigned to instruments into whose ranges they fit. Dynamics appear to have been assigned freely in order to give variety to the instrumental parts. The combination of all of the methods described here constitutes the realization of the general compositional plan indicated in the probability matrix.

3. AN ANALYTICALLY INFORMED STRATEGY FOR LISTENING

Fred Lerdahl begins his book *Tonal Pitch Space* [4] by positing an approach to tonal analysis in which the dual criteria of temporal grouping and harmonic stability form the basis for a reductive method that results in the prolongational analysis of the music's salient outer voices. From there the approach is adapted to chromatic tonal and atonal music, the harmonic stability criterion gradually giving way to more general criteria for the determination of salient sonorities within the context of a given work's particular harmonic style. After analyzing atonal works by Schoenberg and Webern, Lerdahl makes the following, rather tantalizing statement:

> How well does the method survive for later atonal music? The answer varies. I believe it will be useful for analyzing the pedals and proliferations of Boulez's mature style, for example, but not the stochastic textures of Xenakis (unless the "event" is redefined in terms of global texture rather than individual pitch events). [4:373]

The analytical approach to *Achorripsis* offered here is a free adaptation of Lerdhal's method, adjusted where necessary in order to accommodate the work's particular structural features.



Section	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Flute		**X**	X	X	X				X							X	X	X	X	X		X	X		X		X	X
Oboe						**X**	X		X	X			X		X			X	X			X			X			X
Brass							**X**		X		X			X				X	X	X					X		X	
Percussion			**X**		X		X			X	X	X				X	X	X	X	X				(X)	X	X		
Arco				**X**	X		X	(X)		X	X		X				X	X	X	X					X	X	X	
Pizzicato	**X**	X	X		X	X	X		X				X				X	X			X	X	X		X		X	X
Glissando			**X**			X			X	X			X		X	X	X			X		X				X	X	(X)

Example 3: Hierarchical Grouping of Sections in *Achorripsis*

Among Xenakis's mature works, *Achorripsis* is unusual in that its sections are approximately equal in duration.[3] The basic structural units in *Achorripsis* do not consist of chords, phrases, or subphrase units as in most of the music that Lerdahl analyzes, but rather of approximately six-and-a-half measure passages (of approximately 15 seconds' duration each) whose boundaries are determined by changes in instrumentation and/or density. The equal durations that

[3] *Analogique A* for nine strings (1958) is another such work.

are represented graphically in Xenakis's probability matrix are actually realized in an approximate manner in the score, with frequent overlaps between sections making for greater continuity on the musical surface than may be implied by the rigid demarcations between sections found in the matrix. In this analytical interpretation, these sections form the building blocks of a hierarchical grouping structure, as shown in Example 3.

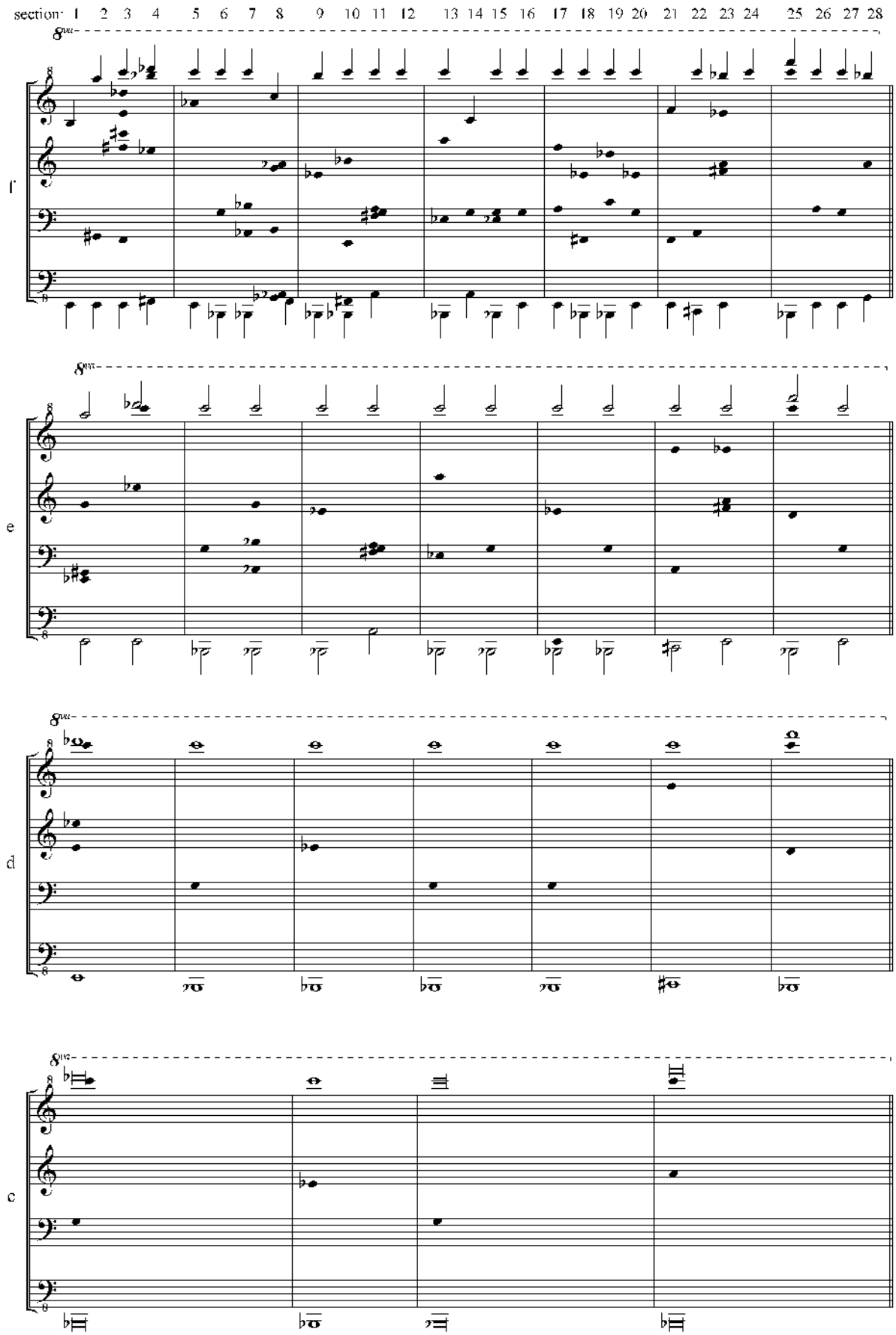
A table at the bottom of the example shows the instrumental groups that are active in each section. Above this table appears a hierarchical tree diagram that represents proposed grouping structure for the sections. The listing of the instrumental groups follows the labels used by Xenakis, but places the labels in score order. Hierarchical level *f* (not labeled in the example) consists of single sections. Levels *e* and *d* are derived from level *f* recursively, grouping the sections into pairs and fours respectively. At level *c* the grouping suggests a possible large-scale organization of the work that is based on several factors. Within sections 1-8 each of the instrumental groups appears at least once, the brass being the last to be introduced (in section 7). Section 8 contains empty cells in Xenakis's matrix, but the score shows a passage of minimal density for the arco strings, represented as an X in parentheses in Example 3. (The density for this section is shown graphically in Example 2). Although sections 1-8 certainly do not qualify as an exposition in a sonata form, nonetheless it appears to be structurally significant that each instrumental group is "exposed" at least once within this group. (The first appearance of each group is shown with a bold X in the example.) A sense of structural punctuation is further reinforced by the minimal density of section 8. Skipping ahead for a moment to the final group at level *c*, it is notable that section 21, like section 1 in the first group, begins with a solo for the pizzicato strings. These are the only two sections that feature a solo in this instrumental group. Section 24, like section 8, features a solo of minimal density, this time in the percussion. Thus sections 21-4, comprising the first half the final *c* group, "recapitulate" aspects of sections 1-8. The lull in density in section 24 prepares for the work's textural and instrumental climax in section 25, after which the density levels off in an uneven, zigzag pattern, eventually settling down to a density of 19.7 sounds per measure (see Example 2), a close approximation of the mean density per section, which is 19.2. From the standpoint of density, then the work achieves a sense of equilibrium by its conclusion.

The middle groups at level c contain unequal numbers of sections, the first of them simply taking the four-group up from level *d* while the second combines two *d*-level groups. The middle *c*-level groups fuse at a higher level to form a middle group within a tripartite design at level *b*. The dot at the cross between the branches for the outer sections within this grouping indicate that at the *a* level, the final 8-section group is taken to be a "weak prolongation" of the first one, in part for the "recapitulatory" function of sections 21-4 described above. Weak prolongation signifies repetition with modifications. There are reasons for this designation to be found in the pitch structure as well, which is examined next.

Example 4 shows the salient pitches within sections and groups of sections in *Achorripsis*. The criteria for the determination of salience are exceedingly simple in this case because this is not music in which single events (pitches) or small groups of events (e.g., chords) may be assumed to have structural significance in themselves. Instead, the smallest structurally significant events are the sections, whose boundaries are determined by changes in instrumentation and/or density. At level *f* in Example 4, the highest and lowest pitches that appear in each section are deemed salient and are stemmed in the manner of structural "outer voices." The time scale is compressed so that each section is represented by a quarter note, and thus all 28 sections are represented in the seven "measures" in the example. Unstemmed notes between the "outer voices" are deemed salient due to the frequency of their occurrence within each section. Any pitch that appears more frequently than any of the others, or just as frequently as a few others in the section, is shown as an unstemmed note. The half notes, whole notes, and breves represent groupings of sections into pairs, fours, and eights, respectively. The salient pitches in the groups of sections are those that appear as the extremes or as the most frequently articulated within the given *group* of sections. One of the most frequently appearing pitches in the work is C8, which is the only pitch produced by the xylophone but may also be articulated by other instruments. This pitch may appear as a salient "upper voice" in a section or group at one level, due to its extreme register, but as an "inner voice" (due to its frequency of occurrence) in a higher-level grouping in which it is no longer the highest pitch.

As one might expect, the differentiation among groups on the basis of pitch salience diminishes as one moves to higher levels within the grouping structure. What is fairly consistent throughout, however, is that Xenakis tends to make use of the extremes within each instrumental group. (Example 4 should be viewed in conjunction with Example 3 in order to trace the connections between instrumentation and salient pitches.) While the strings in general are capable of producing extremely high pitches, Xenakis observes a more moderate upper limit for the pizzicato strings than for the arco or glissando strings. This accounts for the upper limits of B5 and F6 in sections 1 and 21, respectively, which are for pizzicato strings alone. The upper limit of C7 in section 8 is due to the fact that the solo for the arco strings there is of such low density that there are not enough pitches available to articulate the registral extremes. Section 14 is a solo for the brass instruments, which accounts for its relatively moderate upper and lower extremes. The instruments with the lowest pitches are the contrabassoon (B-flat0) and the double basses (E1). Sections that do not feature the "oboe" or string groups, therefore, do not have these extreme low notes available to them.

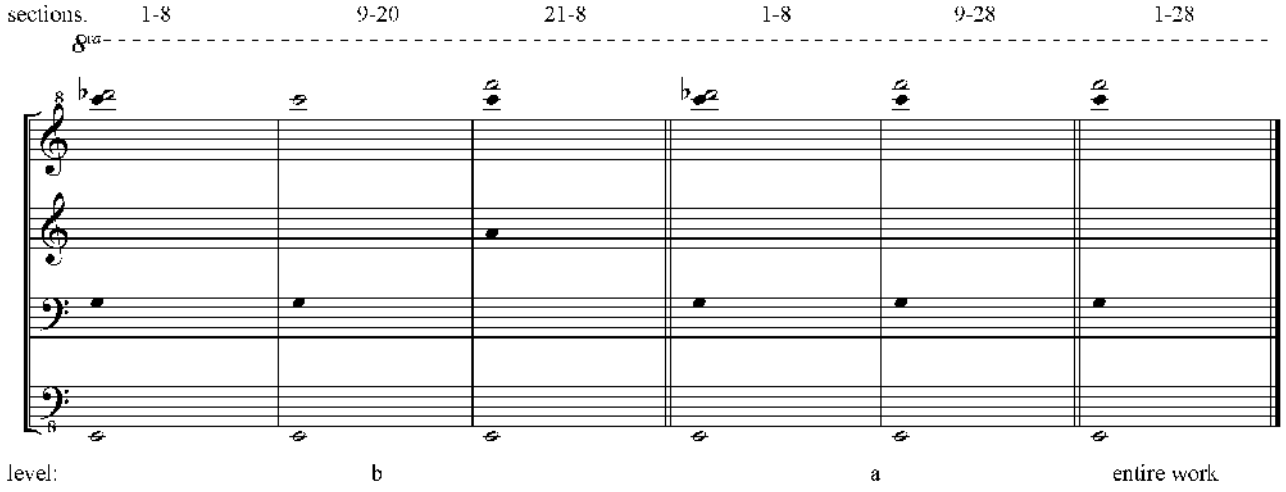
It is important to note that the inner voices within groups of sections are not necessarily derived from the sections or groups at the previous level by a process of reduction, as one might ordinarily expect in a hierarchical analysis of pitch structure. For example, the E-flat2 and G4 that appear in sections 1-2 at level *e* do not appear in either



Example 4: Salient Pitches within Sections and Groups of Sections in *Achorripsis*

section 1 or 2 at level *f*. The reason for their inclusion at level *e* is that these pitches are among those that appear most frequently within sections 1 and 2 taken as a unit. Perceptually, therefore, if one is focusing attention on sections 1 and 2 as a unit, these pitches are likely to be more salient than the pitches that surround them. As the groupings incorporate larger numbers of sections, the inner pitches tend to gather toward the center of the register. The culmination of this process may be seen in Example 5, which shows the salient pitches within levels *b* and *a* and within the work as a whole. Of course, large-scale hearing at these levels extends beyond what may be considered to be perceptually viable, but the graphs do at least indicate the logical end of the listening strategy that is initially proposed for the first few levels in Example 4.

The idea of featuring the mean and extremes of the pitch range as a structural element in *Achorripsis* may have been present in the composer's mind as he worked, as evidenced by a characteristically Xenakian closing gesture that is superimposed upon the musical surface in the work's final section. This gesture, which is not accounted for in the probability matrix, consists of a tremolo glissando for violin 3 and double bass 3, moving outward in opposite directions from a central pitch (A3) that is sustained, tremolo, in violoncello 3. By means of this gesture the remotely perceptible large-scale mean-and-extremes pitch emphasis is manifested literally on the surface of the music, thereby creating a suitable auditory signal that the work is drawing to its conclusion.



Example 5: Salient Pitches within Upper-Level Groups in *Achorripsis*

4. CONCLUSION

The present study represents a preliminary attempt to analyze Xenakis's stochastic music by adapting a method that has proven effective in highlighting pitch and temporal structures in other atonal music. Each reader must decide for him- or herself the degree to which the analytical insights proposed here correspond to his or her experience in listening to *Achorripsis*. Whether or not it is possible to determine the perceptual viability of the analysis with any certainty, the logical consistency and transparency of the analytical method should be self-evident. Toward the aim of a more sensitive and detailed aural appreciation of this work, this analysis presents a mediation between the over-generality of Xenakis's probability matrix and the highly detailed information contained in the published score of the finished work.

This method may be extended easily to other works that contain sections of equal or near-equal duration, such as *Analogique A*, and may perhaps be extended further to works with sections of unequal duration, which comprise the majority of Xenakis's output. It is conceivable, for example, that one might analyze a work like *Herma* for piano (1960-1) by using the mean section duration as a basic unit of temporal measurement. In a hierarchical pitch/time-span graph such as Example 4 above, sections shorter than the mean might be represented by divisions of the basic temporal unit while longer sections might be represented by multiples of the same unit. As the analysis proceeds upward in the hierarchy, the differences in section durations will gradually be subsumed within the large-scale grouping structure.

An advantage of adapting an analytical method such as Lerdahl's to the analysis of Xenakis's stochastic music is that it provides a basis for comparisons between specific structural features of this music and related features of music by other composers whose works may have been composed according to very different compositional procedures.

5. REFERENCES

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