

Formalised or Music? Some Thoughts on Xenakis's *Khoai*

Barbara DOBRETSBERGER¹

Abstract: *The analytical approach to Xenakis's compositions is largely focused on the underlying mathematical operations of the music. More recently; however, some analyses have relativised the relevance of the mathematical basis. Xenakis's own statements can support this relativisation. Taking into account the meaning of the title and recognising Khoai's distinctly gestural character, an interpretive approach to Khoai is ventured. The form and performance of the work can be interpreted as storytelling, with the gestures and movements involved in the preparation of a sacrifice to the ancient gods.*

Key-words: *Xenakis, harpsichord, Chojnacka, Khoai, contemporary music, analysis, semantics.*

1. Phoenix from the ashes

In the music of the Baroque period, the harpsichord emancipated itself from the continuo or accompanying instrument to a virtuoso solo instrument. The music of the late 18th century, however, as well as that of the long 19th century, discovered the range of sounds of the rapidly developing fortepiano and its technically sophisticated successors. Due to this competition, the harpsichord was relegated to a historical corner and remained there until the curiosity of some 20th century composers (and the pioneering work of Wanda Landowska) brought about its reversal of fortune. As is well known, Xenakis was by no means the only composer to discover the harpsichord as an instrument for contemporary composing in the second half of the 20th century. Taking into account the chronology of compositions written in the avant-garde field, one could state that Xenakis followed in the footsteps of pioneers such as Henze (*Six Absences*, 1961), Donatoni (*Doubles*, 1961), or Ligeti (*Continuum*, 1968, *Hungarian Rock*, 1978). However, the existence of the preceding works in no way implies that Xenakis acted as a free rider or even epigone-like or eclectically. In each of the works mentioned above, a specific avant-garde attitude towards the instrument is evident, and it would not

¹ University Mozarteum Salzburg, barbara.dobretsberger@moz.ac.at

make sense to make a valuation here in the terms of their greater or lesser importance for music history. Henze, Donatoni, Ligeti, but also Dinescu, Gubaidulina or Bussotti, among others, showed, in a highly individual way, an old-fashioned instrument with a new livery. An overview of harpsichord music of the last century is given by Martin Elste (1995). The research work of Emmanuelle Tat (2002), whose doctoral thesis on *Présence du clavecin dans la musique française des années 1970 à nos jours* took stock of the situation in France, points to desiderata for further research (at both the national and international levels). Chau-Yee Lo (2004) provides a somewhat nonsystematic but nevertheless meritorious study which includes analyses of six harpsichord works.

2. “[...] a new relation between art and science, notably between art and mathematics.” (Xenakis 1987, 46)

In one respect, however, Xenakis differs from the above-mentioned composers – he is characterized by a pronounced affinity for a systematization and logical comprehensibility of the act of composition. This fact may indeed be described as unique. The justification of music as a scientific discipline was a core concern of Xenakis. In *Formalized Music*, and also in several of his essays as well as in interviews, he formulates the necessity of a new type of musician who, as a universal scholar, should move nimbly in the most diverse disciplines:

“Paleontologist, geneticist, biologist, physician, chemist, mathematician, historian and expert in human sciences, these qualifications comprise the identification card of tomorrow's musician, whom I call the conceiving artist. Who searches after the secret order that rules the universal apparent disorder. Who considers a new relation between art and science, notably between art and mathematics.” (Xenakis 1987, 46)

The education of this new type of “conceiving artist” goes hand in hand with the abandonment of traditional aesthetics. According to Xenakis, this turn is guaranteed by specific methods of structuring the material and an objective, neutral attitude towards the potential of music:

“It is not so much the inevitable use of mathematics that characterizes the attitude of these experiments, as the overriding need to consider sound and music as a vast potential reservoir in which a knowledge of the laws of thought and the structured creations of thought may find a completely new medium of materialization, i.e., of communication.” (Xenakis 1971, ix)

Consequently – i.e., following Xenakis's own signposts – research to this day has largely focused on the stringent mathematical operations that the composer presented in his writings and made comprehensible and calculable by means of concrete examples of compositions. This kind of research approach is particularly profitable when sketch material for individual compositions or comments by the composer are available, such as in the studies on *Herma* by Exarchos (2019) or on *Akrataby* Schaub (2005). The appeal of the clarity, not to say, beauty, of mathematics, which manifests itself in normal distribution, the Gaussian bell curve, Poisson's law, Boolean operands, probability and stochastics, among other things, sets the direction in the analysis of the works. From the analyst's perspective, this kind of approach is a direct confirmation of the plausibility of the analytical process. In a way, it is "reassuring" to be able to check compositional phenomena or sound results computationally and to state "correctness". The application of Poisson's formula $P_k = (\lambda^k / k!)e^{-\lambda}$ to a work like *Achorripsis* (Shand 2020) is as coherent as it is comprehensible, justifying the logic of the compositional decisions down to the "variables of the 'vector-matrix'." (Xenakis 1971, 31). The additional integration of stochastics gives chance in the compositional process its own new quality of aesthetic relevance. The relevance of game theory for Xenakis's work has also been and continues to be intensively researched.

At the same time, there are analytical approaches that relativise the relevance of a mathematical approach by distancing themselves from the systematic analysis of the compositional process and thus view the works primarily as music, or rather sound, to be heard and understood. Such methods of analysis, which include semantics and the listening experience, can also be understood as a reaction to a fundamental problem of formula-centred analysis. "Numerous inconsistencies between the theoretical principles advanced by Xenakis and their application" (Gibson 2011, xviii) led and lead to the realization that the analyst's attention has to be directed to a non-calculable phenomenology of a work. Xenakis himself provides an argument for this approach: all of his works "are mostly handiwork, in the biological sense: adjustments that cannot be controlled in their totality. If God existed He would be a handyman" (Xenakis 1987, 23). In addition, conductor Pascal Rophé, who experienced Xenakis as a guest lecturer at a six-day seminar at the Paris Conservatoire, reported Xenakis's own nonchalant approach to his principle of formalized music (Rophé 2011, 5).

The exploration of logic and the possibilities of combinations in composing dates back long before Xenakis. Comprehensive laws in music were already traced in Greek antiquity, which Xenakis names as one of his main sources of inspiration. As is well known from research on ancient mathematics, the idea of averaging preoccupied the Babylonians long before the Pythagoreans (Neugebauer 1969).

Closer to the 20th century are the works of Marin Mersenne, Athanasius Kircher and Gottfried Wilhelm Leibniz, who traced compositional possibilities by means of combinatorics, factorials and permutations. With regard to the utilization of the Gaussian distribution for his composing, Xenakis (1971, 15) borrowed from the kinetic theory of gases (James Clerk Maxwell, Ludwig Boltzmann) and Paul Lévy's probability theory and stochastics.

3. "...but most of the time [music] is fearsome" (Varga 1996, 62)

As noted above, much of the literature on Xenakis's compositions focuses on analytical procedures that start from the systematization of the material. Musical phenomenology and the semantics of music are treated with some restraint, sometimes even clearly as marginal phenomena. However, Xenakis labels his compositions as music; nowhere does he suggest that his musical *œuvre* should be understood primarily as a "system", as a sounding manifestation of mathematical preliminary considerations. In fact, relevant arguments can be put forward against such a viewpoint. The main argument is provided by the creator of the works himself, repeatedly pointing out that he reworks his compositions. Aesthetically unsatisfactory results from formalized compositional procedures are improved by hand. Acting as confirmation in this regard is, for example, Claude Helffer's remark in relation to *Herma*:

La première chose qu'il faut dire, c'est qu'*Herma* fut composé à la main. Xenakis a parfois introduit des changements dans la série des calculs, parce que le résultat ne le satisfait pas. Il y a donc eu une liberté de choix. [...] Cela, Xenakis l'entend-il [...] d'une autre manière que Boulez, il n'a pas une oreille analytique, mais il est sensible aux résonances. Puis les intensités ont été mises de façon non mécanique, ce qui est important!"

[The first thing that must be said is that *Herma* was composed by hand. Xenakis sometimes introduced changes in the series of calculations, because the result did not satisfy him. So there was a freedom of choice. (...) Xenakis hears it in a different way than Boulez, he does not have an analytical ear, but he is sensitive to resonances. Then the intensities were put in a non-mechanical way, which is important.] (Albéra 1995, 46)

In terms of a review of Xenakis's logic, *Herma* is certainly one of the best studied works. The considerable discrepancies that emerge between the claimed, supposedly mathematical-logical, basis and the final notation led to critical reactions. Eugene Montague (1995, 36-65), among others, concluded that the work

was far from being composed on a logical basis. This statement might apply to other works as well.

Xenakis gives almost all of his works titles that are largely based on abstract Greek expressions, but ultimately result in extremely “sounding headings”. These titles certainly stimulate semantic references and legitimize an analytical approach from the “outside”, that is, the sound impression. In the following, from the field of music for keyboard instruments (piano and harpsichord), some examples of titling are given, which clearly point beyond sober references to an abstract construction: *Herma* (germ cell, bond, foundation), *Eonta* (present participle of the verb “to be”: the being), *Naama* (flux), *Dikthas* (double), *Komboï* (knots), whereas Xenakis gives some further hints by mentioning “knots of rhythm, knots of timbres, knots of structures, knots of personalities [...]” (Xenakis 1982, preface).

Consequently, and comprehensibly, Pierre Albert Castanet propagates an approach to Xenakis's music that more strongly includes the poetic and spiritual side of the works as well as the archetypal theory of C.G. Jung: “Créateur dans l'âme et par nécessité, Xenakis n'a pas réussi à oublier qu'une communauté indissoluble nous unit aux hommes de l'antiquité.” [A creator at heart and by necessity, Xenakis did not “succeed in forgetting that an indissoluble community unites us with the men of antiquity”] (Castanet 2014, 15). The references to a concrete poetic symbolism in quite a few work titles serve Castanet as a starting point for a modified understanding of the work, which takes the mathematical roots into account, but banishes them from the centre, such as in his “Petit guide d'écoute de *La Légended'Eer*” (Castanet 2014, 28).

Furthermore, as an argument for the reading of Xenakis's music as a “personal” statement afflicted with semantics, his own comments may also be taken into account: In fact, Xenakis distances himself in his music from sentiment in the sense of sentimental outpourings of sadness, cheerfulness, joy, etc. His music, however, contains, he says, all the anguish of his youth, and that which he felt during the time of the resistance movement (Bois 1968, 11).

“Everyone has observed the sonic phenomena of a political crowd of dozens or hundreds of thousands of people. The human river shouts a slogan in a uniform rhythm. Then another slogan springs from the head of the demonstration; it spreads towards the tail, replacing the first. A wave of transition thus passes from the head to the tail. The clamor fills the city, and the inhibiting force of voice and rhythm reaches a climax. It is an event of great power and beauty in its ferocity. Then the impact between the demonstrators and the enemy occurs. The perfect rhythm of the last slogan breaks up in a huge cluster of chaotic shouts, which also spreads to the tail. Imagine, in addition, the reports of dozens of machine guns and the whistle of bullets adding their punctuations

to this total disorder. The crowd is then rapidly dispersed, and after sonic and visual hell follows a detonating calm, full of despair, dust, and death.” (Xenakis 1971, 9)

Xenakis then continues with stating that these are “statistical laws [...], the laws of the passage from complete order to total disorder in a continuous or explosive manner” (Xenakis 1971, 9). He summarizes these sonic phenomena in a demonstration under the term of “stochastic laws” (Xenakis 1971, 9), which closes the circle to his compositional process.

These examples must suffice here, within this limited framework, to show that composing for Xenakis is certainly connected with imagination. Furthermore, an increasing semanticization in his work from the 1980s onwards should be pointed out, a tendency that can be seen in the 1981/82 radio piece *Pour la Paix*, in *Aïs* or in *Nekuia*. In addition, a less strict attitude towards the necessity of understanding the underlying mathematical formulae is noticeable in some interviews. The rejection of music as a medium capable of communication may apply to Xenakis as a composer; conversely, this premise can hardly be considered universally true for his audience (or his performers). Revealing in this regard are Varga's experiences in personal conversations with Xenakis. The fact that his music could have an emotional, powerful effect on his audience, which could lead to quite subjective reflections and semantic interpretations, seemed to make Xenakis uncomfortable. In any case, his “fortress of [...] native reserve” (Varga 1996, 138) withstood all of Varga's suggestions or questioning, with a few exceptions, which attract all the more attention. Referring to Roland Barthes, Duhautpas, Meric, and Solomos (2012, 10) argue for more open views of Xenakis's electronic music and its expressive semantics. In particular, they emphasise the influence of the titles on listeners, referring to James Harley (2002, 48-51). However, this statement has validity not only in relation to Xenakis's electronic music, but also to the other portions of his *œuvre*.

4. Many roads lead to Rome – about *Khoai*

Ronald J. Squibbs states “considerable difficulties” for the analyst “due to the singular nature of Xenakis's compositional process.” (Squibbs 1996, abstract to vol. 1). This general statement also applies to *Khoai*. In the following review of *Khoai*, the focus will be on a structural analysis that includes the listening experience rather than treating the sonic result as a by-product or side note.

Whoever listens to Xenakis's harpsichord works will first of all come across the name of Elisabeth Chojnacka. Makis Solomos (2008, 52) mentions the considerable number of more than 150 works composed for the harpsichordist and inspired by her. Elisabeth Chojnacka is the dedicatee of Xenakis's harpsichord compositions *Khoai* (1976), *Komboi* and *Oophaa* (for harpsichord and percussion solo, 1981 and 1989 respectively), and *Naama* (1984). In *À l'île de Gorée* Xenakis combines the harpsichord with an ensemble of twelve other instruments. Chojnacka's comments on the major difference between piano and harpsichord are revealing – “l'écriture pour clavecinn'arien à voir avec l'écriture pour piano” [Writing for the harpsichord has nothing to do with writing for the piano] (Chojnacka 1981, 227), which Xenakis was obviously aware of as well. Xenakis, who was absolutely unfamiliar with the harpsichord, had the harpsichordist demonstrate all the acoustic and technical possibilities of the instrument before he dared to enter this completely new territory with *Khoai*. Some time after Xenakis had accepted Wolfgang Becker's (Westdeutscher Rundfunk WDR) commission to compose, the work was completed. Mixed in with Chojnacka's joy at her being presented with *Khoai*'s completed score was a surprised astonishment, if not slight panic: “Quand j'eus la partition sous les yeux, je fus complètement affollée devant cette écriture diabolique.” [When I got the first glimpse at the score, I was completely distraught by this diabolical writing.] (Chojnacka 1981, 227).

The technical challenges of Xenakis's first work for harpsichord are extreme, but somewhat mitigated, as Chojnacka says, by the instrument's amplification, whereby “les possibilités de changements de jeux sont beaucoup plus rapides et commodes.” [the possibilities of changing stops are much faster and more convenient.] (Chojnacka 1981, 228). Similar to his piano works (*Evryali* may be mentioned as an example), Xenakis pushes the limits of what is technically feasible, or rather exceeds them, trusting in an “approximation value” that first-class performers are capable of achieving. After all, Elisabeth Chojnacka was available for the premiere of the score, which was notated in up to six systems; Xenakis's “ruthlessness” or nonchalance with regard to playability was thus relativised to a certain degree.

The meaning of the title is rich in connotations – “offerings poured within the earth, libations and vows to the gods of the inferno.” (Harley 2004, 103). The piece itself lacks a solemn atmosphere (which could be connotated with the title) but rather shows a tendency towards drama from the very beginning. This intense, unyielding attitude lasts for all of the fifteen minutes Xenakis gives as its approximate duration. The outer structure is obvious and allows for an initial formal overview of the 331 bars. The method of analysis employed here, which progresses from the large to the small while attempting to be “both synthetic and analytical” (Xenakis 2008, xvii), mimics Xenakis's philosophy in composing, which seeks to mediate and switch back and forth between the specifications in

composing (“from the small to the large”) and in architecture (“from the large to the small”) (Xenakis 2008, xvii).

A first rough overview of the work can lead to an organisation into four sections. Section A (b. 1-73), B (b. 74-134), C (b. 135 with anacrusis-215), and D (b. 216 with anacrusis-331). Bar 135 as the beginning of section C is determined according to Chau-Yee Lo (2004, 93) and Ian Pace (2001, 127). The striking fermata in b. 134, unique in the work, may justify this. Nevertheless, b. 120, with the resumption of the F sound in the bass, could also be argued as the beginning of a new section. However, in connection with the beginning of section D in b. 215, after the “laissez vibrer” and a long pause, b. 135 is readily arguable as the beginning of section C. The length of each section A, B, and C is approximately equal; section D is the longest. In the listening impression, however, there is a more differentiated subdivision that includes more than just the alternation between dense polyphonic passages and thinner, more transparent sections. As can be read from the score, the individual sections are differentiated in their structure, which of course influences the perception. Before we delve more deeply into *Khoai*, however, some remarks on the formal concepts of *Komboi*, *Naama*, and *Oophaa* should be added. In *Komboi*, a similar division into sections (seven in number, or only five, depending on one's point of view) seems logical, which, however, is clearly more stringent than in *Khoai* due to changes in instrumentation as well as metronome indications. Due to the greater richness of timbre in connection with the percussion instrumentation (vibraphone, wood blocks, bongos, congas, tomtoms, bass drum and flower pots), the scope for timbral differentiations, which can be used to shape the form, is larger. Here, pars pro toto, we may refer to the beginning of section B at No. 100 (Xenakis does not count bars here, but quarter notes), which brings a complete change of colour. At least to mention here in passing is the completely different level of expression in *Komboi*, which the composer himself describes as at least partly “meditative and nostalgic” (Varga 1996, 171). *Naama*, by and large, lives up to its title (flux), but here individual sections can also be defined primarily by changes in density as well as changes in registration (related to *Khoai* in this respect). *Oophaa* stands out from the older preceding works by a certain monochromaticity – the potential for a division into sections lies here in the structure and less in colour changes.

The analytical approach with its inclusion of aural experience is carried out in the awareness that there are different types of listeners and, of course, that previous education and listening experience play a role in the precision of perception. The listening impressions recorded here reflect the result of a subjective perception. They are not to be understood as complete, but represent a first “red thread”, in addition to which the table does not provide a complete analysis, but highlights individual aspects. Overlaps between AE and AO are unavoidable.

Section A	Bars	Argumentation based on aural experience (abbreviated AE) and analytical observations (abbreviated AO)
A/1	1-15	<p>AE: Noisy opening followed by a diminuendo; “Basso ostinato” with F-sounds; counter voice in the higher register characterized by short and slightly longer motif-cells; tonal anchorage in the harmonic field of Fs allows an overall orientation despite some randomly occurring events (e.g. repetitive motif in b. 13).</p> <p>AO: pitch set 1 (Pace 2001, 127) in the upper systems; repeated Fs in the bottom part; registration I/II/IV, therefore an ambitus of six octaves; motivic cells represented by the “pedal tone” F, the jump motifs (upper systems) and the occasional 3-tone clusters (b. 9, 11, 12); the repetitive motif in b. 13, though much more concise, is probably derived from b. 5.</p>
A/2	15-22	<p>AE: Scale in semitones is surprising; only a brief moment of surprise, as the music immediately returns to the familiar harmonic F-field.</p> <p>AO: first occurrence of chromatic in b. 15/16: “random walks” resp. “Brownian movement” (Xenakis 2008, 269); combination of “random walk”-motif with 3-tone cluster in b. 16; these random walks are generated from pitch set 1, which is made to proliferate by random pitches; different exposure of the 3-tone cluster, which is less prominent here as an “accompaniment” to the random walk; pitch set 2 from b. 20.</p>
A/3	23-31	<p>AE: b. 23 evokes the beginning of the piece by similar timbre/registration. The return to the tonal centre F creates a reminiscence of b. 1ff.; the impression of a deliberate shaping of the piece is conveyed (key words could be: repetition, variation, resumption, motto).</p> <p>AO: the Fs from b. 1, which function as additional material to pitch set 1, leave the bass register in b. 23 (quasi a variant of b. 5); repeated Fs in the bottom part with registration I/II/IV; b. 24ff. change to pitch set 2 and registration III/III. New timbre, new material.</p>
A/4	31-36	<p>AE: b. 31-33 brings the now familiar scale in semitones from b. 15, but extended. Bar 35 again functions as an anchor point with the Fs in the usual registration.</p> <p>AO: “random walks” b. 31-33, again in combination with 3-tone clusters. Transformation by the extension of the random walk (proliferation of the material); b. 35 closes the section with the modified F “motto”. It would also be conceivable to see the Fs in the low register not as a conclusion but as an initial spark for the new texture that follows (similar to how in b. 23 the Fs initiate the following pitch set 2 and in b. 45 the Fs initiate pitch set 3).</p>

Section A	Bars	Argumentation based on aural experience (abbreviated AE) and analytical observations (abbreviated AO)
A/5	37-38	AE: New texture, extreme density, high density of events; polyphonic confusion; change of timbre by the use of registration I (4'). AO: first occurrence of "arborescence" in b. 37-38 (6 lines simultaneously); passage from order (previous section with translucent linearity) to disorder (complex polyphony of layered random walks).
A/6	39-44	AE: Sudden interruption of the chaotically proliferating polyphony; resumption of the alternation of linear events with the 3-tone clusters. After repeated listening, the impression of a "variation", or better a condensation of b. 1ff. can arise here. The d# in b. 39 initiates this reminiscence (compare the relevance of the d# in b. 1, 8, 11, 19, 21). AO: The high-density field in b. 37 and 38 is again replaced by grouped sound events. However, there is no return to the texture of b. 1ff., since the characteristic Fs (also as a "tonal centre") are missing.
A!	45	AE: Key point in listening: Function of a full stop, "conclusion", or "summarisation"; probably even function of a "colon", because a new idea follows. AO: Compare to the beginning (b. 1); "tonal centre" with Fs; singularity ("motto", "citation"); Sound massing by registration with I/II/III/IV; pitch set 3 (b. 46) prepared by the F sound plus 3-tone cluster.
A/7	46-73	AE: Polyphonic and absolutely random clouds of sound. The confused impression is softened, however, by the appearance of familiar F "harmony". Throughout the section, the impression is one of tension. Points of relaxation (which could function as clear formal structuring points) are missing. AO: Pitch sets 3, 2, 4, partly in superpositions. Lute stop in b. 61 brings a further increase in timbre; arborescence; repeated Fs in b. 58, 63, 66; The movements of the clouds of sounds is not predictable and follow no (musical) logic.

Fig. 1. Overview of the form of "Khoai"

The continuation of the analysis in section B (b. 74-134) shows that the rough division into four sections is coherent, although it does not reflect a clearly perceptible form in the traditional sense of the word, but rather reflects rough tendencies of the musical facture or the auditory impression. In the analytical process, the concept of form (and the term itself), as problematic as it may seem in the context of contemporary music, is retained. This can be argumentatively supported by Chojnacka's (1981, 229) use of the term in reference to *Khoai* on the

one hand and Xenakis's own words on the other. In the conversations with Varga, Xenakis reveals one of his preferred models of form: “[...] you can start with a kind of introduction, followed by a development, and the ending is also clearly indicated. This is one of the ways in which I work.” (Varga 1996, 160). Chojnacka, stating that “d'autres, auxquels Xenakis appartient, possèdent leurs concepts formels, et l'instrument sera alors le moyen de leur réalisation” [others, to which Xenakis belongs, have their formal concepts, and the instrument will then be the means of their realisation] (Chojnacka 1981, 231), shows the counterworld to a compositional creation in which “la forme [...] devient de l'intellect.” [The form then becomes intellect.] (Chojnacka 1981, 231). Ultimately, however, it must be stated that Xenakis does not explore his relationship to the term form in any depth, either in his writings or in the interviews. Revealing is his reply to a question from Varga: “The best solution is, I think, to live with form. That is, one builds it day by day, bit by bit. [...] Music is a kind of organism, it's slow to take shape, like the gestation of babies.” (Varga 1996, 203). This statement, in turn, is consistent with Chojnacka's observation that “*Khoai*'s form is not defined, but rather evolves from an additive process; the work generates itself.” (Chojnacka 2010, 80).

Not an additive process, but the idea of “sieving” material, thinning it out, is a procedure developed by Xenakis for the logical-systematic generation of the diastematic progression. Xenakis's Sieve Theory (Xenakis 1971, 180-200), as he labels it, starts from an “abstract scale” (Xenakis 1971, 195) that “may be constructed with tempered semitones [...], with quarter tones, with whole tones, thirds, fourths, fifths, octaves, etc. or with any other unit that is not a factor of a perfect octave.” (Xenakis 1971, 195). The next step is to “define another equivalent scale.” (Xenakis 1971, 195). This second scale shows a “unitary displacement which is a multiple of the first.” (Xenakis 1971, 195). The following operation is based on the two integers x and n , which can only be whole numbers (positive, negative, or zero) and no fractional numbers. Depending on which units of displacement the composer chooses, a second scale emerges which is connected to the first one. In other words (Varga 1996, 94): The first row is sieved by specific criteria, which is a personal decision of the composer. Depending on the complexity of the sieves, complex scales can be built. The mathematical operations (based on the Logic of Classes) include disjunction (union), conjunction (intersection), and negation (complementation). In this way, any given scale can be expressed in terms of logical functions, and the modus operandi is especially “useful in entirely new constructions.” (Varga 1996, 198). Thus, the best conditions are given for a diastematic order off the beaten track. It should be noted here that the development of Xenakis's method can certainly be placed in a historical context. Dodecaphonics, serialism and also Messiaen's modes can be understood as

forerunner attempts at thinking and composing “outside the box” by “sieving” specific material. Starting from techniques of serial music, Besada (2022) traces these connections in the development of seemingly quite different compositional procedures.

Immediately at the beginning of section B (b. 74-134), the Sieve Theory procedure can be observed. The B, F, and C at the immediate beginning of B/1 (b. 74-80) open up a new “harmonic field” without changing the pitch set itself (a combination of pitch set 3 and 4 as indicated by the composer in b. 70). The initially minimal density (only B in octaves in b. 74) increases until b. 80. The diastematic material has thus been “sieved” and now gradually condenses to the original pitch set. The rhythm of b. 74ff. is striking, with its regular (and conventional) metrical emphases suggesting a 4/4 time signature. Thus, b. 74 forms a break in the course of the composition, which confirms the division into sections both from the listening experience and from the analytical findings. In section B/2 (b. 81-87), the d# initiates a phase of arborescence, the complexity of which Xenakis seeks to channel through performing instructions (division into right and left hands). Bar 83 shows the first interpretive note from the composer's hand (“plus lent progressivement”). In B/3 (b. 87-111), the pitch set B, C and F again takes centre stage at the beginning of the section (F is circled in a random walk). After the a tempo bar in b. 87, a random walk begins in b. 88, which sounds like an echo of the random walks in the section before it. At the same time, b. 88 and b. 91 (combined with Fs in the bottom line) gradually lead to the arborescence in the following bars. The tonal centre is now again the F (octavated or as a single note). In addition, the use of the 3-tone clusters provides a reference to the beginning of the piece (cf. b. 99, 100 ff. and b. 9, 11, 12). Repetition is the main feature (e.g. b. 97ff.). Bars 105-111 feature a harmonically monochrome texture. After some arborescence at the beginning of section B/4 (b. 111-134), Xenakis returns once again to a harmonically static structure (b. 117ff) with the note E in the foreground, only interrupted by three short, F-centred interjections (b. 120-125). Random walks appear for the first time in the lower register (b. 111ff.). Gradually, the larger tonal space is reclaimed, and from b. 119 onward, ostinati or “varied groups” dominate. The rhythmic level is kept stable from the a tempo in b. 117 in latent quarter note beats as a basic pulse. Both the random walks and the repeated notes, despite their transformations, establish the connection to the first A section.

Section C can be divided into three sections. C/1 (b. 135-175) continues the texture of section B/4 with modifications. The foundation of the bass line is again on the F; the rhythmic static is maintained for the time being, though the random walks in 32nd notes (b. 138 and 139) seem to be the initial spark for the rising and falling arborescence (b. 141-147). The alternation of rather static 16th-note fields,

random walks, and arborescence dominates the section up to b. 175. The enigmatic annotations in b. 161 (“C+7+3+4”), among others, cannot be explained. According to Chau (2004, 102), who refers to a conversation between Xenakis and Jukka Tiensuu, these are notes on the compositional process without relevance for the interpretation. The composer's reluctance or hesitation to provide information here could substantiate as well the author's thesis that knowledge of the mathematical-logical compositional process could be secondary after all. In section C/1, several register changes provide a tonal dramatization of the action. C/2 (b. 175-205) begins with a sound massing (notation in three lines; full registration with I/II/III/IV), and random walks develop into scales. Register changes continue to dominate the timbre. With the beginning of C/3 (b. 205-215), the gestures change massively: a chord massing in semiquavers, reminiscent of *Evryali*, heralds the end of the C section. A successive thinning out of the chordal movement leads to a strong reduction of voices in b. 212-214 and simulates an anticlimax, which is counteracted by the use of registers and a “laissez vibrer”.

Special attention should also be paid to the ending, which Varga, in conversation with Xenakis and unchallenged by the latter, reduces to two possible manifestations: “your endings either die away or use strong chords.” (Varga 1996, 160). The final section D (b. 216-331) is *Khoai*'s longest section. Repetition, arborescences, and random walks accumulate, and the central note, C, establishes a “tonal anchor” beginning at b. 225. The preparation of the actual final structure is already heralded in b. 273 and 274 with two “soundless” bars (rests). Also b. 280 as well as b. 302 and 303 suggest as “silence bars” a moment of pause, which is concretised in the last section (from b. 314), in which tonal material and rhythm are thinned out to the “meagre” two-note chord. From this point, the facture can no longer resist the power of the rests, or rather silence. The previously extremely dense, compact, proliferating score dissolves into empty spaces and an “al niente” sound that suggests the end of the sacrificial act. The difference of this ending to the end of *Naama*, *Komboi* or even *Evryali* is evident and supports the thesis of an “individualised”, title-bound, semantically afflicted interpretation of the work.

Specific differences can also be observed with respect to a compositional technique and facture associated with the title. In *Komboi*, for example, wave-like, mirrored and parallel structures appear, which as “geometric translations” establish a connotation to the title. Such references can be discovered in most of Xenakis's works. The composer also comments on the phenomenon of silence or pause in his conversations with Varga, who questions him on his description of silence as being banal (Xenakis 1985, 95): “Silence is always a surprise. Music suddenly stops and we don't know when it will return. It's also interesting psychologically: our brain thinks backwards and forwards. During silence we can

think over what we have heard and understand it better. [...] If there's no music, there is silence. In other words, silence is the negation of music.” (Varga 1996, 63). The fact that pauses or silences can have a specific function or quality is also evident from Chojnacka's statement: “Even silences in the piece [*Khoai*] are charged with tension (musically speaking) and not a place to take a breath.” (Chojnacka 2010, 80). This quality of tension-pauses is maintained until the final section of the piece.

5. Conclusions

After this review of the score and listening to it several times, what reference can be made to the title *Khoai*? The title can perhaps be understood as a reference to the gestures and movements which are involved in bringing a sacrifice to ancient gods: the preparation of the ritual act, the execution of the sacrifice according to a regulated procedure, and the end of the sacrificial ritual. The sacrificial act is connected with a strong inner participation in the event, with an inner tension. Very understandable, given the uncertainty of whether the deities will accept the sacrifice. Indeed, in comparison to *Komboï*, *Naama* and *À l'île de Gorée*, a strongly gestural character is noticeable in *Khoai*, which is recognisable in the score itself. In addition, the importance of expressive gestures comes into play in the performance on the harpsichord and influences the listening experience and the perception of the piece. The idea that both hands must simultaneously change, not to say shift, their position on the manuals is extravagant and begins in an almost striking way already in b. 1. While the F sound is realized with both hands in the low register, both hands have to change manuals, quasi in the reverberation of the F sound, in order to realise the motif in the high register. This change of positions becomes the program of the piece and can be found in all sections, albeit with varying intensity. The comparison with the scores of *Komboï* or *Naama* safeguards against the worries of overinterpretation with regard to the connection between title and music in *Khoai*. Both reference works are notated in a comparatively “flatter” way and present different challenges in terms of playing technique. An almost continuous realisation of the piece on different “levels”, as is the case in *Khoai* (with up to six “levels” or lines), is not to be found in either *Komboï* or *Naama*. To give another example: In *À l'île de Gorée*, semantics-free listening is also not possible and probably not intended by the composer. It is practically impossible to separate the title *À l'île de Gorée* from the music heard. In *Khoai*, the connection between music and title may be less close; it is nevertheless present, as has been shown above.

The exact realisation of *Khoai*'s score is only partly possible. Xenakis was aware of this, and yet he preferred a human approximation to the precision of a machine. "Je lui ai posé la question à plusieurs reprises: n'aurait-il pas préféré avoir une machine, de [laquelle] il aurait pu obtenir l'idéal? Mais si l'interprète ne rend pas tout exactement, il obtiendra, en revanche, une tension particulière: l'être humaine stir remplaçable." [I asked him several times: wouldn't he have preferred to have a machine, from which he could have obtained the ideal? But if the interpreter does not render everything exactly, he will, however, get a particular tension: the human being is irreplaceable] (Chojnacka 1981, 230). Being human, however, is not only irreplaceable, it is, according to Chojnacka (1981, 232), also largely unexplored, and the complexity of Xenakis's music lies, as the harpsichordist sees it, in his effort to "atteindre à un mode mental et sonore supérieur" [reach a higher mental and aural mode] (Chojnacka 232) and thereby establish a "prééminence de l'esprit." [pre-eminence of the spirit.] (Chojnacka 1981, 232). Therein lies a possible answer to the question of how to "understand" *Khoai* – namely as a work full of tension that wants to be interpreted, heard and understood a little differently each time. *Khoai* is enigmatic and will remain so (like every work of art), "*Khoai* est un morceau de plomb, c'est un bloc" [*Khoai* is a piece of lead, it is a block] (Chojnacka 1981, 231), Chojnacka states.

The question that inspired the title of the congress contribution must remain unanswerable: Formalized or music? In his conversations with Xenakis, Varga made several attempts to draw the composer out of his shell regarding the semantics of his works. In response to the question – "I wonder if you agree that your works can be divided into two groups based on whether or not they express something beyond music. [...] It seems to me that in some compositions you speak directly to the listener, whereas in others you seem interested mainly in the science of composition, so to speak." (Varga 1996, 161) – Xenakis answers with "Could be. [...] I didn't want to write programmatic music, in any sense. I wanted the music to be self-sufficient without a need to know what it's about" (Varga 1996, 161). Even if the degree of possible semantic connotations in a work such as *Aïs*, for example, to which Varga refers in the conversation, is incomparably greater than in *Khoai*, Xenakis's response does not testify to a complete absurdity of such a reading of his music. On the contrary, Varga's insistence, his reference to psychoanalytic possibilities of interpretation, at least in this specific work, opens up a wide field of connotations in Xenakis's response and finally culminates in the astonishing observation: "I have used something similar to these cries [bird-cries] also because the bird has a mysterious quality in mythology and folklore – as if it were the voice of Destiny" (Varga 1996, 163). "So perhaps it's not surprising that I should add meanings to your music which aren't there." – "It's a kind of symbolism. Yes, you're

right” (Varga 1996, 164), answers Xenakis. If this is true of *Aï̄s*, a kind of symbolism of sounds could also apply to other works.

A further, only for the time being, last question should be added: Can a work like *Khoaī* be understood to its end at some point? Chojnacka as a performer denies this question, and the music analyst must probably also admit the limits of the possible: “*Khoaī* is like a horizon that one tries to approach but that always remains in distance.” (Chojnacka 2010, 75).

6. References

- Albèra, Philippe. 1995. *Entretiens avec Claude Helffer* [Conversations with Claude Helffer]. Genève: Éditions Contrechamps.
- Besada, José L. 2022. “Xenakis' Sieve Theory: A Remnant of Serial Music?” In *MTO. A journal of the Society for Music Theory*, vol. 28, no. 2. <https://www.mtosmt.org/issues/mto.22.28.2/mto.22.28.2.besada.html>
- Bois, Mario. 1968. *Iannis Xenakis. Der Mensch und sein Werk* [The man and his music]. Bonn: Boosey & Hawkes.
- Castanet, Pierre A. 2014. “Les humanités sensibles d'un sphinx à l'oreille d'airain: Notes pour une philosophie xenakienne de l'art, de la science et de la culture [The sensitive humanities of a sphinx with an ear made of brass: Notes for a Xenakian philosophy of art, science and culture].” In *Xenakis et les arts. Miscellanées à l'initiative du centre Iannis Xenakis* [Xenakis and the arts. Miscellanea on the initiative of the Iannis Xenakis Centre], 14-35. Rouen: Éditions point de vues. <https://ensa-normandie.fr/wp-content/uploads/2021/02/2014-2014-xenakis-et-les-arts.pdf>
- Chojnacka, Elisabeth. 1981. “*Sur Khoaī*.” In *Regards sur Iannis Xenakis*, ed. by Hugues Gerhards et al., 227-235. Paris: Stock.
- Chojnacka, Elisabeth. 2010. “The Harpsichord according to Xenakis.” In *Performing Xenakis*. Transl., comp. and ed. by Sharon Kanach, 71-90. Hillsdale, New York: Pendragon Press.
- Duhautpas, Frédéric, Renaud Meric, and Makis Solomos. 2012. “Expressiveness and Meaning in the Electroacoustic Music of Iannis Xenakis. The Case of *La légende d'Eer*.” In *Meaning and Meaningfulness in Electroacoustic Music*. Stockholm: <https://hal.archives-ouvertes.fr/hal-00769895/document>
- Elste, Martin. 1995. “Kompositionen für Nostalgische Musikmaschinen. Das Cembalo in der Musik des 20. Jahrhunderts [Compositions for nostalgic music machines. The harpsichord in the music of the 20th century].” In *Jahrbuch des Staatlichen Instituts für Musikforschung Preußischer Kulturbesitz*,

- ed. by Günther Wagner, 199-246. Stuttgart: Metzler. https://link.springer.com/chapter/10.1007/978-3-476-03568-4_12
- Exarchos, Dimitris. 2019. "The Berlin sketches and Xenakis's middle-period style." In *Exploring Xenakis. Performance, Practice, Philosophy*, ed. by Alfia Nakipbekova, 21-36. Delaware: Vernon Press.
- Gibson, Benoît. 2011. *The Instrumental Music of Iannis Xenakis: Theory, Practice, Self-Borrowing*. Hillsdale, New York: Pendragon Press.
- Harley, James. 2002. "The Electroacoustic Music of Iannis Xenakis." *Computer Music Journal: "In memoriam Iannis Xenakis"* 26 (1): 48-51.
- Harley, James. 2004. *Xenakis. His Life in Music*. New York: Routledge.
- Lo, Chau-Yee. 2004. *Endangered Species. The Harpsichord and its New Repertoire since 1960*. Dissertation, University of Leeds, 2004. https://etheses.whiterose.ac.uk/430/1/uk_bl_ethos_411561_pdf.pdf
- Montague, Eugene. 1995. "The Limits of Logic: Structure and Aesthetics in Xenakis's *Herma*." *Ex Tempore* 7 (2): 36-65. <http://www.ex-tempore.org/montague/>
- Neugebauer, Otto. 1969. *Vorlesungen über Geschichte der antiken mathematischen Wissenschaften. Erster Band: Vorgriechische Mathematik* [Lectures on the history of ancient mathematical sciences. First volume: Pre-Greek mathematics]. Berlin, Heidelberg: Springer.
- Pace, Ian. 2001. "The Harpsichord Works of Iannis Xenakis." In *Contemporary Music Review* 20 (1): 125-140. https://www.academia.edu/65874662/The_Harpsichord_Works_of_Iannis_Xenakis.
- Rophé, Pascal. 2011. "It's time for Xenakis." In https://issuu.com/durand.salabert.eschig/docs/xenakis_english
- Schaub, Stéphan. 2005. "Akrata, for 16 winds by Iannis Xenakis: Analyses." In *Definitive Proceedings of the "International Symposium Iannis Xenakis" (Athens, May 2005)*, ed. by Makis Solomos et al. <http://articles.ircam.fr/textes/Schaub05a/index.pdf>
- Shand, Jessica (supervised by Ski Krieger). 2020. "Game Music. Game-Theoretic Principles in Music Composition." In *Course Math 243: Evolutionary Dynamics* (Harvard College). https://static1.squarespace.com/static/5c3b71680bdba39a391e9dd5/t/5efb83c7be87e018f0023f4c/1593541579081/Math243_Final_Shand.pdf
- Solomos, Makis. 2008. "Notes sur Elisabeth Chojnacka et les œuvres pour clavecin de Xenakis [Notes on Elisabeth Chojnacka and the harpsichord works of Xenakis]." In *Autour du clavecin moderne. Hommage à Elisabeth Chojnacka* [Around the modern harpsichord. Homage to Elisabeth Chojnacka], ed. by Danièle Pistone, 51-58. Paris: Observatoire Musical Français.

- Squibbs, Ronald J. 1996. *An Analytical Approach to the Music of Iannis Xenakis: Studies of Recent Works*. Dissertation. Yale University. <https://www.proquest.com/openview/19b0701779501fb94df6c269f72498b0/1?pq-origsite=gscholar&cbl=18750&diss=y>.
- Tat, Emmanuelle. 2002. *Présence du clavecin dans la musique française des années 1970 à nos jours* [The presence of the harpsichord in French music of the 1970s to the present day]. Thèse de doctorat. Université Paris IV.
- Varga, Bálint A. 1996. *Conversations with Iannis Xenakis*. London: Faber and Faber.
- Xenakis, Iannis. 1971. *Formalized Music. Thought and Mathematics in Composition*. Bloomington, London: Indiana University Press.
- Xenakis, Iannis. 1982. *Komboï pour clavecin et percussion solo*. Paris: Editions Salabert.
- Xenakis, Iannis. 1985. *Arts/Sciences: Alloys. The Thesis Defense of Iannis Xenakis before Olivier Messiaen, Michel Ragon, Olivier Revault d'Allonnes, Michel Serres, and Bernard Teyssèdre*. Transl. by Sharon Kanach. New York: Pendragon Press.
- Xenakis, Iannis et al. 1987. "Xenakis on Xenakis." *Perspectives of New Music* 25(1/2): 16-63.
- Xenakis, Iannis. 2008. *Music and Architecture. Architectural projects, texts, and realizations*. Comp., transl. and commented by Sharon Kanach. Hillsdale, New York: Pendragon Press.