The Voice of the UPIC: Technology as Utterance

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Iannis Xenakis, in his predilection for the ancient rather than the modern, has always proved a puzzle for theorisation focused on notions of the avant-garde. His own early critique of serialism (Xenakis 1955, 1956) already marked him as being on a different path to the generation of European and American composers who shaped the discourses of post-war music. Furthermore, Xenakis's aesthetic outlook was deeply informed by non-Western cultures, particularly following his trip to Indonesia in 1972 (cf. Andreyev 2022), as well as by ancient Greek thought (cf. Xenakis 2001). This led him to repurpose the practices of music away from Eurocentric concerns with works of art created in the aesthetics of modernity, and from the technocratic development of more or less esoteric musical structures, opening up the possibilities of sound and music in ways that offer a positive counter to the standard tropes of modernism through their recognition of a specific and material correspondence between the real forces of existence and the creative insights of the imagination. This correspondence is of course fundamental to the ancient philosophical traditions of Greek thought, and in an interview given at the Huddersfield Festival in 1987, Xenakis stated quite clearly: "I brought myself up into the ancient Greek tradition, that's for sure", (Xenakis 1987) and in a published interview with Bálint András Varga he says, "I felt I was born too late – I had missed two millennia" (Varga 1996: 15).

What are we to make, then, of Xenakis's consistent concern for new technological means, particularly his use of the digital computer? Starting with his collaboration with engineers at IBM France in 1962, through the establishment of the CEMAMu (Centre d'Études de Mathématique et Automatique Musicales)[1] in Paris in 1966, and his work at Indiana University in Illinois, all the way to his later development of the stochastic granular synthesis programme GENDY (cf. Serra 1993), the digital computer was a constant in Xenakis's creative endeavour.

1 CEMAMu was founded in 1965 at CNET (Centre national d'études des télécommunications), Issy-les-Moulineaux, France, with grants from the French Ministry of Culture.

Here, I want to consider the computer music system, he developed between – roughly speaking – 1977 and 1992, the UPIC (Unité Polyagogique[2] Informatique du CEMAMu), and I want to think of it both as a modern technological innovation, and as a producer of sound with a specific and, I will argue, *non*-modern intent. The discussion of sound, in a historical context, is tricky, and I intend to attempt a sort of philological approach to the matter, in order to trace a narrative of listening in relation to the material resources and sonic effects of the UPIC.

This volume specifically proposes the development of a *philology* of electroacoustic music. That term sets up as a primary area of research "the specific material situation of the sources of electroacoustic music."[3] The digital computer must figure here as one of these critical 'sources', a source with its own materials and histories which, in fact, include sound almost from its beginning. However, that is not the source I want to consider: I am concerned here with the source not of sound but of listening. In the process, I will ask how a resolutely non-modern approach, such as that of Xenakis, can encounter a radically modern technological device such as the digital computer in a manner that opens up listening to different opportunities.

So, first I will consider some of the implications of taking a philological approach: How does a disciplinary paradigm based on words, books, and language map onto something which, while language-like, is constituted rather differently, not just as *music* but as music rooted in specific sorts of technological and communicative practice? Next, I will consider the notion of listening from within that philological perspective, drawing on some insights of the Scottish philosopher Thomas Reid, to attempt to get a sense of what we might hear when we listen to certain of Xenakis's electroacoustic works. Finally, I will take Xenakis's UPIC computer music system as a case-study, trying to link together histories of practice and histories of listening, from this philological perspective, to see what sort of 'renovation' might be possible for the UPIC – now a rather historical method of music production – and its musical repertoire.

Music Philology

Nikolaus Urbanek asks, "What is a music-philological question?" (Urbanek 2013) and I want to begin by considering some approaches to that puzzle, in order to

2 'Polyagogic' is a sort of plural of pedagogic (cf. Varga 1996: 121).

3 Call for Papers: *Xenakis 2022: Back to the Roots*. 19–21 May 2022, University of Music and Performing Arts Vienna, Austria.

lay out the terms of my own discussion here. Editorial and performance practices in traditionally notated music have undergone a process of more or less rigorous and self-critical development over the last 200 years or so: The application of similar insights to electroacoustic music is a fairly recent development, focused on specific repertoires. Thus, Sean Williams has sought to establish the relationship between the studio practice of Karlheinz Stockhausen as annotated in the published score for *Electronic Study II*, and the physical realities of that studio practice, both as remembered by Stockhausen's collaborator, Gottfried Michael Koenig, and as experienced by Williams himself in his attempts to reconstruct Stockhausen's work on reconditioned equipment from the era. This might be close to what, for other repertoire, can be called historically informed performance practice, and it raises, for Williams, the central issue of "the agency of technology" (Williams 2016: 445). To what extent is technology an active participant in music creation, and how can that agency be registered across a historical gap in time? What is lost, what remains, and what can be reconstructed? This does seem like a music-philological question, insofar as it is at least metaphorically related to similar questions concerning textual sources. In this reading, technology becomes text. Williams identifies three key themes in his reading of this 'technological text': first, technology as material presence, then a theme of temporality, and lastly the notion of ontology: Where do sound and music come from? (ibid.) Williams sources these themes in Georgina Born's theorisation of relational musicology (Born 2010: 62), though he omits Born's fourth theme, sociality, which is arguably present anyway in his discussion of studio practice. Since the agency of technology establishes itself in the discussion through historical narratives, Williams writes:

> I use temporality as a way of categorizing elements, characteristics or problems that change their nature over time: for example, the composer's differing attitudes to the use of particular technologies used in the realization process; and the different capabilities and affordances of technologies of the 1950s, on the one hand, and of the second decade of the twenty-first century, on the other. (Williams 2016: 446)

In this account, temporality is a key element in the philological enterprise since it is the trajectory of changes that philology undertakes to map. Technologies, in Williams's sense, refer to actual pieces of machinery, like tape recorders and electronic filters, as well as to the practices that are developed in their physical operation. But, of course, there are other sorts of technology, specifically thoughtful methods and processes for identifying and organising sounds: Stockhausen's use in *Electronic Study II* of a basic frequency step that never

produces octave relations might be one such technology. Thus, technology and ontology are deeply bound together, even if, following Philip Bohlman (Bohlman 1999), one must acknowledge that music has multiple ontologies.

The ontology of music is also a key concern of Xenakis; the principal foundation of his book *Formalized Music* (Xenakis 1992). Indeed, he says explicitly that "it is incumbent on music to serve as a medium for the confrontation of philosophic or scientific ideas on … being" (ibid.: 261). Insofar as ontology is concerned with stories of origin, it must be seen as a key philological concern: Not only does philology seek to identify the originary sources of the material it investigates, but the very notion of 'material' includes the narratives by which that material itself comes to be identified, as well as its "elements, characteristics or problems that change their nature over time" (ibid.: 201). These narratives are explored by Xenakis as "an 'unveiling of the historical tradition' of music" alongside the attempt "to construct a music" (ibid.). Thus temporality figures here, as in Williams's work, as a grounding thematic strand in order to develop narrative as a key strategy for investigation. This is a strategy I want to develop here.

Williams's concern with technology, in a material sense, is also a concern with sound, and I now want to make my own approach to sound explicit. As the nascent discipline of Sound Studies has shown, sound is tricky to talk about, its history even more so. However, sound clearly has a history,[4] and I would claim that that history is as prone to gaps, inconsistencies, and misunderstandings as other textual constructs. My specific interest here is the sound of the UPIC computer music system. I will leave the material technology aside,[5] apart from some brief discussion of the graphic nature of the UPIC's interface, and concentrate instead on its sound. In particular, I am interested in how that sound is and was heard. As Georg Feder remarks, in the introduction to his book on music philology, "Philology is love of words and the mental images manifested in words" (Feder 2011: 1). Sound also produces mental images, both through what we could, by analogy, call 'syntactic structure', and through its sheer presence to our senses. The sound of the UPIC has always been marked as somehow 'unsatisfactory', raw, or rebarbative, even by its creator. When Brigitte Condorcet (Robindoré) refers to the perception of the UPIC's sound as being "somewhat harsh" (Condorcet 2020: 403), she is registering the frequent sense of disappointment of people using the device for the first time. I want to interrogate that response, and to try to construct a narrative of listening to the UPIC, both as itself, and in a context of other sonorous images, in order to attempt both

4 An attempt at such a history is made in R. Murray Schafer's book, *The Tuning of the World* (1977).

5 For further information on the UPIC see Weibel et al. (2020).

a reconstruction of the birth of a particular sound world, and a reassessment of how that sound world appears to us. Urbanek remarks on the difficulty of assessing aspects of a text that seem unhappy or unlikely when he says: "Is a problematic moment in a text to be interpreted as a textual error, or as a moment of compositional audacity?"[6] (Urbanek 2013: 161). This remark may have been made of text as notation, but in the context of the UPIC, a certain *sound* might in fact appear as "eine problematische Textstelle". How is one to assess the possible "audacity" that this seeming sonic "error" proposes? Barbara Johnson suggests that, indeed, one of the tasks of philology is "to read in such a way as to break through preconceived notions of meaning in order to encounter unexpected otherness – in order to learn something one doesn't already know – in order to encounter the other" (Johnson 1990: 29). So now I want to consider the sound of the UPIC as 'sonic other'.

Listening

Listening turns out to be a complex phenomenon.[7] Discussions of listening, particularly in relation to sound disseminated through loudspeakers, were dominated, until the last 20 years or so, by the theorisation of Pierre Schaeffer, with its attempt, inspired by Husserl's phenomenology and its notion of the *epoché*, to cut off mediated sound from what surrounds it. More recently, however, several scholars including Jean-Luc Nancy, Peter Szendy, Georgina Born, and others have opened up a different sort of discourse that centres on, in Born's terms "the *relations* [my emphasis] between musical object and listening subject, where the latter demands an analysis of the social and historical conditions and the mediation of listening, as well as the changing forms of subjectivity brought to music" (Born 2010: 80f.). In order to get a sense of how listening might figure in a philological enterprise, I want to consider listening to the UPIC from a number of perspectives. The basis for this is the thought – crazy perhaps – that, just as we have come to value 'historically informed performance', we could also attempt a 'historically informed listening'.

The first move in my argument is to recall a line of thought from the Scottish Enlightenment philosopher Thomas Reid. Reid traverses an intriguing path between pragmatic realism and a transcendental idealism that finds strong parallels in contemporary neuroscientific notions of mirroring systems: What hap-

6 "Ist eine problematische Textstelle als Textfehler oder als kompositorische Kühnheit zu werten?" Unless otherwise stated, all translations by the author.

7 This is an understatement! But see, for example, Nancy (2007).

pens outside the body is induced to also happen inside the body. This allows sound a particular sort of reality, that does not deny the psychological and philosophical subject-formation described by Born, but that also implies a stronger connection between sound and the social and material network than Born and others have implied.

In his *Essays on the Active Powers of Man* (1788), Reid writes:

> I call those operations social, which necessarily imply social intercourse with some other intelligent being who bears a part in them. … Between the operations of the mind, which, for want of a more proper name, I have called solitary, and those I have called social, there is this very remarkable distinction that, in the solitary, the expression of them by words, or any other sensible sign, is accidental. They may exist, and be complete, without being expressed, without being known to any other person. But, in the social operations, the expression is essential. They cannot exist without being expressed by words or signs, and known to the other party. (Reid 2010: 330)

This presents the social act as a moment of inter-subjectivity, where there is a sort of co-creation by the social group of something that takes place out in the open, not in the inner sanctum of anyone's mind. Moreover, Reid's assertion that the words or signs uttered must be "known to the other party" stems from his belief in some sense before language, "by which we are sensitive to our world and to one another. It is not learnt as a matter of habit and customs, but exists as an *a priori* condition of our experience" (Reid 1983: 41). Thus, the co-forming of the matter presented in social signs is underwritten by some sort of foundational representation of a sense of selves, within which acts may be undertaken and understood as *counting* for the participants. How can sound figure within such a representation of a recognised world?

The social understanding of sound is at least partly present in historical record. It is not just music criticism that concerns itself with the description and discussion of sound. Thus, for example, Douglas Kahn, in his book *Earth Sound Earth Signal* (Kahn 2013), surveys the historical record of accounts of the sounds registered by telephone lines, radio antennae, seismic monitors, and electrical devices. An early example he gives comes from the 1893 manual *Practical Information for Telephonists* in which different sorts of line noise are categorised in a manner strikingly similar to the aesthetic categorisation of sounds attempted by Luigi Russolo in his manifesto of 1913, *The Art of Noises* (Russolo 1986). Some 40 years later, Hugo Benioff's long-playing record, *Out of this World* presented recordings of just these sorts of sounds, like earthquakes, the atmospheric phenomena called 'whistlers,' and ionospheric radio signals, described by Eric D. Barry as a sort of "audiophile spectacle" (Barry 2009: 120) of the sonic wonders of the universe. These historical accounts of sound, in their mundane as

well as their artistic manifestations, give us a narrative of common understanding in relation to sound: They register the sort of co-creation of a listening-sense that allows us insight into traditions of social intercourse and social meaning concerning sounds that came within the collective consciousness during specific historical time periods. The configuration of the experiences thus registered is consistent, and presents a critical context for the appearance in the 1940s and 1950s of concrete, electronic, and electroacoustic musics. I would represent that configuration as: First, the presence of an apparatus – usually a metal cable or stylus attached to some registering device, configured for purposes of communication, like a sort of stethoscope applied to the surface or the atmosphere of the earth; second, a narrative of discovery and exploration, as epitomised in the novels of the 19th century French writer Jules Verne, in which the Universe and planet earth figure as mysteries to be uncovered for the progressive development of scientific, industrial colonialism. In this network, the device itself is a conduit, rather than an instrument: In the narrative of its operation, it conveys and collects rather than produces, and the common imaginary of the listening experience it provides is one of colonial exploration and science fictive appropriation. Thus, Karlheinz Stockhausen can characterise his work *Hymnen* as opening with "the international gibberish of short-wave transmissions" (Wörner 1976: 59) and as moving towards a "Utopian realm" centred on the harmony of the spheres as an image of the collected sounds of the world.

I have tried to indicate here how a philological narrative of 'historically informed listening' might be developed, considering listening, in Reid's terms, as an inter-subjective moment of subject-formation in relation to sound experiences with a specific historical availability, configured through particular types of apparatus with their own material presence, practices of operation, and narratives of existence and purpose. I could now try to relate this listening to a specific historical canon of sound and music practice, particularly as developed within the genres of concrete, electronic and electroacoustic music. But instead, I want to try to show how Xenakis, both in principle, and specifically through the development of the UPIC and its sound world, is in fact concerned with a totally different sort of enterprise.

Writing and Sounding

There is a moment, in an interview given at the Huddersfield Festival in 1987 where the UPIC was showcased, when Xenakis seems to express some regret

about its functioning. In answer to a question about the quality of computer-generated sound, he said the following:

> The natural sounds, yes, they are, indeed they are richer. Of course, the instruments for instance have still a very fine sound which can be very complex, […] and the computer is still poor in that domain. I think it's not a matter already of the technology, but also of thinking and theories. (Xenakis 1987)

He then goes on to speak about what, as formulated in the 1970s by Steve Holtzman, has come to be known as 'non-standard sound synthesis', that is, in the case of Xenakis, the direct transcription, either by hand or by calculation, of the instantaneous pressure differences that lead to the perception of sound. Holtzman describes non-standard synthesis as an approach which,

> given a set of instructions, relates them one to another in terms of a system which makes no reference to some super-ordinated model, […] and the relationships formed are themselves the description of the sound. (Holtzman 1978: 1)

More recently, Luc Döbereiner has explored the implications of this approach to sound, noting not just the technical but also the poetic and ontological narratives that underpin it. Thus, he cites Rainer Maria Rilke's text of 1919, *Ur-Geräusch* ('Primal-sound') which presents the groove of the gramophone as a sort of terrain of radical possibility:

> What if one changed the needle and directed it on its return journey along a tracing which was not derived from a graphic translation of a sound, but existed of itself, naturally – well: to put it plainly, the coronal suture, for example. What would happen? A sound would necessarily result […] which of all the feelings here possible prevents me from suggesting a name for the primal sound which would then make its appearance in the world … (Rilke 2001: 23)

This reconfigured apparatus becomes, in Döbereiner's words "an extension of our senses in that it renders perceptible otherwise imperceptible structures" (Döbereiner 2011: 30). Döbereiner connects this notion of extending the senses explicitly with the act of listening when he asserts that the act of synthesis is "understood as generating a unique sonority […] actively transforming listening habits" (ibid.: 34). This is reminiscent of Barbara Johnson's suggestion, mentioned above, that one of the tasks of philology is "to read in such a way as to break through preconceived notions of meaning in order to encounter unexpected otherness" (Johnson 1990: 29). In this case, however, the text be-

ing interrogated is a material reality registered as a sequence of instantaneous pressure differences. In what sense could this *be* a 'text' open to a philological reading?

The analysis of listening I outlined earlier, based on Reid's avowal of inter-subjectivity, might seem to preclude this sort of "unexpected otherness", yet if music is not social, what else is it? Reid's explicit formulation of the social as incorporating "any other intelligent being" prefigures the sort of open, non-hierarchical ontologies proposed by Latour and others, and in this instance would seem to allow the "primal sound" or 'unique sonority' the opportunity to be heard: Indeed, in so far as it is heard – rather than remaining obscure and unintelligible, below the threshold of our perception – it must, in Reid's account, be *recognised* within a social, if not within an acoustic sensibility. It is recognised because of its impact on us as a particular social construction that counts for us. But what could it be recognised *as*?

Here we have to stop for a moment to take account of Xenakis's attribution of a certain 'poverty' in the sound quality of synthesised sounds. It is clear that this 'poverty' does not relate to the unlike-ness of the sounds to previously known sounds. The whole purpose of non-standard synthesis, as exemplified in the apparatus of the UPIC, is the *extension* of the domain of sound, not in the exploratory sense I described a moment ago, where a sort of palpating of the world and its inter-stellar location is undertaken with an acquisitive intent, but more in a revelatory sense, where the requirement is – in a manner of speaking – to engage with moments of enunciation. In this context, the 'poverty' described by Xenakis is a registering of the import of the enunciation: The oracle has spoken, but has not yet – for Xenakis – uttered a completely compelling message. This is to say that, in these works, Xenakis is not so much *making with* as *listening for*. The compositional effort, as is clear in all of the early works with their detailed mathematical working out, is not a putting together of materials found but the registering of a trajectory or track that is sought for in the terrain of the created universe. This *seeking* is a detailed investigation that is at the heart of Xenakis's compositional process; it uses logic and mathematics in an ancient sense as a sort of *divination*, uncovering or bringing forth into social reality the imprints of creation. Thus, the computer becomes a sort of apparatus like Rilke's altered gramophone, a modern manifestation of ancient concerns. As Xenakis put it, in the interview he gave in Huddersfield:

> whenever you say computer, you must put in the computer all these fantastic experiences that mankind has acquired during these millennia. So, when you deal with these things even if you don't have computer, I mean when you deal with problems, deep problems in music, you have to deal wi-

> th the things that the computer makes easier to handle you see. So, when you have a computer it's very natural to use it. (Xenakis 1987)

In this sense, Xenakis shares a certain attitude with the American composer John Cage, although their methods and aesthetics could not be more different. Where Cage listens for the imprint of chance events, Xenakis seeks out and registers flows and forces, transitions and transformations. Cage approaches the oracle with dice and yarrow stalks, Xenakis with tracings of the imprints made by elemental forces.[8]

Here, in this invocation of the oracular, we might think for a moment about the relation between Rilke's "coronal suture" and the graphism of the UPIC. One of the key moments of philology is the tracing of genealogies; the narratives that contextualise words and their meanings. Thus, Plato has Socrates remark, in *Cratylus*, "The name of the Muses and of music would seem to be derived from searching and their making philosophical enquiries (μῶσθαι)" (Plato 1961: 406a). The coronal suture is a material manifestation of a being, and the implication of its 'primal sound' is the hearing of a voice from beyond: It is oracular, in the sense that it interprets a sign – the suture – and the sign is emblematic and prophetic of the person who bears it and their evolution as both individual and species. One could see a similarity to other oracular methods, such as the examining of entrails or tea leaves. These are all sorts of graphism. The UPIC, in Xenakis's hand, explores a number of graphic potentials, but I will use just one here as an example: the arborescence. Xenakis was fascinated by arborescent structures. In one of the conversations with Bálint András Varga, he says:

> I believe that is what is lacking today, a theory about shapes. […] (A) fantastic shape is that of trees. Arborescences. Veins and nerves have that shape. Lightning has it. (Varga 1996: 207)

And river deltas: The wall of the UPIC atelier had satellite images of river deltas pinned to it. The arborescence is a material structure, like the coronal suture, that can be traced to reveal primal forces that allow a sort of oracular enunciation: the sound, not of the world as a resource for sonic accumulation and exploitation, but of the world as inter-subjective co-respondent to our supplication and interrogation.

8 For another account of such 'tracings' see Morton (2013).

Conclusion

The aim of this discussion has been to reconsider the UPIC as an apparatus, where, following Giorgio Agamben, an apparatus is "a heterogeneous set that includes virtually anything. […] The apparatus itself is the network that is established between these elements" (Agamben 2009: 2f.). Thus, *listening* seems to me to be a critical component of the network that extends around the UPIC. Following Reid's characterisation of communication within the social network as a sort of apparatus of inter-subjectivity, the *philological* project has been to try to trace the narrative of a root of common understanding that allows the UPIC to be heard, not as a poor version of something it is not, but in its own voice: an oracular voice that speaks from behind appearances. This is not just a historical project: an attempt to hear with the ears of the 1970s, but also a project of renovation, attempting to uncover, by narrative means, what it might mean to listen to the UPIC as a radically different approach to the acousmatic project. I have tried to characterise the voice of the UPIC as a voice of enunciation, rather than replication or presentation, and I have tied the notion of enunciation to an oracular moment. This is partly in acknowledgment of the commitment of Xenakis to an ancient, rather than a modern mindset, but of course the oracle is not just ancient, and never really about foretelling the future. Its predictions are always ambiguous (see Kindt 2017): It is about the revelation of unlikely correspondences, between human narratives and the contingent narratives of events – a drawing together of humans and the teeming life around them in nodes of sympathetic and inter-subjective connection.

Bibliography

Agamben, Giorgio (2009) "What Is an Apparatus?", in *What Is an Apparatus? And Other Essays*, trans. by David Kishik and Stefan Pedatella, ed. by Werner Hamacher, Stanford: Stanford University Press, 1–24.

Andreyev, Samuel (2022) *The Samuel Andreyev Podcast – Betsy Jolas: My Trip to Bali with Xenakis and Takemitsu*; https://podcasts.apple.com/gb/podcast/betsy-jolas-my-trip-to-bali-with-xenakis-and-takemitsu/id1455789353?i=1000530410090 (accessed March 27, 2024).

Barry, Eric D. (2009) "High-Fidelity Sound as Spectacle and Sublime 1950–1961", in *Sound in the Age of Mechanical Reproduction*, ed. by David Suisman and Susan Strasser, Philadelphia: University of Pennsylvania Press, 115–138.

Bohlman, Philip V. (1999) "Ontologies of Music", in *Rethinking Music*, ed. by Nicholas Cook and Mark Everist, Oxford: Oxford University Press, 17–34.

Born, Georgina (2010) "For a Relational Musicology: Music and Interdisciplinarity, Beyond the Practice Turn", in *Journal of the Royal Musical Association* 135/2, 205–243.

Condorcet (Robindoré), Brigitte (2020) "Beyond the Continuum: The Undiscovered Terrains of the UPIC", in *From Xenakis's UPIC to Graphic Notation Today*, ed. by Peter Weibel, Ludger Brümmer, and Sharon Kanach, Berlin: Hatje Kantz, 296–415.

Döbereiner, Luc (2011) "Models of Constructed Sound: Nonstandard Synthesis as an Aesthetic Perspective", in *Computer Music Journal* 35/3, 28–39.

Feder, Georg (2011) *Music Philology: An Introduction to Musical Textual Criticism, Hermeneutics, and Editorial Technique*, Hillsdale: Pendragon Press.

Holtzman, Steven R. (1978) "A Description of an Automatic Digital Sound Synthesis Instrument", in *DAI Research Report No. 59*, Edinburgh: University of Edinburgh Department of Artificial Intelligence.

Johnson, Barbara (1990) "Philology: What Is at Stake?", in *Comparative Literature Studies* 27/1 (What Is Philology?), 26–30.

Kahn, Douglas (2013) *Earth Sound Earth Signal: Energies and Earth Magnitude in the Arts*, Berkeley: University of California Press.

Kindt, Julia (2017) "The Inspired Voice: Enigmatic Oracular Communication", in *Mercury's Wings: Exploring Modes of Communication in the Ancient World*, ed. by Richard J. A. Talbert and Fred S. Naiden, Oxford: Oxford University Press, 211–229.

Morton, Timothy (2013) *Hyperobjects: Philosophy and Ecology after the End of the World*, Minneapolis: University of Minnesota Press.

Nancy, Jean-Luc (2007) *Listening*, trans. by Charlotte Mandell, New York: Fordham University Press.

Plato (1961 [1892]) "Cratylus", trans. by Benjamin Jowett, in *Plato: the Collected Dialogues*, ed. by Edith Hamilton and Huntington Cairns, Princeton: Princeton University Press, 421–474.

Reid, Thomas (1983) *Inquiry and Essays*, ed. Ronald Beanblossom and Keith Lehrer, Indianapolis: Hackett.

Reid, Thomas (2010 [1788]) *Essays on the Active Powers of Man*, ed. by Knud Haakonssen and James A. Harris, Edinburgh: Edinburgh University Press.

Rilke, Rainer Maria (2001 [1919]) "Primal Sound", in *The Book of Music and Nature*, ed. by David Rothenberg and Marta Ulvaeus, Middletown: Wesleyan University Press, 21–24.

Russolo, Luigi (1986 [1913/1916]) *The art of noises*, trans. with an introduction by Barclay Brown, Hillsdale: Pendragon Press.

Schafer, R. Murray (1977) *The Tuning of the World*, New York: Knopf.

Serra, Marie-Hélène (1993) "Stochastic Composition and Stochastic Timbre: GENDY3 by Iannis Xenakis", in *Perspectives of New Music* 31/1, 236–257.

Urbanek, Nikolaus (2013) "Was ist eine musikphilologische Frage?", in *Historische Musikwissenschaft, Grundlagen und Perspektiven*, ed. by Michele Calella and Nikolaus Urbanek, Stuttgart: Metzler, 147–183.

Varga, Bálint András (1996) *Conversations with Iannis Xenakis*, London: Faber & Faber.

Weibel, Peter, Brümmer, Ludger, and Kanach Sharon, eds. (2020) *From Xenakis's UPIC to Graphic Notation Today*, Berlin: Hatje Cantz.

Williams, Sean (2016) "Interpretation and Performance Practice in Realizing Stockhausen's Studie II", in *Journal of the Royal Musical Association* 141/2, 445–481; https://doi.org/10.1080/02690403.2016.1216059 (accessed March 27, 2024).

Wörner, Karl H. (1976) *Stockhausen. Life and Work*, introduced, ed. and trans. by Bill Hopkins, Berkeley: University of California Press.

Xenakis, Iannis (1955) "La Crise de la Musique Serielle", in *Gravesaner Blätter* 1, Mainz: Ars Viva.

Xenakis, Iannis (1956) "Wahrscheinlichkeitstheorie und Musik", in *Gravesaner Blätter* 6, Mainz: Ars Viva.

Xenakis, Iannis (1987) Interview with Richard Steinitz. Huddersfield Festival of Contemporary Music 1987, 21 November 1987, recorded and transcribed by the author.

Xenakis, Iannis (1992) *Formalized Music: Thought and Mathematics in Music*, rev. ed. compiled and ed. by Sharon Kanach, Stuyvesant [NY]: Pendragon Press.

Xenakis, Iannis (2001 [1958]) "Problèmes de Composition Musicale Grecque", in *Présences de Iannis Xenakis*, ed. by Makis Solomos, Paris: Centre de documentation de la musique contemporaine, 11–14.