Meta-Xenakis

New Perspectives on Iannis Xenakis's Life, Work, and Legacies

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Cover image: Iannis Xenakis at the C.R. MacIntosh Museum, Glasgow, Scotland, 1987. Photo by Henning Lohner, courtesy of CIX Archives, Lohner collection.

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20. An Approach to the Epistemic Potential of the UPIC

Mauricio Arturo Meza Ruiz

Introduction

The present chapter arises within the framework of a doctoral research project that investigates the role of artificial memory in the processes of musical creation mediated by digital technologies.[1] My research aims to contribute to the emergence of new categories of listening, specific to the process of musical creation, from a critical perspective that puts the digital trace to the test.[2] By digital trace I understand the retention in digital memory of the information input from a human agent into a computer system, in a context of interactivity.

I thus distinguish between two types of interactivity. The first is one in which computer formalism governs the whole process of creation, and in which bodily movement and aural perception have no relevant role in the output of the process. The second is a kind of interactivity in which a coupling between body movement and listening modulates the whole process, implying a richer and more dynamic exchange of information between the terms (entities, agents) that relate to each other, in the context established by the creative process itself.

Although the processes of music creation mediated by digital technologies involve at least some elementary level of interactivity, such processes do not always integrate a significant bodily engagement on the part of the composer.[3] In the current

1 This chapter presents elements of a previous publication, Meza, 2022, based on a presentation given by the author at the international conference Electroacoustic Music Studies Network, held at the Casa del Lago, Mexico, in 2019. I offer here a new version of the comparative analysis, putting it into an appropriate context in response to the celebration of the centenary of Iannis Xenakis.

2 For an appreciation of the state of progress of the music creation project linked to this research, see Meza, 2021a; 2021b.

3 It is convenient to distinguish between what I understand by interactivity and interaction. The latter term has a broad and generic application, referring to any interactive relationship between agents that inform each other in an analogical, digital, and/or hybrid context. Whereas, the term interactivity refers, in the framework of this research, on the one hand, to any interactive relationship in which at least one of the terms or agents that constitute such relationship is a digital agent, and on the

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stage of development of my research, my purpose is to study those cases in which the projections of musical creativity are conveyed by a coupling between auditory perception and bodily movement; movement that is captured, inscribed, and indexed in digital memory. I focus on cases in which such projections arise from a close relationship between listening and imagination, and in which the captured information is converted into data, which in turn is transferred to the symbolic domain of music, that is, to graphic representations and notations of musical symbolic order.[4]

At the origin of the concerns that have shaped my research is my interest in a certain kind of musical artwork, including the work of Iannis Xenakis, particularly his technological proposal, the UPIC.[5] Among the potentialities of the UPIC is that of projecting and capturing an interactive creation process. Such a process of musical creation would imply, from my perspective, the possibility of building a dialogic relationship with sound, which in turn would give rise to the emergence of new procedures that require considering the advent of a new configuration of the relationship between technique, body movement, auditory and visual perception, and imaginary and creative intentionality, within the context of musical creation. Thus, it would be convenient to rescue the analogical and digital registers of the pieces that have been created with the UPIC system, in order to submit them to analysis and determine how, and to what extent, a digital enactive *poiesis* would have been emerging, at least as a potentiality, in the field of the creative use of the UPIC. By this I mean the fabrication or production of objects (works of art) from a corporeal foundation, situated in a digital technological environment. Paul Valéry (1875–1945) theorizes this in his account of *poiesis*, or poietics, that concerns "human action, from its psychic and physiological roots, to its undertakings on matter and on individuals, [...] invention [...] composition, [...] chance, reflection, imitation, culture and the medium [...] techniques, procedures, materials and supports of action [...] in the production of works of art."[6] On the other hand, the enactive approach "understands cognition as a way of regulating the relationship between the agent and his world, following rules that are based on the nature of the living body, which is considered as a precarious and self-constituted system, autonomous but in need of constant interaction with the environment."[7]

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other hand, to the situation of interaction in which the flow of information is mediated by digital technologies.

4 For an *état de l'art* on the subject of digital traces in musicology and music creation see Meza, 2020.

5 UPIC (Unité Polyagogique Informatique du CEMAMu). CEMAMu Centre d'Etudes de Mathématique et Automatique Musicales) Center for the Study of Musical Mathematics and Automatics.

6 Valéry, 1948, p. 260 [*une idée générale de l'action humaine complète, depuis ses racines psychiques et physiologiques, jusqu'à ses entreprises sur la matière ou sur les individus,* [...] *l'étude de l'invention et de la composition, le rôle du hasard, celui de la réflexion, celui de l'imitation ; celui de la culture et du milieu ; d'autre part, l'examen et l'analyse des techniques, procédés, instruments, matériaux, moyens et suppôts d'action*] (author's translation).

7 Thelma Garrison, "Jerome Bruner—Cognitive Learning" (May 15 2009), *Medium*, https://medium.com/interactive-designers-cookbook/jerome-bruner-cognitive-learning-abf4b3318c75

Among the drawings created with the UPIC device I single out the graphic records of *Mycènes Alpha* by Iannis Xenakis and *eua'on* by Julio Estrada (b. 1943), pieces created in 1978 and 1980, respectively.[8] I now offer a succinct presentation of the history and functioning of UPIC. In the following section, I present a comparative analysis of two excerpts from the graphic registers of both of these emblematic works created with this device.

The UPIC

In 1979, in an interview published in *Le Monde de la Musique*, in which he is questioned about his technological proposal, Xenakis offers an answer that begins by problematizing the use of computers in music:

> The computer should be used not only for sound synthesis but also for macro-structures, large-scale constructions. [...] The obstacle stood on the side of the computer: how to transmit to the machine a notation and concepts that the musician learns in the conservatories?[9]

Xenakis then reveals, in the course of the same interview, a solution that, to the great interest of my investigative project, places a particular emphasis on the integration of the body and, therefore, of its dynamic potential, in the dialogue with computers in the process of musical creation: "The solution was the hand: that the musician should give orders to the computer by means of drawings, and not by means of punch cards or programs."[10]

Although Xenakis had already been cultivating the vision of this tool since the 1950s, it was not until 1977 that he came to its implementation, with the support of his collaborators, within the CEMAMu, located in Paris (Figure 20.1).[11] Taking agogic as a reference—that is to say, the component of music that encompasses the elements that regulate the dynamics of musical expressiveness—Xenakis's intention, by proposing a *poly-agogic*, was to extend the spectrum of possibilities in the domain of musical creation by implementing such a project in a computerized system that takes *drawing*

8 Estrada is a music creator, researcher, and pedagogue. He maintained a close professional and friendly relationship with Xenakis. He was in charge of the research direction of CEMAMu between December 2000 and July 2001. He is a member of the National Institute of Aesthetic Research of the National Autonomous University of Mexico (UNAM) and professor of composition at the Faculty of Music of the same university.

9 Xenakis, 1979, p. 96 [*Il ne faut pas se servir de l'ordinateur uniquement pour la synthèse des sons, mais également pour les macrostructures, les constructions à grandes échelle.* [...] *L'obstacle se situait du côté de l'informatique : comment transmettre à la machine une notation et des concepts que le musicien apprend dans les conservatoires ? La solution, c'était la main : que le musicien donne ses ordres à l'ordinateur par l'intermédiaire de dessins, et non de cartes perforées ou de programmes*] (author's translation). See "Présentation de L'UPIC," *Centre Iannis Xenakis*, https://www.centre-iannis-xenakis.org/cix_upic_presentation?lang=fr

10 Ibid.

11 See "UPIC – Presentation," *Centre Iannis Xenakis*, https://www.centre-iannis-xenakis.org/cix_upic_presentation?lang=en

as the main vector of creativity. When working with the UPIC, the composer is faced with the possibility of designing all the formal and temporal aspects of the musical work, from the waveform to the macrostructure, passing through all the intermediate levels.[12]

Fig. 20.1 Alain Després during a UPIC demonstration in Delphi, 1985. Photographer unknown, courtesy of CIX Archives, Després collection.

For his part, Estrada (Figure 20.2) gives a brief description of the UPIC, of its characteristics and its functioning.[13] He underlines that one of the foundations of Xenakis's musical thought, namely the use of the Cartesian plane to represent sound graphically, takes shape in the poly-agogic computational device: "[...] the UPIC materialized a central aspect of Xenakian thought, the analogical representation of sounds by means of a two-dimensional graph."[14] On the other hand, Estrada highlights the challenges that any music creator must face when making use of the UPIC, and thus assumes the freedom that it offers to the creative process: "Whoever makes use of such a device must obtain all the results without having to be guided by preferences

12 See the video by uploaded by XenakisCollection, "Xenakis Documentary UPIC 2" (10 Mar 2019), *YouTube*, https://www.youtube.com/watch?v=lNPWub-MNxg

13 Estrada describes his relation with the UPIC: "*Usuario de la UPIC en obras y en proyectos de búsqueda, colaborador en la divulgación del sistema en festivales y cursos diversos,* [...] *vinculado al desarrollo de dicho sistema a lo largo de las últimas dos décadas*" [I used the UPIC in works and projects of research, having been a partner in the spreading of the system in festivals and different courses [...] linked up to its development over the last two decades]. See Estrada, 2000.

14 The "x" axis representing time; "y" axis for frequency. See Estrada, 2000.

coming from a foreign aesthetic. The UPIC is in this sense a table of free musical creation where each user can explore what suits his thinking and his imaginary."[15]

Indeed, the component that characterizes the UPIC device, and that gives it all its originality, is a drawing table, similar to a drawing board for architects, with the important difference that this table is electromagnetic, and its purpose is to mediate between the hand gesture of the *musical creator-composer-drawer-designer* and a synthesizer integrated to a computer. Thus, this design table is an interface that has among its functions to transfer to a computer the information generated by the drawings made by the composer. The data resulting from this transfer of information is then assigned to the dynamic control of the parameters of a synthesizer, finally giving the audition of the drawings through a pair of loudspeakers. The system allows various transformation algorithms (transposition, inversion, retrogradation, etc.) to be applied to the captured information.

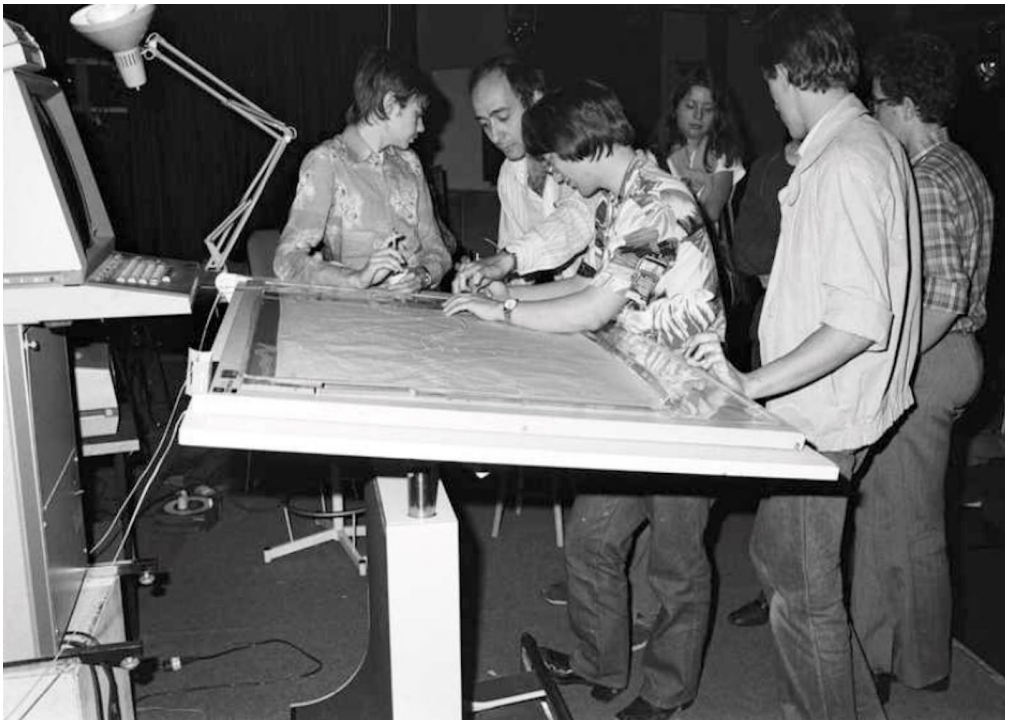

Fig. 20.2 Julio Estrada, in charge of a group of blind youths learning to use the UPIC, *Ateliers Portes Ouvertes UPIC, Forum des Halles*, Paris, 1981. Photo by Bruno Rastoin, CIX Archives, Rastoin collection.

15 Ibid., p. 1 [*Quien se sirve de dicho equipo debe obtener todos los resultados sin requerir ser orientado por selecciones previas provenientes de una estética ajena. La UPIC es en ese sentido una mesa de libre creación musical en la que cada usuario puede explorar aquello que conviene a su pensamiento y a su imaginario*] (translated by the author).

Three versions of the UPIC device were created.[16] With the first version, UPIC A, the one with which Xenakis composed *Mycènes Alpha* in 1978, it was necessary to draw on loose sheets of paper. In order to transfer these shapes to the computer, it was needed to place them on the electromagnetic table and highlight them with an electromagnetic pen. Then, after processing that could take a considerable time to produce its results, it was possible to listen to the resulting sounds.[17]

In addition to *Mycènes Alpha*, Xenakis composed two other solo tape pieces with the system: *Taurhiphanie*, created nearly ten years later in 1987, with a duration of eleven minutes; and *Voyage absolu des Unari vers Andromède*, which dates from 1989 and has a duration of sixteen minutes. It should be noted that Xenakis also composed a mixed work, *Pour la Paix*, in 1981, in which he integrated UPIC generated sounds.[18]

The UPIC was very widely used, resulting in an important production that testifies to the interest that a multiplicity of composers had in it and, at the same time, to the potential of this instrument to facilitate the emergence of a whole wealth of contemporary musical expressions. Among the creators and works composed with UPIC are, in a non-exhaustive enumeration, Nicola Cisternino (b. 1957), *Xöömij*, for bass voice and UPIC, 1997, 11′57; François-Bernard Mâche (b. 1935), *Tithon*, for magnetic tape, 10′10, 1989; Gerard Pape (b. 1955), *Le Fleuve du Désir III*, for string quartet and UPIC, 1994, 12′41; Jean-Claude Risset (1938–2016), *Saxatile*, for soprano saxophone and UPIC, 1992, 7′45; Curtis Roads (b. 1951), *Purity*, for tape, 1994, 7′13; Brigitte Robindoré (b. 1962), *L'Autel de la Perte et de la Transformation*, for UPIC, 1993, 8′33; Takehito Shimazu (b. 1949), *Illusions in Desolate Fields*, for voice, sangen, and UPIC, 1994, 13′27; and Daniel Teruggi (b. 1952), *Gestes de l'écrit*, UPIC, 1994, 11′00.[19]

16 The 1976 prototype, the UPIC A; the UPIC B, in 1982, with a higher sampling resolution rate, thanks to the 16-bit architecture of the IBM-8086 processor. The UPIC C version, implemented in 1986, introduced important advances, including a synthesizer with 64 oscillators, an analog-to-digital converter with a resolution rate of 44.1 KHz, the possibility of reading four pages simultaneously, a reading duration of up to one hour per page and, the most important of these, which distinguishes it from the two previous versions, the ability to reproduce in "real time" the sounds resulting from the drawings. A software version for the Windows system was implemented in 1990; since then, several applications based or inspired by the UPIC have been developed, including UPIX, in 2001 (Maroino, Fontalirant, Estrada), IanniX, 2001 (T. Coduys); HighC, 2007 (T. Baudel); Proba Painter (2008) implemented by R. Bourotte. In 2014, the development of UPISketch began at the Centre Iannis Xenakis, based at the University de Rouen Normandie, by a team of developers under the direction of R. Bourotte. The most recent version is 3.0, available as a free download for OSX and Windows: "UPISKETCH" (9 Mar 2022), *Centre Iannis Xenakis*, https://www.centre-iannis-xenakis.org/upisketch. See also "UPIC (UNITÉ POLYAGOGIQUE INFORMATIQUE DU CEMAMU)," Philharmonie de Paris, *Musée de la Musique*, https://collectionsdumusee.philharmoniedeparis.fr/0130439-upic-unite-polyagogique-informatique-du-cemamu-e992191-5.aspx?_lg=fr-FR

17 See the interactive timeline "CHRONOLOGIE INTERACTIVE," *Centre Iannis Xenakis*, https://www.centre-iannis-xenakis.org/exhibits/show/expo-upic/timeline

18 Four versions of this piece exist: mixed chorus, narrators, and tape; mixed chorus only; narrators only plus tape combining the UPIC sounds and prerecorded chorus; all parts (UPIC, mixed chorus, and narrators) on tape.

19 With the exception of *Tithon* by Mâche, the rest of the works mentioned are part of the collection published as CCMIX Paris Xenakis/UPIC/Continuum, *Œuvres électroacoustiques et instrumentales*, CD Mode 98/99, Paris, 2001 (henceforth CD Mode, 2001). A more

Fig. 20.3 A group of children playing with the UPIC, Les Ateliers UPIC in Orsay (France), 1983. Courtesy of CIX Archives, Alain Després collection.

For Xenakis, creativity is an attribute of every individual; society must make available tools that allow everyone to experiment and amplify their creativity (Figure 20.3). The UPIC project provides a model for a computerized system that, in addition to allowing the creator to integrate his listening and body movement to a process of creation that implies an immediate return of information by the computer, also allows the recording of this creative, corporeal, and perceptive activity. Thus, among the potentialities of the UPIC system, is one of projecting and capturing an interactive creation process. Indeed, the UPIC project makes it possible to consider the importance of recording the creative process, both analogically (graphic registers) and digitally (computer code or digital traces).

These aspects, memorial and corporeal, intrinsic to the implementation of a system such as UPIC, are of great interest for the purposes of my research. There would be macro-structures, inherent to the process of creation, that would exceed the temporal scope of the individual piece, or that would even surpass the totality of the corpus of a creator's work. What could then be inferred, from these *emerging dynamic forms* of a localized musical creation process, with respect to the process of creation, in a broad sense? A creative and investigative approach to a system such as that of UPIC, conducted and organized on a methodology that takes as its vector the capacity to

thoroughly detailed list can be consulted at "UPIC Composers," *Centre Iannis Xenakis*, https://www.centre-iannis-xenakis.org/upic_compositeurs?lang=en

capture information; its memorization and analysis should, by the same token, make such structures emerge.

To advance in the exploration of this line of research I propose, in the following section of this paper, a comparative analysis made from a *traceological* point of view, of two extracts of the graphic traces elaborated with the UPIC: one from *eua'on* by Estrada, and the other from *Mycènes Alpha* by Xenakis, an analysis that will illustrate the arguments that support my premises.

Comparative Analysis of *Mycènes Alpha* and *eua'on*

The analytical confrontation of two images extracted from the graphic records of *eua'on*, on the one hand, and of *Mycènes Alpha*, on the other, will reveal an ensemble of qualities of the creative processes that made them appear, at the same time as revealing the interest of the approach from a traceological perspective.[20] Thus, the comparative analysis that I present below will allow us to detect some characteristics regarding the activity that has taken place in each of these creative experiences. My intent is to demonstrate how, in this context of creation and research, a *traceological analysis*, that is, an analysis of the *traces of use* of the UPIC, can be conducive to the emergence of knowledge about the music creative process. But first, it is necessary to offer a brief presentation of the two musical works in question.[21]

Mycènes Alpha (1978)

Mycènes Alpha, for two-channel magnetic tape, composed in 1978, was created with the first version of the UPIC, being at the same time the first work of music created with the system. Xenakis composed it with the purpose of integrating it into the *Polytope de Mycènes*, a multimedia project premiered in September 1978 on the ruins of the Acropolis of Mycenae, Greece.[22] The French premiere took place the same year, within the framework of a concert program dedicated to Olivier Messiaen on his 70th birthday. The piece lasts nine minutes and thirty-six seconds, and its graphic register is composed of nine pages, one of which is repeated at the final section of the piece's sequence. Figure 20.4 shows an excerpt from one of Xenakis's original sketches, which corresponds to page one of the sequence.[23]

20 Which considers the object analyzed as traces of use of some tool, machine, or instrument.

21 "Traceology, or functional analysis, is a discipline linked to archaeology that aims to determine the function of tools through the study of traces of use." In "Tracéologie" (10 Mar 2024), *Wikipedia*, https://fr.wikipedia.org/wiki/Tracéologie (translated from French by the author).

22 A catalog dedicated to the polytopes, Xenakis's cycle of multimedia projects, established by Elsa Kiourtsoglou is at "Polytopes," *Les Amis de Xenakis*, https://www.iannis-xenakis.org/en/category/works/polytopes-en/. See also Xenakis, 2008, Part Four.

23 Xenakis's preliminary sketches for this work can be found at "Mycènes Alpha," *Centre Iannis Xenakis*, https://www.centre-iannis-xenakis.org/upic_mycenae?lang=en

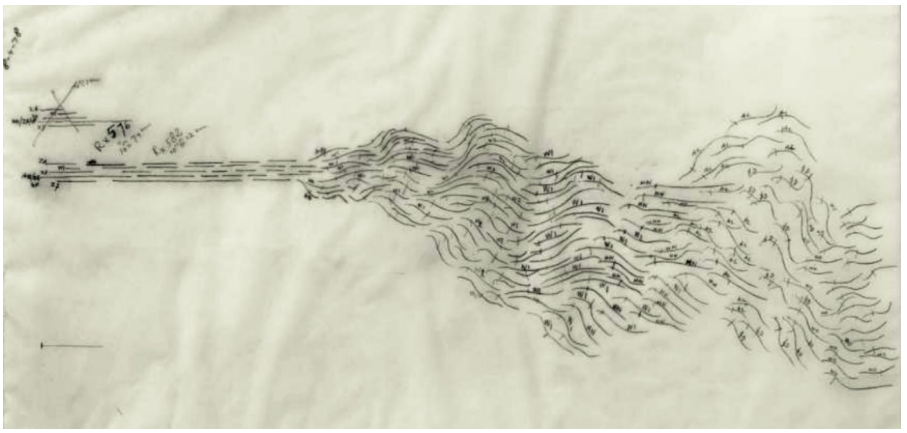

Fig. 20.4 Excerpt from one of Xenakis's original *Mycènes Alpha* sketches; page one of the sequence. Reproduced by permission of CIX Archives.

eua'on (1980)

Estrada wrote *eua'on* for UPIC in 1980. The process of creating this piece will serve as a catalyst for the composer in multiple ways, inspiring him to formulate novel concepts and ideas. A few examples of these include: the *continuous macro-timbre*, an original spatiotemporal conception of music, quite close to acoustical reality, expressed through the synthesis of the entire set of components (pitch, intensity, vibrato, etc.) of a sonic flow; the *method of chronoacoustic recording*, an idea for a musical creation process that uses the graphic register of imagination as a vector; and the *continuum*, an original project with profound aesthetic and philosophical resonances.

Furthermore, the experience of creating *eua'on* led the composer to progress in the acceptance of personal loss.[24] Hence the title, *eua'on*, which comes from the Nahuatl *eua*, to take flight; *on*, at a distance.[25] The sound that served as material for *eua'on* is a recorded sample of Estrada's voice.[26] The piece lasts seven minutes and fifty-six seconds and was integrated into the previously mentioned compilation published by Mode.[27] The first public performance took place on 19 June 1981, in Paris, as part of the Festival Estival du Théâtre du Petit Forum.[28] This is the only electronic music

24 The period of time devoted to creating *eua'on* fell within the period of the composer's grieving the death of his father. In the booklet of the compilation CD Mode, 2001, Estrada discusses the process of composing *eua'on*: "I refused to symbolize musically the loss of my father by a long silence of several months. Then I was able to access the creation of a music certainly brutal but perfectly analogous to the rage of my pain."

25 According to what the composer stated in his keynote at the international Electroacoustic Music Studies Network Conference, June 2019, Casa del Lago, UNAM, Mexico City.

26 CD Mode, 2001. In the accompanying booklet, Estrada explains that, having been dissatisfied with the sound of the UPIC, he decided to record his own voice and submit it to the transformations offered by the integrated synthesizer.

27 CD Mode, 2001.

28 "Julio Estrada (1943) *eua'on* (1981)," *IRCAM*, https://brahms.ircam.fr/fr/works/work/48877/

work in Estrada's catalog, and the only piece he created with the UPIC.[29] An extract of the sketched graphic register, whose dimensions span many meters, is shown in the figure that follows (Figure 20.5). The graphics for this musical composition were really created on twenty-five sheets, each of which was around forty-five cm long and thirty-five cm wide, or a length of nine to ten meters.[30]

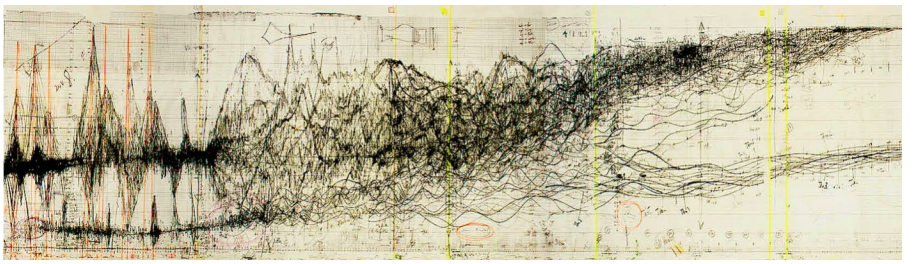

Fig. 20.5 Excerpt from the graphic register of *eua'on*. According to my observations, this passage is located between minutes three and four of the piece. Reproduced by permission of Julio Estrada.

Analysis

Below are presented, side by side, two extracts of the graphic registers made with the UPIC, on the left hand, *eua'on*, while on the right side, an excerpt of *Mycènes Alpha* (Figure 20.6).

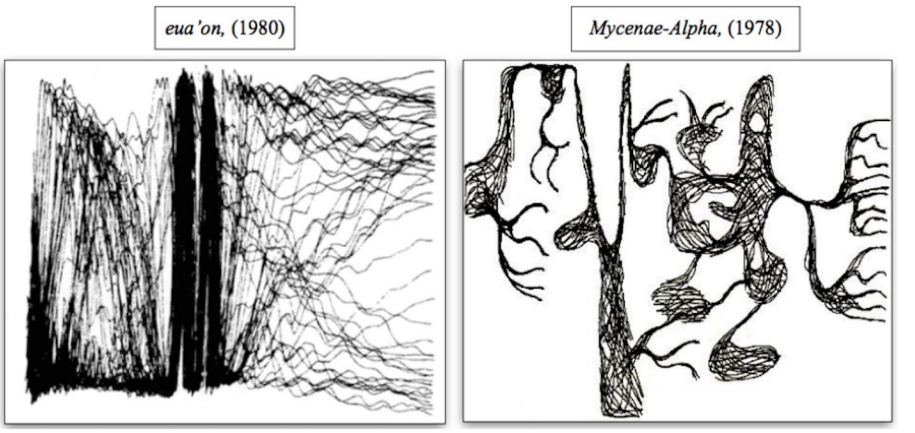

Fig. 20.6 An excerpt from the graphic register of *eua'on*, on the left, (reproduced by permission of Julio Estrada), located between 6′05″ and 6′25″. The *Mycènes Alpha* excerpt, on the right, corresponds to page six (reproduced by permission of CIX Archives) and is located between 4′17″ and 5′16″.

29 Estrada, 2024.

30 The author is grateful to Dr. Manuel Rocha Iturbide for scanning the graphic register of *eua'on* as well as for providing us with a copy of the document.

First of all, it can be observed, in the case of *eua'on*, an extremely intense gestural activity, which proceeds by the accumulation of the same long and continuous gesture (a characteristic both of this extract and of the graphic record on its whole integrity), which gives rise to a visual and sound texture of great plastic and organic density.[31] Meanwhile, in the *Mycènes Alpha* excerpt, it can be observed a gestural activity that in turn could be associated with a more reflexive attitude towards what should become a sound texture obtained through drawing. Indeed, Xenakis seems to proceed by *constructing the sound* from a precise and predetermined *idea of graphic forms* and designs, that is, from the projection of a mental image that gives primacy to the graphic form over the projection of a sonority. On the contrary, in the case of *eua'on*, the relation of analogy between gesture, graphics, and sound seems to be narrower. Futhermore, it is quite easy to discern a dramatic component in this fragment of the *graphic-analogical traces* of *eua'on's* creative experience. Indeed, the dense, blackened accumulation, vertically traversing with apparent violence the space of abscissae and ordinates, gives rise to the idea of an accumulation of energy made at a high-rate speed; located in the middle of the image, it dramatically divides the space of the "score" without, nonetheless, inducing a break in the flow of gestural energy. Arises here the idea of a mental and emotional state, or if one prefers, a particular *state of* (*un*)*consciousness*, which I dare to qualify as an "obsessive-compulsive-in-trance" kind of listening, that characterizes this particular moment of *eua'on's* experience of creation. At this point, I could say that we are in the presence of a process focused on the construction of a dialogical relationship with sound, and in which, the structural coupling of listening, as inner listening, with the dynamism of the body, informs in turn the construction of a dramaturgy, which would perhaps be that of a listening in *emergence*.[32] I conclude that, in the case of *eua'on*, it is rather a matter of a *performative listening*, that is, a listening in the process of creating itself, which transcends the graphic dimension of the experience and tends to establish a dialogue with sound. In the case of the excerpt from *Mycènes Alpha*, it would be a question of a more *speculative listening*, which focuses on constructing the sound from the projection of a graphic design.

Discussion

At this point, it is necessary to underline those aspects that seem to me of greater relevance for the clarification, both of my intentions in proposing this task of analysis, and of what appears as a perspective for my research from here on.

31 The piece can be heard to in its entirety at: "Julio Estrada: 'Eua-On,'" *Bandcamp*, https://moderecords.bandcamp.com/track/julio-estrada-eua-on

32 I use the term "emergence" in the sense of Varela and Maturana's theory of cognition, according to which knowledge emerges from the interaction between at least two autopoietic (autonomous, self-regulating) entities. Musicality and musical listening could be understood as emergent qualities of a context of interactivity. On the subject of embodied cognition and the theory of enaction, see Varela et al., 1991. See also Maturana and Varela, 1991.

First of all, regarding the nature of the analyzed objects, it is important to emphasize that, beyond graphic representations of sound, these are fragments of *graphic traces* of what was a creative, sensorial, and interactive experience, focused on sound. Indeed, these graphic objects are more *traces of the usage* of UPIC than graphic scores themselves; *graphic registers-traces* that stand as testimony of the presence of a body involved, both on a sensorial and on a perceptual level, as well as on a gestural level, all in a process of musical creation. These traces reveal the relationship between two domains of reality that converge or hybridize in interactive experiences with environments dedicated to music and sound creation, such as the UPIC: what we see are the graphic traces of a corporeal movement involved in the creation of a sonorous dynamism.

Another aspect that seems important to emphasize is that, by making it possible to create sound through drawing, the UPIC generates at the same time the traces of its use, and this on two interdependent levels: analog and digital. This interdependence of two heterogeneous information flows that unfold as manifestations of the same gesture of creation, in a context that implies creative actions committed from a full state of consciousness that assumes full responsibility for the creative act, a context induced by the very nature of the device, calls for a broader observation and an in-depth study that could reveal new aspects of the genesis of works of art, as well as of aesthetic cognition.

It should also be emphasized that what came to inform my descriptions of these creative experiences is a set of graphic registers that, being considered as traces of the use of a tool, retain for us a particular status, not only for the purposes of this analysis and my research, but perhaps also for what could be a broader description of what comes into play when working with a creative device such as the one proposed by Xenakis. The epistemic-generative dimension, inherent to this type of technological proposal, is still a territory yet to be explored.

The graphic traces that I compared are obviously analogical, however, the core of the device that has facilitated these creative acts, and that has captured and collected them, is a digital computer. This means that these traces have had a digital, symbolic correlate, which is the complementary part of the analog graphic register. This digital correlate has a specific double function: that of mediation between drawing, graphic design and sound projection, on the one hand, and on the other hand, to establish a structural coupling between gesture and listening, similar to that produced when playing a musical instrument. An analysis of this digital component could inform us in quantitative, and even qualitative, terms about the creative experience of both *eua'on* and *Mycènes Alpha*. Indeed, the temporality of the creation process is unknown to us, since it cannot be inferred from the graphical registers. Hence, what I have described, in the case of *eua'on*, as a state of "obsessive-compulsive trance-like" listening could only be corroborated by two methods that could complement each other: either by directly questioning the composer, or by *reconstructing the process* from the information captured in digital memory (it could inform us, for example, in terms of the speed of execution of the gestures, or the duration of the creation process of a specific passage, etc.).

Conclusion

The purpose of my analysis is to infer preliminary elements for the construction of technical-conceptual tools that can be used to describe the experience of musical creation. The traceological approach allowed us to undress the drawings made with the UPIC of the cultural charge that was in the way, not permitting for their deconstruction. The whole documentation of the creative experience with the UPIC should be analyzed. Unfortunately, it will never be possible to do so, since the magnetic tapes containing the digital part of the traces were destroyed.[33] I was unaware of this fact when I first proposed to analyze the creative process of the UPIC back in 2017. This opens-up the question: were Xenakis and Estrada so unaware of the memory of their own creative processes that they did not take care to at least preserve it? A response could have been given by Xenakis in the following remarks:

> The great idea is to be able to introduce randomness in order to break up the periodicity of mathematical functions, *but we're only at the beginning*. The hand, itself, stands between randomness and calculation. It is both an instrument of the mind [...] and an imperfect tool. The products of the intelligence are so complex that it is impossible to purify them in order to submit them totally to mathematical laws. Industrialization is a forced purification. But you can always recognize what has been made industrially and what has been made by hand. Industrial means are clean, functional, poor. The hand adds inner richness and charm.[34]

Hence, since I have no access to the digitalized registers of the drawings made with the UPIC, my demonstration cannot go further; nonetheless, other research perspectives are being opened by this exercise of analysis and approach to the UPIC. Indeed, a project in continuity with this one, and concerning *eua'on*, can be outlined here: Estrada revisited his experience with UPIC between 1994 and 1995 to create *eua'on'ome* for large orchestra, a large-scale work that, for the convenience of my research perspective, I consider, hypothetically, as a *transferential sequel* to *eua'on*. The systematic relationship between them situates these two works in a specific terrain of creative activity, which I must approach and investigate in order to elucidate and define the role of *eua'on's* traces in the creation process of *eua'on'ome*. The transfer of information gathered during the interactive creative experience to the instrumental realm sets an important precedent for what could be a musical composition practice that incorporates traceological analysis techniques. Beyond enriching my criteria for describing this type of creative, sensorial, and interactive experience, what would be the interest, in terms of musical creation, in an analysis of the analogue and digital traces produced by the type of creative and interactive sound experiences I have discussed here? This creates a twofold perspective, which I shall address in the subsequent stages of my study and

33 The memory supports (magnetic tape) were destroyed, according to what Estrada commented during a telematic meeting I had with him in 2021.

34 Xenakis et al, 1987, p. 23 (author's emphasis).

creative endeavor. On the one hand lies the ability to include the observation of the creative process into the process itself; on the other, the music work itself, conceived as a recorded, visible, audible, and *transferable* process... Here are a few creative and research opportunities that come to light when one considers Iannis Xenakis's magnanimous legacy from the perspective that time has allowed.

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