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Four States of the Personality of Composer Iannis Xenakis and Their Extensions in the Contemporary Digital Environment

Cătălin CREȚU[1]

Abstract: *The research addresses some digital implementations in music-specific programming environments generated by Xenakis' musical concepts, capitalizing on influences of the composer's artistic thinking. Starting from the identification of four states of his personality, I present and analyze selected software that bears the imprint of the composer's ideas or influence and techniques that were at the basis of the conception of the composition I.X.@100 for soprano and tape.*[2]

Key-words: *granularity, stochastic synthesis, UPIC, digital deployments*

1. Four states of professional aggregation of the composer's personality: symbolic representations in music and digital deployments

Electro-acoustic music is increasingly present in contemporary musical life, in its multiple states of aggregation: pure-electronic, accompaniment of solo instruments or ensembles, live electronics, algorithmic compositions, computer music, support or pretext of syncretic genres, multimedia, etc. Most of these types of sound manifestations benefit from the contribution of computers and specific software, indispensable tools for the contemporary composer who approaches such genres, technologies that need to be tested and be validated in creative processes as well as in teaching.

In the present research, I have set out to investigate the extent to which ideas and influences of the artistic thought of Xenakis – himself a pioneer of music of this type – can be found in the contemporary digital musical environment, particularly in software capable of using or simulating techniques of composition or processing of sound material specific to the composer.

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[1] National University of Music Bucharest, catalin.cretu@unmb.ro

[2] The first part of this article was presented, in Romanian, at the International Musicological Symposium: Musical Creation and Exegesis, Bucharest 2022

Since I needed a method of structuring the exposition, I chose to identify and name traits or states of professional aggregation of the composer's personality, to trace how they manifest themselves in the musical space, and to present some digital implementations (in the form of selected software) that bear the imprint of ideas and thoughts generated by the four identified hypostases: the architect, the physicist, the mathematician, the graphic designer.

1.1. Xenakis the architect – symbolic representation in music: spaciousness

In a broadcast on Radio Stockholm in 1958[3], the composer foreshadows his concern for the spatial parameter in his music. In the parable of space he describes his own vision of constructing surfaces and sound volumes from basic spatial elements such as line and point, talks about inflections of curved surfaces, twists, various transformations, all in a musical context. Here we have the image of a visionary spirit who meditates on sound to construct – both conceptually and physically – complex dynamic acoustic spaces. In a Darwinian sense, Xenakis takes music out of its two-dimensional state, facilitating an evolutionary leap, a paradigm shift, with sound and the environment in which it propagates discovering, in a compositional context, its corporeality.

Leigh Landy[4], analyses the "space parameter" as a permanent emancipation of a new characteristic of sound. Looking historically, the musicologist notes that until the 20th century, musical productions (both secular and religious) were generally performed on a stage in front of an audience. The only exceptions were responsorial singing and the organ, which produced sound events in churches ŢbehindŢ the audience. The history of the 20th century shows a continuing trend to "break" this type of "classical" space both through compositional ideas and technological input.

In this context, it would be worth noting Iannis Xenakis' willingness of certain types of sound organisation to "move"[5]. We can point to his experiments in the 1950s and 1960s: from the timid movement of sounds on stage in Pithoprakta, to the spinning of brass instruments in Eonta or the spiral movement of sounds emitted by the orchestra scattered through the audience in Terretektorh, to the

[3] Xenakis, Iannis. 1958. "The three parables." (in Swedish), *Nutida Musik Radio Stockholm* 2 (Musique. Architecture): 16-19.

[4] Landy, L. 1991. *What's the Matter with Today's Experimental Music?*. Chur: Harwood Academic Publishers.

[5] Harley, Maria.1994. "Spatial Sound Movement in the Instrumental Music of Iannis Xenakis." *Journal of New Music Research* 23: 291-314.

simultaneous concentric circling of sounds in Persephassa or the spatial canons in Alax, we are struck by the kinetic potential of this dynamic type of sound spatiality. In the works of the composer's Polytope cycle, we also notice the capacity of movement of sonorities through multiple loudspeakers arranged according to architectural concepts.

Digital deployments

Spat[6], a software suite of objects dedicated to the MAX[7] programming environment, has been developed at IRCAM Paris, allowing specialization, sound localization control and playback through speakers in real time. With the help of an intuitive interface (Figure 1) and other auxiliary objects, the software allows control of parameters such as: sound panning in two- and three-dimensional space, artificial reverberation, perceptual control of room acoustic quality, various processing and filtering algorithms, multi-channel manipulation of sound signals, calibration of speakers or room acoustics, headphone monitoring, remote control of interfaces and other facilities.

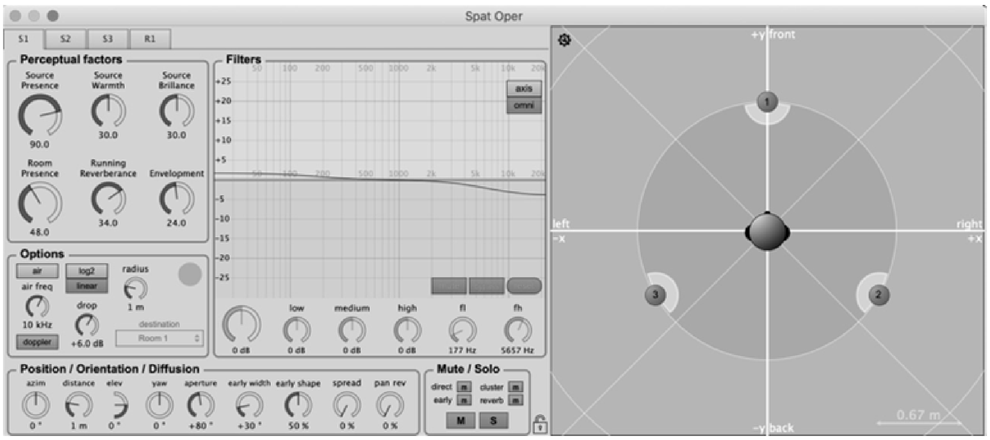

Fig. 1. *SPAT interface*

Ambisonics[8], a digital technology based on a series of objects also dedicated to the MAX environment, was developed at the Institute for Computer Music and Sound Technology at the Zurich University of the Arts. The interface (Figure 2) allows

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[6] https://forum.ircam.fr/projects/detail/spat/
[7] programming environment dedicated to the development of interactive audio-visual projects; for more details: http://cycling74.com/
[8] https://ambisonics.ch/page/ambisonics-externals-for-maxmsp

three-dimensional control of sound in a virtual space through two types of coordinates: cartesian (x, y, z) or spherical (azimuth, elevation, distance).

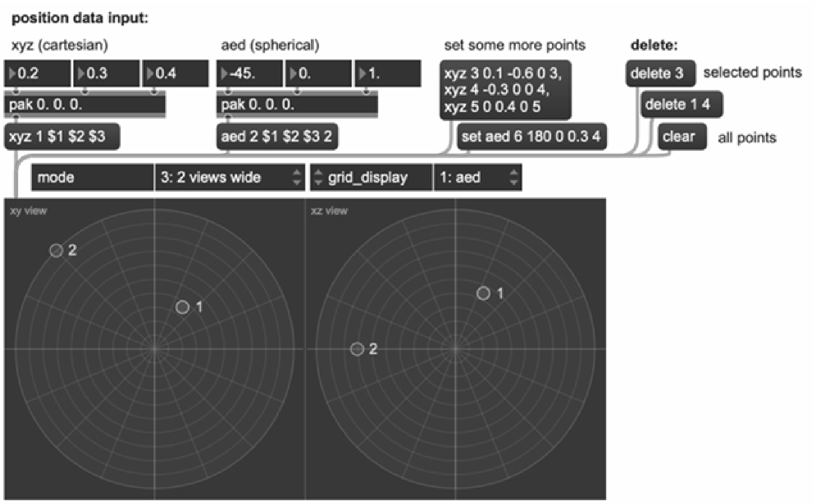

Fig. 2. *Ambisonics interface*

Zirkonium software[9] (Figure 3) developed at the Center for Art and Media Karlsruhe allows real-time control of the 47 loudspeaker installation in the Klangdome hall.

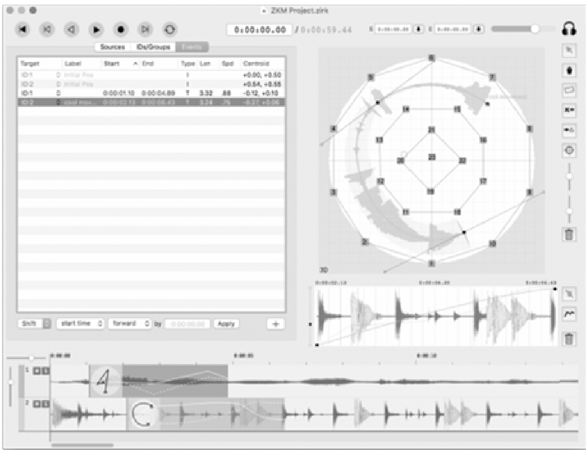

Fig. 3. *Zirkonium interface*[10]

[9] https://zkm.de/en/about-the-zkm/organization/hertz-lab/software/zirkonium

[10] https://zkm.de/en/media/video/ludger-bruemmer-dan-wilcox-and-pierre-ritt-zirkonium

1.2. Xenakis the physicist – symbolic representation in music: granularity

In the parable of gas[11], Xenakis talks about the gaseous aggregate state of music. This approach entails a volumetric-granular thinking of sound space, sound becoming acoustic quantum with a dual state: wave-particle/corpuscle. In this context, taking notions from theoretical physics such as pressure, temperature, density, velocity, space/time, the composer transforms sound, metaphorically, from a static-photographic state into a dynamic-film state, which is hypostatized as a vector.

The granular synthesis of sound was theorised by the physicist Gabor in 1947, applied to Xenakis' musical creation and further developed theoretically and practically by the American researcher and composer Curtis Roads. For Gabor, elementary signals are harmonic oscillations of any frequency, modulated by a probabilistic pulse. Xenakis uses this concept in his composition Analogique B[12] (1959), based on a Markov chain, a process in which future states of the system are independent of past ones. He also combats the Fourier paradigm, on the basis of which a complex sound is decomposed into a sum of simple oscillations, thus opting for the particle character of the sound rather than the wave character.

Digital deployments

Because granularity produces sonically spectacular results, many digital implementations have been developed, and there is even a website dedicated to this type of sound synthesis[13]. Of particular note in this context is the EmissionControl2 software[14] developed by Curtis Roads (Figure 4). Multiple audio files loaded into the interface can be controlled via several specific parameters: number of sound particles emitted per unit time, their duration and envelope, left/right emission – synchronous/asynchronous, size of the pause between grains, number of sound streams, playback speed, filtering indexes, mode, place and speed of playback of initial files, panning, amplitude. It's a classic, practical, useful approach with an intuitive, clear and easy-to-use interface that offers the possibility of exceptional sound synthesis.

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11 Xenakis, Iannis. 1958. "The three parables." (in Swedish), *Nutida Musik Radio Stockholm* 2 (Musique. Architecture): 16-19.

12 An analysis of the work in Di Scipio, Agostino. 1998. "Compositional Models in Xenakis's Electroacoustic Music." *Perspectives of New Music*, 36(2): 201-243.

13 http://granularsynthesis.com/software.php

14 https://www.curtisroads.net/software

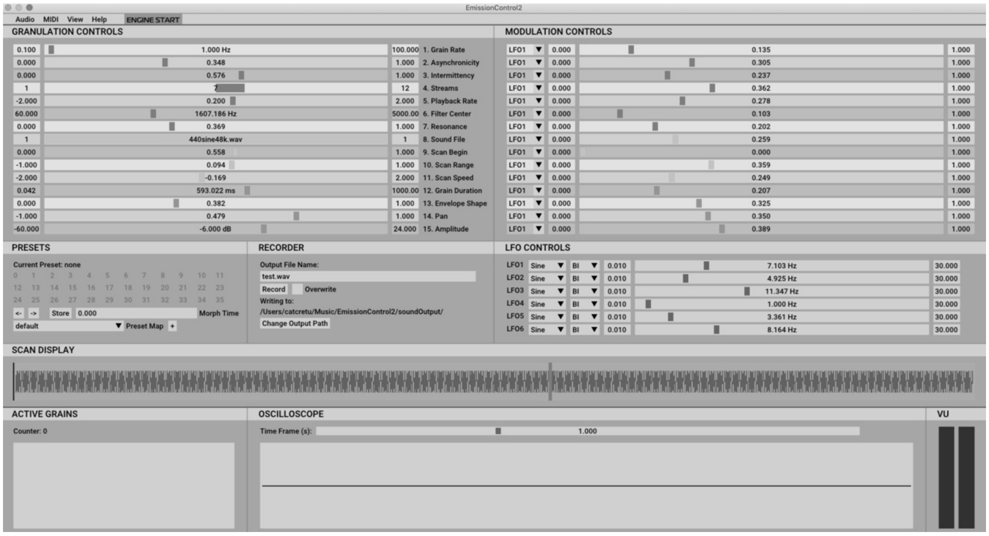

Fig. 4. *EmissionControl2 interface*

A dedicated live electronics approach is provided by Apesoft's Density software[15] (Figure 5). Eight granular sound streams can be mixed in real time, offering a range of acoustic processing possibilities.

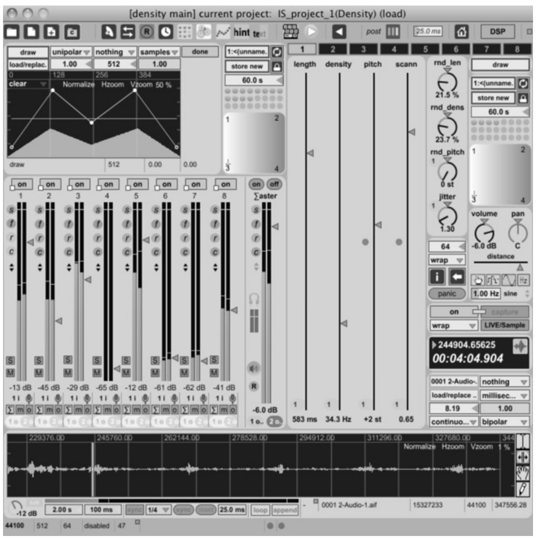

Fig. 5. *Density interface*

[15] http://www.apesoft.it/download/

1.3. Xenakis the mathematician – symbolic representations in music: stochastic synthesis, cellular automata

Xenakis' approach to mathematical concepts and models for the purpose of organizing musical material started from the study of particle behaviour, observation of surfaces and moving smoke volumes, elements that gradually led to the use of statistical laws involving point, granular sonorities: probability calculus, entropy, randomness, stochastics. At the acoustic level, all these phenomena have resulted in the predominance of the global effect – texture – over the singular one. As modes of manifestation in musical reality, two are important in the present approach: stochastic synthesis and cellular automata.

Methods of probabilistic computation have been used by Xenakis since the beginning of his musical career. They were first used for the purpose of organising musical material to be played by acoustic instruments, with wide implications for structuring the score at the macro-formal level, at the level of densities and textural organisations, generating stochastic music. Later, supported by technological progress, the composer's interest turned to micro-timbral probabilistic approaches, understood as transformations in the interiority of electronically generated sound. This new technique, called stochastic synthesis by the composer, is defined as an approach to microtonal synthesis that uses probabilistic distributions to manipulate simple sound samples[16], or as an algorithm that harnesses probabilistic fluctuations to synthesize live, animated sounds[17].

Xenakis thus becomes a granular spectra list who modifies the DNA of sound, its genetic fingerprint, in his creative laboratory. Here we observe a musical thinking on temporal micro-components containing partial elements outside the harmonic spectrum or noises, causing a disorder in movement, the method placing itself at the antipodes of spectral order and discipline. Although this technique has been intensely courted throughout the creation, the most sophisticated approach has been achieved using a dedicated software called GENDYN (GENeral DYNamic stochastic synthesis) and to which several compositions have been dedicated, most notably GENDY3[18].

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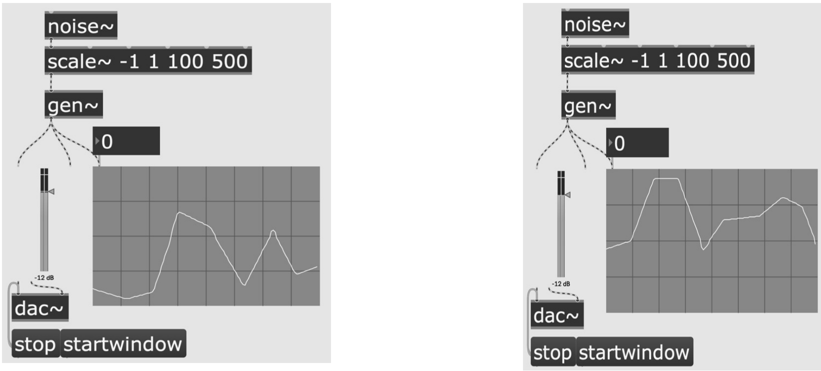
[16] Luque, Sergio. 2009. "The Stochastic Synthesis of Iannis Xenakis." *Leonardo Music Journal* 19: 77–84.

[17] Hoffmann, Peter. 1996. "Implementing the Dynamic Stochastic Synthesis" *Journées d'Informatique Musicale*: 341-347.

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

Digital deployments

Two researchers at the Institute of Sonology in The Hague have implemented stochastic synthesis in specific software. Johan van Kreij, in an educational application – gendy.maxpat[19] – shows graphically how the waveform, and hence the spectral structure, changes at the fraction of a second level (visible in Figures 6 a and b), which is specific to stochastic synthesis. In the GendyNoise application[20] (Figure 7), Jeyong Jung explores, based on the concept developed by Xenakis, the prospects of noise transformation as a compositional method[21].



a b

Fig. 6a, b. *Two stages of the waveform*

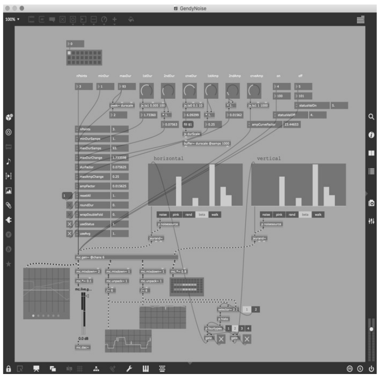


Fig. 7. *GendyNoise interface*

[19] https://www.jvkr.nl/home/04code/

[20] https://jey-noise.com/

[21] https://www.researchgate.net/profile/Jeyong-Jung/publication/360939263_Revisiting_the_Gendy_model_from_the_perspective_of_noise_transformation_as_a_compositional_method/links/62949d6b88c32b037b5d04fb/Revisiting-the-Gendy-model-from-the-perspective-of-noise-transformation-as-a-compositional-method.pdf?origin=publication_detail

Another mathematical concept used by Xenakis in composition is the cellular automata. It is related to dynamic behaviour in chaos theory, focusing on modelling the evolution of natural systems – especially biological ones – in relation to the idea of self-organisation. The choice of chord sequences in Horos composition is based entirely on this theory[22].

A particular case of cellular automata – the game of life – was developed by the mathematician John Conway (1970). He stated 3 rules underlying the transition of systems from one state to another: a cell is either alive or dead; if a living cell has 2-3 living neighbours, it stays alive; if a dead cell has 3 living neighbours, it will resurrect, otherwise it stays dead. As an example I have chose an application made in the MAX environment based on the Conway model[23], where the living cell is equated with a white pixel, the dead one with a black one. Figures 8 a and b shows a sequence of two states of the system.

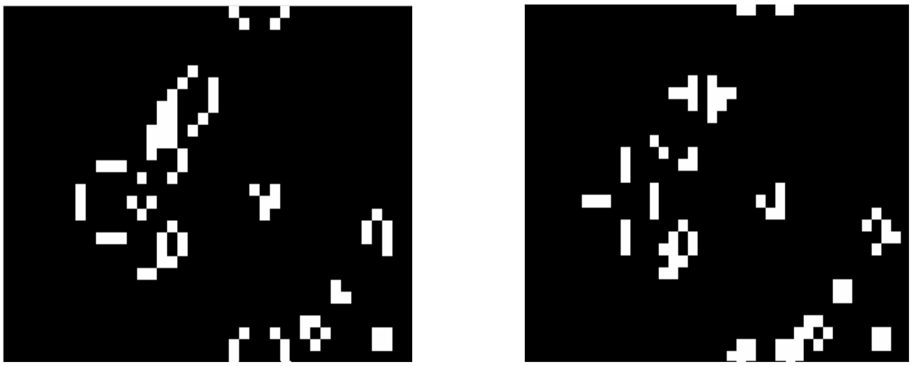


Fig. 8 a, b. *Sequence of two states of the system*

1.4. Xenakis the graphic designer – symbolic representation in music: UPIC or the relationship between graphic image and sound structure

From the earliest opuses, the history of music records the graphic sketches underlying Xenakis's compositions, a true "professional defect" of the architect, born of an organic need for visual representation of music. As a corollary, the thought of creating software that would turn images into sound came naturally. The idea was not entirely new; attempts had already been made by Evgeny Murzin

[22] Solomos, Makis. 2005. "Cellular Automata in Xenakis' Music. Theory and Practice." *International Symposium Iannis Xenakis. Conference Proceedings*, ed. by Makis Solomos, Anastasia Georgaki and Giorgos Zervos, 120-138, Athens

[23] using the jit.conway object

(1938) and Percy Grainger (1952)[24]. In 1978, Xenakis finalised the UPIC system (Unité Polygogique Informatique de CEMAMu), a computerised system capable of creating sounds via an electromagnetic graphic interface made up of a tablet and a pencil. The most famous work made with this system is Mycenae Alpha, a composition that has been intensively analysed and publicised[25].

Digital deployments

The UPISketch software[26] (Figure 9) – developed at CIX (Centre Iannis Xenakis – Université de Rouen) – allows the transformation of graphic elements (lines) drawn directly on the interface, using sound samples chosen by the user.

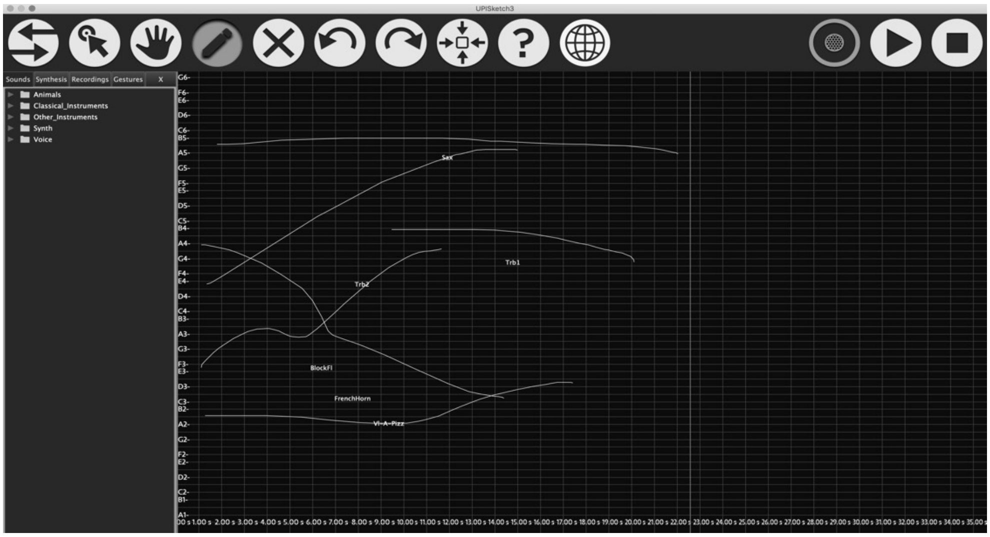


Fig. 9. *UPISketch interface*

The Iannix software[27] (Figure 10) is a very versatile open source platform that allows – from graphical elements – the control of complex audio-visual processes based on MIDI and OSC communication protocols.

[24] Marino, Gérard, Serra, Marie-Hélène, Raczinski Jean-Michel. 1993. "The UPIC System: Origins and Innovations." *Perspectives of New Music* 31(1): 258-269.

[25] Squibbs, Ron. 1996. "Images of Sound in Xenakis's Mycenae-Alpha." *Journées d'Informatique Musicale*

[26] http://www.centre-iannis-xenakis.org/upisketch

[27] https://www.iannix.org

The international music community's interest in UPIC was confirmed in 2020 with the publication of the collective volume “From Xenakis's UPIC To Graphic Notation Today” at ZKM[28].

The compositional and sound processing techniques described above are also found in numerous applications on mobile digital devices. A simple search on the App Store using keywords such as “granular synthesizer”, “sound spat” or “upic” reveals dozens of programs with intuitive interfaces capable of processing the original sound material in the most ingenious ways, further proof of the enduring visionary spirit of the four-way composer featured here.

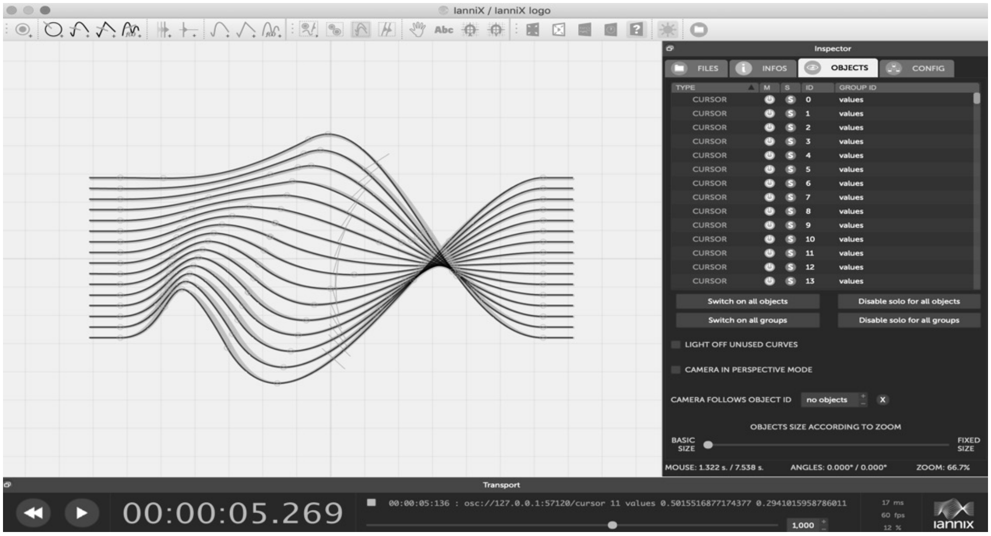


Fig. 10. *Iannix interface*

2. I.X.@100 – a composition for soprano and fixed media: digital implementation techniques

The generation of sound material in the composition *I.X.@100* for soprano and fixed media, both electronic and acoustic – the score – is based exclusively on numbers or letters related to the names and dates in the life of the composer Iannis Xenakis – to whom the work is dedicated, as can already be seen from the title –, developed through various techniques. As basic numerical elements I used the year of birth (1922), the year of death (2001), the year of the composition (2022), the age at which he died (79), the symbolic number of the centenary of his

[28] https://zkm.de/de/from-xenakiss-upic-to-graphic-notation-today

birth (100) as well as the difference between the last two (21), and the letters used are those that make up the first and last names.

2.1. Techniques for translating numbers into sound

2.1.1. Using the MIDI standard

In order to facilitate communication between electronic equipment, in the MIDI standard each musical note is assigned a numerical value (e.g. middle C = 60). As the octave of the keyboard contains 12 different sounds, to find the musical note corresponding to a given number we use the mathematical operation "modulo" – the remainder of the division by 12 (e.g. 60 mod 12 = 0). So we have a pattern (C = 0, C# = 1, D = 2, etc.) that allows us to identify the correspondence between any number and that musical note. After a few calculations (Figure 11) we get:

79 mod 12 = 7 (G)
1922 mod 12 = 2 (D)
2001 mod 12 = 9 (A)
2022 mod 12 = 6 (F#)

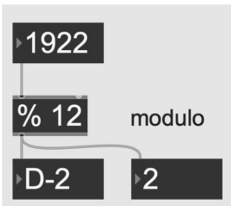


Fig. 11. *Modulo operator in MAX software*

It can be seen that the composer's age, year of birth and year of death translated into musical dates are in perfect fifth intervals (G-D-A). The addition of the note F#, corresponding to the year of the work's creation, generates a major chord (D-F#-A). We can consider the data obtained as belonging to a tonality (relationship: dominant-tonic chord) or to a spectrum (fundamental and harmonics 3, 9, 15), both with a G base.

2.1.2. Correspondence between sound frequencies and musical notes

Due to the characteristics of tempered tuning, also taken over by the MIDI standard, when we try to find correspondences between sound frequencies and musical notes, we have to make some adjustments and approximations, in the sense that non-tempered values will be rounded to the nearest note.

The 1922, 2001, 2022 Hz values all correspond to the note B (the major third of the fundamental in our system), and the 100 Hz value (the symbolic birth centenary number) corresponds to the note G, a correspondence to the MIDI 79 value above and a completion and affirmation of the tonality or spectrum model on G (Figure 12).

MIDI Note	Required Frequency (Hz)
96 - C	2.093
95 - B	1.976
94 - Bb	1.865
...	...
79 - G	784
...	...
43 - G	98

Fig. 12. *Correspondence of MIDI values to frequency*

2.1.3. Turning numbers into musical motifs

Using the G note as a basis, I constructed musical motifs from the 3 calendar years considered, which I then mirrored (Figure 13).

Fig. 13. *Turning numbers into musical motifs*

2.2. Techniques for translating letters into sound

2.2.1. Using the correspondence between letters and numbers in the Greek alphabet

Each letter in the word corresponds to a numerical value (as shown in Figure 14[29]), and then this is translated into a MIDI motif (Figure 15).

IANNIS: 10, 1, 50, 50, 10, 200/A#, C#, D, D, A#, G#

XENAKIS: 60, 5, 50, 1, 20, 10, 200/ C, F, D, C#, G#, A#, G#

[29] https://en.wikipedia.org/wiki/Isopsephy

Letter (upper and lower case)	Value	Name	Trans-literation
Α α	1	Alpha	a
Β β	2	Beta	b
Γ γ	3	Gamma	g
Δ δ	4	Delta	d
Ε ε	5	Epsilon	e
(Ϝ ϝ / Ϛ ϛ)	6	Digamma (later Stigma)	w
Ζ ζ	7	Zeta	z
Η η	8	Eta	ē
Θ θ	9	Theta	th
Ι ι	10	Iota	i
Κ κ	20	Kappa	k
Λ λ	30	Lambda	l
Μ μ	40	Mu	m
Ν ν	50	Nu	n
Ξ ξ	60	Xi	x
Ο ο	70	Omicron	o
Π π	80	Pi	p
(Ϙ ϙ)	90	Koppa	q
Ρ ρ	100	Rho	r
Σ σ	200	Sigma	s
Τ τ	300	Tau	t
Υ υ	400	Upsilon	y
Φ φ	500	Phi	ph
Χ χ	600	Chi	ch
Ψ ψ	700	Psi	ps
Ω ω	800	Omega	ō
(Ϡ ϡ)	900	Sampi	ts

Fig. 14. *Correspondence between letters and numbers in the Greek alphabet*

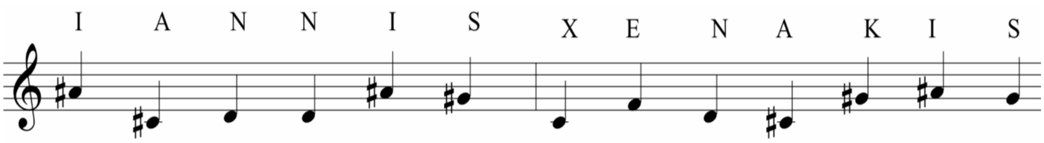


Fig. 15. *Conversion to MIDI motifs*

2.2.2. The use of letter-number correspondence in the Latin natural alphabet in Bach's time[30]

Each letter in the word corresponds to a numerical value (as shown in Figure 16[31]), which is then translated into a MIDI value (Figure 17).

A=1	D=4	G=7	K=10	N=13	Q=16	T=19	X=22
B=2	E=5	H=8	L=11	O=14	R=17	UV=20	Y=23
C=3	F=6	IJ=9	M=12	P=15	S=18	W=21	Z=24

Fig. 16. *Correspondence between letters and numbers in Latin natural alphabet*

IANNIS: 9, 1, 13, 13, 9, 18/ A, C#, C#, C#, A, F#
XENAKIS: 22, 5, 13, 1, 10, 9, 18/ Bb, F, Db, Db, Bb, A, F#

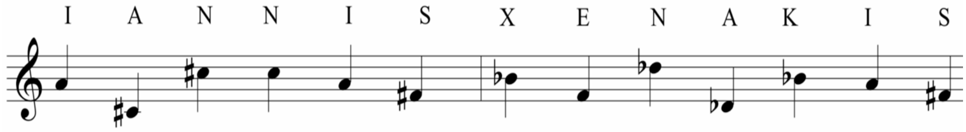


Fig. 17. *Conversion to MIDI motifs*

2.3. Some numerological observations:

*If we add up the digits of the years of birth and death and convert the sum into MIDI format, we get between the results a small descending second, the musical figure of *suspiratio* (Eb-D).

2+0+0+1=3 (Eb)
1+9+2+2=14
14 mod 12 = 2 (D)

If we consider the centenary years, 2022 and 1922, the calculations yield the same musical figure suspiratio, transposed (Gb-F):

2+0+2+2=6 (Gb)
1+9+2+2=14
1+4 = 5 (F)

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30 Tatlow, R. 2006. *Bach and the Riddle of the Number Alphabet.* Cambridge: University Press
31 Rumsey, David. 1997. "Bach and Numerology: 'Dry Mathematical Stuff'?." *Literature & Aesthetics* 7:143-165.

Merging the two musical cells, we obtain the Eb-D-Gb-F motif (Figure 18), a B.A.C.H-like design, around the sound "E" which is the MIDI correspondent of the number 100 and the frequency 21 Hz and which configures the baroque musical figure of *chiasmus* (from gr. khiasm = "crisscrossing"). It is a symbolic numerological-musical figure discovered from the perspective of the centenary of the birth of the great composer.

Fig. 18. *Eb-D-Gb-F motif*

*If we add up the terms of the composer's age of death, 79 years (7+9=16, 1+6=7), we get the number 7, which corresponds to the MIDI note G and also represents the number of letters in the name Xenakis. We get the same number if we add up the MIDI values of the above motif (Eb/3+D/2+Gb/6+F/5=16, 1+6=7).

*We can conclude from these numerological observations that Xenakis' life was marked by the number 7 and a sound spectrum on G. Perhaps not coincidentally, his most famous work, Metastasis, begins with this note.

2.4. Digital implementation techniques in the electroacoustic part of the composition

After describing the techniques used to transform numbers and letters into sound, I will present some digital strategies used to generate the electronic material.
*Glissando with band pass resonant filter based on white noise

The algorithm constructed allows the realization of a glissando on 20 voices, within the sound spectrum with the 100.05 Hz fundamental (G1) whose 20th harmonic is 2001 (year of the composer's death). Imitating the gesture at the beginning of the composition Metastasis, the glissando starts from G2 and ends with the whole spectrum (Figure 19). White noise is used as the sound source and the sound effect is achieved by glissando at the centre of the resonant frequency (Figure 20).

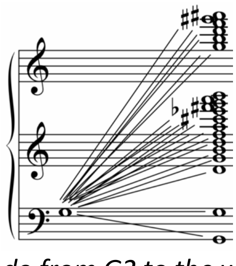

Fig. 19. *Glissando from G2 to the whole spectrum (20 harmonics)*

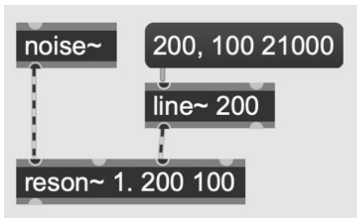

Fig. 20. *Core algorithm*

*Dynamic descending glissando, with permanent increase in the distance between harmonics

The programmed algorithm (Figure 21) allows for fanning out a number of 21 saw tooth sounds with a frequency of 2022 Hz, until the whole is divided into identical intervals of 101.1 Hz. After two 21-second stretches, the sound is fragmented by rapidly intoning a randomly chosen chord/cluster from the 21 constituent harmonics.

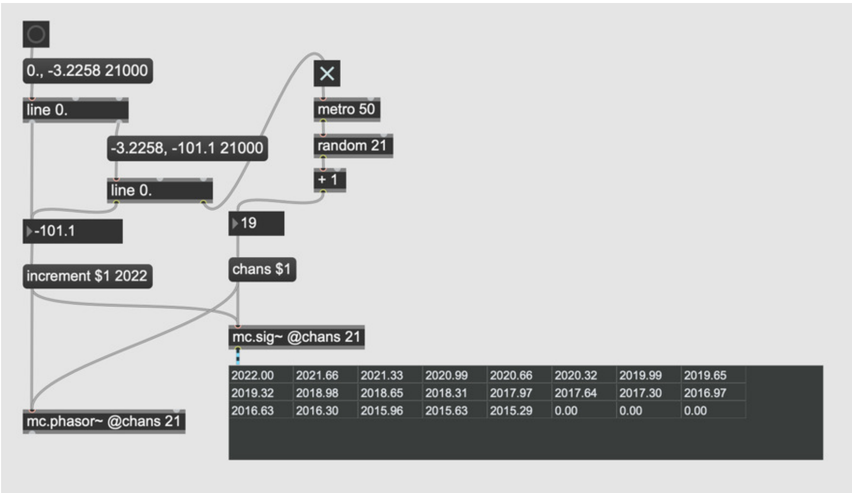

Fig. 21. *Fanning out a number of 21 saw tooth sounds*

* Ascending/descending glissando using sub harmonics

Making a fan-shaped opening/closing of 21 sounds using the “sub harmonic” command implemented in the MAX environment (Figure 22).

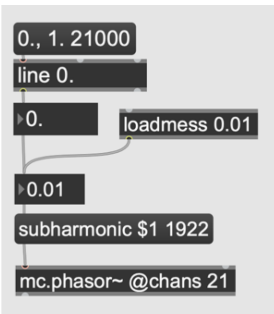

Fig. 22. *Using subharmonics*

*Glissando and stop on a grainy chord

Algorithm allows glissading sounds in opposite directions, starting from 100 Hz and 2001 Hz and stopping on a preset chord, then granulating it.

*Granular synthesis of a pre-recorded sound

Transforming the composer's recorded name (a 1-second audio file) by playing and panning it granularly at 100 times slower speed[32]. (Figure 23)

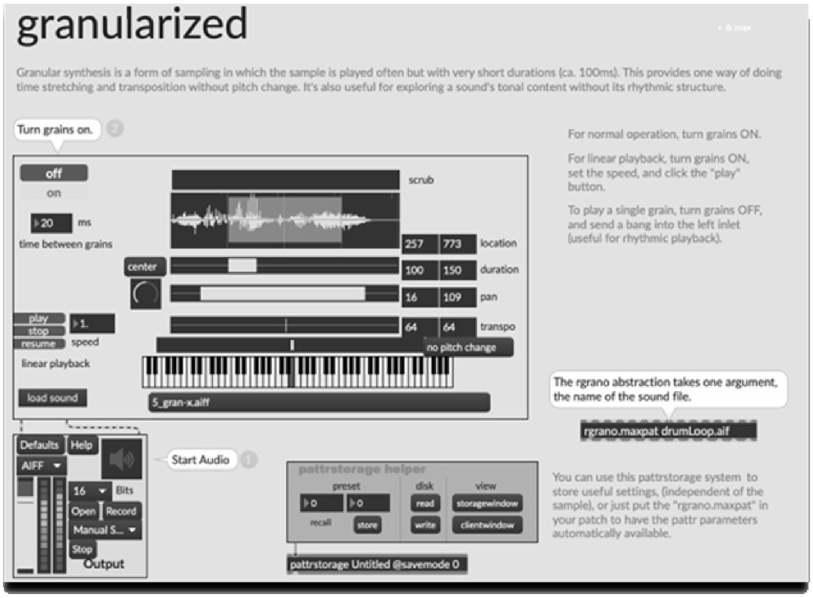

Fig. 23. *Granulator*

*Spectral acoustic beat texture

This technique, involves the simultaneous playback of 79 instances of a saw tooth sound, with frequencies at 0.0079 Hz ascending distance from each other, starting at 100 Hz (Figure 24). The result is a variable, panned spectrum of the base frequency that will be further granulated.

[32] I used the granulator implemented in MAX

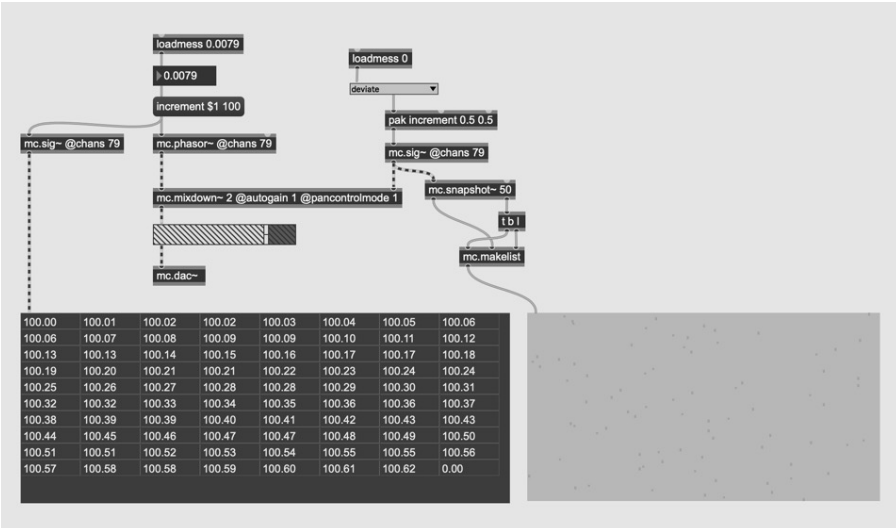

Fig. 24. *Spectral acoustic beat texture algorithm*

* Random spectral cannon

Generating a spectral melody with multiples of 100Hz and replicating it in the other speaker. (Figure 25)

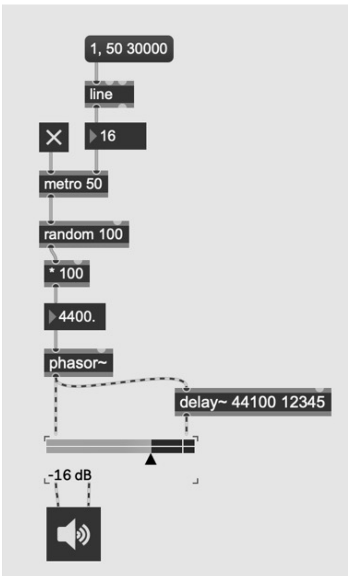

Fig. 25. *Random spectral cannon algorithm*

*Random polyphony in the lower register

A random melody with values between 0-100 Hz and values emitted with a frequency of 79 Hz in the left speaker is dynamically imitated in the right speaker.

*Random values of resonant filtered white noise

The algorithm generates a dynamically controlled random white noise, with resonant frequency values between 1922 and 2001, and with the range between 0 and 79 controlling the resonance Q factor, intensity, and frequency of the initial random signal. (Figure 26)

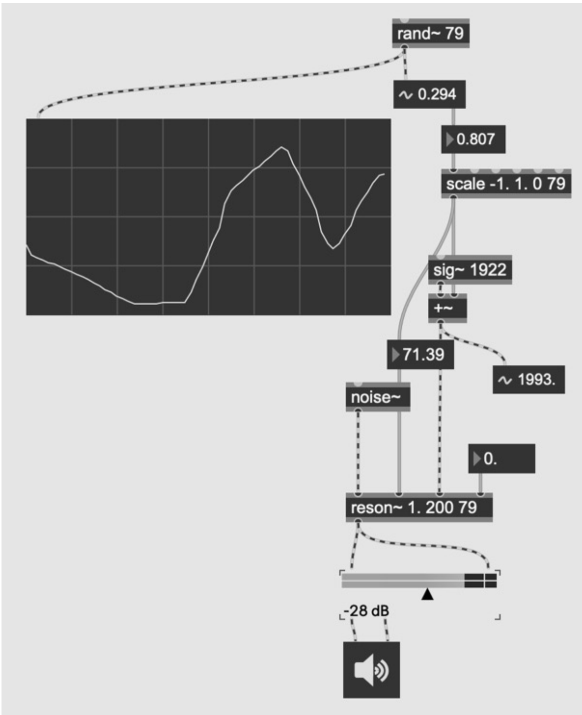

Fig. 26. *Random values of resonant filtered white noise algorithm*

*White noise filter with resonant filter, controlled by variable ramps

The resonant filter is controlled by 21 variable ramps, generating a point texture. (Figure 27)

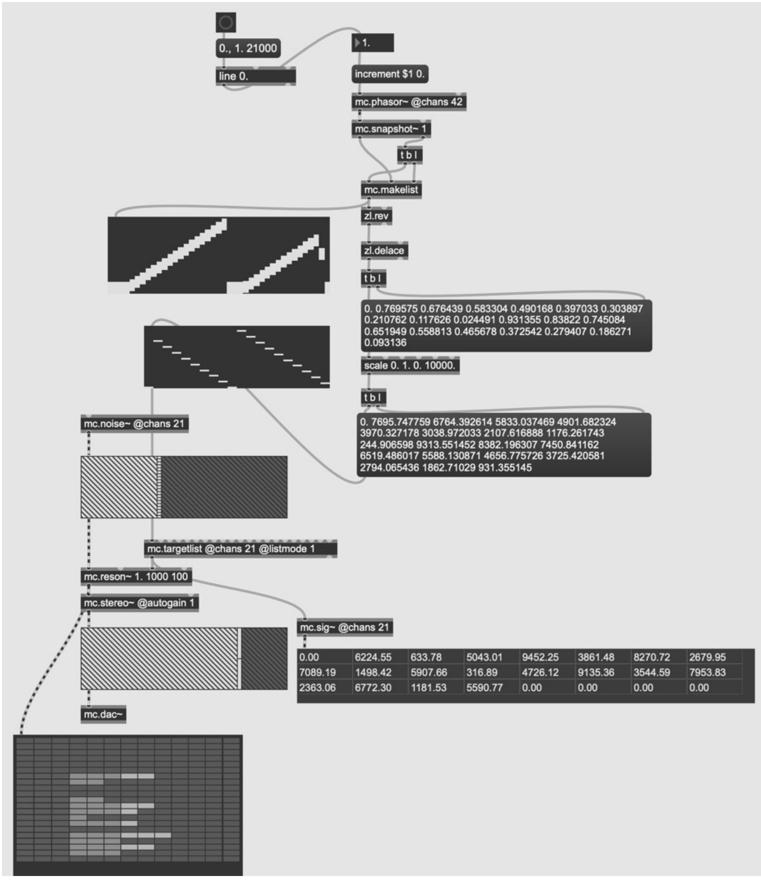

Fig. 27. *White noise filter with resonant filter, controlled by variable ramps algorithm*

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