Creativity Through Technology
And Science In Xenakis

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ABSTRACT

Nowadays it is common for creativity to be linked to technological advancement and there is a widely held impression that new ideas and concepts emerge daily as a result of technology. However, technology and even science and progress are often criticized leading towards a tendency for simplification and more human and natural consideration of reality.

This issue is much discussed in music and one of the field's most representative figures is Iannis Xenakis. His work with technology is well known and widely studied; and allowed him to create a number of highly original and creative artistic compositions. However, he was always aware of the danger of being "trapped by tools". So let us begin by looking at how, and to what purpose Xenakis used technology.

In his work we encounter his desire to justify the world through philosophy. His philosophical considerations touched on different domains and proved extremely fertile in his music, such as, for example, the interpenetration of determinism and indeterminism, or of inference and revelation.

This paper endeavors to highlight certain aspects of his creative process, beginning with his technological realizations and philosophical considerations that touch his music and other work and his relationship with a philosophy of technology.

1. INTRODUCTION

> "It seems to me that the moment has come to attempt to penetrate more profoundly and at the same time more globally into the essence of music to find the forces subjacent to technology, scientific thought, and music."
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> Iannis Xenakis [1]

Xenakis' artistic output cannot even partially be understood without regard for his stance on fundamental questions concerning music such as: What is the essence of music? What is creativity in music? How should technology be used? How can we introduce the "new" in music? Xenakis addressed such philosophical questions

in order to create a space favorable to the emergence of creativity in art.

The need for creativity, originality, authenticity, also guided Xenakis in his study of the relationship between music, technology and the sciences. This relationship developed from a philosophical consideration of a reality that connects a historical past with modern scientific thought.

2. XENAKIS AND TECHNOLOGY

One of the areas in which Xenakis' creativity manifested was the cutting-edge technology of his time. His experience with technology began in Greece while studying civil engineering at National Technical University of Athens. His study continued in the ateliers of Le Corbusier and the use of reinforced concrete in architecture (Couvent de la Tourette, Philips Pavilion...).

In relation to music, Xenakis employed electronic technology quite early. He would talk about investigations he had been making since the early 1950s, applying the Fibonacci numbers over sound duration, with the help of a tape recorder he had acquired [2, 30]. However, the decisive moment came in 1954, when he was accepted in the studios of Pierre Schaffer and had access to the latest cutting-edge electronic equipment of the day on which he could experiment and apply his musical ideas through technology.

Analog electronic technology allowed him to create Musique Concrète electroacoustic works such as *Diamorphoses* or *Concret PH*. It also gave him the opportunity to apply granular sound synthesis for the first time in *Analogiques B* [3] using tape-splicing techniques.

Computerized digital electronic technology aided in the calculation of stochastic parameters, a time-consuming task that had originally been done by hand and which he used to create works of instrumental music such as the series of *ST/*.

Later, in the 1970s, the possibilities offered by the development of computer technology permitted him to experiment in the transfer from visual to aural reality through the UPIC (Unité Polyagogique Informatique de CEMAMu). This was a concept that he had initially realized on paper for his first official work, *Metastaseis* in 1953-54. The UPIC not only allowed for calculation of the parameters of the transfer, but it could also directly produce sounds. With the UPIC Xenakis composed

works like *Mycenae A,* or *Voyage Absolu des Unari vers Andromède.*

The GENDYN (Génération Dynamique) program followed later in the 1990s. Here, he implemented a new kind of sound synthesis which had been conceptualized much earlier in the 1960s before the technology existed to support it. The idea of Dynamic Stochastic Synthesis, as it was called, was to move away from reliance on manipulation of sinusoidal waveforms or Fourier analysis and to control the creation and the variation of the original waveform by stochastic means. [4, 109-115] Moreover, the GENDYN program could create the entire work, from the micro-composition (sound synthesis) to macro-composition (composition in the strict sense). [5, 164]

Technology was also used by Xenakis in the field of visual creation (Philips Pavilion, Polytopes, Diatope) in a fusion of architecture, light and sound. There are additional records of his projects that were never realized such as creating an artificial aurora borealis in temperate regions of the globe, or a "laser show on the heights of Paris, accompanied by music played by warning sirens", or "a network of laser beams to be reflected by artificial satellites", even "joining the earth and the moon by filaments of light". [4, 5]

However, Xenakis' relationship to technology was a part of an overall general interest in sciences and was not limited to their applications. Thus, we find a wide scientific-technological area of Xenakis' interests that can be seen not only in his electroacoustic works but in his instrumental works too; in their conception, realization and the use of certain sonorities. [6]

Let us turn now to some questions that arise from this relationship: Why and how did Xenakis connect music to science and technology? Why was the need for a philosophical music base so important for him? Why was it essential for Xenakis to have not only a philosophy of music, but also a philosophy that included music, technology and science?

3. XENAKIS ON MUSIC PHILOSOPHY

> "I was saying that all the work I have done over the years is a sort of mosaic of hierarchical coherencies. At the hierarchy's summit I'd place philosophy. Philosophy, but in what sense? In the sense of the philosophical impulse which pushes us toward truth, revelation, research, general quest. interrogation, and harsh systematic criticism, not only in specialized fields but in all possible domains."
>
> Iannis Xenakis [4, 7-8]

In his article "Vers une philosophie de la musique" (Towards a Philosophy of Music), in 1966, Xenakis presented his point of view through a historical framework. He began by weaving an encomium to Ionian naturalist philosophers, who introduced reason and the significance of question (ἔλεγχος) "in spite of religions and powerful mystiques" like Orphism, "early forms of reasoning", [7, 201] that tried to escape the Wheel of Birth and reincarnation via ecstasy, purifications and sacraments. Xenakis

believed two of the pre-Socratic philosophies to be "the high points of this period: the Pythagorean concept of numbers and the Parmenidean dialectics - both unique expressions of the same preoccupation [the search for reason]". [7, 202]

The Pythagorean thesis proposes that all things in nature are numbers, a theory which Xenakis points out is developed from the study of musical intervals. According to Aristoxenos the Pythagoreans "used music to cleanse the soul", "to obtain the orphic catharsis" and thus to avoid reincarnation. However, Xenakis was not so much interested in the mysticism of Pythagoreans as in the fact that:"[...] all intellectual activity, including the arts, is actually immersed in the world of numbers (I am omitting the few backward-looking or obscurantist movements). We are not far from the day when genetics, thanks to the geometric and combinatorial structure of DNA, will be able to metamorphise the Wheel of Birth at will, as we wish it, and as preconceived by Pythagoras. ...[It will be] the very force of the "theory", of the question, which is the essence of human action, and whose most striking expression is Pythagorism. We are all Pythagoreans." [7, 202]

The second important philosopher for Xenakis was Parmenides, to whom he dedicated the piece *Eonta*. Parmenides introduced the dialectic, "discovered the principle of the excluded middle and logical tautology" and got "to the heart of the question of change by denying it, in contrast to Herakleitos". [8, 73] Xenakis emphasized Parmenides' reasonable method (excluded middle) to prove the non-existence of the *non-Being*.

We could suppose that the *Being* of Parmenides, which is "one, motionless, filling the universe, without birth and indestructible" [8, 73], resembles what Xenakis was searching for via axiomatic and formalization: a total explanation of music that covers the past, the present and the future, an explanation beyond the concepts of time and space, eternal and universal. However Xenakis does not allow us to reach this conclusion. He drew a parallel between the *non-Being* and the absolute indeterminate that, logically, would not be supposed to exist, for the same reason that *non-Being* also does not exist. Would that mean that indeterminism is the only truth? Xenakis says: "We know, moreover, that if an element of chance enters a deterministic construction all is undone... pure chance and pure determinism are only two facets of one entity...". [7, 204-205]

There is another essential reason for Xenakis to reject absolute determinism, that being the search for freedom. The freedom that Xenakis was searching for, beyond the "heroic", anti-Nazi period of his youth, was an inner freedom. [9] However, we accept the concept of pure determinism, we meet the negation of human free will. Xenakis says: "For if all is logically ordered in the universe, consequently as well as in our bodies, which are products of it, then our will is subject to this logic and our freedom is nil". [7, 205] At this juncture he found an advocate of freedom in Epicure.

Epicure introduced the concept of indeterminism with the theory of *deviation*, (*ekklisis*, Lat. *clinamen*)[1], giving "an axiomatic and cosmogonical foundation to the proposition of man's free will". Xenakis quotes from Lucretius, "in the straight fall that transports the atoms across the void, ... at an undetermined moment the atoms deviate ever so slightly from the vertical ... but the deviation is so slight, the least possible, that we could not conceive of even seemingly oblique movements". [7, 206] This deviation causes collisions between atoms, and so, the cosmogony begins! Moreover, by introducing chance as a key constituent of nature, Epicure also releases the human from fatalism and gives, as Xenakis says, "an axiomatic and cosmogonical foundation to the proposition of man's free will". [7, 205] Xenakis writes: "Epicure thus based the structure of the universe on determinism (the inexorable and parallel fall of atoms) and, at the same time, on indeterminism (ekklisis). [...] No one but Epicure had ever thought of utilizing chance as a principle or as a type of behavior". [7, 206]

Making a huge jump in the time, Xenakis reaches the 17th century. Pascal and Fermat tried "to determine" chance giving birth to the Theory of Probabilities in 1654. Later, in 1713, Bernoulli, in his book *Ars Conjectandi (Art of Conjecturing),* spoke about the Law of Large Numbers, which "removes the uncertainty with the help of the time (or the space)." [8, 79] He introduced the term *stochastic*: as long as the number of samples that we have at our disposal grows, the probabilities converge to a value, to a target *(stochos)*.

Through axiomatization and probabilities, the music of Xenakis creates a space of interactions between determinism and indeterminism, between Parmenides and Epicure, "[...] between two age-old poles, which are unified by modern science and philosophy: determinism and fatality on the one hand, and free will and unconditioned choice on the other. Between the two poles actual everyday life goes on, partly fatalistic, partly modifiable, with the whole gamut of interpenetrations and interpretations". [7, 178]

Following this philosophical narrative, Xenakis draws the link with music composition addressing the following two questions:

"1. What consequence does the awareness of the Pythagorean-Parmenidean field have for musical composition?

2. In what ways?"

To which he answered:

"1. Reflection on *that which is* leads us directly to the reconstruction, as much as possible *ex nihilo*, of the ideas basic to musical composition, and above all to the rejection of every idea that does not undergo the inquiry (ἔλεγχος, δίζησις).

2. This reconstruction will be prompted by modern axiomatic methods." [7, 207]

In his first answer Xenakis proposes "reflection" and "inquiry"; i.e. the scientific method for an *ex nihilo* ("as

much as possible") reconstruction of musical composition. In his second answer he suggests a method based on modern mathematics.

In defending his thesis at the Sorbonne in 1976, he returns to the question of "reflection" and "inquiry", writing about two modes of activity: "inferential" and "experimental". However, what is interesting, is that he also includes a third mode, which is proper to art: "revelation". He writes: "But in addition to these two modes - inferential and experimental - art exists in a third mode, one of immediate revelation, which is neither inferential nor experimental. The revelation of beauty occurs immediately, directly, to someone ignorant of art as well as to the connoisseur. This is the strength of art and, so it seems, its superiority over the sciences. Art, while living the two dimensions of inference and experimentation, possesses this third and most mysterious dimension which permits art objects to escape any aesthetic science while still enjoying the caresses of inference and experimentation". [4, 4]

Art's superiority over science gives it the role of "universal guide", as he explains later in the same text: "[...] the artist, and consequently art, must be simultaneously rational (inferential), technical (experimental) and talented (revelatory): three indispensable and coordinated modes which shun fatal failures, given the dimensions of these projects and the great risk of error. This greater complexity of the fundamental system of the three modes which govern art leads to the conclusion that art is richer and vaster and must necessarily initiate condensations and coagulations of intelligence; therefore, serve as a universal guide to the other sciences". [4, 5-6]

For Xenakis, the alloy of science and art, their mutual interpenetration, is at the same time the alloy of inference (and experiment) and revelation. "Yes, revelation is absolutely indispensable", he says, "it is one of man's crutches. He has two crutches: revelation and inference. And in the artistic realm, both are valid. In the scientific domain, there is one which takes precedence over the other, and that is inference". [4, 33]

Inference and revelation, which for Xenakis have nothing to do with mysticism, are the two modes of knowing that he tries to interrelate in music creation. Thus, we arrive at the question: How can Xenakis' philosophical considerations in music be inserted in a philosophy of technology?

4. PHILOSOPHY, TECHNOLOGY, CREATIVITY

"Ultimately, all the experiences that I have delivered over the past years led me to the conviction that the future of music lies in the advancement of modern technology."

I. Xenakis [10]

The philosophy of technology is a field of investigation that particularly concerns our culture in the early 21st century though we encounter philosophical investigations into technology long ago in Plato's *Timaeus*, and

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[1] After Lucretius, *De rerum natura.*

Aristotle's *Physics* with regards to *techne* (τέχνη - art, or craft) as an imitation of nature. In late Renaissance, Francis Bacon published *New Atlantis* (1627), depicting a utopia that harmoniously embraced, technology and natural philosophy in the service of human society. In the 20th century Martin Heidegger in his famous 1955 lecture on "The Question of Technology" [11] argued that technology produces not only technological objects, but also a different way of knowing; "technology is a way of uncovering", he claimed. [11, 13]

At this point I would like to turn to the ideas of Gilbert Simondon that clearly reflect the climate of the era in which Xenakis began to shape and develop his relationship with technology. Simondon was a contemporary of Xenakis involved in the philosophy of technology at the end of 1950s though his writings have only recently drawn attention. In 1958 Simondon published his essay *Du mode d'existence des objets techniques (On the Mode of Existence of Technical Objects),* in which he argues against technophobia. He writes in the introduction to his book: "We should like to show that culture fails to take into account that in technical reality there is a human reality, and that, if it is fully to play its role, culture must come to terms with technical entities as part of its body of knowledge and values". [12, 1] Simondon endeavored to develop a new relationship between man and machine, society and technology. His ideas support reevaluation and emancipation of the technical object and its reinsertion into society. As he writes: "The opposition established between the cultural and the technical and between man and machine is wrong and has no foundation. What underlies it is mere ignorance or resentment. It uses a mask of facile humanism to blind us to a reality that is full of human striving and rich in natural forces. This reality is the world of technical objects, the mediators between man and nature". [12, 1]

According to Simondon, technology creates technical objects, from simple utilities to complex machines, as mediators between man and nature, and man has to be the organizer and interpreter at the same time; a stance that agrees with Xenakis' intention of human control over machines. Simondon writes: "A purely automatic machine completely closed in on itself in a predetermined operation could only give summary results. The machine with superior technicality is an open machine, and the ensemble of open machine, assumes man as permanent organizer and as a living interpreter of the inter-relationships of machines". [12, 4] However, according to Simondon, organizer doesn't mean a sort of "dictator", but more a kind of "coordinator" similar to an orchestra conductor. He explains in the same text: "Far from being the supervisor of a squad of slaves, man is the permanent organizer of a society of technical objects which need him as much as musicians in an orchestra need a conductor. The conductor can direct his musicians only because, like them, and with a similar intensity, he can interpret the piece of music performed; he determines the tempo of their performance, but as he does so his interpretative decisions are affected by the

actual performance of the musicians; in fact, it is through him that the members of the orchestra affect each other's interpretation; for each of them he is the real, inspiring form of the group's existence as group; he is the central focus of interpretation of all of them in relation to each other. This is how man functions as permanent inventor and coordinator of the machines around him. He is among the machines that work with him". [12, 4]

In matters of art, Simondon uses the word "techno-aesthetic", first used in a letter to Derrida [13], to determine a new aesthetic in relation to technology, and he often makes references to Xenakis and Le Corbusier as artist-technicians. He finds this "techno-aesthetic" in Le Corbusier," [...] with his preference for the incomplete: respect the materials - avoid roughcasting." Even when he uses cement roughcasting, "that was no longer done with the trowel, whose entelechy is an optically smooth surface. It's a projection that was done with a cement canon, covering the walls with a kind of cresting on which the light can play. In this way, one achieves interference between art and nature". [13]

As in Le Corbusier, Simondon finds in Xenakis an aesthetic of the "brut", of the "raw". In Xenakis' *Terretektorh,* he notices the aesthetic of an archaic-primitive sonic reality (generated by instruments of primitive technology) organized by mathematical formalisation (stochastic distribution of sound sources in space). "[...] the piece of Xenakis [*Terretektorh*] is [...] a work that incorporates very primitive sounds and noises produced by instruments easy to build, existing for thousands of years; one could say that there are raw sounds as well as musical sounds; this work includes the effects of a "wild" sound material, incorporated to a so complete formalization that determines, during execution, the displacements of the localizable sound source in the mass of performers, as part of aesthetic perception." [14, 181]

Xenakis shares the same intention for aesthetic perception through sound spatialization, either in an instrumental piece like *Terretektorh,* or in an electroacoustic piece, e.g. *Bohor*. Xenakis' aesthetic defies the media; electronic technology is just another possible area to engage intelligence and creativity, "to express human intelligence by sonic means". [7, 178] However, he insists on the "untalented" use of technology. He writes about the introduction of computers in music composition: "The danger is great of letting oneself be trapped by the tools and of becoming stuck in the sands of a technology that has come like an intruder into the relatively calm waters of thought in instrumental music. For we already have a long list of attempts at composition by the computer. But what is the musical quality of these attempts? It has to be acknowledged that the results from the point of view of aesthetics are meager and that the hope of an extraordinary aesthetic success based on extraordinary technology is a cruel deceit". [1]

Francis Bayer, in his book *De Shönberg à Cage*, is also skeptic about the blind confidence in technology. Making a comparison between Xenakis' intention to "correct" the computer output and Pierre Bardaud's wish for "no

intervention" on the sound result of a mathematic algorithm, he writes: "The total subordination of music to mathematics, the attempt to exclude the composer's creative activity and to replace it by the automatic operation of a mechanical process, the renunciation of the work [of art] in favor of the program and the desired aesthetic neutrality of the produced resulting sound, all these power-ideas of algorithmic music combined, don't they ultimately lead to an elimination of art?" [15, 108]

Xenakis prefers to keep a distance from computer's resulting output, and to "filter" it through his subjective free will: "When I used programs to produce music like *ST/4*, *ST/10* or *ST48*, the output sometimes lacked interest. So, I had to change, I reserved that freedom for myself". [2, 201] Freedom is a means to reach originality, which is maybe one of the main aims of Xenakis' research effort. "The idea of originality is inherent in the question of freedom", he says; "The value of art, of the artistic offer of a person, a nation, a people, a civilization, depends on originality - this fundamental freedom". [16, 120]

Xenakis was strongly original and creative in both his musical and theoretical works. For Xenakis, creativity was a part of human nature: "To start with creativity (that is a word which is very much used but is sometimes meaningless) in the following sense: that it is something different from what existed before, that you did something which is new, be it in music, be it in politics, be it in cosmogony, whatever, whenever. And, *if,* for instance, the newness is distant enough from the past, then it's a great jump that might not be understood or appreciated by lots of people. [...] I think there is a part of the movement of creativity that is unfortunately, our destiny: to do things that are interesting and different, whatever you do." [17]

For Xenakis, creativity was an inescapable condition; "unfortunately", he said it is a part of human destiny, a human need for a "supreme hope". With regard to this purpose, he refers to Heidegger: "As Heidegger says, the artist, the thinker, the human being all have the pressing need for a supreme hope: to be able to invent and create, not just discover or unveil". [18, 136] Where does this creativity emerge from? Out of nothing! *Ex-nihilo*, declares Xenakis. "Create would be for him [man] to do something original in other words bearing no similarity or resemblance to anything seen before. Bringing into being something out of nothing. Engendering the unengendered". [18, 107] In other Xenakian terms, "One must always cultivate a new approach. One must always be an immigrant. In everything". [19, 123]

5. CONCLUSION

Xenakis sought to link science and technology with artistic creativity. For a large part of his generation, technology was a welcoming aid to facilitate "everyday life", to solve "problems". For him, it was a welcome aid to investigate questions that were, in some way, transhistorical: determinism and indeterminism, Parmenides and

Epicure, inference and revelation, axiomatization and probabilities, science and art and so forth.

His contribution to dialogues concerning music and technology was a rich and fruitful one that constantly examined the relationship between man and machine. Xenakis regarded technology as potentially beneficial to music, but with a risk of becoming sterile under the wrong circumstances. The need for innovation and originality in art is a need for creativity, and technology may help enlarge the field of investigations and open up the doors to hidden aspects of reality, but on the other hand, the need for artistic creativity is a human need, and has to be approached though human subjective criteria too.

Nevertheless, for Xenakis, the *stochos*, the aim of artistic research, with or without technology, should always remain the "fundamental function" of art, of music: "[...] to draw towards a total exaltation in which the individual mingles, losing his consciousness in a truth immediate, rare, enormous, and perfect". [7, 1]

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