STUDII

Xenakis' conception of creativity and the notion of emergence[1]

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Since the 1970s, mathematicians, physicists, biologists, philosophers and more recently also composers have attached new meanings and connotations to the notion of emergence[2]. I would like to suggest that, as early as the 1950s, Iannis Xenakis, through his music and his way of considering artistic creation, foreshadowed these developments. He thus offered a remarkable illustration of his belief that music, with its particular power of revelation[3], can guide the entire body of arts and sciences.

1. The musical work as emergence

The arising of life and then of intelligent life is often mentioned as an example of emergence. This kind of event, which implies an unexplainable transition between two different stages of evolution of an organized system[4], is known to be difficult to understand, as it defies

[1] This paper was originally published in the *Proceedings* of the *Xenakis 22: Centenary International Symposium*, Athens & Nafplio (Greece), 24-29 May 2022.

[2] One can mention, among many others, René Thom, Ilya Prigogine, Francisco Varela, Henri Atlan, Edgar Morin.

[3] Xenakis (1979, 12-14) distinguishes three kinds of knowledge: by logical inference, by experience and by revelation. He points that, while the first two are accessible to arts and sciences, the last is reserved to arts.

[4] Xavier Hautbois (2019, 34) argues that the transition between different levels of reality, each governed by specific laws, "is not accessible to knowledge". The theories of emergence, he adds, are precisely built on the assumption of the "irreducibility of reality".

causality[1]. In fact, one cannot yet determine the exact cause of the emergence of a new property such as life, or the cause of certain phenomena studied by quantum physics.

Music is also concerned by emergence. Indeed, does not composing amount to making something new emerge?[2] Isn't the musical work an emergent phenomenon, in the sense that, according to an established formula, it represents "more than the sum of its parts" (in this case, more than the sum of the sounds that compose it)?[3] Moreover, do we not have the impression that it "emerges" in an unaccountable, even mysterious way, at the whim of inspiration?[4]

Xenakis does not address the notion of emergence in an explicit way. He deals with it indirectly, when he discusses notions such as creation, novelty and originality, or dualities like determinism-indeterminism, order-disorder, causality-non-causality. Beyond this theoretical reflection, it is above all his musical approach and his compositional techniques that refer, in many ways, to the notion of emergence.

2. Weak emergence: simulations of randomness

Borrowing two terms employed by physicists, I would suggest that Xenakis' music illustrates two kinds of emergences: "weak" and "strong" (adjectives which in this case do not imply a value judgment)[5]. Weak emergence concerns new realities whose causes are only partially explainable. It can therefore be understood rationally to a certain extent.

In contrast, strong emergence is supposed to be entirely unexplainable. It manifests itself through absolutely unpredictable phenomena, like those studied by quantum physics. There is something irrational about it, a kind of "magic" which makes scientists

[1] Geoffroy Drouin (2017, 84) evokes in this respect a "causal break", due to "the impossibility of a causal articulation" between two different structural levels.

[2] Horacio Vaggione (2019, 57) notes that a composer is above all concerned with the question of how to make things emerge, which implies the existence of an acting subject.

[3] As Vaggione put it (2019, 66), "the musical work is an emergent phenomenon for it is not reducible either to its parts or to its constituent elements, or to the operations carried out during the processes of composition".

[4] Xavier Hautbois (2019, 144) notes that, since it "resists traditional logic", emergence risks making us "fall into a metaphysical explanation".

[5] On various aspects of weak and strong emergence, see: Bedau (1997), Bersini (2007), Lestienne (2012) and Virole (2015).

uncomfortable, as it seems to support the idea that something can arise from nothing.

2.1. The mass-granular approach

Modern physics has shown that the complexity of the interactions occurring in a turbulent cloud of particles is a source of randomness, of unpredictable events, and by this means of emergence. The behaviour of the sound masses in *Pithoprakta* evokes the evolution of such a chaotic cloud. It implies a great deal of complexity in musical structures, due to the large number of operations involved[1]. It is this complexity that prompted a stochastic treatment.

Xenakis also imagines every single sound as a complex cloud of tiny grains that he calls phonons or sound quantums. In theory, this granular approach should allow, as Horacio Vaggione remarks (2019, 61-62), to compose sonic emergence through a logic of "coupling" between different scales of temporal organization[2]. However, conceptual (theoretical) emergence, which is a matter of logic, should not be confused with physical emergence which really happens.

Xenakis' mass-granular approach relies on an abstract concept: that of stochastics. Yet this concept engenders a real sonic dynamic and, with it, a striking impression of emergence. Stochastics still have their limits: as Xenakis acknowledges (1994, 62), randomness can be fabricated (simulated) only up to a certain point. For, he argues (1976, 76), humans have not so far managed to provide a satisfactory explanation of "pure randomness".

Then, if, as Michel Philippot put it (1963, 13), for Xenakis, composing means making a suitable level of order "emerge from disorder", this emergence is a "weak" one, since, as the composer notes, it is not the product of a "pure randomness". The striking aural impact of *Pithoprakta*'s masses comes from their capacity to set up a pseudo-randomness allowing to simulate the emergence of sonic morphologies against a background[3].

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[1] As Geoffroy Drouin remarks, (2019, 112, 429), in music the "over-accumulation of writing operations" is a framework for emergence.

[2] Emergent processes, Vaggione points out (2019, 59), can be "composed" starting from a "diversity of overlapping strata".

[3] Xenakis' sound masses, seen as forms (*Gestalt*) arising against a background, can be discussed in the light of a theory of information according to which music is "the emergence of a form from noise" (Moles 1972, 134). Michel Serres (1972, 181-194) points out the originality of Xenakis in his report to the "background

Analogiques A and *B* show another case of weak emergence: that of an endeavour to make "second-order sonorities" emerge through the fusion of many individual sounds (Xenakis 1963, 122). Makis Solomos (2010) pointed to this kind of process which recalls in his view a large-scale sound synthesis (Solomos 2001, 137). The "failure" of *Analogiques* to produce genuine sonic emergence, as it has been evoked by Agostino Di Scipio (1997), reflects in fact the impossibility, in the given circumstances, to produce a "strong" emergence[1].

With the *GENDYN* programme, Xenakis made a last attempt to induce emergence through rationally controlled transitions between three different levels of sound organization. In the works he composed with the help of this algorithm, the musical structures "emerge" by means of a generative mechanism which determines, in principle, the temporal evolution of sound "grains" but also that of medium-sized sonic morphologies and of macroform[2].

2.2. Organic growth

The Xenakian arborescences exemplify another emergence pattern, that of vegetal growth[3]. These tree-like structures are ambivalent. Their branches can "run" in the opposite direction to that of organic growth, thus involving a reversible time. However, like traditional polyphony or heterophony, they globally unfold the irreversible time of bourgeoning (*Thallein*) and of branch growing (*Evryali*)[4].

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noise of the universe". René Thom's catastrophe theory, with its concepts of *pregnance* et *saillance*, also sheds a light on Xenakis' morphodynamic approach (Iliescu 2000).

[1] For a discussion of emergent processes in Xenakis and Agostino Di Scipio, see Makis Solomos (2010).

[2] The difficulty of this project is not unlike that faced by physicists searching for a "theory of everything" which could explain all the interactions observable in universe, from the infinitely small to the infinitely large.

[3] Makis Solomos (1993, 120) identified the Goethean principle of the "original plant" (*Urpflanze*) as early as in *Pithoprakta*, a work which he thinks is a simulation of the structure of a living organism. Pierre Albert Castanet (1987, 26) argues for its part that Xenakian arborescences are the perfect example of a "topographical/biological transfer".

[4] Mihu Iliescu (2000) suggested that the arborescences also illustrate the morphogenetic model of bifurcation described by René Thom in his theory of catastrophes.

Arborescences also show a kind of fractal invariance, in that their branches are replicated at higher hierarchical levels[1]. As I will underline later, this duplication is "unfaithful". It implies irregularities similar to those of real vegetal forms[2], justifying the status of "presumptuous rival" of nature conferred to Xenakis by François-Bernard Mâche (1972, 52). Moreover, the arborescences announce the computerized models of organic growth which today allow to imagine "a music evolving like a living organism"[3].

Yet they do not interact with their environment and do not self-organize "by taking care of themselves", as living organisms do[4]. Consequently, they do not display the kind of unpredictability that Xenakis nonetheless associates with life (Delalande 1997, 66). While the composer apparently strives to make the "style" of natural shapes his own (Restagno 1988, 50), his arborescences (unlike deleuzian *rhizomes*[5]) thus can only simulate the specific emergence of life.

Organic growth and self-organization are also at stake in *Horos*. In this orchestral work Xenakis uses a cellular automaton[6], a mathematical formalism allowing to simulate the proliferation of organic cells, thanks to which he tries to approach the "mystery of sound" (1992, XII). He thus undertakes to make "new and rich timbral fusions" emerge out of certain harmonic progressions[7], a process that could be attached to the notion of "algorithmic emergence"[8].

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[1] Xenakis (1992, 22) remarks that fractal geometry finds "a mathematical expression to natural patterns apparently due to pure randomness".

[2] Natural forms, Peter Stevens observes (1978, 126-127), are "neither so regular as to be boring" nor "so irregular as to be shapeless".

[3] According to Mikhail Malt, quoted by Geoffroy Drouin (2019, 109).

[4] For Peter Stevens (1978, 125), a tree gives the impression of "taking care of itself".

[5] As thematized by Gilles Deleuze and Félix Guattari (1980, 31), the rhizome differs from the arborescence precisely by its capacity to burst forth, that is to emerge anytime and anywhere, in an absolutely unpredictable way.

[6] On Xenakis' use of cellular automata, see Peter Hoffmann (2002) and Makis Solomos (2005).

[7] As emergent properties, these new timbral fusions are indicative of what Nicolas Darbon (2006, 81) calls "chaocity". This term precisely concerns the chaotic nature of processes such as those involved in organic growth which also inspired Ligeti, another composer who referred to cellular automata.

[8] Geoffroy Drouin (2019, 429) designates by "algorithmic emergence" the "switching to a higher level" which occurs in musical works drawing on the model of complexity through noise.

3. Strong emergence: irruptions of irrationality

Over the years, Xenakis abandoned the mathematical formulas he used in the 1950s and 1960s and controlled the sound flow rather empirically. Having achieved "a superior form of nonchalance" (Restagno 1988, 50), he relied more and more on his intuition. He then also accepted a growing part of pure randomness and of immastery[1]. By recognizing the existence of an unformalizable musical domain, he thus opened the door to a "strong", irrational emergence[2].

One may wonder, however, about the real significance of this evolution. Is this not just another form of simulation, certainly more subtle than that discussed so far? To answer this question I will briefly discuss four notions tackled by Xenakis in his writings. The first one is that of repetition, more exactly the non-identical or, as the composer called it, "unfaithful" repetition.

3.1. "Unfaithful repetitions"

Repetition is synonymous with life, Xenakis argues. "We need repetition", he declares. Moreover, he adds, "there is no rule without repetition" (1994, 91-92). He then sets up repetition itself as a rule – the most fundamental of all – that must be respected in musical composition. He thereby confers to it an aesthetic value, also considering it as a primary source of musical creation[3].

However, Xenakis specifies, repetition has to be "unfaithful", that is, non-identical. This requirement can be understood in the light of Gilles Deleuze's dialectic of difference and repetition, but it also refers to a number of dualities which reveal the mechanisms producing emergence:

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[1] The notion of "immastery" (*immaîtrise*), as discussed by Jean-Paul Dupuy (2005), could be understood in the light of the concept of "unavailability" forged by German philosopher Hartmut Rosa (2020).

[2] The concepts of "gap" (*écart*), "*dé-coïncidence*", "*inoui*" (unheard-of) and "incommensurable", forged by French philosopher François Jullien, also provide an exciting perspective for understanding the notion of emergence.

[3] On the various ways of repeating through self-borrowing in Xenakis' works, see Benoît Gibson (2011).

permanence-variation[1], identity-plurality[2], redundancy-variety[3], invariance-drift[4], archetype-realization[5].

Xenakis postulates that reality never reproduces a given entity, for there is always "unfaithfulness" in reproduction. In other words, to use Deleuze's terms, there is always difference in repetition. It is precisely this difference that engenders various kinds of irregularities leading to what modern physics calls singularities, and then to emergence.

By mentioning the Epicurean concept of *ekklisis* as a philosophical foundation of unfaithful repetition, Xenakis highlights the latter's irrationality. The *ekklisis* – an infinitesimal deviation exceptionally affecting the trajectory of certain atoms – has indeed no rational explanation. It introduces, as Xenakis notes, "a senseless principle within the marvelous deterministic atomistic system" (1976, 77-78).

This senseless principle legitimizes the many "errors" that the composer commits in regard to the rules he sets himself. In fact, like those observed in the evolution of living organisms (Atlan 1976), these are not really errors. They rather mark the salutary abandon of a certain mechanical rigour[6] in favour of the irrationality of creation, that is, of emergence.

3.2. "Time in itself"

Physicists and biologists assume that emergence is fundamentally bound to time (Lestienne, 2012, 146). Some of them suggest that time itself is an emergent property, resulting from random processes occurring at a microscopic level (Prigogine 1996, 69)[7]. With the *Gendyn* algorithm,

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[1] Geoffroy Drouin (2019, 113) qualifies this duality as a "privileged moment of emergence".

[2] Duality identified by Makis Solomos (2013a, 404) in Horacio Vaggione's music.

[3] Henri Atlan (1979) points out the role of this duality in the functioning of living organisms.

[4] Michel Serres (see Xenakis 1979, 109) considers that the duality invariance-drift is characteristic of music.

[5] On Xenakis' musical approach seen as a repetition of archetypal cosmogonies, see Mihu Iliescu (2015, 225-240).

[6] Edgar Morin (1980, 368) highlights the significance of the "lack of rigour" as a source of profitable errors. We can "live with error", he argues, and even "make of an error a virtue".

[7] More recently, Carlo Rovelli and Alain Connes put forward the hypothesis that time emerges progressively in a universe composed of tiny grains of space and/or time that are still indistinguishable from each other (Lestienne 2012, 212).

Xenakis illustrates this hypothesis: he makes the macroscopic time of the musical work emerge through stochastic procedures applied to the microstructure of sound.

Beyond the singular experience occasioned by Gendyn, any temporal expression of what Xenakis calls *outside-of-time* structures is likely to produce emergence, for it involves an irrational aspect. Indeed, from Saint Augustin to Ilya Prigogine and Isabelle Stengers (1988, 145), time is deemed to be "obscure", difficult to grasp, thus escaping rationality. The last Xenakis (1994, 98, 106) also describes it as a "fuzzy", "impalpable flow", lending to "mysterious judgments"[1].

After having founded his "formalized music" of the 1950's on the radical hypothesis of "the exclusion of the time factor" (1963, 186-187) – since music, estimated then Xenakis, "does not really happen in time" (1972a, 28) – and after having asserted the necessity "to tear itself off from time", "to hold on against the river of time" (1994, 101), in his late writings he thus finally takes into consideration what he calls "time in itself", that is time acknowledged to be irreversible.

The idea of a "union of Parmenides and Heraclitus", formulated by Xenakis in the 1970s, indicates this turn. The composer's ontology, initially centered on the Parmenidean Being, now accommodates the Heraclitean Becoming, implying irreversibility. Such a change has significant consequences: as Horacio Vaggione remarks (2019, 63), once the irreversibility of time is recognized, sound pitch is no longer an absolute parameter but, at least partially, an emergent phenomenon.

It results, for Xenakis, a singular mix of reversible and irreversible: "an irreversible gorged with reversible", as Michel Serres said, referring to a music which "flows while restraining itself from flowing" (1977, 187). These paradoxical formulations imply the possibility to produce emergence through a partially rational control of the temporal flow, in spite of its intrinsic irrationality. They thus reconcile a global mastery of creative processes with a punctual immastery.

3.3. "A child's gratuitous play"

In Xenakis' words, music is a "child's gratuitous play" (1976, 40). To understand this sentence which the composer never developed, I

[1] Yet Xenakis continues to express doubts about the "reality" of time. Is it not, he asks, "merely a notion-epiphenomenon of a deeper reality [...] and therefore a delusion that we unconsciously accept?" (1994, 94).

think it could be useful to discuss it in the light of a passage from Nietzsche's *Zarathustra*:

> The child is innocence and forgetting, a new beginning, a game, a self-propelled wheel, a first movement, a sacred "Yes". For the game of creation, my brothers, a sacred "Yes" is needed.

While the child's play signifies a new beginning carrying a cosmogonic connotation, the self-propelled wheel symbolizes a mechanism capable to run with no external intervention. It reminds the automatic generative process imagined by Xenakis for *Achorripsis*, that can be launched by a simple "initial push" (1991, 518). Mythical cosmogonies consider this kind of strong creative gesture, inducing pure emergence, as a privilege of gods and demiurges[1].

Heraclitus' Fragment 52, known to have considerably influenced Nietzsche[2], further clarifies the meaning of Xenakis' sentence:

> Time [αἰὼν] is a child playing draughts, the kingly power is a child's.

The Greek word *aïon*, today usually translated as "time" or "eternity", could also designate the lifespan of human existence and the energy needed to achieve it[3]. Fragment 52 then teaches us that living one's life is in a way similar to a child's gaming (Therme 2017, 646-647). Yet this game should be taken seriously, like that mentioned by Heraclitus: a combat game, common in ancient Greece, requiring concentration and strategy.

Some of Xenakis' works evoke this kind of game which "combines rules and unpredictability" (Therme 2017, 645-646). In *Duel* and *Stratégie*, two conductors confront each other through their orchestras, using "tactics" elaborated with the help of mathematical game theory. But the decisions they make in the midst of their "battle" are partially irrational. The game is biased anyway, and its rules restrain the arising of unexpected events and thus of genuine emergence.

Another particular case is that of *Taurhiphanie*, a composition demanding the participation of bulls and horses. Their choreography,

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[1] "Aren't gods a kind of automaton, much more powerful?", Xenakis asks (1988a, 5).

[2] On Nietzsche's self-identification with Heraclitus and on his tendency to use riddles involving children at play, see Anne-Laure Therme (2017, 653-657).

[3] On the interpretation of Heraclitus' Fragment 52 and especially on the polysemy of the word *aïon*, see Marcel Conche's commentaries (Héraclite 1998, 446-449).

planned by the composer, could not be properly controlled during the creation (Couprie 2020, 434-457) because, unlike humans, animals did not "play the game". Although their presence was important to him[1], Xenakis eventually dispensed with them, perhaps acknowledging the unpredictability of life.

3.4. "Getting out of self"

The last irrational source of emergence I will discuss is the surpassing of self. Xenakis actually rather uses the expression "getting out of self", a translation of the Greek word *ekstasis*. He assumes that the loss of control induced by the *ekstasis* is beneficial to artistic creation; for, he argues, "if you dominate everything, you don't create anything" (Xenakis 1997, 60). The *ekstasis*, he adds, reveals the true human nature, allowing the "soul" to escape its destiny (1994, 67).

In this sense, the *ekstasis* is similar to the Dionysian state of trance. Indeed, Xenakis finds that music shares with alcohol and love the "power of Dionysus", which he admits he would like to acquire himself (1987, 18). Dionysus, known as the bearer of a "divine spark"[2], embodies for him the irrational nature of a creation arising from chaos, as expressed in Nietzsche's famous sentence from *Zarathoustra*: "You need chaos in your soul to give birth to a dancing star".

It also seems possible to "get out of self" through a challenging effort, like that required from musicians performing the reputedly unplayable Xenakian works. The inevitable compromises and approximations inherent to their execution lead in fact to unpredictable emergences. However, the *ekstasis* finds its supreme expression in the collective effort that, according to Xenakis, human species should undertake in order to surpass its own "mental categories".

A "very high effort", he observes (Xenakis 1994, 107), is in fact necessary to simply survive, be it for a person, for humanity in general or for the universe. This kind of effort illustrates in his view the "dialectical struggle" of life "against extinction, against nothingness"[3]: a universal,

[1] In Xenakis' view (1988b, 105), through the presence of animals his music was supposed to "become Nature".

[2] The "divine spark" of Dionysus, mentioned by Xenakis (1994, 134), refers to ancient gnostic doctrines.

[3] Xenakis imagines in this respect a universe "desperately struggling to cling to existence, to the being, by its own endless renewal, at every instant at every

cosmic process which, by its cyclicity, also reminds Nietzsche's eternal return[1].

Xenakis' music thus emerges from a fierce struggle: a fight going back to the composer's commitment to the Greek Resistance during World War II. It requires a strong determination which is that of transgressive heroes such as Prometheus and Sisyphus, but also that of the "essential man" described in the Hermetic gnosis evoked by Xenakis in *La Légende d'Eer*[2].

4. Making emerge and letting emerge

Finally, Xenakis' conception of creativity is quite ambivalent, as it implies the possibility of *making emerge* but also of *letting emerge*. In the first case, the recourse to mathematical formalisms pushing the limits of rationality has effects which could be assimilated to "weak" emergence. In the second case, irrational, arbitrary or unmastered decisions allow a "strong" emergence.

This ambivalence bears a contradiction which is inherent to emergence itself, insofar as this notion can be defined as "a mix of freedom and determinism" (Besnier 2010, 30). Indeed, on the one hand, Xenakis assures he wants "the things [he] asks for [...] to be randomness"; he requires "more freedom", which implies a part of irrationality and unpredictability. But, on the other hand, he imagines "a constraint, an abstract mechanism, which would do exactly what [he] asks"[3].

He generally solves this kind of contradiction in the manner of a presocratic philosopher, by reducing it to one and unique principle. He thus claims a "tautological" approach that reduces oppositions to identities[4]. For example, he argues, determinism and indeterminism are

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death" (1994, 105). His metaphor of the "hecatomb of pure sounds [...] necessary to create a complex sound" also expresses this connection between life (renewal) and death (1963, 61).

[1] Xenakis evokes a scenario in which the Being, "in order to continue to exist, had to die, and then once dead, to begin its cycle again" (1994, 111).

[2] On the Hermetic and other gnostic elements in Xenakis, see Mihu Iliescu (2015).

[3] Quoted by Solomos (2013b).

[4] In this regard, Xenakis quotes Parmenides: "the same is at once thinking and being"; then he paraphrases him, pushing the tautology to its ultimate consequence: "the same is at once being and not being" (1992, 24).

two aspects of one and the same thing, so they "can ultimately be confused" (1994, 114-115)[1].

Music, however, escapes this tautological approach. It seemingly preserves an irreducible part of irrationality, where its specific power actually lies. "I attain the inaccessible through my music", Xenakis declares (1972b, 58). Maybe he means by this that he has the privilege, once reserved to the gods, of creating *ex nihilo*, that is of producing a strong emergence, even if he calls it otherwise: "engendering the unengendered", or birth "out of the nothingness" (1994, 105; 115).

The notion of emergence is inherent to the Xenakian vision according to which humanity, by its powerful will, relentless struggle and unlimited creativity, should ensure its survival as well as that of the universe. It answers the "imperious necessity" of a "supreme hope": that of being capable of "inventing, creating, not only discovering or unveiling". "There must be creation in the universe", the composer claims (1994, 136-137). He acts accordingly, considering himself as an infinitesimal but significant parcel of the universe.

Xenakis' acception of creativity ultimately refers to a perpetual emergence of novelty coupled with a perpetual return to nothingness. "It is necessary", he points, "to stand by [the] conclusion of a universe open to the new, which would relentlessly arise or disappear in a truly creative whirlwind". I suggest that this cosmic metaphorical vision, as Xenakis applies it to "the foundation of art" as well as to "the destiny of humanity" (1994, 111), is essential for understanding the power and the originality of his musical endeavour.

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[1] Xenakis argues that "Einstein's god should possess the power to encompass and overcome the apparent opposition between determinism and incertitude." This god, he adds, "means us, the cosmos" (Delalande 1991, 70).

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SUMMARY

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Xenakis' conception of creativity and the notion of emergence

Since the 1970s, several scientific breakthroughs have brought mathematicians, physicists, life scientists, philosophers and more recently also composers to attach new meanings and connotations to the notion of emergence. Xenakis' musical approach announced these developments as early as the 1950s, thus illustrating the composer's belief that music can guide the entire body of arts and sciences.

Xenakis initially conceived emergent processes by fabricating (simulating) randomness with the help of probabilistic laws. Relying on a granular conception of sound, he made sonic morphologies (masses, arborescences) and even entire musical works "emerge". This kind of approach comes under what physicists call "weak" emergence, which can be rationally explained and, to a certain extent, predicted.

Nevertheless, Xenakis also accepted genuine, non-simulated randomness hence a part of irrationality and unpredictability, of arbitrariness and immastery. He was then brought to *let music emerge*, producing a "strong" emergence that escapes causality. Some particular topics tackled in his writings point to this aspect: the "unfaithful repetition", "time in itself", the "child's gratuitous play", the "getting out of self".

The notion of emergence is inherent to the Xenakian vision of a humanity which, through its powerful will, relentless struggle and unlimited creativity, is called upon to ensure its survival but also that of the universe. It answers a "compelling need" and a "supreme hope" which, Xenakis argues, is essential to humans: that of "being capable of inventing, creating, not only discovering and unveiling".