

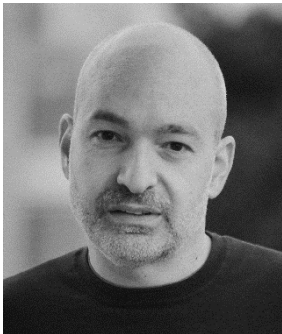
# Xenakis and the Other

## Between determinism and the unexpected

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### **Abstract**

Iannis Xenakis, throughout his career, employed deliberately mathematical models as compositional tools. Through those models, and mathematical abstract

thought in general, he sought to break the rules and disrupt the determinism of established musical practices. In other words, mathematical models provided for Xenakis the means towards a freer and at the same time totally unique musical style.

In his quest for mathematically driven composition, Xenakis employed several different mathematical models, both stochastic and deterministic, in a highly personal – and somehow almost cryptic or even mystical – manner. Among those models, one can find his sieve theory, which he developed in the 60s and he employed in compositions like *Nomos alpha* (1965), *Jonchaies* (1977) and *Akea* (1986). Sieve theory holds an interesting and rather unique place in his inventory: It is arguably the most deterministic of the methods that he used, while it arrived in the aftermath of his polemical texts of the 50s, where he attacked serialism - listing determinism and linearity as its faults – and proposed indeterministic, non-linear processes as an alternative. In other words, Xenakis' sieve theory seems to oppose his own, earlier views and practices in a rather direct way. We argue here that this paradox – Xenakis

championing indeterministic methods while using himself highly deterministic methods – is not necessarily true. Or rather, that one must look at the different levels of the process in order to understand where indeterminism is to be found. This realization can inform our understanding of similar issues in the field of design.

### **Criticism on serial music and deterministic logic and Xenakis' alternative to achieve a balance between musical structures of the past and modern scientific theories.**

Many post-war European composers tried to shake off the influence of fascism from their culture and rebuilt and reimagine music, starting anew. Several of them felt that serial organizational schemes of pitches, like Webern's, could be a solid ground for a new music, free of post-war conventions and restrictions. [10] Serial music became more widespread and was studied by many, including Messiaen himself. However, several composers criticized the principles behind serial music, finding them problematic and contradicting. One of the most austere reviews was Xenakis' in his article "La crise de la musique sérielle" [12]. As he explains in his book "Formalized Music", although serial music was utterly deterministic - following indeed a very strict organization of its multiple variants - the aural outcome was incomprehensible and chaotic, or as Xenakis mentions, it was "*an auditory and ideological nonsense*" [13]. His explanations for this paradox, was the serialists' inability to handle indeterminism with the appropriate tools. By failing to do so, they had to resort to

deterministic ones with which they were comfortable. Urging to find an operative framework to cope with this, he proposed to introduce stochastic mathematics and indeterministic ways of thinking in musical composition. More specifically, Xenakis proposes that the composer should employ probability theory and stochastic logic in order to be able to create indeterministic compositions, and most importantly, in order to control their products.

### **The agents of the "other", the unexpected: Xenakis' use of mathematical models and logic and his ulterior motives for musical composition.**

Following the line of thinking developed above, one could indeed argue that Xenakis' concern with serial music was not determinism per se; instead his reservations were more about the ambiguity of the whole process and the confusion that was apparent – at least in his view - in its outcome. For Xenakis therefore, the use of tools deriving from outside music or common musical practice, could pave the way to the liberation of music. To the production of freedom in form and structure that balances between order and disorder, benefiting from both. Without being lost in indeterminism, by missing the essence or by the lack of any logic, while at the same time not being trapped in determinism, by losing all freedom and sentiment.

Serialists, in their attempt to escape past mistakes, appear in Xenakis' view to totally ignore the past; they compose as if older approaches never happened, and try instead to begin from scratch; In a way they attempt to create something

new from nothing, leaving their compositions to chance. To that, Xenakis asserted firstly, that aleatory processes should be calculated. Secondly, that a composer can benefit from past knowledge without repeating it. This is where the element of the 'unexpected', the element outside of the music process, comes into play. On the one hand, although it has been demonstrated that aleatory processes cannot be tamed or imitated, stochastics can ensure ways to navigate through them and hopefully inform compositional processes through this voyage. On the other hand, for Xenakis, scientific and mathematical thought had another, particularly important role to play. They could form the substructure that would support the construction of an original axiomatic musical theory with its ensuing formal structures, that would conglomerate the time continuum.

This past-present-future unification Xenakis talks about [13], concerns in essence the universality that in his view, music should achieve. The universality that, through his eyes, is exactly what serial music lacks. He claims that the "other" (mathematics and logic) could pave the way to a more continuous and global music and replace the linearity and discreteness of serialism.

Hence, it can be argued that the ulterior goal of Xenakis, was not indeterminism for indeterminism's sake, but instead that very same universality of music. With the aid of the agents of the "other", this timeless universality could be realized. To resume, he aspired to create a conception of music that would be global, timeless, open and inclusive, and abstract enough to be applicable to any case, and not simply dependent on chance or pure intuition.

In fact, Xenakis' stochastic music was just a first step towards this direction. The next step was to study the tonal system, which he considered to be the foundation of all music, to understand its structure and transformations and finally to distort it. He attempted to catch the "abstract logical construction" of the diatonic system and translate it through mathematics to a comprehensible, easy to use, global methodology of musical composition and analysis. [13]

It is important to note that the quality of timelessness mentioned before, does not just refer to an eternal aspect of Xenakis' conception. It also means literally "without time" or "outside of time". In fact, Xenakis' approach to musical composition was strongly spatial [7]. He thought that reintroducing spatiality to music could provide the means to achieve his ulterior goals. In "Formalized Music", he explicitly demonstrates that some musical elements or structures that other composers considered to be temporal belonged in the 'outside-time domain'. Therefore, he distinguished musical elements between outside-time, in-time, and temporal, based on their architectural characteristics [13]. Mathematics, as the agent of the unexpected, aided him analyze the relations between compositional elements, their internal structures and the rules that govern them. This way, he was able to synthesize a completely new approach on music, that he trusted it could be a formal and abstract expression of a global and absolute musical conception.

**Sieve theory: its role on Xenakis' abstract thought process and the way it managed to break determinism, while being**

## **a deterministic mathematical model.**

As mentioned above, the introduction of stochastic logic in musical composition, on the one hand, placed musical indeterminism on a proper framework (theoretical and practical), while at the same time, set up the groundwork for the spatiality of music to flourish and blend uniformly with its temporality. This fusion was essential to create a global, timeless, and coherent conception of music. However, it still did not suffice for Xenakis' ambitions. Since, as we have already demonstrated, indeterminism alone was not the Xenakis' goal. He also aimed to axiomatize and formalize his conception. This is where deterministic, set-theoretical, modular logic, on which his sieve theory was based, was of assistance. Xenakis considers sieve theory to be necessary for the axiomatization of musical configurations.

A mathematical sieve works like a filter. From a set of numbers, only the ones that follow a predefined rule are allowed to pass through. Similarly, Xenakis' sieves can produce series of numbers which obey a rule of his making. A Xenakis' sieve can be conceptualized as a line with points that seem to be randomly distributed on it. However, there is a hidden pattern behind this seemingly random distribution. [4] There is a starting point and then every point is located on an equal distance apart from the points on either side of it. For there to be variations to the distance between the points and break this totally symmetric repetition, such sequences can be combined with Boolean operations, creating the final sieve. Having this simple process as a basis, Xenakis used his sieve theory to study the "intervallic" structure (or the "spatial identities", as he called them) of archetypical music, to

reveal their concealed patterns, compare them and eventually distort and combine them. Hence, using sieve theory as a formal tool, he managed to construct new musical patterns of high complexity that emerged through simplicity and transcended classical patterns. A procedure that while technically deterministic, at the same time it resembles fractal procedures. Therefore, a procedure that even when considered deterministic through a deterministic lens, it surely cannot be understood in a linear manner.

Xenakis experimented a lot with his sieve theory and used it in many different ways, playing games with numbers and exploiting their mathematical properties. At first, it was a formal tool that helped him to analyze the outside-time structures of musical compositions and reveal their "hidden symmetries". [3] An interesting example is the prime-number sieve generator. It was a mathematical procedure that could generate a series (in fact, a cycle) of prime numbers that belong to a certain commutative group, by repeating a simple multiplication pattern between pairs inside that group. The sieve he used for *Nomos Alpha* was created by this generator. [6]

There were times, though, that he only used sieve theory to produce scales and organize musical elements. [2] In fact, many times he went beyond that and combined it with other tools at his disposal. For example, he used stochastics and aleatory processes to produce the basic elements then deterministic sieve theory to organize them in space, and finally dramatized this configuration creating a "cinematic progression in-time. In other words, we could say that he employed a combination of increasing complexity in terms of vocabulary, engaging this

complexity in terms of structure and parametrizing it temporally to add a dramatic effect.

An additional reason why Xenakis thought his sieve theory - and its subsequent axiomatization - was so necessary, was its ability to be computerized or mechanized. Hence, he saw it as a weapon to fight the developing industrialization of music. It is important to note that he was not trying to find a way to escape from this industrialization of music. Instead, he was looking to find a way to prevent its domination over music and try to control it while exploiting its advantages. [13]

### **Originality: The role of the artist in the analytical process of formalizing and axiomatization musical composition.**

It is important to place Xenakis' conception of sieves and deterministic processes in general within the larger context of his compositional process. Until now, we have analyzed how the agents of the "other" helped Xenakis create a coherent, universal and timeless conception of music. Besides those qualities, there was one more that was extremely important for his conception, that we have not mentioned yet: originality [13]. This additional quality changes essentially everything concerning Xenakis' view and may resolve many misunderstandings about his work.

He claimed that he made theories and guides for these theories, but in reality, he did not follow them to the letter. He, essentially, developed tools for analysis and production of music, but the way of using those tools in practice was far from the theory he developed. As a result, many have accused him of creating a

gap between his theories and his practice. [11] This becomes clear when someone attempts to employ Xenakis' algorithm and try to work in reverse: in other words, to begin from a score and try to reconstruct the original sieve that was used to produce that score. Actually, in most of Xenakis' compositions, it is nearly impossible to achieve that. Mainly, because the process has been tampered by the composer - in many cases quite extensively. Therefore, many analysts claimed that his process was either confusing and frustrating or just wrong and incomplete. [6] All of the above have a point to make of course, and in that sense Xenakis' theory might not be complete in analytical terms; it might also not be a way to formalize music - as it was supposedly meant to do. But that view can change when Xenakis' processes are examined in creative and syncretical terms. On those terms, his processes succeeded in breaking the norms and escaping the predetermined protocols. It is exactly this ultimate escape from protocols that can justify the use of deterministic processes and the one that grants access to the originality that he sought after.

In fact, by adding originality to the equation, we might understand things even more differently. Xenakis was always in control of the process while he continuously bended and deliberately altered the results of those models to fit his scope and through his own, subjective, artistic judgement. [9] In that sense, for Xenakis the mathematical and computational models that he used were the means to disrupt the standard compositional processes. They were an element of the 'unexpected' that came from the outside of the musical process and altered it in unique ways. On that level, it is of little importance if the

models were deterministic or indeterministic. What matters is that they acted as agents of the 'other' – the non-musical – that when paired with the musical instinct of the composer disrupt the determinism of standard processes.

By employing agents outside of music to analyze and formalize the process of musical composition, Xenakis manages to understand its rules and laws and thus create new ones that serve his own purposes and aesthetics. But through this process, the rules that he creates are not the most important part, especially regarding the product of the composition. What is of most importance is that through understanding the thought process and the way a composition functions, he managed to reach a point where he was able to manipulate and change his own rules. This flexibility becomes apparent if we compare *Nomos alpha* (1956), where he first applied his sieve theory, with *Phappa* (1975), where sieve theory is not used in a formal way, but in a more intuitive one, based on his experience. [8] In addition, the importance of the artist's intuition is highlighted when comparing Xenakis compositions (like *Nomos Alpha*) with the products of his computer program, which one could argue that are less interesting.

Xenakis conception was in essence a fusion between existing knowledge in music and existing knowledge in science. But the secret of his recipe was that he always added his aesthetic criteria, that could affect the outcome on details, or it could change it completely. With the assistance of the agents of the "other" he managed to change the rules and achieve the universality he was searching for in music. That 'other', the non-musical for Xenakis, becomes a constructor or narratives. Musical narratives, that redistribute what was

already 'sensible' – and are therefore aesthetic in nature – and that ultimately manage to push the limits of musical composition in a way that underlines music's autonomy as a discipline. And there lies maybe the most interesting paradox: it is through the reference of the other, of the non-musical, that music manages to remain autonomous.

## **Conclusion: Towards a Xenakian conception of architecture**

Xenakis' processes and techniques are most valuable for many disciplines other than music too. In fact the example of Xenakis' process with musical composition through mathematical models – both the specific example of sieve theory as most other models that he used – can provide invaluable insight into how similar issues can be faced in the field of design and architecture. Indeed, architecture and design seem to be trapped in a position where they are unable to escape the homogeneity and determinism imposed by the standards of the computational protocols that they use. Bringing into those processes the 'other' – the non-architectural – might be a way to develop non-linear, unexpected architectural narratives that - even momentarily - manage to escape the omnipresent control of digital design protocols.

One could argue that the key motivation of the work outlined here is to study how mathematical logic can be used in creative processes as a tool that does not dictate the artistic outcome but is simply at the service of the artists' intentions and facilitates them to explore their options, expand their horizons and go beyond the normal procedures. But it



goes beyond that. Mathematical logic – or for that matter any ‘other’ that is employed – operates in parallel with the artists’ intentions; on the same level with them. That way it can transcend the creative process – either musical or architectural – and through an affirmation of its nature and autonomy becomes able to produce results that would have been otherwise impossible to reach.

This paper’s focus has been to analyse the example of the Xenakis’ sieves as a tool to create a unified, global, timeless, and original conception of music that could be used as a method to face (or better control) the industrialization of music. Ultimately however, the purpose of this analysis is the prospect of projecting the Xenakian conception to architecture, hoping that it could be used as a method to control digital protocols. After all, as Xenakis mentions:

*Sieve theory... is applicable to any other sound characteristics that may be provided with a totally ordered structure, such as intensity, instants, density, degrees of order, speed, etc.... This method can be applied equally to visual scales and to the optical arts of the future.*

Xenakis example seems essential, since when bringing outside agents to an artistic composition, like mathematical or digital, there is an impending risk that those agents will impose their rules and protocols on the compositional process. It is, therefore, necessary not to misinterpret the agents of the “other” as a black box that magically produces interesting art. [5] Xenakis understood that, and synthesized a compositional process that benefited from outside agents (both mathematical and digital) to assist him create structures that emerge from the inside, instead of being imposed

from the outside. His process managed to avoid the sovereignty of the outside agents he brought to the process (mathematics), and at the same time, it provided the means to battle the domination of already existing outside agents (industrialization). At the same time, it is important to point out that the ‘other’ - the non-musical for Xenakis, the non-architectural in architecture's case - is not a matter of inspiration neither a matter of legitimization. What comes from the outside of music, or from the outside of architecture, is not a mere stimulus that will trigger creativity neither a universal truth that will explain why things are carried out in a certain way. The ‘other’ is a catalyst, a constructor, that can help each discipline to escape the processes of command in favor of those of autonomy.

In conclusion, if today’s architects want to escape the command of digital design, while continuing to benefit from its advantages, and without replacing digital protocols with new ones (mathematical, for example), a deeper analysis of Xenakis’ process, following the line of thinking that is presented in this paper, can provide a very helpful framework. The way he managed to balance between thin lines separating order and disorder, science and art, time and space, analysis and synthesis and to create a compositional process that does justice to his vision of “arts/sciences alloys” [9], is worth to be further analyzed, translated and projected on other disciplines, like architecture, that struggle with those dipoles.

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