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Iannis Xenakis

Formalized Music:

Thought and Mathematics in Composition

“Art, and above all, music has a fundamental function, which is to catalyze the sublimation that it can bring about through all means of expression. It must aim through fixations which are landmarks to draw towards a total exaltation in which the individual mingles, losing his consciousness in a truth immediate, rare, enormous, and perfect. If a work

of art succeeds in this undertaking even for a single moment, it attains its goal. This tremendous truth is not made of objects, emotions, or sensations; it is beyond these, as Beethoven's Seventh Symphony is beyond music. This is why art can lead to realms that religion still occupies for some people.”

From his autobiography

I have felt a kind of fascination for music that has been with me ever since the day I turned six, when my mother gave me a child's recorder. She began to play it, and it felt as if I had been turned to stone. Then I listened to the radio.

We were living at the time in Romania, and we could receive signals from Katowice, in Poland, where the stations broadcast a lot of music. Classical music, popular or gypsy music, and Church music — Catholic and Orthodox. When my mother died, I went back to Greece with my father, who sent me to a private school that taught the Greek curriculum, together with an English sports education. But what I remember best is the presence of a radio in the assembly room. One day I heard Beethoven's Fifth Symphony, which struck me like an apocalypse. From then I entered progressively into music, by listening to it. I had no idea that I would practice music — neither play nor compose it — since I only decided to compose much later, when I was 17 or 18.

As a youth I had decided to become an archeologist, probably because I was submerged in classical literature and lived amid statues and temples. I had also been lucky enough to encounter a wonderful professor, who initiated me into philosophy and recited verses from Homer that I remember still today. At the same time, I was very interested in mathematics and the sciences, particularly astronomy. I had prepared for the entrance exams to the Athens Polytechnic while also studying physics, law and political science at the University. I also had infinite love for nature. I would bicycle to Marathon. At the place where the battle was supposed to have taken place there was a little tumulus with a bas-relief of

Aristocles, and I would stay there for long periods, absorbing the sounds of nature, the crickets and the sea.

Before reading Debussy, who speaks so beautifully of the wind, Debussy whom I heard much later, I had already felt the same impressions as he. War came and I joined the resistance against the Germans: nationalist organizations, and then communist ones. At the time, those were the only groups that were well structured, and they could demonstrate a sense of total sacrifice. There was a time when perhaps 60 or 70 % of the Greek population had joined the Communist Party, until it committed such political errors that the Right won, and remained in power practically until the Colonels.

During these war years I was often imprisoned. Then I fought against the English, who had demanded that the liberation forces give up their weapons. The English bombed the city with their fleet and aviation, and they even installed canons at the Acropolis, something the Germans had never dared do. It was during this combat that I was wounded.

Even before the end of the war, I had decided, in my distress, to compose music. Only music could help me regain a little calm. At the same time, I was reading Plato. I became a Marxist from that source. I did not find Marx's books very well written, but to me they represented the only roughly contemporary attempt to seek harmony within mankind, as well as harmony between mankind and nature, in a single whole. In any case Marx gave me a sense of contradiction, which is the true driver of the mind and the world — to the extent that in my eyes the fatal sin of Marxism, if I may say so, is its belief that there will one day be a society where all contradictions have disappeared.

I managed to flee Greece. The plan was that I would settle in the United States (I had never, in any case, thought of going to the Soviet Union), and I was still determined to study astrophysics, mathematics, archeology and music. Since my path to the United States went through Paris, I stopped there. True, I spoke French badly, but I did speak it: I had read a lot of classical literature and French novelists, and I knew a number of Hugo's poems by heart, as well as the Pensées of Pascal.

Since I had obtained an engineering diploma in 1947 from the Athens Polytechnic, I looked for a job in that field. I had been recommended to several Communist engineers, but because they didn't give me any work — I have no idea why — I ended up with Le Corbusier. I began with calculations of the resistance of various materials, in particular for Le Corbusier's Housing Unit in Marseilles. This position enabled me to discover the disturbing domination of the technical over the architectural, since I was constantly asked whether such and such a project would stand upright. Occasionally, when I didn't like the project, I would reply, "No it won't hold up. It would be better to build it this way". And people listened. Then one day I said to Le Corbusier, "I'd like to make architecture myself". He accepted, and gave me the project of the Tourette monastery in Éveux-sur l'Arbresle. I drew up all the plans for the monastery, but the final result is a mix of my ideas and Le Corbusier's. As for the Philips Pavilion, I developed it on my own, as Le Corbusier later wrote.

During this period, I sensed the link that is often made between music and architecture very strongly, and their respective influences on me were fundamental. For example, musicians learn at the Conservatory that they must begin by choosing a theme, and from it they create a form, by juxtaposition, expansion, reduction and so on. In architecture the starting point is the terrain, and then appears the program, and within it the necessary functions and forms; then come the materials. So we work from the global to the detail. To me, this movement in architecture, as with music, did not seem entirely natural. I thought it was possible to do it differently.

Le Corbusier too felt this, and said one day to me, "I've made a whole house by beginning with the details". He had drawn a gargoyle, and from the shape of that gargoyle had derived the entire architecture of the house. In reality the two approaches are not contradictory. On the contrary, they demonstrate that as an architect one must deploy both synthetic and analytical thought, just as I instinctively did in music, because of an internal necessity that is common to both arts, whatever the type of music or architecture that one practices. In the same way, I succeeded in transposing certain problems of musical rhythm to architecture, thanks to the undulating glass panes at Tourette, in Chandigarh in India, or at the Brazilian Pavilion at the Cité universitaire in Paris.

Shortly before I left Greece, I had begun to listen to music again: Bartók, Debussy, Ravel, and the Rite of Spring, which moved me almost as violently as Beethoven's Fifth Symphony had. On the other hand, Debussy and Ravel seemed to me to correspond perfectly to the classical world. I then returned to musical studies

in Athens, deciding that I would restart them from the beginning, studying counterpoint, harmony and orchestration. I continued in Paris, where I registered in Honegger's class at the Conservatory. From time to time he would ask his students to present a composition, and one day my turn arrived. I played my composition at the piano. Suddenly he interrupted me: "But there are parallel fifths and octaves — you're not supposed to do that". When I answered, "Perhaps, but I like it", he grew angry and said, "There's nothing musical in this. Perhaps in the first three bars, and even there..." I never saw Honegger again. I entered Messiaen's class, after a brief sojourn with Nadia Boulanger who said to me, "You have a lot of talent but you're too much of a beginner. I'm too old, I can't take you on". Messiaen, meanwhile, began with a statement that annoyed me, "You have a naïve quality". He calmed me down by adding, "Don't be annoyed, I think I am naïve too, and I hope to remain so all my life". He continued, "Don't go back to traditional classes, you don't need them, listen to music and compose". I followed this advice, which confirmed my own inner conviction.

Alongside Messiaen, another important encounter for me was with Hermann Scherchen. Having begun his life playing music in bars, at the age of 16 he decided suddenly to become an orchestra conductor. He then worked with Schonberg, whose first works he presented in a number of German cities. He subsequently devoted himself to promoting contemporary music, founding the magazine Mélos, which still exists. He was, in particular, a supporter of Webern and the Viennese School. When I went to see him I brought with me the sheet music for Metastaseis, which I had just completed. It was the first piece in which I had introduced new concepts in musical composition, with an

orchestra that was completely divided into 65 parts. When he received me Scherchen was lying on his bed, and progressively, as he read through the score, the pages fell onto his nose. His conclusion was, "Your music interests me, because it has been written by someone who comes from outside music. But as usual, there are too many stringed instruments. I'll want you to cut all that. It's difficult to find so large an orchestra". Then he asked me to write articles for his magazine Gravesaner-Blatter.

The first article I wrote was entitled "The Crisis in Serial Music." It earned me the animosity of all the serial musicians of the time, and a solid and enduring wall in every circle that was involved in so-called avant-garde music.

In any case, I will always be grateful to Scherchen, who gave me self-confidence and supported me for years.

At roughly the same period, in the 1950s, I discovered music from outside Europe: from India, Laos, Vietnam, Java, China and Japan. Suddenly I felt I was in my own world. At the same time, I also saw Greece in a new light, as the crossroads of surviving elements from an ancient musical past. Another fertile encounter for me was with Musique Concrète. Whereas in serial music, everything repelled me — its esthetic, which escapes me; the useless exasperation of a romantic music that I love; its constructions, which I find very limited — musique concrète, on the contrary, I found immediately and profoundly attractive. It allowed me to perceive a new world of musical possibilities, which I proceeded to explore without delay. Years before this encounter, when I had bicycled through Attica and visited monasteries in Peloponnesus, I had listened to the sounds of nature and known then, unconsciously, that these sounds had real dignity and

constituted music. Similarly, when I participated in the bloody demonstrations of Athens, we came together soundlessly in the narrow streets to emerge as vast processions in the broad main roads, and as we gradually approached the German command center, rose up a highly rhythmic clamor of slogans. The entire city was filled with this cadence. When we arrived against the tanks and machine-guns that shot at us, the slogans, the cries of the crowd punctuated by the machine-guns, the pounding feet of those who fled, all this composed an extraordinary musical phenomenon. During the cold nights of December, as we fought against the English, I heard another music. It wasn't a pitched battle but a series of skirmishes, in which people took shots at each other from house to house, with long intervals of silence, and each detonation reverberated on and on through the town, accompanied by tracer bullets, which added to the echo the spectacle of gunfire. All these memories would surge up years later in my first composition, Metastaseis, and those that followed.

The work of composing music led me to realize that the main obstacle which a musician encounters is the difficulty of controlling and judging his own inventions. In this sense music is probably the art in which the dialogue with self is the most uneasy. This is why musicians always need to rely on an instrument as a guide, generally the piano, following its invention, in order to hear their score. But the piano didn't permit me to master the new forms that I was conceiving. Thus I turned to modern techniques that might put an end to these never-vanquished limits. Mathematics and computers brought me the answer I sought.

I had for many years noted, as have many others, that there is a close relationship between music and mathematics. Musicians, for example, invented analytic geometry long before Descartes, with the solfège system of musical notation, which is nothing more than a two-dimensional space in which the dimensions are foreign to each other: pitch and time. In the same way, Aristoxenus, in his Elements of Harmony, foretold what modern mathematics have demonstrated: that music is an additive group structure, contrary to the belief of the Pythagoreans who founded their musical theory on the multiplicative property of string lengths. For my part, thanks to mathematics, and notably probability, I was able to go further into the internal understanding of music and also its practice, searching for all the mathematical possibilities of the sound combinations that I invented.

Computer science led me to construct, In the early 1970s, a new apparatus: an analog-digital converter which could be attached to a speaker or to a cassette recorder. It was manufactured for the first time in Europe by the Cemamu (Centre d'études mathématique et automatique musicales, Center for the Study of Mathematics and Musical Automation), which I had founded with several friends. The Upic is an even more advanced machine which means that, thanks to the combination of an electrical drawing table and pencil with a computer and a speaker, anyone can compose music by drawing, and can then correct the drawing after listening to the result. The method is accessible to people who have mastered neither computers nor musical notation, and who cannot play an instrument. So adults and even children can compose their own music without prior apprenticeship, and are able to immediately evaluate what they have created and their taste.

The use of modern technology is not a sudden disruption in the history of music. Music has always been, and continues to be, both sound and number, acoustics and mathematics, and this is why it is universal. Even to express sensuality or emotion, which music suggests admirably well, musicians all over the world proceed by grouping sounds by pitch and by intensity according to mathematical laws that are invariable. But today musicians have at their disposal a range of instrumentation, thanks to computers, whose possibilities are incomparably greater than the classical music chamber, and these possibilities, together with mathematics, mean composers can take their exploration of self to new depths, or can transform our representations of the world to make them more true. It is now possible to deepen and to command a musical intuition in all its density. The musical creator today is comparable to the astrophysicist who investigates of the mystery of the galaxies. But the astrophysicist does not create the galaxies he is exploring, whereas the musician actually produces his, by his creative act. The Diatope is the movement of the galaxies placed within reach of mankind. Music, the daughter of number and sound, on an equal basis with the fundamental laws of the human mind and of nature, is naturally the preferred way to express the universe in its fundamental abstraction. Modern science brings us to a more primeval knowledge of music, and by expanding the imagination of the musician it moves him towards unknown horizons.

The music that I composed for years was thus a sort of dialectical movement between what I was writing as a musician, with my instinct and my senses, and what I was diversifying by a theory-based approach commanded by the computer. But this research,

which was rather simple in its principles, gave rise to a number of misunderstandings. I remember that after a concert at the Musée Guimet, in 1958 I believe, I was asked to give a talk. I began writing down equations, thinking that I would demonstrate how you can make music with new rules, like counterpoint in the past, since that is also a rule that can be framed with mathematics. But many people surmised that since there was mathematics in my music, it must be cold. They paid no further attention to what they were hearing. I was often devastated by this incomprehension. I handled it better once I realized that I will never know what people understand from music. Whatever I place there, consciously and probably also unconsciously, is perceived by the listener in a way that is perhaps not completely different, but sufficiently different in any case that you can never immediately draw conclusions about the meaning or value of a piece of music.

These uncertainties in the appreciation of music are not restricted to contemporary music. I have encountered the same variations during performances of works by the classical musicians I prefer: Bach, Beethoven, Brahms, Monteverdi, Chopin. Music does not transmit a representation in a direct and immediate way. It acts more as a catalyst. The composer chooses his music because it creates in him, via the ear that detects repetitions and symmetries, an effect that promotes expression of his representation. This music then sets off in the listener a psychological effect that may be close to or far from that which the musician has felt. Moreover, music comprises several levels of comprehension. It can be sensual and only sensual, in which case its effect on the body can be very powerful and even hypnotic. Music can also express all the facets of sensitivity. But it is probably alone in sometimes arousing a very specific feeling of

expecting and anticipating mystery, a feeling of astonishment, which suggests absolute creation, without references of any kind, like a cosmic phenomenon. Some forms of music go further, drawing you intimately and secretly towards a sort of gulf where the spirit is happily submerged.

All my experience in recent years has led me to the conviction that the future of music lies with the progress of modern technology. This will affect both how we create and listen to music. I observed this in the performances I created for Montreal, with electronic flashes, for Cluny with the Polytope lasers, and for Persepolis, where the performance took place at night in the ruins and in the mountains, with fires, projectors and children carrying torches. The music became visual, thanks to the use of space. In terms of listening to music, the Diatope created at Beaubourg and then presented in Bonn should constitute an important step. In addition to being an entirely automated musical performance which attempts to further develop my previous work, the Diatope is an attempt to resolve an architectural problem that has always haunted me. I have always been struck by the mediocrity of concert halls, which are not conceived for contemporary music and which are not much better adapted to older music. In Beethoven's symphonies, for example, there is no reason to be outside the sound space. And in general I dislike seeing the orchestra in a frontal position, which obliges the listener to remain outside the music. The concert hall of the Berlin Philharmonic was an attempt to place the orchestra in the middle of the audience, but this interesting idea was not completely realized because in several parts of the hall the orchestra is not audible in its totality. We need therefore to invent the architectural form that will liberate collective listening from all

these disadvantages, and this is what I tried to do with the Diatope. But I expect also that technical progress will have great impact on individual listening. Thanks to computer systems that can be incorporated within the chain of sound reproduction, it should be possible for the listener to regulate individually, at home, the quality of the sound, as well as the volume of the sound space, benefiting from the ability to listen totally or specifically to this or that instrument or instrumental group, simultaneously viewing the image of the interpreters.

There can be no doubt. Thanks to technology, we can be certain that the music of the past, like the music that is yet to come, will be music that has never been heard before.