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Interview with Iannis Xenakis
Author(s): Henning Lohner and Iannis Xenakis
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Henning Lohner
Aha Tonstudio
P.O. Box 10 01 27
5000 Cologne 1
Federal Republic of Germany

Interview with Iannis Xenakis

Introduction

Iannis Xenakis is one of the pioneers of computer music, having developed the ST (stochastic) music composition program in 1962. He has been involved in numerous computer-based projects since then. His book *Formalized Music* (1971) summarizes his work of the 1960s. A more recent survey is available in (Xenakis 1985).

This interview, held in English, took place 17 August 1985 in Delphi, Greece.

Lohner: You started the Centre d'Études de Mathématique et Automatique Musicales (CEMAMu) in the 1960s as a cooperative. What have been some of the important developments at CEMAMu since then?

Xenakis: I founded it twenty years ago when we didn't have any money, with some friends who were mathematicians, statisticians, psychologists, or professors at the University in Paris. Gradually, we evolved and finally we received some grant money, to start with from the Gulbenkian Foundation.

That was more than 16 years ago. In the early 1970s, we produced the first converters in the world with a resolution of 52,000 samples per second and 16 bits per sample. We had to produce sound by programming computers and then storing the samples on digital tape. Then the digital tape was translated by our converter into sound. Later we received more grant money in order to create the UPIC system, with graphic input via a drawing board. The UPIC is linked to a minicomputer, or to microprocessors in the present case. I hope that this development will continue also with the help of manufacturers; their task is to forge ahead in implementation technology and to make it better, faster, and cheaper!

Lohner: To what extent must you as a composer be concerned with the technical details?

Xenakis: In spite of the fact that I did studies of programming and wrote programs myself, of course I cannot immerse myself in the details of electronics. If I had to spend my time doing that, I would never compose anymore! But, I know what direction to go, and if you have accurate and good collaborators, then it works.

I have a team that works with me who are informatics [computer science—Ed.] people and electronic or software engineers. Of course they are aware of what's going on, but nevertheless it would be a very difficult task to produce new equipment in addition to our other projects because it's not our goal here. This is why it is so important to collaborate with a manufacturer who is obliged to go ahead with new discoveries and make them cheaper and of better quality.

Lohner: As a composer who likes to work in both instrumental and electronic fields, how do you see this electronic music work?

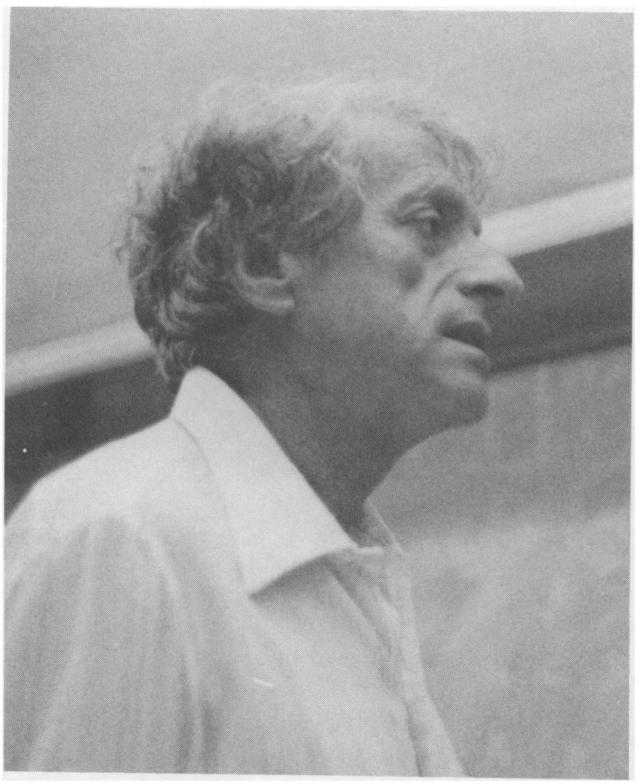
Xenakis: Well, the difference from writing for the orchestra is that in writing electronic music you also have to direct the invention of new tools. With the UPIC at the level of the sound this means sound synthesis, and at the level of musical architectures: how to manipulate architectural structures. Then you must determine which theories are most appropriate and simple to be used in music and sound transformation. They must be usable by everybody in a standard way because that is very important. After all, if you can introduce standard ways, then that doesn't mean you cannot also be specific on your own. A specific approach has to be developed by the composers who are using the systems, but based on something more general, more universal.

Lohner: Here, alongside your writing music, the CEMAMu project comes in. . . .

Xenakis: Yes, the UPIC is a tool that enables one to work in a systematic way on various levels at the same time—which is not the case with instrumental music—and especially not with most computer music so far, when you have to filter your ideas through some theories that might not be the best

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ones, such as Fourier analysis. Although it's a very powerful tool in other domains, in music its use is limited. So you have to invent different theories in order to produce, explore, and create new musical worlds.

With the UPIC you have the potential to enter into the problem of composition in a much more simple and direct way—and by this I mean direct to the mind. That is, you explore sounds on a much larger scale, from the micro or almost micro elements of a sound up to more general architectures.

The system is based on elementary acoustics, that is, acoustics based on a sound signal—a variation of atmospheric pressure versus time. You construct these variations by drawing them. So you have them directly. Instead of superimposing or piling up sine waves, which is the traditional way of synthesizing sound or music by computer, you delve into the other part of that equation. You specify directly the waveform or the shape of the signal versus time, which is much easier—and you can see it and hear the results immediately. But you needn't analyze it on a theoretical basis. Instead of correcting a sound by modifying the program, which is much more complicated and time-consuming (computer waiting-times, etc.), it's much more accessible to just hear the lines and correct them in a much easier way: by hand.

Lohner: Working with graphics has always been close to you, especially through the architectural work you do. Did CEMAMu develop out of the necessity of finding appropriate means of translation?

Xenakis: Yes, except that the UPIC did not come from architecture, but it came from music itself. Because when I wrote for orchestras, some of the things were too complicated to be specified in stave notation. So I had to introduce a graphic notation which, by the way, is also more universal.

Everybody can understand a line, whereas you have to do specific studies in order to understand what the symbols of traditional writing in music mean. If you have training, it's OK, but then there are also complicated things that cannot be discussed or studied with that kind of symbolic and graphic notation; as you know, traditional notation is actually a combination of those two. Beyond that, I think this more universal notation is possible for everybody because it is the end of the hand that creates the drawings. The hand is the organ of the body that is closest to the brain.

Lohner: But automatic functions for rhythmic patterns, for arranging mathematical curves, or for the creation of an envelope transformation are things of mechanical nature that are not possible on UPIC—and this has been criticized by some.

Xenakis: Yes, there are no machines or functions that can do this in UPIC; you need another device that is completely different. But these systems can only do simple things; you can't compose something that is complex and would last a long time. For example, keyboards as a control device are not very sophisticated; continuity doesn't exist with them. UPIC, considered as an instrument, extends to the limits of human perception, utilizing systematic pitch, dynamics, page control, and so on. Decide if you really want to use a tool that is very sophisticated, so that the music itself will be rich,

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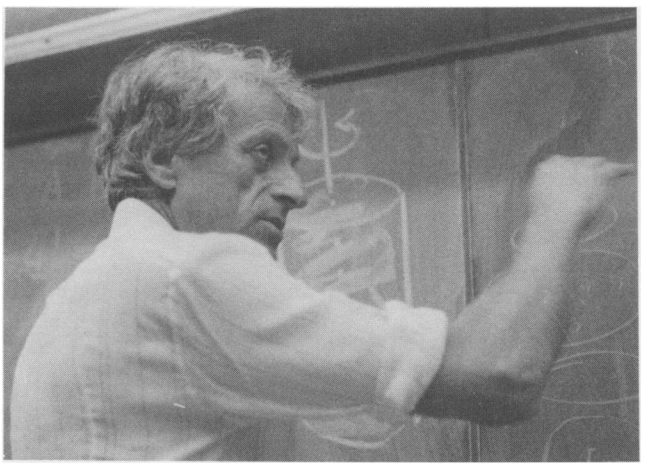
or, whether you are happy with something that is unsophisticated. As far as pedagogy is concerned, these unsophisticated instruments would be harmful: everyone would get used to something that is simple, like pop music. And there's nothing more unsophisticated than pop music. But to add special-purpose machines like this to the UPIC: that's another realm.

Lohner: And what about constantly varying a waveform? With acoustical instruments the waveforms are subject to constant change, which is especially noticeable in different registers. In UPIC these changes don't exist, and many people insist that this should be innate also to electronic instruments for musical reasons. Is there a way of foreseeing (random) variations of intensities, pitches, dynamics, and other sound parameters? And will it be possible on this machine?

Xenakis: This is very important aesthetically. Two things were brought up in this observation: on the one hand, different drawings of waves sometimes produce the same effect. This is well known. The ear doesn't always hear the differences between graphisms (the contour of the waveforms); it only distinguishes different classes of waveforms. It would be interesting to examine this. As for the variation of a waveform or a dynamic envelope, you'd need to have special transformation functions, maybe algebraic or other types with special keys on the drawing tablet itself. This could happen by varying the same function, or it could vary stochastically. For example, presently we can do this by following the same curve that you draw to describe different envelopes. So graphically we have certain ways of achieving variation.

On the other hand, if you want to simulate musical instruments, you have to see what the waveforms correspond to. For instance, if you take the low G tone on an organ, the waveform has a certain complexity. As you go towards the higher pitches, the complexity diminishes until it becomes almost a sine wave, and this you hear. So when you start with a given timbre of an organ pipe, the more you gravitate toward the higher notes, it converges toward the sound of a little flute.

On the one hand, this is valid for all of the instrumental sounds and is due also—probably—to the



elasticity of the materials used to make the instruments. Given the large waves, the rate of air flow, and the dimension of the tube as air passes by the little tongue of the pipe, things are simplified with increasing speed due to elastic inertia. On the other hand, there's also an effect on the ear. In listening, the inner ear simplifies the complexity of the perceived effects. For this phenomenon we don't know very well how the ear functions. We don't have enough technology to test these types of things to see if there is a continuity. Does the ear respond equally to the high notes as it does to the low notes? And does it converge if there's a variation in timbre? Anyway, since the ear is not linear, there is certainly variation in the perceived spectrum or in the perceived waveform. Both are equivalent inasmuch as the waveform is a function of time and the spectrum is the series of Fourier components.

If you wanted to simulate traditional instruments you would have to obtain instruments, study them, record them, class them by sufficiently differentiated registers, and then use them as if they were specific waveforms in various frequencies and intensities. UPIC certainly wasn't made to simulate existing instruments.

Lohner: You have written two pieces for the UPIC machine so far?

Xenakis: Yes, I do too much administration for the UPIC system, so I don't have that much time to work on it. I hope to compose more with UPIC in

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the near future. One of my UPIC pieces is music in itself. It was the first piece to be written on UPIC, made directly with it.

Lohner: *Mycenae Alpha.*

Xenakis: *Mycenae Alpha,* yes. And the other one is called *Pour la Paix* (*For Peace*), based on texts by my wife, who is a writer, with UPIC sounds and also a chorus.

Lohner: How do you feel writing for a machine like this, knowing that it has technical limitations to which solutions are foreseeable in the future? At the time of *Mycenae Alpha,* the mixing function was not yet possible. Did you conceive the piece rather as an etude, an exercise or practice piece that you might change later on?

Xenakis: Sure, there are things tht you can do as an exercise, but if they are good enough, then they are not exercises anymore. They are results. *Mycenae Alpha* I did as a technical exercise, but also as a musical exercise, and I knew the limitations of the machine. I could not do any mixing at all, so I did pages of the score in a way that they could be linked to each other just by timewise juxtaposition.

Lohner: Have you planned any compositions now? Are you going to wait for the next generation?

Xenakis: I am waiting for the next generation of UPIC synthesis, which will be in real time. The sample calculation will be done immediately. That is, as you draw on the page, you would press on the "listen" button and immediately you have the result of the page or any other function or part of the machine that is used for this effect.

Lohner: What sampling frequency will that have then?

Xenakis: It will go to about 45,000 or 50,000 samples per second with 16 bits per sample—for the time being. I hope that it will be extended further within the next year or so to a higher sampling rate and maybe also a better sample resolution than 16 bits.

Lohner: For the moment, the present sampling rate implies alias distortion which is audible because of the extremely large frequency and amplitude range of the instrument.

Xenakis: Correct. In the manufacture of the compact discs, for instance, they use up to 44,000 samples per second, with 16-bit resolution as a standard. For orchestral music, this might be enough, but I think if we want to go farther in acoustical experimentation and also improve digital sound quality, then we have to go on to a higher sampling rate for the kind of music that is much more complex than instrumental music and less recognizable. Other extensions to the UPIC could be simultaneous with this development.

Lohner: Computers in music are very supportive of this line of abstract thought, that is, expanding different dimensions at the same time.

Xenakis: Exactly. This means that you have to control the tiniest events as much as possible, or—when you talk about informatics which deals in numbers—the range and the level of the sample. This is quite a new aspect opened up by computer science.

Lohner: Continuity is a word that has often been used during this conversation. Our views on musical objects have changed in this respect and we are now aware of the fact that we are in a continuous medium.

Xenakis: Yes, we are in a kind of continuum from, say, usual objects that we use in music down to the aspects of music that are inaudible, but which produce these events on a higher level. Computers have brought thought down to that "lower" level. Before it was not possible.

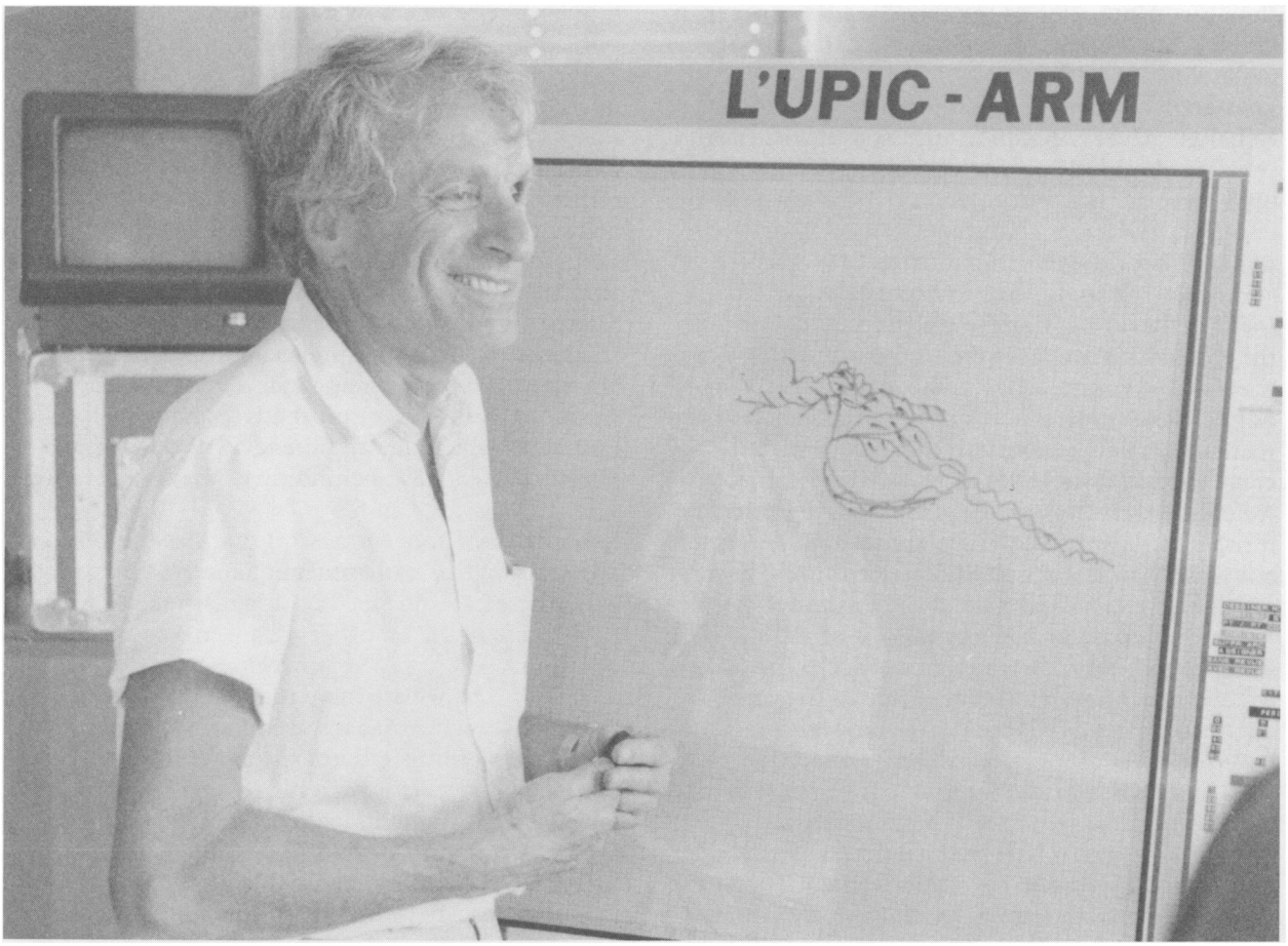
Lohner: Is this awareness reflected in your instrumental music as well as in your projects with a computer?

Xenakis: Yes, because the things that you use, the tools or the ways of thinking which are ascertainable can be applied or used on a much lower level or on a much higher level.

Lohner: How do you decide where the lowest or the highest level is? The other day we were talking about the possibility of having universes beyond the one we know of. When we explore microstructures of matter, and dissect the atom, soon we get to the limits of perception. We encounter a boundary beyond which lies an unknown micro universe.

Xenakis: That's right, but I can't help that. I live in this epoch. These are the tools and possibilities to investigate lower ranges and higher ranges and that's it! I am bound by the technology or the techniques or the thoughts of my time.

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Lohner: Nevertheless you are looking for ways to supersede that condition.

Xenakis: Yes, because this is the way one lives. That is, not only to do what one does, but also to try and understand why and where and what the targets or the aims are, if there are any.

Lohner: For a composer who has consequently gone his own way, what is your motivation to write music?

Xenakis: Well, I write music because it's the way for me to feel less miserable. I would have liked to do other things at the same time, like scientific research or architectural research and so on, but it's very difficult to put them together in 24 hours. It also depends on organizations. Now it's too late anyway because you have to do those things in a continuous way during a whole lifetime.

As I see it, music is a domain where the most profound questions of philosophy, thought, behavior, and the theory of the universe ought to pose themselves to the composer. The role of the musician must be this fundamental research: to find answers to phenomena we don't understand, and to enlarge our powers of conception and action. So it is a perpetual exploration.

Lohner: "Perpetual" is the word I'd like to pick up; isn't that quite in line with Parmenides, whom you've often cited?

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Xenakis: No. Let's just say that Parmenides is in the pure philosophical ontological domain, whereas when you write music you have to make decisions and compromises. There is no doubt about that. Otherwise, you don't do anything. If you admit that the main problem is creativity or originality, that is, doing something new as much as possible—different from what you have received from your environment, if you are not a philosopher, but just a composer, then you have to decide. This in spite of the fact that it might not be absolutely original or new. So it's a perpetual compromise, which is very painful most of the time.

Lohner: Speaking of decisions, what major developments have you planned for this next and following generations of the UPIC?

Xenakis: For instance, we plan to introduce transformation functions for the graphic input with probability calculations and other algorithms. These should be standard and usable by anybody. And in the fourth phase of development, we will introduce image processing. With colors and lines you have a camera that stores the color image in the computer. Analysis by the computer will be a very interesting decoding of this color painting.

In Stockholm 1984 I said that an image processor for a future stage of UPIC is where you could draw or paint a page on UPIC and explore it with a camera. Through a coding system you could transform this exploration into sound, into music. It's very, very difficult to do. For example, take the *Mona Lisa*—almost everyone knows that if you explored it with a camera, the camera would need to read each color type and intensity of color and see what it corresponds to. Each point—each digital point—would have more or less 250 different values: 8 bits. This is an enormous quantity of information in one little point of colored surface. In transforming this, you could put in about 250 values; each one could be structures, pitches, intensities, but also more complicated structures. Each point therefore would open up a fantastic number of possibilities, different ways of coding, depending on how you travel inside the picture. You could explore a type of coding —by lines—and receive music in time. Speed, by the way, is also translated in a simple way, in an automatic way in music. Each line could give you a completely different type of music in correspondence between image and sound.

But this is a future stage which could happen according to the amount of subsidies granted by the government.

Lohner: One would have pens of certain colors, for instance, and composers would be able to write pieces at home, send them in, and they'll be transcribed on an UPIC system.

Xenakis: Yes, yes. It would open up completely new paths in thinking the music all together. This is predictable in a way, precisely because it has never been done before. But nevertheless, it is a new task based on the most advanced contemporary technology that uses image and picture cells.

Lohner: So the idea behind this is to make it more accessible to all people?

Xenakis: Exactly.

Lohner: And another general goal for UPIC is the pedagogical side.

Xenakis: Oh, yes!

Lohner: What are the main points of interest for you and CEMAMu to have the machine developed?

Xenakis: For one thing, we are not trying to make money from it—that's not the point at all. I want to have a tool for myself and for other people that will be general enough to be used in pedagogy, so as to bridge the gap that exists between "normal" people and contemporary music developments. If anybody is able to use such a machine, it will heighten the awareness of the average person who will then be involved in composition also. This makes a much more homogenous environment for music.

Lohner: Every person being essentially creative.

Xenakis: I think so, yes. This is a conclusion I came up with after many years of personal experiences in how people react to music, and what they feel. It also reflects how I feel about them.

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