

Articles

# TECHNOLOGY'S CHALLENGE FOR MANKIND

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XENAKIS [90], "Originality in..."

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## Contents

### Preface

<i>Keichi Oshima</i>	vii
About the Fukushima International Seminar	
<i>Tomonobu Imamichi</i>	ix

### Part 1: The Symbiosis of Technology and Art

Towards a Revitalisation of Nature	
<i>Shozo Omori</i>	3
Originality in Musical Composition	
<i>Iannis Xenakis</i>	17
Mending the Rift between Art and Technology	
<i>Shuji Takashina</i>	25
Mind in Art	
<i>Joji Yuasa</i>	29

### Part 2: Technological Innovation and the Transformation of Society

High-Tech for Whom?	
<i>Ronald P. Dore</i>	41
Keeping Track of Progress	
<i>Nigel Calder</i>	47
The Proficient Community	
<i>Arthur L. Sullivan</i>	55

## Originality in Musical Composition

Iannis XENAKIS  
*Composer*

The problems encountered in the composition of music could apply equally to architecture, or painting, or even science. When I make a gesture with my hand, I am performing an action that I have done millions of times in my life. If you ask whether it is the same gesture, the answer would be that it is and, again, that it is not, since two identical gestures do not exist and they cannot have the same identity. This relates to the matter of identity and non-identity, to existence and non-existence, which has been discussed by such philosophers of the ancient world as Heracleitus and Parmenides, and even by the Buddha. And this forms one of the principle frameworks that guide our daily lives, throughout our life, down the generations, and throughout the history of mankind. Identity is something that may be said to be always the same, yet it is somehow not the same.

This idea is fundamental to music, and we may call it "variation". An example of this idea in music may be found in the discovery in the Renaissance of four ways of repeating a melodic pattern without it being the same. Figure 1 shows a melodic pattern consisting of pitch and time. There is first one sound, or pitch ( $\alpha$ ), then another, higher pitch ( $\beta$ ), and finally a pitch that is between the first two ( $\gamma$ ). Instead of repeating exactly the same pattern (A), invention consists of, first, reversing it (B), then inverting it (C), and, finally, reversing the inversion (D). So here we have four forms, or four transformations, of one original pattern, and they are the same, but they are also different. You

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Klein

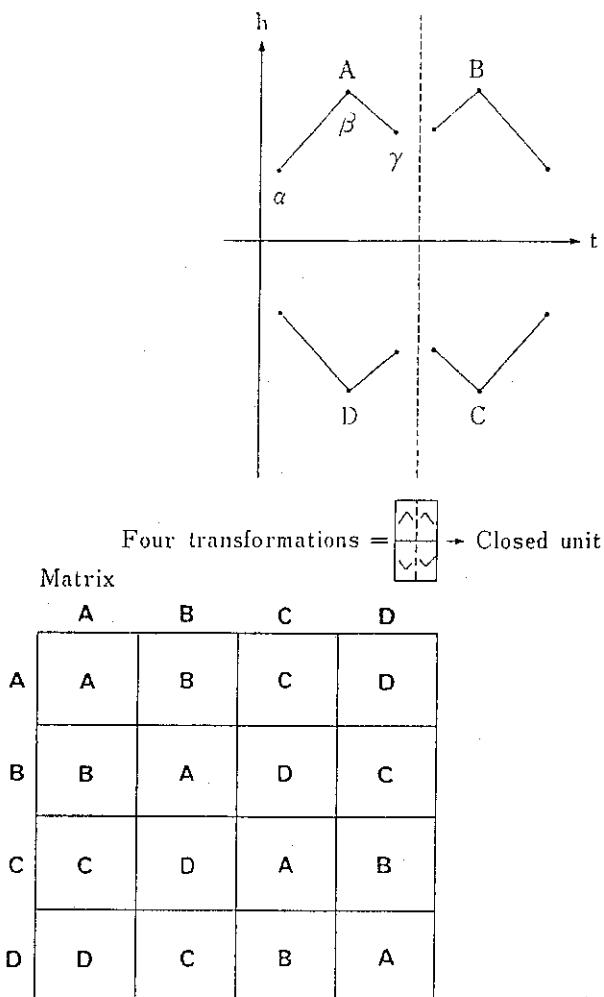


Figure 1

can also combine two of the transformations to produce another one.

The four transformations of a melodic pattern form one closed unit. It is the group structure of the four rotations of a rectangular plate, and its abstract matrix corresponds to the "four group" as coined by the German mathematician Felix Klein (1849-1925). This is one way of

*C* achieving variation, and when it is outside time, as here, its symmetry in space is evident. When it is within time, it is called periodicity.

One important aspect in music, in art and in science—in fact, in every field—is copying. Copying or stealing the idea for an invention from someone else and then using it as though it is your own is plagiarism and it is the bad aspect of copying. However, let us look at plagiarism, or copying, at a deeper, more interesting level. Human beings, like all other beings and matter such as particles, never behave in exactly the same way, and plagiarism is essential to man for the creation and invention of new things. Perhaps this not only pertains to man but also to nature. The evolution of plants has taken place over millions of years, and mankind has evolved even faster. Repetition, or copying, was with us in the past and is still important now, and it involves the idea of causality and of determinism and non-determinism.

Limitations of space prevent us from dealing here with all the philosophical and scientific aspects of this, but I would just like to mention Heracleitus. From his fragmentary extant writings we learn that he thought that everything is in a state of constant flux, and “upon those who step into the same rivers, different and ever different waters flow down.” In other words, it is impossible to cross the same river twice because it has changed. So the idea that we are changing all the time implies the idea of being and non-being at the same time. This idea of absolute determinism was extremely important in the ancient philosophies of the Stoics and the Epicureans and has been transmitted to us by Lucretius.

This topic became fundamentally important in quantum mechanics with the indeterminacy, or uncertainty, principle, which opposed people like Einstein, Heisenberg, Pauli and Dirac. Another aspect of this which relates closely to music is the fact that there is no deterministic movement. Today, following the work of Poincaré, we have the so-called strange attractors. These are also a part of physics, of astrophysics and of music, too.

To invent things means to change. We might say that the extent of the difference in the change reveals the degree of originality. However, in order to be conscious of the difference, it is also important to know the past. The originality of the past may be found in tradition, and tradition represents the originality of the past. It is as important as the

originality which you are creating today and which you will create tomorrow.

However, to know the past and to understand it is difficult. What does understanding the past mean? What does understanding the world mean? Again, we may recall Heracleitus, who said that we know and we don't know, we can know and we cannot know. Another approach is that of the Buddha, who said that Enlightenment is understanding things differently from the way ordinary people see the world, and seeing the contradictions, such as what is right, what is unjust, what is life, what is death?

Ultimately, composition means to do something which is different. How much difference can we put into music? Of course we have to try to understand something that is absolute. Of necessity, originality obliges, indeed forces, us to conceive of a universe which is different from ours, in its totality as well as in its details, and which cannot be reached by man. Because of this necessity, we must confront the whole spectrum of thought in our sciences, whether pure science or social science, because there are overlaps and similarities. Thus, in the deepest sense of the term, musical composition involves questions of theoretical or experimental physics, genetics, psychology, pure and applied mathematics and so on. For instance, if genetics is a tremendous factory for combining things, both deterministically and stochastically, it is only reasonable that musical composition devote itself to penetrating it. Music may consist of distinct and continuous phenomena as in traditional Japanese music. For Japanese music does not have the fixed sounds of Western music, or rather which Western music used to have, but, instead, the sounds move up and down according to feelings. It is very close to genetics, which deals with distinct cases, or quantum mechanics, where one can imagine and make sound particles which spin and are defined by group structures like subatomic particles, not in order to imitate but in order to make the thing free itself. This is perhaps the Enlightenment alluded to by the Buddha, or what Heracleitus meant.

From another perspective, we have seen that composition stems from originality, which is defined by rules and laws outside the memory of individual men and even of the human race. Up to now, we have not dealt with the notion of a rule or a law. A rule or a law signifies a final or

idea of Parmenides, I was able to say, "To be means also not to be," which is a paraphrase of Parmenides.

In a universe of nothingness, a brief series of waves—so brief that its end and beginning coincide—denies time, disengaging itself endlessly. Nothingness resolves and creates, creating existence, and even time and causality. It was thirty years ago that I started to think about musical composition in a deep and primordial way, and I came to the conclusion that a stochastic approach is just such a kind of free originality.

Figure 2 is a musical composition based on the probabilities of the stochastic laws of Siméon-Denis Poisson (1781–1840), of exponential distribution, of linear distribution, of Gauss distribution, and it is not music produced by computer. I had no computer at the time, but it comes to the same thing since the computer is only a tool, an instrument.

In this figure you see the distribution of events according to Poisson's law.  $\square$  is the zero event, no sound at all. The others are all unit events, a collection or cloud of sounds.  $\square$  is one event,  $\square$  is two events,

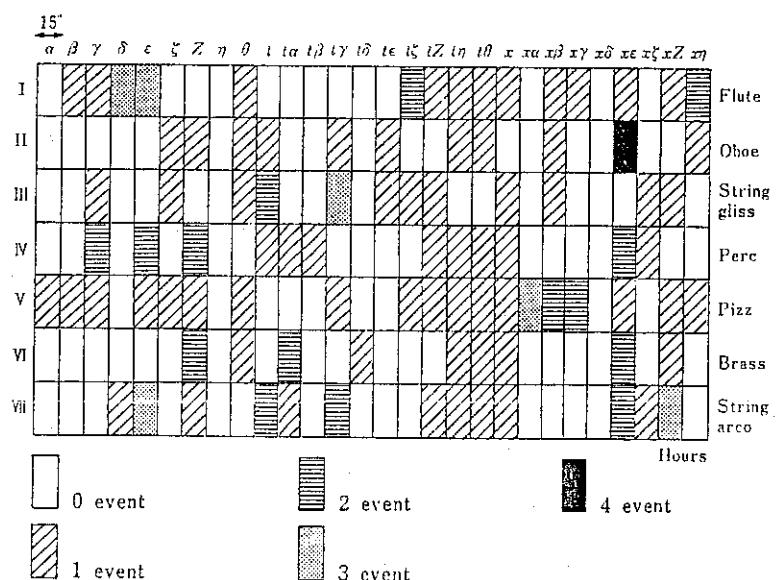


Figure 2

or double, which is much denser. And  is three events, or triple. Finally, there is , which is four events, or four times. This is a composition created without a computer, approaching non-causality and, finally, the idea of freedom. It combines things to achieve freedom and to start something from nothing. It is the highest degree of freedom, which God alone possesses.

Recently, with regard to the expanding universe, the "Big Bang", there has been some serious speculation as to whether the actual creation of the universe can be explained by physical laws. In this view, the universe originated as a quantum fluctuation starting from absolutely nothing. The idea was first proposed by Edward Tryon of New York's Hunter College in 1973, and it was put forward again in the context of the expanding model by Alexander Vilenkin of Taft University in 1982. The expanding universe was created in  $10^{-50}$  of one second, and this is a very interesting explanation of what happened. In this context, nothing might refer to empty space, but Vilenkin uses it to describe a state devoid of space, time and matter; it is not just devoid of space but devoid of everything.

Quantum fluctuation of structural space/time can be discussed only in the context of quantum gravity, so these ideas must be considered highly speculative until a working theory of quantum gravity is formulated. Nevertheless, it is fascinating to contemplate physical laws that may determine not only the evolution of the present state of the universe but also the initial state of the observable universe.

I end up this lecture with the following citation<sup>1)</sup>:

"... From a historical point of view, probably the most revolutionary aspect of the expanding model is the notion that all matter and energy in the observable universe may have emerged from almost nothing. This very new claim stands in marked contrast to centuries of scientific tradition which believed that something cannot come from nothing. This tradition, dating back as far as Parmenides in the fifth century B.C., has manifested itself in modern times in the formulation of a number of laws which state that certain physical quantities cannot be changed by any physical process. A decade or so ago, the quantities thought to be conserved included energy, linear momentum, angular momentum, electric charge and baryon number, which is the number of protons or neutrons and nuclei. And if unified theories are correct in the predic-

tion that the baryon number is not conserved, there is nothing to prevent the observable universe from having evolved out of nothing. The expanding model of the universe provides a possible mechanism by which the observable universe could have evolved from an infinitesimal region. It is attempting to go one step further and speculate that the entire universe evolved from literally nothing."

Originality and its links to other fields of activity, especially astrophysics, interests us so much because we are the products of the universe.

- 1) "The Inflationary Universe," by Alan Guth and Paul Steinhardt, in *Scientific American*, May 1984.