

Introduction

An objective need

Patrick Greussay started his doctoral thesis [5.12] with the question "are there problems in composition and in musical analysis?"

He reminds us that a question is formal when the form of the answer is given at the same time as the question, that is to say, when, independently of the answer, we have the criterion of the acceptability of this answer.

Otherwise, the question is informal.

He also notes that a question is considered objective if the answer has the ability to appease the intellectual concern that was behind the question.

In his article "vers une philosophie de la musique (towards a philosophy of music)" [2] Iannis Xenakis praises reason, not as the faculty of sequencing mechanisms of thought, but as a curiosity; the need to express questions.

Orphism posited that the human soul was a fallen god, and only the leaving of the self (ec stasiV) (ec stasy) could reveal its true nature and recover its lost superiority through purifications, thereby escaping from the "wheel of births" (trocoV genesewV), that is to say from the fatality of reincarnations in the animal and plant worlds. I quote this doctrine because it opposes, in a certain fashion, the idea of cycle, closed circuit, and that of self-escape or the breaking free from the self.

All of music oscillates between these two poles:

the trance born of the infinite repetition of the same figures (Dionysian)

and the constant search for the unknown (Apollonian).

Now, by analogue with language, the whole of musical "semantics" is founded on the incarnation of structures, materialised at the level of syntax by the relations between the parameters of the sound. These structures, more interior than the explicit signification (the signified), may be considered, if they are chosen with discernment, like kernels of pure thought that are translated into sensations when they traverse the physical world.

Born of the fetishist belief that it originated from sensation itself, music is in fact, in my opinion, the acoustic solicitation of psychic mechanisms of that are essentially temporal which react usually to perceptions and to their implications for the emotions. Each time the creative imagination of the composer led to innovation, that innovation was initially qualified as madness or incommunicability. We shall therefore set out to pin down the abstract forms, with the means we have at our disposal, trying to locate fragments of these nodes of pure thought to which I alluded previously.

In choosing the questions to which I try to find the answers, I will endeavour to express them in a formal manner, it being understood that at one time or another, they have had, have or will have an objective nature for me and, I hope, for you.

Formalisation

All music is organised time.

When we feel it as such, it is because it contains correspondences with certain patterns in our own physical-psychic organisation; we intuitively accept, in variable scales of time, what it is proposing to us; it confirms certain paths we recognise or activates some others that we have the desire to explore further.

The scale of time is important here. An isolated sound, whether simple or complex, can touch us through its timbre, plastic contents, for instance, a chord on the vibraphone. This is the ear's pleasure at naive definitions, a certain form of sensuality. If several of these sounds are organised into a figure, according to a pulsation or beat, it may, in some cases, seem familiar to us, we may even memorise it (think of the song) or it may evoke in us some kind of movement that is both new and expected, that Pierre Boulez summarised in the famous expression "the unforeseeable becoming necessity". But beyond a few seconds, unless we are satisfied with a sort of repeated confirmation, our acceptance, if it persists, changes in nature. The correspondences that are established escape the immediate present, and imply a kind of "operation".

If we wish, in our turn, to become a "source of music", and have mastered the means, whatever they may be, for producing sounds, we must make this integration outside the present explicit, in any case for ourselves; we must imagine proportions, transitions, perhaps even constants; in a word, we must formalise structures. This formalisation may be translated in the form of graphics, diagrams or conventional sheet music according to each person's conception, but the final form must be transcribed in symbols that are understood by the performers who shall reproduce it.

It is this area between conception and performance that I intend to explore here, trying, whenever possible, to situate the tools and methods afforded us by recent developments in information processing, but also all the formalisms that may be of use to us, in particular mathematics.

The innovations of contemporary music

Let us suppose for the moment that traditional music, roughly up to the 19th century, is known. This is a false supposition, and we shall come back to it, in so far as the analysis of a Mozart symphony or a Bach fugue leaves a great many questions open.

We can, however, give a clear definition of a good part of the basics and of the language used. Let us look, therefore, in a body of recent works or experiments, for the range of the principal innovations that can be typified.

We shall group them together into 3 categories in increasing order of degree of abstraction:

The means of sound production

Symbolic musical materials, that operate a selection in the infinite range of possible sounds and group them together according to notions of total or partial order.

The new conceptions of form in the global sense

Let's take up these three categories again and make them slightly more explicit:

1 - The means of sound production first of all:

- The search is carried out at the level of an unexpected use of traditional instruments - such as Vinko Globokar's trombone or John Cage's prepared piano.

- The incorporation of all vocal phenomena issuing from natural expression and perhaps even exceeding it: laughter, clucking, onomatopoeic sounds, murmuring, sounds made by the mouth. See

the soloist in *Momente* by Karlheinz Stockhausen, or *Sequenza numero 3* for voice only by Luciano Berio.

- The use of the principal electro-acoustic and electronic techniques: and here, there are two different ways:

- Capture of surrounding sounds (musical or not), either for a pure and simple assembly, or to transform them through operations ranging from the simple (filtering, mixing) to the complex (ring modulation, frequently used by Stockhausen)
- Creation of synthetic sounds, whether or not they can be reduced to a determined pitch, already vulgarised in light music by synthesisers, but which, through the use of the computer, can be extended to the discovery of as yet unheard sounds (see the work of Jean-Claude Risset).

- Another significant fact is the advent of percussion, that is to say of complex timbres with transient resonance, in both:

- determined pitch instruments, among which are the vibraphone, marimba, bells and even the piano.
- undetermined pitch instruments, which can roughly be divided into metallic percussion instruments such as cymbals and gongs, and skin percussion instruments: drums, tam tams, various sound boxes, to which have been added a large number of exotic instruments such as maracas, rasps, bongos, etc., and lastly, by extension, all the materials that can be used to produce sound.

Anyone who has heard the Strasbourg percussion orchestra will have an idea of the extreme richness of this new palette.

2 - The second category deals with new musical materials or scales of pitch or duration.

What I mean by this; in the actual range of sounds, for example, is the subdivision greater than the chromatic of the sound scale ($1/3$, $1/4$, $1/6$ tones), or based on a subdivision different from 12, an extension that is only accessible using complex technical means.

To this subdivision, which is only used sporadically, should be added the creation of defective scales (that is to say that do not use all the sounds listed) and that operate as non repetitive modes over the entire audible range; they can be obtained by means of mathematical operations using set theory - we shall come back to this.

Furthermore, these new means have a tendency to modify, or even abolish the hierarchy traditionally established between sounds based on simple numerical ratios: octave, fifth, fourth, etc.

In the category of durations, superimpositions of first durations among each other have appeared, or even of durations that are not measured according to Boulez, due to the use of long values.

3 - The third category of innovation relates to the global form of works:

Related to the evolution of scientific theories and the concept of system, emerged a notion of variable form that can be assimilated to a trajectory in an oriented graph; the number of solutions is therefore limited and can be more or less controlled, as in Boulez (*3e sonato* for piano).

To be significant, it assumes the establishing of a mathematical model. We can attach to it the statistical control of large numbers of sound events, dear to Xenakis.

The next stage is the open form, which is produced by partial notation, which pre-supposes the active participation of the performer and for which the solutions are countable, but infinite, as in *Archipels* by Boucourechliev.

Even greater detachment leads to the notion of the random, or accepted chance, as developed by John Cage, the last stage in the sharing of responsibilities being group improvisation.

Stages of a formalisation

We shall now attempt to define the stages required for the conception of a musical work

- The first intuition is that of a global model, a sort of incomplete interior representation which comprises proportions, implicit or explicit operations on sound entities traversing fields, and their interactions.
- This stage assumes a certain number of hypotheses about the final realisation: fixed form, leaving a maximum amount of liberties in interpretation, or open form and its degree of openness, type of instrumentation (traditional, electronic, computer output).
- The fields are to be characterised in a multidimensional musical space comprising:

a) For the pitches of the sounds:

- Either a localisation in frequency bandwidths
- Or a selection of sounds in a discrete number, within which scales are organised and communicate with each other.

b) For timbres and their dynamic:

- If the sounds are of determined pitch, an order sequencing of the instruments to be used
- If the sounds are complex and already known (instruments or objects used for percussion, recordings of actual sounds, synthetic sounds), an inventory of these sounds and of the transformations to be applied to them.
- For new sounds we wish to synthesise (as yet unheard sounds), prior work is required to define them. However, it is difficult to have a global intuition of a work, the sound material of which is not already in memory.

c) For the durations:

Perception of the degrees of mobility of the sounds in the proportions of the model (minimal fixed unit or fluctuation of the tempo).

Different subdivisions of a same macro-unit of time.

Note that new techniques, in the same way as returns to more traditional modes of notation, appear regularly. Let us mention the spectral approach, whose principal proponents (Hugues Dufourt, Gérard Grisey particularly) have adopted personal variants, and which continues to evolve according to the experience of each proponent.

The fixing stage consists in specifying, in notation that is as economic as possible,

- the basic entities and the operators that ensure their modes of trajectory through the defined fields, as well as their interactions.
- the modes of local application of the operators to the entities, which pre-supposes continuous criticism and correction of the data, most often by successive iterations.

Note that, here again, all variants are possible, from traditional notation to real time recording and all types of intermediate combinations and collages.

The final stage is the performance of the work, for an audience or a recording take.