

Opening Address

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Since the Second World War, computer science has invaded the domain of human activities. The arts, and in particular music, have not been overlooked by this tidal wave. Slowly in the 1950's, then accelerating, the computer and its peripherals have been spreading like mushrooms in the centers of musical activity, upsetting the attitudes of composers to a far greater extent than did the revolution of the tape recorder which originated the first physically permanent memory of sound—to such a point that the danger is great of letting oneself be trapped by the tools and of becoming stuck in the sands of a technology which has come like an intruder into the relatively calm waters of the thought in instrumental music. For we have already a long list of attempts at composition by the computer. But what is the musical quality of these tries? It has to be acknowledged that the results from the point of view of aesthetics are meager and that the hope of an extraordinary aesthetic success based on extraordinary technology has been cruelly deceived. Indeed little of this music goes beyond the recent rich findings in instrumental music or even beyond the babblements of electronic music in the 1950's.

Why? In my opinion, the reasons for these failures are multiple, but we can signal out two essential ones:

(a) The musicians using computers are cripples in general theoretical ideas, especially in mathematics, physics, and acoustics. Their talent, whenever it exists, is powerless in penetrating the virgin domain where only abstract thought would be capable of guiding their experimental attempts, and it grasps but shadows.

(b) The scientists having access to computer technology are sucked in by a sort of inferiority complex in front of the aesthetic aspect of music and, not having had to struggle on the aesthetic plan, are inexperienced and lacking and have no idea where they should be heading. Consequently, they fool around with mathematical and technical gadgets with the net musical result of very little, if any, artistic interest since they are not able, do not know how to employ talent when they have it. In these two cases, artistic talent, as it can clearly be seen, plays—and must play—a determining role.

To escape from these impasses, the remedies are obvious: The first category of musicians should make an apprenticeship in the necessary sciences and the second category should plunge into the delicate questions of talent and aesthetics constantly confronting them. But this will not suffice. It seems to me that the moment has come to attempt to penetrate more profoundly and at the same time more globally, into the essence of music in order to find perhaps the fields of forces subjacent to technology and scientific thought as well as to music. I am going now to confine myself to sketching one single line of approach—because there are many—which appears to me to be very important. As an illustration of my thought, I take only two levels of music—the macroscopic and the microscopic.

On the macroscopic level—that is, on the level of the macroform—I will look, as did Anteus, for an example in the musical heritage. Let us examine the essence of the fugue, which was a fundamental success in the evolution of musical thought.

The fugue consists of at least one "subject" which is an in-time succession of pitches taken from an ordered ensemble which is called a scale. The subject is then "imitated" more or less faithfully, and thus the answers are obtained. Then the countersubject or subjects intervene which must be different from the subject. The countersubjects themselves are then imitated more or less faithfully. These operations constitute the developments of the fugue, among which, as a particular case, is the *stretto*. To enter more abstractly into the heart of the fugue, I will rebaptize its constituent elements as well as the imitation as follows: "subject" will become "entity," "imitation" and "operation of repetition or renewal," and "countersubject" an "anti-entity." We can see quite well that the whole mechanism of the fugue may be summarized roughly by the periodic reproductions of some entity and some anti-entity. I use the term "periodic" here in the broad sense, reserving the expression "periodicity in the strict sense" for the faithful, identical reproduction of the entity. Therefore in the broad sense the term "periodic" includes all reproduc-

tions, varying more or less from the entity. These variations can even become very large to the point of total disorganization of the entity, indeed, to its destruction.

The first obvious conclusion from this is that the modalities of the reproduction of the entity and of its anti-entity form a set of rules and laws. In fact, the notion of a rule or law is inconceivable without the notion of renewal, or periodicity (strict or large). A second conclusion follows: the starting entity is somehow confronted with itself by the operation of reproduction, of renewal. It is this operation which establishes the existential permanence of the entity, which, without the operation, would constitute a unique event in the infinity of time and space therefore logically impossible to imagine and which would be, somehow, unable to be engendered. A third consequence can be drawn: the identical reproduction of the entity is outlawed in general. On the other hand, the entity modified more or less strongly (until it reaches the anti-entity) becomes indispensable. In psychology, it is the fear of boredom that calls out for variation in periodicity. In philosophy, the variation of the entity in its periodicity may be seen as the partial or total negation (through excessive variation) of the proper entity. But this negation has, in fact, a second positive function: to reaffirm the entity by its more or less complete destruction. The child or the researcher breaks the toy or object to see how it is made.

The essence of the fugue's structure recalls forcefully the principle of heredity which is also, roughly speaking, based on the entity of molecular helices which reproduce, but never identically, thereby engendering the wealth of life on earth from the procaryotes until man, passing through all the species of animals and plants which have lived during the some three billion years already spent. These facts show to what point musical thought is plunged into the cosmos and that it is even in the forefront of the scientific avant-garde; in the case of the fugue, it precedes abstract automata and genetics.

On the microscopic level—on the level of the micro-form—I will take as example the nature of sound. In a steady state, a held sound may be described by a curve within a two-dimensional space—atmospheric pressure versus time—whose form is identically reproduced (therefore at regular time intervals). This curve is an entity which would not be heard, except in certain cases like instantaneous noises, if it were not reproduced a sufficient number of times in a given time span. A curve without renewal will not be perceived by our ear and mind which act like a sort of very complex detecting machine adept at recognizing the operation of repetition and even at measuring it instantly, since one is capable of telling the pitch to which corresponds the density of reproductions per time unit, that is, the frequency.

Now, here also on this microscopic level, the identical reproduction bores the listener, the reason for which musicians, intuitively, try to introduce variations in successive reproductions of the entities, that is, to establish a periodicity in the broad sense. The failure of the electronic music coming from classic studios with synthesizers or studios outfitted with computers derives also in large part from the incapacity of technicians and composers to understand very well the fundamental nature of music, even on the microscopic level of sound, a nature which can be summarized by the notion of periodicity in the broad sense. The violinist, by intuition, varies the starting sound entity in a very subtle manner, and, if he is talented, he "knows" how to do it in a highly effective

way. The technician or scientist lacking this aesthetic intuition of beautiful sound will naively fall back on the theory of harmonic analysis, which is emphatically founded on periodicity in the strict sense, and will produce results musically stillborn.

We can observe here to what extent the notion of the entity and of its survival by periodic reproduction in the broad sense is fundamental and profound to these two levels of music, the macroscopic and microscopic. This observation is equally relevant for the intermediate levels in music.

Grasping these basic notions firmly in our hands, we can now continue in the following manner: let us suppose that the reproduction strays more and more from the entity of origin, in other words, that the deviation is applied at the same time to all parts of the entity. The entity will be pulverized into a statistical cloud of constituent elements. On the macroscopic level, we will have an amorphous cloud of sounds, rhythms, timbres, dynamics, etc., while on the microscopic level we will obtain a Brownian curve which will be perceived as white noise. So we are introducing here the stochastic element as the limit of periodicity in the wide sense; in other words, renewal of the entity and at the same time a greater and greater negation in the reproductions.

At each reproduction, the entropy of the entity increases according to a certain delta; that is, the information about the entity degrades partially at each renewal, irretrievably. Now it becomes the job of the composer to master, with intuition and reason at the same time, the doses of these entropy-deltas circulating through all the macro-micro-intermediate levels of the musical composition. To put it in other words, one establishes the entire range between two poles—determinism, which equals strict periodicity, and indeterminism, which equals periodicity in the large sense. It is this that is the true keyboard of musical composition. Thus we emerge in a domain of multiple scientific and philosophic resonances. The continuity and discontinuity of the mathematicians and of the time-space of quantic physicists are such resonances.

To show to what extent this duality, that is the entity and negation of the entity by varied reproductions at each step, is important, I put forward the following question in the specific case of sound synthesis by computer and digital/analog converter: how can one obtain a rich, living, unheard of sound? Does one start from an entity and its reproductions into which are injected through probabilities variations creating greater and greater deviations from the initial entity and going all the time towards a stronger negation? Or, on the contrary, should one when starting, in the time-pressure space, from an absolute negation—in other words a Brownian curve containing absolutely no germ whatsoever of an entity—inject more or less varied reproductions of fragments of this curve in such a way as to engender progressively or explosively a notion of an entity which would correspond to, at the best, an unheard of, rich, living sound? In the first case, one would define the starting entity by strict periodic functions (trigonometric, for example) stacked or adroitly combined, then inject probabilistic perturbations at each reproduction of the entity. For the second case, one would define a set of functions of probability functions describing a specific Brownian movement which would thus constitute a furthermost negation, then one would inject there reproduction laws for connected or unconnected fragments of the Brownian curve to go toward the definition of the entity corresponding to these laws. These are

two pathways, opposite and symmetric, which answer the question of a rich, living, unheard of sound. Naturally there is no exclusivity of one pathway over the other and the results can be extremely interesting and strikingly different in the two methods.

Here is again, this time in philosophy, another expression of this universal duality formed by the entity and its negation, the duality of the conflict opposing the thesis of Parmenides to that of Heraclitus. Parmenides, in interrogating his reason, did decide that the Being must exist always and everywhere, homogenous without variation. Heraclitus did decide that nothing is immutable, that everything changes. Thus expressed, these two positions are not compatible. They become compatible, however, if one decides that the Being of Parmenides is the entity which we have invoked at the beginning. But an entity which would not last—as if time were formed of strings of cells and that the entity inscribed in this bounded set of cells would not be able to avoid disappearance, death, once all the limits were reached except in exchange for an imperfect reproduction. Then the perpetual change of Heraclitus is precisely realized by the reproduction of this entity in a periodicity in the large sense. Thus in this way, the Being of Parmenides conserves its integrity in the entity but is stained with temporal, spatial, and homogeneity limitations. Change, in general, cannot be instantaneous and total but is obtained progressively by periodicity which is

synonymous with varied reproduction although it can be explosive at times. The universe of genetics is a beautiful and clear incarnation of this marriage between Parmenides and Heraclitus. Music is another.

It is evident that my remarks are not pessimistic. On the contrary! A critique accompanied by new propositions that must be verified lifts the mind and forces one to take up the challenge, for, finally, it is only results that count. Unfortunately, in the case of the arts, there are no recipes for success. Only the intuitive appreciation of man and of his collectivities establishes truths which are nevertheless provisional. Everything happens as if the artist took man, or the societies of man, for a guinea-pig and his artistic works for dissection instruments or for drugs. But this particular guinea-pig, as opposed to the real ones, does not die in the unsuccessful case. Rather, it is the artist's work which disappears. In general.

Never in all the history of music from all times and from all countries has the amalgamation of original theoretical vision, on one hand, and artistic intuition, on the other, been so constraining a necessity as today, at the hour of this birth of a new field of sonic creation founded on the flower of technology and the spirit of man.

I wish that this idea will guide the work of this colloquium. I wish for it the best.

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