this theory and its widespread use with the help of computers, for it is entirely mechanizable. Then, in a subsequent stage, there will be a study of partially ordered structures, such as are to be found in the classification of timbres, for example, by means of lattice or graph techniques.

Conclusion

I believe that music today could surpass itself by research into the outside-time category, which has been atrophied and dominated by the temporal category. Moreover this method can unify the expression of fundamental structures of all Asian, African, and European music. It has a considerable advantage: its mechanization—hence tests and models of all sorts can be fed into computers, which will effect great progress in the musical sciences.

In fact, what we are witnessing is an industrialization of music which has already started, whether we like it or not. It already floods our ears in many public places, shops, radio, TV, and airlines, the world over. It permits a consumption of music on a fantastic scale, never before approached. But this music is of the lowest kind, made from a collection of outdated clichés from the dregs of the musical mind. Now it is not a matter of stopping this invasion, which, after all, increases participation in music, even if only passively. It is rather a question of effecting a qualitative conversion of this music by exercising a radical but constructive critique of our ways of thinking and of making music. Only in this way, as I have tried to show in the present study, will the musician succeed in dominating and transforming this poison that is discharged into our ears, and only if he sets about it without further ado. But one must also envisage, and in the same way, a radical conversion of musical education, from primary studies onwards, throughout the entire world (all national councils for music take note). Non-decimal systems and the logic of classes are already taught in certain countries, so why not their application to a new musical theory, such as is sketched out here?

Chapter VIII

Towards a Philosophy of Music

PRELIMINARIES

We are going to attempt briefly: 1. an "unveiling of the historical tradition" of music,[1] and 2. to construct a music.

"Reasoning" about phenomena and their explanation was the greatest step accomplished by man in the course of his liberation and growth. This is why the Ionian pioneers—Thales, Anaximander, Anaximenes—must be considered as the starting point of our truest culture, that of "reason." When I say "reason," it is not in the sense of a logical sequence of arguments, syllogisms, or logico-technical mechanisms, but that very extraordinary quality of feeling an uneasiness, a curiosity, then of applying the question, ἔλεγχος. It is, in fact, impossible to imagine this advance, which, in Ionia, created cosmology from nothing, in spite of religions and powerful mystiques, which were early forms of "reasoning." For example, Orphism, which so influenced Pythagorism, taught that the human soul is a fallen god, that only *ek-stasis*, the departure from self, can reveal its true nature, and that with the aid of purifications (καθαρμοί) and sacraments (ὄργια) it can regain its lost position and escape the *Wheel of Birth* (τροχός γενέσεως, *bhavachakra*) that is to say, the fate of reincarnations as an animal or vegetable. I am citing this mystique because it seems to be a very old and widespread form of thought, which existed independently about the same time in the Hinduism of India.[2]

Above all, we must note that the opening taken by the Ionians has finally surpassed all mystiques and all religions, including Christianity.

English translation of Chapter VIII by John and Amber Challifour.

Never has the spirit of this philosophy been as universal as today: The U.S., China, U.S.S.R., and Europe, the present principal protagonists, restate it with a homogeneity and a uniformity that I would even dare to qualify as disturbing.

Having been established, the question (ἔλεγχος) embodied a Wheel of Birth *sui generis*, and the various pre-Socratic schools flourished by conditioning all further development of philosophy until our time. Two are in my opinion the high points of this period: the Pythagorean concept of numbers and the Parmenidean dialectics—both unique expressions of the same preoccupation.

As it went through its phases of adaptation, up to the fourth century B.C., the Pythagorean concept of numbers affirmed that things are numbers, or that all things are furnished with numbers, or that things are similar to numbers. This thesis developed (and this in particular interests the musician) from the study of musical intervals in order to obtain the orphic catharsis, for according to Aristoxenos, the Pythagoreans used music to cleanse the soul as they used medicine to cleanse the body. This method is found in other *orgia*, like that of Korybantes, as confirmed by Plato in the *Laws*. In every way, Pythagorism has permeated all occidental thought, first of all, Greek, then Byzantine, which transmitted it to Western Europe and to the Arabs.

All musical theorists, from Aristoxenos to Hucbald, Zarlino, and Rameau, have returned to the same theses colored by expressions of the moment. But the most incredible is that all intellectual activity, including the arts, is actually immersed in the world of numbers (I am omitting the few backward-looking or obscurantist movements). We are not far from the day when genetics, thanks to the geometric and combinatorial structure of DNA, will be able to metamorphise the Wheel of Birth at will, as we wish it, and as preconceived by Pythagoras. It will not be the *ek-stasis* (Orphic, Hindu, or Taoist) that will have arrived at one of the supreme goals of all time, that of controlling the quality of reincarnations (hereditary rebirths παλιγγενεσία) but the very force of the "theory," of the question, which is the essence of human action, and whose most striking expression is Pythagorism. We are all Pythagoreans.[3]

On the other hand, Parmenides was able to go to the heart of the question of change by denying it, in contrast to Herakleitos. He discovered the principle of the excluded middle and logical tautology, and this created such a dazzlement that he used them as a means of cutting out, in the evanescent change of senses, the notion of Being, of that which is, one, motionless, filling the universe, without birth and indestructible; the

not-Being, not existing, circumscribed, and spherical (which Melissos had not understood).

> [F]or it will be forever impossible to prove that things that are not are; but restrain your thought from this route of inquiry. . . . Only one way remains for us to speak of, namely, *that it is*; on this route there are many signs indicating that it is uncreated and indestructible, for it is complete, undisturbed, and without end; it never was, nor will it be, for now it is all at once complete, one, continuous; for what kind of birth are you seeking for it? How and from where could it grow? I will neither let you say nor think that it came from what is not; for it is unutterable and unthinkable that a thing is not. And what need would have led it to be created sooner or later if it came from nothing? Therefore it must be, absolutely, or not at all.
>
> —Fragments 7 and 8 of *Poem*, by Parmenides[4]

Besides the abrupt and compact style of the thought, the method of the question is absolute. It leads to denial of the sensible world, which is only made of contradictory appearances that "two-faced" mortals accept as valid without turning a hair, and to stating that the only truth is the notion of reality itself. But this notion, substantiated with the help of abstract logical rules, needs no other concept than that of its opposite, the not-Being, the nothing that is immediately rendered impossible to formulate and to conceive.

This concision and this axiomatics, which surpasses the deities and cosmogonies fundamental to the first elements,[5] had a tremendous influence on Parmenides' contemporaries. This was the first absolute and complete materialism. Immediate repercussions were, in the main, the continuity of Anaxagoras and the atomic discontinuity of Leukippos. Thus, all intellectual action until our time has been profoundly imbued with this strict axiomatics. The principle of the conservation of energy in physics is remarkable. Energy is that which fills the universe in electromagnetic, kinetic, or material form by virtue of the equivalence matter—energy. It has become *that which is* "par excellence." Conservation implies that it does not vary by a single photon in the entire universe and that it has been thus throughout eternity. On the other hand, by the same reasoning, the logical truth is tautological: All that which is affirmed is a truth to which no alternative is conceivable (Wittgenstein). Modern knowledge accepts the void, but is it truly a non-Being? Or simply the designation of an unclarified complement?

After the failures of the nineteenth century, scientific thought became rather skeptical and pragmatic. It is this fact that has allowed it to adapt

and develop to the utmost. "All happens as if . . ." implies this doubt, which is positive and optimistic. We place a provisional confidence in new theories, but we abandon them readily for more efficacious ones provided that the procedures of action have a suitable explanation which agrees with the whole. In fact, this attitude represents a retreat, a sort of fatalism. This is why today's Pythagorism is relative (exactly like the Parmenidean axiomatics) in all areas, including the arts.

Throughout the centuries, the arts have undergone transformations that paralleled two essential creations of human thought: the hierarchical principle and the principle of numbers. In fact, these principles have dominated music, particularly since the Renaissance, down to present-day procedures of composition. In school we emphasize unity and recommend the unity of themes and of their development; but the serial system imposes another hierarchy, with its own tautological unity embodied in the tone row and in the principle of perpetual variation, which is founded on this tautology . . .—in short, all these axiomatic principles that mark our lives agree perfectly with the inquiry of Being introduced twenty-five centuries ago by Parmenides.

It is not my intention to show that everything has already been discovered and that we are only plagiarists. This would be obvious nonsense. There is never repetition, but a sort of tautological identity throughout the vicissitudes of Being that might have mounted the Wheel of Birth. It would seem that some areas are less mutable than others, and that some regions of the world change very slowly indeed.

The *Poem* of Parmenides implicitly admits that necessity, need, causality, and justice identify with logic; since Being is born from this logic, pure chance is as impossible as not-Being. This is particularly clear in the phrase, "And what need would have led it to be born sooner or later, if it came from nothing?" This contradiction has dominated thought throughout the millennia. Here we approach another aspect of the dialectics, perhaps the most important in the practical plan of action—determinism. If logic indeed implies the absence of chance, then one can know all and even construct everything with logic. The problem of choice, of decision, and of the future, is resolved.

We know, moreover, that if an element of chance enters a deterministic construction all is undone. This is why religions and philosophies everywhere have always driven chance back to the limits of the universe. And what they utilized of chance in divination practices was absolutely not considered as such but as a mysterious web of signs, sent by the divinities (who were often contradictory but who knew well what they wanted), and which

could be read by elect soothsayers. This web of signs can take many forms—the Chinese system of I-Ching, auguries predicting the future from the flight of birds and the entrails of sacrificed animals, even telling fortunes from tea leaves. This inability to admit pure chance has even persisted in modern mathematical probability theory, which has succeeded in incorporating it into some deterministic logical laws, so that *pure chance* and *pure determinism* are only two facets of one entity, as I shall soon demonstrate with an example.

To my knowledge, there is only one "unveiling" of pure chance in all of the history of thought, and it was Epicurus who dared to do it. Epicurus struggled against the deterministic networks of the atomists, Platonists, Aristoteleans, and Stoics, who finally arrived at the negation of free will and believed that man is subject to nature's will. For if all is logically ordered in the universe as well as in our bodies, which are products of it, then our will is subject to this logic and our freedom is nil. The Stoics admitted, for example, that no matter how small, every action on earth had a repercussion on the most distant star in the universe; today we would say that the network of connections is compact, sensitive, and without loss of information.

This period is unjustly slighted, for it was in this time that all kinds of sophisms were debated, beginning with the logical calculus of the Megarians, and it was the time in which the Stoics created the logic called modal, which was distinct from the Aristotelian logic of classes. Moreover, Stoicism, by its moral thesis, its fullness, and its scope, is without doubt basic to the formation of Christianity, to which it has yielded its place, thanks to the substitution of punishment in the person of Christ and to the myth of eternal reward at the Last Judgment—regal solace for mortals.

In order to give an axiomatic and cosmogonical foundation to the proposition of man's free will, Epicurus started with the atomic hypothesis and admitted that "in the straight line fall that transports the atoms across the void, . . . at an undetermined moment the atoms deviate ever so little from the vertical . . . but the deviation is so slight, the least possible, that we could not conceive of even seemingly oblique movements."[6] This is the theory of *ekklisis* (Lat. clinamen) set forth by Lucretius. A senseless principle is introduced into the grand deterministic atomic structure. Epicurus thus based the structure of the universe on determinism (the inexorable and parallel fall of atome) and, at the same time, on indeterminism (*ekklisis*). It is striking to compare his theory with the kinetic theory of gases first proposed by Daniel Bernoulli. It is founded on the corpuscular nature of matter and, at the same time, on determinism and indeterminism. No one but Epicurus had ever thought of utilizing chance as a principle or as a type of behavior.

It was not until 1654 that a doctrine on the use and understanding of chance appeared. Pascal, and especially Fermat, formulated it by studying "games of chance"—dice, cards, etc. Fermat stated the two primary rules of probabilities using multiplication and addition. In 1713 *Ars Conjectandi* by Jacques Bernoulli was published.[7] In this fundamental work Bernoulli enunciated a universal law, that of Large Numbers. Here it is as stated by E. Borel: "Let p be the probability of the favorable outcome and q the probability of the unfavorable outcome, and let ε be a small positive number. The probability that the difference between the observed ratio of favorable events to unfavorable events and the theoretical ratio p/q is larger in absolute value than ε will approach zero when the number of trials n becomes infinitely large."[8] Consider the example of the game of heads and tails. If the coin is perfectly symmetric, that is to say, absolutely true, we know that the probability p of heads (favorable outcome) and the probability q of tails (unfavorable outcome) are each equal to 1/2, and the ratio p/q to 1. If we toss the coin n times, we will get heads P times and tails Q times, and the ratio P/Q will generally be different from 1. The Law of Large Numbers states that the more we play, that is to say the larger the number n becomes, the closer the ratio P/Q will approach 1.

Thus, Epicurus, *who admits the necessity of birth at an undetermined moment*, in exact contradiction to all thought, even modern, remains an isolated case;* for the aleatory, and truly stochastic event, is the result of an accepted ignorance, as H. Poincaré has perfectly defined it. If probability theory admits an uncertainty about the outcome of each toss, it encompasses this uncertainty in two ways. The first is hypothetical: ignorance of the trajectory produces the uncertainty; the other is deterministic: the Law of Large Numbers removes the uncertainty with the help of time (or of space). However, by examining the coin tossing closely, we will see how the symmetry is strictly bound to the unpredictability. If the coin is perfectly symmetrical, that is, perfectly homogeneous and with its mass uniformly distributed, then the uncertainty[9] at each toss will be a maximum and the probability for each side will be 1/2. If we now alter the coin by redistributing the matter unsymmetrically, or by replacing a little aluminum with platinum, which has a specific weight eight times that of aluminum, the coin will tend to land with the heavier side down. The uncertainty will decrease and the probabilities for the two faces will be unequal. When the substitution of material is pushed to the limit, for example, if the aluminum is replaced with a slip of paper and the other side is entirely of platinum, then the uncertainty will approach zero, that is, towards the certainty that

* Except perhaps for Heisenberg.

the coin will land with the lighter side up. Here we have shown the inverse relation between uncertainty and symmetry. This remark seems to be a tautology, but it is nothing more than the mathematical definition of probability: *probability* is the ratio of the number of favorable outcomes to the number of possible outcomes when all outcomes are regarded as equally *likely*. Today, the axiomatic definition of probability does not remove this difficulty, it circumvents it.

MUSICAL STRUCTURES *EX NIHILO*

Thus we are, at this point in the exposition, still immersed in the lines of force introduced twenty-five centuries ago and which continue to regulate the basis of human activity with the greatest efficacy, or so it seems. It is the source of those problems about which we, in the darkness of our ignorance, concern ourselves: determinism or chance,[10] unity of style or eclecticism, calculated or not, intuition or constructivism, a priori or not, a metaphysics of music or music simply as a means of entertainment.

Actually, these are the questions that we should ask ourselves: 1. What consequence does the awareness of the Pythagorean-Parmenidean field have for musical composition? 2. In what ways? To which the answers are: 1. Reflection on *that which is* leads us directly to the reconstruction, as much as possible *ex nihilo*, of the ideas basic to musical composition, and above all to the rejection of every idea that does not undergo the inquiry (ἔλεγχος, δίζησις). 2. This reconstruction will be prompted by modern axiomatic methods.

Starting from certain premises we should be able to construct the most general musical edifice in which the utterances of Bach, Beethoven, or Schönberg, for example, would be unique realizations of a gigantic virtuality, rendered possible by this axiomatic removal and reconstruction.

It is necessary to divide musical construction into two parts (see Chapters VI and VII): 1. that which pertains to time, a mapping of entities or structures onto the ordered structure of time; and 2. that which is independent of temporal becomingness. There are, therefore, two categories: *in-time* and *outside-time*. Included in the category outside-time are the durations and constructions (relations and operations) that refer to elements (points, distances, functions) that belong to and that can be expressed on the time axis. The temporal is then reserved to the instantaneous creation.

In Chapter VII I made a survey of the structure of monophonic music,

with its rich outside-time combinatory capability, based on the original texts of Aristoxenos of Tarentum and the manuals of actual Byzantine music. This structure illustrates in a remarkable way that which I understand by the category outside-time.

Polyphony has driven this category back into the subconscious of musicians of the European occident, but has not completely removed it; that would have been impossible. For about three centuries after Monteverdi, in-time architectures, expressed chiefly by the tonal (or modal) functions, dominated everywhere in central and occidental Europe. However, it is in France that the rebirth of outside-time preoccupations occurred, with Debussy and his invention of the whole-tone scale. Contact with three of the more conservative traditions of the Orientals was the cause of it: the plainchant, which had vanished, but which had been rediscovered by the abbots at Solesmes; one of the Byzantine traditions, experienced through Moussorgsky; and the Far East.

This rebirth continues magnificently through Messiaen, with his "modes of limited transpositions" and "non-retrogradable rhythms," but it never imposes itself as a general necessity and never goes beyond the framework of the scales. However Messiaen himself abandoned this vein, yielding to the pressure of serial music.

In order to put things in their proper historical perspective, it is necessary to prevail upon more powerful tools such as mathematics and logic and go to the bottom of things, to the structure of musical thought and composition. This is what I have tried to do in Chapters VI and VII and what I am going to develop in the analysis of *Nomos alpha.*

Here, however, I wish to emphasize the fact that it was Debussy and Messiaen[11] in France who reintroduced the category outside-time in the face of the general evolution that resulted in its own atrophy, to the advantage of structures in-time.[12] In effect, atonality does away with scales and accepts the outside-time neutrality of the half-tone scale.[13] (This situation, furthermore, has scarcely changed for fifty years.) The introduction of in-time order by Schönberg made up for this impoverishment. Later, with the stochastic processes that I introduced into musical composition, the hypertrophy of the category in-time became overwhelming and arrived at a dead end. It is in this cul-de-sac that music, abusively called aleatory, improvised, or graphic, is still stirring today.

Questions of choice in the category outside-time are disregarded by musicians as though they were unable to hear, and especially unable to think. In fact, they drift along unconscious, carried away by the agitations of superficial musical fashions which they undergo heedlessly. In depth,

however, the outside-time structures do exist and it is the privilege of man not only to sustain them, but to construct them and to go beyond them.

Sustain them? Certainly; there are basic evidences of this order which will permit us to inscribe our names in the Pythagorean-Parmenidean field and to lay the platform from which our ideas will build bridges of understanding and insight into the past (we are after all products of millions of years of the past), into the future (we are equally products of the future), and into other sonic civilizations, so badly explained by the present-day musicologies, for want of the original tools that we so graciously set up for them.

Two axiomatics will open new doors, as we shall see in the analysis of *Nomos alpha.* We shall start from a naive position concerning the perception of sounds, naive in Europe as well as in Africa, Asia, or America. The inhabitants of all these countries learned tens or hundreds of thousands of years ago to distinguish (if the sounds were neither too long nor too short) such characteristics as pitch, instants, loudness, roughness, rate of change, color, timbre. They are even able to speak of the first three characteristics in terms of intervals.

The first axiomatics leads us to the construction of all possible scales. We will speak of pitch since it is more familiar, but the following arguments will relate to all characteristics which are of the same nature (instants, loudness, roughness, density, degree of disorder, rate of change).

We will start from the obvious assumption that within certain limits men are able to recognize whether two modifications or displacements of pitch are identical. For example, going from C to D is the same as going from F to G. We will call this modification elementary displacement, ELD. (It can be a comma, a half tone, an octave, etc.) It permits us to define any *Equally Tempered Chromatic Gamut* as an ETCHG sieve.[14] By modifying the displacement step ELD, we engender a new ETCHG sieve with the same axiomatics. With this material we can go no farther. Here we introduce the three logical operations (Aristotelean logic as seen by Boole) of *conjunction* ("and," intersection, notated $\wedge$), *disjunction* ("or," union, notated $\vee$), and *negation* ("no," complement, notated $-$), and use them to create classes of pitch (various ETCHG sieves).

The following is the logical expression with the conventions as indicated in Chapter VII:

The major scale (ELD = $\frac{1}{4}$ tone):

$$(8_n \wedge \overline{3}_{n+1}) \vee (8_{n+2} \wedge 3_{n+2}) \vee (8_{n+4} \wedge 3_{n+1}) \vee (8_{n+6} \wedge \overline{3}_n)$$

where $n = 0, 1, 2, \ldots, 23$, modulo 3 or 8.