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DRAFT - 8/15/86
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**MUSIC VS. SCIENCE: THE CONTEMPORARY QUEST
FOR THE UNITY OF MUSICAL TIME**

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The Fifteenth International Conference on the Unity of the Sciences
Washington, D.C. November 27-30, 1986

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The theory of music has always sought models from extraneous disciplines - to quote only the most evident borrowings : mathematics, since Pythagoras ; physics, since Galileo and Newton... - and Leonard B. Meyer has pointed to the fact that "such models have generally been used to rationalize already existing musical practice"(1). Yet in certain cases, musical practice does not anticipate, but seems to depend entirely on the borrowing of the model. For instance, when the Iliac Suite for String Quartet was played in August 9, 1956 at Urbana (Illinois) the real author was neither Hiller nor Isaacson, but the computer which had been "taught" a programming of material and stylistic parameters and fed the resulting numbers to the two researchers, who then translated the output into traditional notation. According to the French philosopher Etienne Souriau, that date of 1956 is to be taken as a turning point in the history both of musical theory and of science in general, since it summarizes an epistemological revolution: in the thirties, physics, viz the study of vibrations, was the basis and starting point of the theory of music - a treatise of Acoustics of 1931, quoted by Souriau, contained chapters on "scales", "chords", "sharp and flat", and so on - so that the composers were supposed to use toward musical goals the structure of resonating objects, obeying thus the laws of Nature which "dictated" realities as "scales", "chords" etc. Today, Souriau argues, all that theory is out of date ; though the musician holds to acoustics, the acoustics itself (which has taken some turns) appears ^{as} ancilla musicae rather than magistra aut conditrix as before (2). The more it progresses, the more it is superseded by "pure" mathematics, notably the group theory, statistics, logical-linguistic models and computer programming, not to say anything about proportions and information theory. Music is refashioning itself as an ars combinatoria.

In order to understand the meaning of such a revolution, we have to remember first that during more than twenty centuries, musical acoustics has been the one and unique quantitative type of physical science available to Western (and Eastern) civilization ; and that even if music was taken as "the" basic model, the acoustical discoveries were considered as mathematical, since "mathema" means "knowledge". During all the Middle Ages, these "mathematical" facts were seized as having been imposed upon matter by the divine intelligence or will ; while exhibited by the cantor, they were interpreted by the musicus as revealing the hidden numbers and proportions underlying the structure of the visible /audible world, and as allowing a purely arithmetical unconcealment of the universal harmony. Such speculations, as Souriau notices, did not disappear with medieval thought : suffice it to recall the well-known letter of April 12, 1712, in which Leibniz defines music as "exercitium arithmeticae occultum nescientis se numerare animi"; and let us not too hurriedly imagine that Schopenhauer tolls the definitive bell for musica mundana with his parody, "Musica est exercitium metaphysices occultum nescientis se philosophari animi"(3).

Nevertheless, it is at the beginning of the XVIIth century that the "first" important epistemological revolution takes place, with Galileo : physical science blooms into a full-range mathematical discipline in the "modern" sense, thus opening the way to ^a domination of "physicianism" over music which, as we have seen, has endured till our epoch. With Father Mersenne, Huygens and Sauveur, the theory of music begins to move, and fixes its basis on a truly "physical" phenomenon : resonance. Then Rameau reduces the innumerable "concrete" chords of the musical practice to a formal corpus of "fundamental" (and yet abstract...) chords ; hence the development of a (Cartesian) harmony. D'Alembert will propagate Rameau's system among the physical scientists : hence the development, with Prony and Chladni, Fourier and Arago, Savart and Helmholtz, of the acoustical "translation" of musical facts, together with the triumph of the tonality ; so that between the composer Gabriel Fauré (Prométhée, 1900), the theorician of harmony Gevaert (Treatise of Harmony, 1905) and the acoustician Bouasse (The Physical Foundations of Music, 1906), there is a complete mutual agreement which looks promising for the future.

What happens next is to be related, Souriau argues, not only to the decline of ethnocentrism (thanks to the development of anthropology, one begins to wonder if tonality is the only "natural" system), and not only to the decomposition of the tonal idiom as such (with polytonality, atonality, dodecaphonism, serialism and pantonality), but to the fact that the agreement between physics and musical theory was far more apparent than real (for instance, neither the musical scale, nor the sharpening of a note correspond to any acoustical necessity - and similarly, the "perfect" chord cannot be said, from an acoustical point of view, to be the "most consonant" of all chords). In sum, the physical scientist who gives a "scientific" expression to the concepts of the musician is obliged to comply with the conventions of a situated-and-dated musical ideology. Therefore the acoustical discipline will develop itself all the more easily as it will cease to be swamped under the musical requisits ; and conversely these requisits will find to spread themselves out quite suddenly as soon as they will recover their real - mathematical - status. Hence the impression of a "temporal compression" in the evolution of contemporary music : one is tempted, as Henry G. Bauer, to allege a kind of acceleration here as well as in other fields ("We do seem to be much less patient nowadays - pyramids and cathedrals were constructed on time-scale of centuries, but we now plan and act in much shorter segments of time..."). We may add that such an acceleration is made today incredibly easier thanks to the developments of late-modern technology : as Souriau thought, the computerization of sound-generation and/or compositional processes has literally whipped musical theory. Since computers are fundamentally so simple, they can "lose a bit of their mystique ; the complicated ^{w/}ards are often merely rows upon rows of millions of devices housing smaller devices whose only job is to be on/off, open/closed, or the equivalent"; substances "need merely show only two states of existence" - so "the operations can be quick (often less than a trillionth of a second) and take little space (some designers are now talking in terms of "molecular" operations)" (4). - So far, so good ; but let us not forget the warning of the most acclaimed French composer of computer music, Jean-Claude Risset : "The computer is the only machine capable of hundred thousands mistakes per second"!

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Jean-Claude Risset's quip needs of course to be taken seriously. Indeed, the "compression" or "acceleration" mentioned by Henry G. Bauer, together with the crisis of style due to the crash of the tonal system, "has produced an almost frantic search for plausible models for music and music theory"; of course, "there is nothing inherently wrong with borrowing suggestive concepts and formulations from other disciplines (...). Such "borrowing", however, may lead to unfortunate consequences when the model, taken to be the "main event", begins to influence and mold the actual practice of music" (5). The contemporary treatment of musical time is an example.

In the XVIIth century, the age of clock-making, it was possible to consider the clock as a miniature of the universe ; long before Leibniz, many a scientist could conceive the universe as a machine whose parts intertwined with one another according to the laws of causality, and trust in a linear time, measurable by the movement of the clock. The musicologist Paul Henry Lang has described the essence of tonal music as "causal relationship achieved by the grouping of many small units into larger ones and finally into a great system of architecture" (6) : according to such a view, musical time was supposed to occupy an exactly predictable segment of the infinite temporal continuum ; the work had to progress resolutely and regularly from a clear-cut beginning to a fore-ordered end; each of its sections being punctuated by the harmonic cadence playing the role of the swinging pendulum of the clock, it was impossible to get lost in time (7).

Now, in our XXth century, not only the composer has been invited to identify himself with and imitate the methodology of mathematics, but the apparently correlative changes in the new physics have encouraged him to treat his work as a contextually isolated logico-mathematical system. Since he is no more allowed to rely on the outdated Newtonian linear model, he has to make to his own measure the temporal rationale of the piece he is composing; and if possible to thicken the plot...

In this sense, one may speak of a conscious intent to experiment with temporality - we are not trying to rationalize the musician's attitude, nor do we give an interpretation after the fact. Such a situation has been well described by Herbert V. Guenther with regard to space - but his statement concerns time as well : "Newton, he writes, proposed that space was a substance with independent existence (which is plain English for "absolute"), and it was through this sort of space that material bodies and radiations moved. But substance suggests a kind of medium, even if it is claimed to be invisible. This ubiquitous and hypothetical medium, called ether - a kind of fluid filling all of space which, in its glorious absoluteness, was deemed to be at rest - has never been found. Apart from the illogicalness of this assumption of something filling something else - which entails the notion of "size" (while there is nothing to compare absolute space with) - its absence caused another casualty. Newtonian physics was dealt a severe blow from which it was unable to recover. Its picture of space, and incidentally of time also, had to be abandoned (outside of its narrow range of applicability) when Albert Einstein proposed his special theory of relativity, which explicitly denies the existence of any fixed point of any absolute space... Modern scientists now view space along with matter as constituted of many structural levels. It has the properties of continuity, dimensionality, connectedness, and orientability, known as topological features. In addition, it has other mathematical features, as exemplified by various coordinate systems such as Cartesian, cylindrical, spherical, polar. There is almost no limit to our ability to construct mathematical spaces with properties different from those which we believe "real" space has"(8).

However, if several musicians of our century try to overturn the Newtonian clockwork universe, replacing it with the model of some unified field which resembles an electronic circuit rather than a machine, and if in that sense they appear to belong essentially to the same logical realm as that of Einstein's relativity or of Heisenberg's uncertainty principle, they are not for that to be suspected of having directly plagiarized ~~any~~^{any} scientific treatises. For instance, when Xenakis wants to define and legitimate his "stochastic" and mathematical approach to music, he does not invoke only a mysterious and almighty "musical necessity" - or historical reasons, such as the need to outmarch the Serialists - : "other paths, he says, also led

to the same stochastic crossroads - first of all, natural events such as the collision of hail or rain with hard surfaces, or the song of cicadas in a summer field. These sonic events are made out of thousands of isolated sounds ; this multitude of sounds, seen as a totality, is a new sonic event. This mass event is articulated and forms a plastic mold of time, which itself follows aleatory and stochastic laws"(9). And in a similar way, the suggestion, made by C. H. Waddington, of an interaction between the XXth century scientific revolution and current trends in visual arts - complementarity and the all-around view of cubism, or the holistic field and Pollock's or Tobey's "over-allness" - may well not require the artists to have read (and understood !) the implications of the newest scientific literature ; such an erudition may be the case for some painters (for example Georges Mathieu), but seems unlikely for most of them.

But there are other attitudes, ^{(maybe as} ~~more~~ inventive, ^{but} ~~more~~ less happy. In order to understand for example why serial music, as "scientific" as it claims to be, seemed "outdated" to Xenakis already in 1955, we must ask the historian to explain how, since the XIXth century, "the problem of what "true" reality "really" is has plagued compositional practice as well as theories about music"(10). According to Carl Dahlhaus, the musical "realism" which was prevailing from around 1850 onward was supported by the naive convention that "only what is intersubjectively observable is real" ; but that concept of reality "was gradually displaced by a scepticism which spread from the philosophers to infect the public in general. And without going into the profound changes which affected epistemology from Kant to Ernst Mach in any detail, we can make a start with the fundamental thesis that, by philosophical criteria, reality is not straightforward, direct donnée, but is constituted as a relationship between the amorphous material received by the senses, and the categorial form contributed by the perceiving consciousness. In other words, understanding of what things are on their own terms is simultaneously made possible and distorted by the creation of categorial forms" (11). We may, after Kant, emphasize categories : Xenakis, with his reference to Nature seized as introducing into a higher realm of rationality, seems to reaffirm Kant's theory of the mathematical sublime. But we may as well focus,

like Mach, on the "distorting" function of the categories, and "look for "true reality" in the material received by the senses in its amorphous state : the material must be teased away from the categorial structure bit by bit (...). "True" realism would by that criterion be impressionism, represented by (...) Claude Debussy in compositional practice"(12).

Debussy's music, rejecting the tradition of Beethoven and the "processes" of Wagner, "is not goal-oriented, but seems to circle within itself, and to cease rather than close" : its treatment of time leads to a "stasis animated only internally". "The technical features - the dissolution of functional harmony, the disruption of regular, tonally based periodic structure and the cessation of the thematic-motivic working which Debussy felt to be pedantic but which had formed the "teleological" element in music in the XIXth century, in conjunction with tonal harmony - may amount to the abrogation of the traditional categorial apparatus pertaining to musical structure" (13). Since categories, or traditional "prolongation" techniques, leading to the linearization of Newtonian musical time, are abandoned, Debussy may turn himself toward an atomized time ; and since the isolated sound alone can represent the "true reality" of music, the structuration of "higher levels" (the "hors-temps" as a category, according to Xenakis) becomes suspect. Moreover, the recognition that "categorial systems are not inherent in the nature of things but are constructs of the perceptive consciousness" may open the way to the outburst of the composer's subjectivity : it will legitimate any "lower-level" structuration ~~which~~ in serial music - and Dahlhaus quotes here Ernst Krenek's "postulate of a boundless freedom to invent musical axioms" (14) *as coming from Debussy.*

Now how is it possible to join together a composer like Debussy, who reacts to the epistemological problem of the validity of the concept of reality by a distrust of categorial systems, and a composer like Krenek, who as a follower of Schönberg must have reacted to the same problem by a focus on the categorial tradition of **B**eethovenian and **W**agnerian teleological time ? - Answer : the emergence of late XIXth century expressionism out of naturalism is parallel with that of impressionism out of realism, in that both, even in different manners, pave the way to the supremacy of subjectivity ; the apparent fall from Kant to Mach does not re-

fer to a faithlessness of Krenek to Schönberg ⁱⁿ ~~on~~ the case of expressionism, as if serialism could disown dodecaphonism. Carl Dahlhaus' argument is far more subtle : "it is not the artist's subjective self, he says, which presses for expression in either literary or musical expressionism. The psychological outburst registered in works such as Erwartung or the Piano Piece op. 11 no. 3 occurs without personal contribution in a sense - even when it is his own individual feelings or consciousness that the artist seeks to set down in words or music. Never for a moment does the artist abandon the position of an observer and recorder of what emerges from himself : that is as true of expressionism as it is of naturalism" (15). It is thus impossible to interpret expressionism as serving to objectivize Hegel's "subjective inwardness". "Expressionist expressiveness is therefore, broadly speaking, "alienated", in the psychoanalytical sense" - but alienated by the subjectivity itself as "observer" or "recorder" of itself, i.e. functioning as a "positivist" and "scientific" instance (16). In other terms, for Schönberg as well as for Mach, it is the consciousness which elaborates the categorial structures ; but these structures, since they are in themselves expressions of the subjectivity, are not to be dis-trusted but exalted ; immanent or interiorized, instead of remaining, as with Debussy, exterior and transcendent, they bear witness of the creative power of consciousness, ~~and can represent~~ ^{and can represent} consciousness or subjectivity as such. In one word : they are subjective since they have been elaborated by subjectivity, and in turn they ~~show~~ ^{show} it and exhibit it and represent it as "pure" subjectivity, freed from the "impure" emotions of "expressiveness". They cannot "distort" reality since they create or ~~distort~~ ^{mould} it.

Hence Krenek's definition of total serialism as "the extension of the serial concept over all aspects (or parameters) of the musical process". In this totally ordered music, "everything, from pitch succession to density to dynamics to time values is regulated by serial statements derived from ~~one~~ single archetype (usually the order of magnitude shown in the intervals of the basic tone-row) so that everything is intricately and inextricably related to everything else"(17). The next

step adds to the levelling down of the musical process the levelling down of categorial structures : perceiving consciousness does not only produce or contribute categorial form, it unites it and welds it inextricably with the sense data, so that we are supposed to hear directly mathematically defined acoustical items, rather than (qualitative) "amorphous" data, i.e. sounds. The music of total serialists, Krenek asserts, "is based upon the fundamental unity of all acoustical material - on the recognition that everything is identical". Composers obtain thus compensation for the loss suffered of Newtonian linearity of time - they are allowed to fashion directly spatialized and mathematized time-spans. Moreover, they may invent them - let us recall Guenther's formulation of the absence of limits "to our ability to construct mathematical spaces" - so that their subjectivity becomes a time-producing demiurgy. Hence a quadruple argument, which has been summarized by Leonard B. Meyer in the following terms :

- (1) "All differences of acoustic perception can be traced to differences in the temporal structure of sound waves" (Stockhausen) ;
- (2) Since "all acoustic events are time-processes, (it is) possible to dissolve the traditional dimensions of music (...) to form the superior category "articulation of time""(Heinz-Klaus Metzger) ;
- (3) "No longer are the elements (...) to be subordinated to one dominant element ; they are to coexist as individualities"(Dieter Schnebel);
- (4) If all the parameters should be treated equally, "all should be serialized within some encompassing plan" (Leonard B. Meyer).

As Leonard B. Meyer shows, the whole argument is unsound.

Acoustical phenomena are scientific concepts, and cannot be equated with qualitative experiences : there exists nothing like Stockhausen's "acoustic perception". No "parameter" can be reduced to an acoustical event : pitch is a complex function of both frequency and intensity, dynamics a function of loudness and volume, etc... Thus the parameters can never become "equally important". And serialism, if taken as a method for organizing musical processes, need not be "total".

Now, is a restrictive serial order - for instance a serialization of only the two "basic" parameters, pitch and time, as Milton Babbitt has suggested - useful for unifying the work according to the so-called "superior category" articulation of time ? - Alas ! Newton is not dead, Schönberg only

is. While pitch perception is universally characterized by direct or indirect references to visual or spatial instances, i.e. to reversibility, time moves in one direction only and is experientially irreversible ; so that pitch patterns are better able to maintain their relational identity in case of variation, than time patterns. A change in time relationship is generally perceived as a different event, not as a variation ; thus one does not have to subject pitch and time to isomorphic operations, if not in the name of some premusical requisit. Systemic serialization does not allow in general the verification of the theoretical postulates it entails (18).

Of course, as Leonard B. Meyer says, "good musical choices can be made for bad theoretical reasons". But the use of technical and theoretical terms that composers have consciously and purposely borrowed during the XXth century not only from mathematics and mathematical acoustics, but from quantum mechanics and relativity theory, has been scarcely "reasonable" at least in the domain of manifestos and other writings. The will to make the theory of music congruent with the new developments in "exact" sciences annihilates itself if it does not entail enough intellectual energy toward precisely comparing the basic frameworks of both these sciences and of "music as art". For instance, in the case of statistical mechanics, composers usually forget to notice that "indeterminacy" belongs to the realm of subatomic particles and cannot be applied unwarily to macroscopic perceptual levels. It is paradoxal to call on the new physics, where macroscopic events are predictable but not microscopic ones, for helping to organize a serial music where microscopic events (pitch and duration of an individual tone) are predictable but not macroscopic ones (motives, combinations, etc.). No less surprising is the paradox we have described of a "totally ordered" music which would like to assume the reversibility of its time structures, but seeks a model not in Newtonian physics, which allows at least in principle such a reversibility, but in the new physics, which postulates under the law of entropy that "but for a few exceptions, all events in nature are irreversible" (19).

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Since the beginning of ~~the~~^{our} inquiry, we have taken for granted that musical theory seeks, and finds, exterior models, if possible scientific and logical (and as scientific and as logical as possible), in order to rationalize itself, thus rationalizing the practice of music. Our postulate was the weberian one : that, according to the fresco once offered by Max Weber in his Sociology of Music, the history of Western music is one of progressive rationalizing and ordering toward universalization. Nevertheless, as the example of the construction of musical time shows, even in our epoch of unifying and unified theories, even with the retrieval of mathematics and the generalization of computerology, science and music, even if they officially coincide in the writings of the composer-theorists or/and advertisers and propagandists, maintain in fact their autonomy ; and when their encounter happens to be successful, as in the case of Xenakis, it remains isolated and precarious † we can but notice the successive failures of the Serialists in their attempts to domesticate the new acoustics. In other terms, we have to emphasize "the difference between order as a traditional goal of art, pointing in the direction of an ultimate transcendence, and an order, which can be something local, small-scale, provisional, and perhaps established by random means, like the patterns perceptible in ink blobs"(20).

Now we may change our line of argument, and consider no more music "with" science, following science and borrowing models from it as the present situation requires, but rather "in front of" science, viz "in complementarity with" it. According to such a view, to affirm ~~the~~^a complementarity between two entities does not mean to identify each of them with the other, but to show their mutual exclusion. You cannot have one together with the other, but only "in the absence" of the other : presence entails absence, the absence of what is not there and thus gives place to what is there. Music "versus" science : "versus", as the past

participle of vertere, "to turn", gives its meaning to the "verso" - the other side of the phenomenon, its reverse . Both are autonomous - but both are linked. So that our point is not to underline distances or divergences or oppositions, but to outline analogical or metaphorical parallelism "after the fact". The quest for the "unity" of musical time in the XXth century receives therefore a new meaning.

First, when we describe the music of the age of clock-making in "analytic" terms in the manner of Paul Henry Lang, we cannot conclude with the bare statement of linearity as encompassing the whole of any musical construction. "Living" time is far from being as homogeneous as that : it does not seem to progress at the constant rate suggested by the regular movement of the clock hands. If classical works reflect the Weltanschauung that gave rise to "modern" (Newtonian/Galilean) physics, they bear simultaneously, since the beginnings of the tonal system, the testimony of an inner destruction or deconstruction of that Weltanschauung itself. To quote Christopher Small's examples (21), Mozart's chromaticisms or Beethoven's explorations of "timelessness" in his last Piano Sonatas or his last String Quartets induce a fascinating challenge to the idea of a primacy of mechanical linearity. Indeed Beethoven lacked any experience of non-linear musical cultures such as the Balinese, which Debussy was to encounter only 60 years after ; but his Sonatas op. 106 or 111 as well as his Quartets op. 132 or 133 seem literally to transcend the "unnatural" abstraction of periodic segmentation.

How are we to interpret this deconstruction ? The disintegration of linearity begins, as Jonathan Kramer has shown (22), with its "intensification", as if the composer were searching for "unmaterializable goals". If tonal functional harmony is a syntactical system of chord relationships which "arouse and resolve immediately tensions and expectations", its historical development leads to "the increase of the tension by the use of ever more chromatic-dissonant sounds, and the increase in the level of expectation by delaying more and more its satisfaction". With Wagner, and after him the "atonal" cadences of the young Schönberg, one reaches the domain of "nondirected linearity" - a temporal mode not of compression but of decompression ~~and~~ concerning duration, and of breakdown of goal orientation concerning the time's arrow.

However, if we consider that the decisive step consists in an upset of the linear dimension as such, we must turn ourselves again toward Debussy's "stasis animated only internally", as Dahlhaus says. As we have seen, Dahlhaus' interpretation emphasizes, in order to explain "why" Debussy composed in a discontinuous way, the intellectual reaction of the musician to the major epistemological problem of the end of the XIXth century - the dilemma between categories and sensations, or Kant and Mach, or the intelligible and the sensible -; having discovered, as it seems, "the decisive link between compositional practice and modes of philosophical thought", the historian considers as secondary "the fact that the subjects Debussy liked to depict in his piano music betray a marked preference for the fluid and the indefinite (Jardins sous la pluie, Reflets dans l'eau), rather than for the clear-cut and well-defined" (23).

Yet the reality is probably far more simple : if Debussy is interested in "the fluid and the indefinite", it is not primarily for an epistemological, but for a musical reason. As Christopher Small tells us, with him music is to be placed "outside the reach of mechanical time and into the time of nature", conceived of as the very nature of sounds for their own sake. The dissonant chords of the Faune are left unresolved because they are "no more links in a logical chain" but pure sonorities chosen for their concrete quality alone. Being no more perceived as dissonances, they exist, like natural realities, "as things in themselves rather than as means toward an end". Now how to "stop" the indefinite arrow of linear time ? The only mean is to "verticalize" the perception of time ; and such a "verticalization" leads to a cyclic or circular architecture. But perceived time is of necessity irreversible : the solution lies in a combination of circularity and linearity, i.e. in the construction of a spiral. Debussy's musical time will thus be wave-like : hence the choice of "aquatic" subjects, which both are depicted by the music and depict the music itself - "en abyme", exactly in the Mallarmean way of Un Coup de Dés..., in which a whirlwind is simultaneously evoked by the poem and drawn on the white page by the typographical arrangement. Moreover, Dahlhaus is wrong when he opposes "the fluid and the indefi-

nite" on one side to "the clear-cut and well-defined" on the other. As Roy Howat has shown, the "wave-like" pieces by Debussy, including La Mer, rely on the Golden Section and their temporal structure is extraordinarily chiselled, mathematically precise, "clear-cut and well-defined". "Not only basic rhythm and metre, Howat writes, but also the subtler large-scale rhythms and alternations of types of structures (...): for the listener these all might affect aspects of his psychological rhythm, and thus be instrumental in defining our sense of musical time and proportion - as well as in explaining music's ability to warp our sense of time away from clock time. This also makes obvious why good musical proportions cannot just be defined theoretically, but have to be matched to the music's content by the most critical intuition" (24).

Once nature is allowed to return on her own terms, Christopher Small argues, why should one stop, and content oneself only with those sounds which conform to the canons of taste decreed by the official ideology of the day? From Debussy onward, we are allowed to open our ears to all possible sounds, as in the shamanistic explosions of Stravinsky's Rite of Spring. Commenting on this work, Stravinsky himself said: "Very little tradition lies behind Le Sacre, and no theory. I had only my ear to help me...I am the vessel through which Le Sacre passed" (25). Now, when Boulez gives a "scientific" analysis of Stravinsky's rhythmic device in such a piece, his concern with examining the rhythm separately is misleading, since it leaves unexplored the actual coordination of the rhythm with the melodies and polychords, as if the Rite represented "a sort of emancipation of rhythm comparable to Schönberg's emancipation of dissonance" (26). As Benjamin Boretz argues, a "rhythm" is always "a rhythm of something"; it cannot be "determinately isolated", and is in this respect not analogous to "pitch structure" or "timbral structure" (27). No wonder, then, that Boulez "ventured to suggest that to juxtapose in the manner of Stravinsky was not really to compose at all" (28): according to Kant's formula, "concepts without intuitions are blind".

To the question of the restoration of the unity of music and science, it is possible therefore to give another answer than the serial or scientist one, which relies on making heavier the weight of logico-mathematical procedures. According to this new - and, in a sense, very old - answer, the restoration will happen only if science is freed from the urge of domination. In more concrete terms, we may ask how it is feasible to put in agreement the need for a perceived (rather than measured) time, and the necessity of upholding the requisits of cosmic or cosmological (and measurable) time.- Now it is clear that "order" cannot be taken as the ultimate aim of the non-serialist and non-scientist musician who wants to "restore" the possibility of unifying art and science. Christopher Small has underlined the fact that music is a celebration and not an instrument of scientific experiment or investigation : Stravinsky's music, as Debussy's, "celebrates", 40 years before Cage's emancipation of noise through chance operations, "the unknowability, the darkness, that lies at the heart of nature" . Thus it "induces a joy of a quite different kind from the music of the classical tradition. To know that there are things that one cannot, and even need not, know, is to be able to live once more in a world of rich and varied meaning, quite unlike the joyless two-dimensional universe we should inhabit if ever the human race were to succeed in uncovering the last physical secret of the cosmos" (29). As scientifically-minded, modern man may well inquire of nature that she teaches always more about herself, but in so doing he does not relate himself to nature as the shaman or simply the countryman relates himself to the presencing of everything that comes to meet him ; in fact, he begins to question nature before letting her speak ; far from letting things present themselves as they are, he arrests and objectifies them by representing them as a manifold of cause-and-effect sequences. Hence the originality of the artist who nowadays does not seek to emulate the scientist and does not pretend to reveal some fundamental truth , nor to exhibit his conception of order, of history, of values etc. Since he dwells in the interstices of knowledge, he has nothing to teach to anybody - except the way time "times" or "is timing"...

Let us be more precise about those "interstices of knowledge". "Both levels of psychology and ontology, Herbert V. Guenther says, are excluded from the mathematician's and physicist's description of space, time, and space-time" (30). - As concerns, first, the psychological level, it seems impossible today to shut up the musical concept of time in the "inner" world, by subjectivizing it. "The time that is at work in music, Victor Zuckerkandl argues, cannot be "in me", it is not "my" time. It is where music is ; I find it where I find music - that is, in the same direction in which I find the sun, the moon, and the stars. Musical time exhibits all the characteristics of psychological time except one : it does not belong to a psyche". In front of the physical (Newtonian) time, musical time appears thus as "clock versus clock, the organic clock versus the mechanical"; so that "in the great revolution of modern thought,(...) music has something very definite and essential to contribute (...). The physical (Newtonian) time concept does not need to be refuted ; what needs to be refuted is only the assertion that the physical time concept exhausts objective time" (31). Of course, the "objectivity" of musical time is not to be taken as meaning any "thingness" at all.

That statement introduces us to the second of the levels of time "excluded from the mathematician's and physicist's description" : the ontological one. Being is not to be conceived as something "objective", as an object or as a being : even if it opens itself as letting all the particular beings be, "at the same time" it withdraws in concealment - it is not a being in particular - in order that beings may be. Time is an object and a being when it is taken (in "the mathematician's and physicist's description") as a measurable set of now-moments ; but in order to give existence to that measurable set, Being simultaneously "opens itself" and "withdraws" - so that the withdrawing hides the opening : very naturally, the mathematician and the physicist forget that ontological level, since they find in front of them something solid, an object that is present as measurable, time as the set of now-moments. The mathematician and the physicist forget - not the musician.

The musician we have evoked in the first part of our inquiry was entirely devoted to the discovery of scientific models, in order to ground more firmly his music on "something solid" : mathematical acoustics, for example. For him the ontological level does not exist : hence the weakness of his music. But the "great" musician, the true musician, does not need to disguise himself into an engineer : his music is already firmly grounded in the truth of Being. Hence the poverty of even the most exhaustive analyses, if they do not take into account his work as a whole, i.e. as belonging to the ontological level as well as to the mathematical, physical, acoustical, logico-linguistic or psychological level. The "authentic" musician does not conceive of any level as separable from the others : for Stravinsky, there is not a parameter "rhythm" separable from the parameter "pitch" or "melody" or "harmony" - and while composing, Stravinsky was not looking after what Guenther calls "a new epistemological model". He was busy enough : he wanted only "the restoration of vision", i.e. of "Being as knowledge, space, and time, forever there but never as a thing" (32).

Now what is time at the "ontological", primary, level ? If it cannot be reduced to a sequence of disjunct "now(s)", it has to be gathered and grasped in totality, as a whole : as the temporal field or spread of the present, past and future in their togetherness. William Barrett's definition may be recalled here : "Not a present Now, then another present Now, and another, etc., but the whole spread (...) of future-present-past (where the hyphenisation of these three terms is intended to signify the holding together of future-present-past as a unifying synthesis)" (33).

In Heidegger's terms, the unification of time is called "equality of the emergence of the temporalization", Gleichursprünglichkeit : such an "equitemporality" is a dynamic process - Zeit zeitigt, "time times" or "temporalizes", "makes ripe" or "matures" - which prevents us from giving any privilege to one of the dimensions of time over the others. For instance to give privilege to the dimension of the present means to forget not only the two other dimensions, but the unity of time as well. To forget the ontological level by grounding the musical work in the "present" of a scientific model is to loose the whole of the temporality of the work, its equitemporality; but the view of time of the mathematician or of the physicist, i.e. as a clock-sequence or linearity in Newtonian terms, is - unlike what Bergson claims - "entirely valid in its own terms, provided we understand that it is

experientially grounded in the more primordial datum of temporality as the open spread of future-present-past"(34). For the musician, the passing of time in the Newtonian sense, i.e. the "flow of time", "may be a datum equally primordial with the temporal field" : Debussy, using simultaneously linear time and "vertical" time, brings off their togetherness so as to come to a "vortical" (not only "vertical"...) time (35) - the very time of the wave... Thus the view of time as spread is to be complemented by the view of time as passage, as if they were "but dual aspects of the one concrete phenomenon of time as it manifests itself in our experience" (36).

Sure, we are living nowadays - "now that all the old gods have fled" - a difficult epoch. Heidegger has discussed the loss of equilibrium between the "dual aspects of the one concrete phenomenon of time" in his address to the members of the Academy of the Sciences and the Arts in Athens on April 4th of 1967 (37). Is there today, he asks, "after two thousand years, still an art which stands under the same demand as once the arts in Greece did ? And if this is not so, from where then does this demand come to which all arts today try to respond ?" - Answer : nowadays "they all belong to the universality of a world-civilization which is governed and dominated by science and technology. One is thus inclined to think that the domain from which today for the arts this demand has to come, is the scientific and technological world". But what does the expression "scientific world" mean here ? "A word of Nietzsche may (...) be of some help : what is typical for the XIXth century is not the victory of the sciences, but rather the victory of the scientific method over the sciences"(38). "Scientific method" means, in Heidegger's view, that "for each science only that truly is, that can be scientifically measured and experienced"; in other terms, the equilibrium and complementarity between "scientific level" and "ontological level" have been destroyed, and the unity of time has split. "Scientific method" keeps the "sciences" away from recognizing and sparing the existence of anything or any domain which might elude measurement ; and artworks can but bow under the post-industrial one-dimensionality.

The trouble with Serialists lies in that as composer-theorists they thought possible to reassume the old - Pythagorean - dream of referring both sciences and music to a single datum, instead of respecting their idiosyncrasies ; of course, with the help of computers. Newtonian physics had seemed to allow such a monolithism ; but it was at the linear level, and without the technological acceleration. Serialists forgot that the unity of music and science relies on the unity of musical time. Because the unity of musical time lies in the complementarity between flow and spread, the unity of music and science can but consist in complementarity ; without this complementarity, one obtains only unity as fusion, i.e. confusion. No wonder one of Professor Meyer's students labeled "cultural scuttlebutt" the allusions to concepts borrowed from quantum mechanics or relativity theory in the writings of the official Serialists. Music dwells evidently elsewhere.

Even if since the beginning of the tonal era, all music has been in principle linear, we have mentioned that this linearity was instable. Debussy's "verticality" achieves, in this sense, the deconstruction of linearity : it introduces discontinuity. Serialists have interpreted this discontinuity as synonym of "moment time". What is a "moment" (the nucleus of Stockhausen's Momentform) ? - A single "Now" : the "segment of an eternal continuum" (Stockhausen). - But if each of the Now(s) is viewed as situated in an "eternal continuum", their sequence will be simply additive : far from exploring the realm of verticalization, as Debussy did, Stockhausen retrieves Newtonian time. His "eternity" is nothing else than a substitute for the "horizon" of "horizontal" linearity : in comparison with the world of early tonality, we gain nothing. Why therefore not to keep the tonal idiom ? - Still more "horizontal" is the temporality of the post-serial opera aperta; "the extreme of moment time, Jonathan Kramer writes, is "mobile form", in which sections of the piece may be put together in any of a number of possible orderings from one performance to the next". Variation is obtained here thanks to macro-level permutations ; but, as Kramer adds, "the moments must still seem to belong to the same piece". So that "as we go through the piece, we accumulate more and more data concerning the form". Therefore, since to perceive the form is only to accumulate, what have we gained ? The listener is left unable to overtop the "flowing" level : he cannot gain access to the "spread of time"(39).

On the contrary, a "vertical" work, even if it seems "to adopt the requirements of moments (self-containment via stasis or process)", differs from the Momentwerk in that it does not allow any break in the temporal spread, i.e. assumes equitemporality. Thus it offers a "potentially infinite Now, that nonetheless feels like an instant". Hence "a music of utter concreteness, unhampered by referential meaning"; "a music of pure beauty or pure ugliness, never tempered by the passing of time"; whereas "form in linear music consists of relationships between successive events", form in such a non-teleological music "consists of relationships between ever-present layers of the dense sound world" (40).

John Cage, of course, appears today as the rightful heir of Debussy (41); he has included in the "ever-present layers of the dense sound world" all the available sources of sound of all countries and all epochs, so that the "layers" are the dimensions of time as such. But it is worth remembering at this point that Victor Zuckerkandl's thesis about musical time as "knowing nothing of transience" was meant for explaining Beethoven's and Schubert's and Bruckner's "linear" scores. In a similar vein, Jonathan Kramer's exegesis of what he calls "trance music" (i.e. compositions by Steve Reich or Frederic Rzewski) uncovers, "under" horizontal patterns, a secret verticality: even if one may think of such works as pure linear time, "listening to them is not a linear process". In brief, "where we do not perceive a work's directionality, its time world seems vertical"; and conversely, "a composition that has no inherent progression, a vertical form, can be learned so well that the listener has memorized the (random) sequence of events": it may then seem to be or become linear. Conclusion: since we are free to change our attitude toward any musical piece, and perceive it vertically instead of horizontally; and, moreover, since, as Zuckerkandl's thesis entails, such a change may concern any linear music, ~~we might~~ ^{must not we} return to Mach's justification of sensuousness, and describe verticalization in terms of psychological flexibility, i.e. as the triumph of subjectivity? That is Carl Dahlhaus' version: after having equated Krenek's "boundless freedom to invent musical axioms" to ~~the~~ "John Cage's demolition of all relationships and sense-associations between sounds", he recognizes in Cage a "genuine mystic", but whose position "unmistakably derive from the epistemological issues surrounding the concept of reality" (42). - On the contrary, we will take good care not to mistake psych^yology with ontology; nor ontology with mystical thought! What the

"change of attitude"(leading to "verticalize" a piece of music)entails is simply that the essence of music lies in time ; and since the essence of time is stillness (Heidegger), what is most noticeable about music as such - not only "neo-modernist art" - "is its lack of concern with overall "order", with goals or ends. Professor Meyer describes it as "anti-teleological" ; its main function is simply to exist, to catch a perceiver's attention, and not to move in any particular direction, or manifest any ultimate purpose. "Order", it seems, is rejected as part of an obsolescent metaphysical view of the world, and with this rejection goes the traditional notion of the artist as someone who imposes form and order on "life" or the raw flux of experience. Instead, "life" is looked on as inherently superior to art, and the artist tries to work, as Robert Rauschenberg puts it, in the gap between art and life" (43).

Thus musicians have always been, at least potentially, "particular transcendentalists" in Meyer's sense ; so that the avant-garde does not need to exist ⁱⁿ music, if by "avant-garde" we mean the "non-teleological" one, which Meyer describes under the Cagean "post-Renaissance" label. "Not without reason, Eero Tarasti says, Cage has remarked that all necessary music has already been composed, and all we need is to open ourselves to the "music" surrounding us" (44). We could find similar statements in Debussy's writings. And if one makes a point to speak of mysticism, let us evoke the mystic of the birdsongs in the Middle Ages. The musician, but also the listener of today, may accept the comparison, if he recognizes as musical the admirable Catalogue of Birdsongs by Olivier Messiaen. Messiaen's rhythmic practice is, according to his own words, "inspired by the movement of nature, a movement of free and uneven durations" ; music is made, "last and above all, with time, the divisions of time, numbers and durations (quantities)" : here qualities and quantities are not viewed as two different kinds of realities, but as two aspects of a unitary phenomenon - time. The bifurcation between music and science is no more necessary, since science is considered as clear of any desire for total control or will to power.

NOTES

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3 - Werner Beierwaltes, "Musica exercitium metaphysices occultum ?" in Manfred Schröter Festschrift, Philosophischer Eros im Wandel der Zeit, München, Oldenburg, 1965, p. 216-217.

4 - David H. Cope, New Directions in Music (4th printing), Dubuque, Iowa, Wm C. Brown, 1984, p. 183.

5 - Meyer, op. cit., ibid.

6 - Paul Henry Lang, Music in Western Civilization, New York, Norton, 1941, p. 1020. Quoted in Christopher Small, Music, Society, Education, London, Calder, 1977, p. 82.

7 - Small, op. cit., p. 67 and 88.

8 - Herbert V. Guenther, Foreword to Tarthang Tulku, Time, Space, and Knowledge, Emeryville, California, Dharma Press, 1977, p. XX-XXI.

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10 - Carl Dahlhaus, Realism in XIXth Century Music, transl. Mary Whittall, Cambridge University Press, p. 115.

11 - Dahlhaus, op. cit., ibid.

12 - Dahlhaus, op. cit., p. 116.

13 - Dahlhaus, op. cit., ibid.

14 - Dahlhaus, op. cit., p. 117.

15 - Dahlhaus, op. cit., p. 119.

16 - Dahlhaus, op. cit., p. 120.

17 - Ernst Krenek, "Tradition in Perspective", Perspectives of New Music, I (Fall 1962), p. 35. Quoted in Meyer, op. cit., p. 238-239.

18 - Cf. Meyer, op. cit., p. 245-254.

19 - Cf. Meyer, op. cit., p. 255-257.

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- 21 - Small, op. cit., p. 98.
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- 27 - Benjamin Boretz, "In Quest of the Rhythmic Genius", Perspectives of New Music, IX, n° 2, 1972, p. 149. Quoted in van den Toorn, op. cit., ibid.
- 28 - van den Toorn, op. cit., p. 63.
- 29 - Small, op. cit., p. 111.
- 30 - Guenther, op. cit., p. XXIII.
- 31 - Victor Zuckerkandl, Sound & Symbol, Princeton University Press, 1956, p. 246-7.
- 32 - Guenther, op. cit., p. XXVI.
- 33 - William Barrett, "The Flow of Time", in Richard M. Gale, The Philosophy of Time, London, Macmillan, 1968, p. 356.
- 34 - Barrett, op. cit., p. 362.
- 35 - Cf. F. Joseph Smith, The Experiencing of Musical Sound, New York, Gordon & Breach, 1979, p. 157-159.
- 36 - Barrett, op. cit., p. 367.
- 37 - Joseph J. Kockelmans, Heidegger on Art and Artwork, The Hague, Martinus Nijhoff, 1985, p. 204.
- 38 - Kockelmans, op. cit., p. 205.
- 39 - Kramer, op. cit., p. 546-549.
- 40 - Kramer, op. cit., p. 549-552.
- 41 - Cf. Wolfgang Rihm, "Trois Essais sur le thème de..." (II, "Liberté musicale"), in Avant-garde et tradition, Contrechamps n° 3, septembre 1984, p. 79-80.
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- 44 - Eero Tarasti, "On the Rationality of Music History", unpublished manuscript, p. 27. (Cf. the original : "Musiikin historian rationaalisuudesta", Synteesi, 1 - 2 (1985), p. 108-129).