

## Music and Number

Den schlummerköpfigen Haselanten, den Hanswurst von  
Thürenverrammler einstecken lassen! versetzte der Schloßherr. –  
Einstecken lassen, wiederholte der Bürgermeister. Lassen, sagte  
der Polizeisoldat und schob seine Dienstmütze verwegen auf das  
linke Ohr.

(Karl Immermann, *Münchhausen*)

### 1

The relationship of musical composition to its theory is not only chronological, in that the former is subsequently established by the latter, nor only pedagogic (historically and as professional propaedeutics). Rather is it thus: composition pushes a theoretical pretension out ahead of it and refers to this as though to a foundation. Any determination at all of an acoustic event draws away from, just as it follows, the historically taught judgement: the observance of guaranteed rules does not ensure the emergence of any sort of musical sense. When a possible sense results from the decision, this sense cannot be pinned down because decision precludes repetition. However, even if the determination requires a motive, this pinning-down is no less denied it; the presupposed theory devolves on the historical judgement in that it evades it. Even if the lines are extended: the thinking through of an intention cleans the slate. This process nonetheless designates the point where practice tends to merge into theory. The persistence of the division between these two – as opposed to, say, pictorial art – testifies to the social evil of "to rest is to rust" and benefits the ideology of the same. Musical practice in particular conserves the insufficiency of its technique by retaining the utopia of happiness. The fact that the instruments handed down to us have technologically fallen by the wayside transfigures rather than judges them – just as the flotsam of industry bears witness no less to the dream of life than to its decay. The hope that a perfection of the means provides the end bears the stamp of the illusion that the credibility of a promise is already its keeping. The projected theory does not dally with the imperfectible instrument, but unfolds without ado the consequences of the matter (a mixture, of course, of theory and practice) into the zone of direct perception. Where, therefore, the instrumental consideration determines the compositional state either practically (as with John Cage) or theoretically (as with Karlheinz Stockhausen), it relies solely on the strange or shocking new sound, or constructs something that cuts against the grain of practice. Here, primarily, an action is taken toward the repeal of categories, that is unfair to both. The heuristic value of Stockhausen's "duration keyboard" (see *die Reihe* 3, pp 14/15, Universal Edition Vienna) and of his "ideal instrument" (*ibid.* pp 41/42) is indebted exclusively to a theoretical insight and its demonstration; the image of an instrument serves only as a visual aid: if it should really be built as an ideal, the pieces written for it would either be limited once again by the manual capabilities of the player, or be realized in an electronic studio instead of on the ideal in order not to disavow its specific possibilities. The theory, even if illustrated by the image of the instrument whose backward state it opposes, shows a path for composition, that even moves away from the developed instrument. The theory's start does not leave only the instrument behind; composition lags no less. In that it takes the trouble to do justice to the theory, composition can break down the resistance of the instrument but cannot negate the reference of all its data to an acoustical substratum. From this, composition borrows the objectivity which it did not approve in the

historical judgement. In spite of its generalization into a theory, the method of certain composers conserves the fungible element of the authority of their works, on account of which element this method is esteemed by lesser composers. The objective substance is however communicated – even if only apparently – by the schematizing theory to such an extent that a work composed according to its dictates stands not only in the light of the theory but also in the shadow of its authority. That which supposes itself to live from objectivity, is contingent. If this is perceived and the objective sense is not credited to the unregimented subjective impulse, effort is directed towards that determinant of theory, which is as it were historically free and, if the reason be questioned, the least in danger of being disqualified by the historical judgement. Acoustics, Psychology, Mathematics, Aural Physiology already possess objectivity, and those compositions which rely upon this authority carry out – however tautologically – an objectivation of the objective. Such doubling does not, admittedly, remain unnoticed by those who are reluctant to borrow from an authority. At the point where historical continuity intersects with a scientific authority which is undermined by a practice respecting its existence in the face of technical requirements which, were they to be met, would dissolve practice as a category, – at this intersection composition chooses theory and predisposition. The question of the substantiality of the composed result can be answered by a definition of the theoretical presuppositions.

## 2

The category of musical material belongs to the familiar terminology. In this category fall terms like pitch, loudness, themes, colour, bowing, overtones, rhythm, tonality, melody, harmony, 12-note series etc. This pack of words will be differently selected depending on the intention of the presentation; the property of all talk about musical material is, nonetheless, a mixture of notions about acoustics and musical language. Material serves as a definition – anyway in terms of form analysis – of that which is not really definable. Material passes for a stockpile similar to the types in a letter-case. As opposed to this, the concept of material must either be brought into the syntax or be completely narrowed down to that which remains untouched by history. While a case for the latter can scarcely be made out, the variable subsumption is itself an expression of the historical process. Electronic sound production seemed to have exposed, at last, the historically independent stratum of material; for all that, this stratum, which negates the individuated instrument, is compositionally innervated. The sinustone – component for all spectra built up from periodic processes – can pass for a reduced instrument, for elementary, as it first enters a musical context in combination with other sinustones. This context however, is indebted only to the fungibility of the sinustone, whose integrity is, as it were, the focus where all the determinative data meet.

The definition of the instrument may assist that of the material. The instrument designates the constructed thing in its relation to function. A hammer, for example, consists of the materials wood and iron; if the specific combination of the materials is altered, the result is – depending on the degree of alteration – a different hammer or a different tool, while the materials themselves remain unchanged. Whenever a material is indebted to a function for its fashioning, it is called an instrument. As a musical instrument, however, it is not only mechanically fixed but rather lends the sound produced on it a particular *colour*. The analysis of this leads to sinustones as its acoustical material. If sinustones are defined as the simplest periodic oscillations, white noise can be placed beside it as the most general aperiodic form

of oscillation; both may be called elementary and both, as material, came to be the instrument as soon as any combinations of them were defined and sustained in their definition.

If, however, one considers the number of phases of a sinustone as already a definition (namely of the time during which the note sounds), the aspect of material would have to be limited to the single phase. But because a frequency is recognisable only when a particular number of single phases are present, one of these manifests itself merely as a click; the absolute length of the phase cannot be determined by the ear. Thus the concept of material is reduced still further to an event whose true property is not recognized acoustically. The sinustone – also the white noise – would already be an instrument when the number of oscillations – or the statistical formula for the oscillation-form of noise – could be determined and realised.

The distinction between material and instrument can be spread out into the categories of musical language. If all specific combinations of more elementary units count as instruments, melody is the instrument constructed from the materials pitches, durations, and intensities. The distinction applies still more consistently for the 12-note series, because the terms of this make the chromatic total within the octave and do not refer – as major and minor modes – to modulation which never, even when the circle of fifths is completely encompassed, completes the scale to the total chromatic. The single note in the series thus assumes a double significance: syntactically it represents the material state, and as a sound event it takes up the position of an instrument. Every composition written today for conventional instruments must arrest the process by which the composition of the traditioned contents of the theory is overtaken by this last, and accomodate to that practice with which the braked theory already labours.

Up to the present, *Instrumentation* was used on a text that was determined as far as, but excluding, tone-colour; in that it embraces the instruments themselves and the syntactical configurations down to the smallest particle, it must prove itself on the structural idea of the work. Its means are no longer the instruments but definitions of material; statistically or pointillistically defined structure patterns became instruments.

The narrowing down of the sphere of material to indivisible processes extends the notion of instrumental music. This notion designates not only the use of particular instruments, but rather a compositional principle. Instrumental music falls as it were on the one side into an abstract scheme and on the other into a stockpile of motivic or serial shapes, colours, frequencies and intensities that can be introduced into the former. Opposed to this runs a theoretical approach that reduces the material as well as the syntactic practices to elementary processes; the acoustical phenomenon *music* results only from the construction of these. It is true that elementary procedures are also instruments, only as models certainly, not as sounding or sound producing objects. In order that instrumental music should come completely to itself and grasp its substratum as something composed, this substratum – the instrument – needs primarily technical perfection.

### 3

The historical path to the present relationship of theory and composition runs via tonality and dodecaphony. In the times of the former it seems that the compositional theory did not become an object of its practice – by today's standards – nor was a potential rivalry between them perceptible. Practice, rather, apparently remained in the safe keeping of its theory, which left it behind and also ratified it. The technique of crystallisation, which was developed in the

tonal system, imparted itself to dodecaphony, and finally to the serial technique. In the broadest sense, every serial form can be attributed to it, if the peripheral connections were not exactly the opposite of the central ones. To a large extent the 12-tone method has demonstrated its affection for the former, in that two series, for example, can be hooked onto one another with the help of a common initial (or final, resp.) note. Innumerable such practices of tangential contact have been admitted by 12-tone composers. Serial compositional technique is less prone to such temptations; it inclines more towards radial formations as long as it does not only use the nuclei of the crystallisation possibility, and operates pointillistically.

It is decisive for crystallisation that the centre, already, is a cluster-like shape. The cadence does not serve to establish the tonic (as the textbooks would have one believe) but rather to resolve it: the centre, defined by circumscription, jumps virtually to the periphery. As a paradigm case, the cadence is chalked up with only three or four chords; but the 12-tone series allows no such difference between theory and practice. The fact that its nucleus is so much more amplified, already indicates in the distance a time-squeeze, into which serial composers later fell. The further music moves away from its fictive space (from its *space for modulation*, for example) – categories like counterpoint and development also take place in this space, and not merely in a succession of moments of time – and unfolds itself in the articulation of time (physical or experiential), the more differentiation will become a function of crowd relationships. The tonal theme is not “materia”, not a stockpile from which selections can be made; the space for modulation could be much better thus described. But even to draw up of a detailed modulation scheme would not help a tonal work to be a composed unfolding of time: themes and their derivations cannot be entered in the scheme of harmonic functions, for the latter is already inherent in the former. Thematic work progresses by modulation; harmonic relations concern thematic formations and do not remain limited to a cadential succession of degree of a scale. Tonal composition was the really integral composition; dodecaphonic and serial compositions operate much more with strata that can be slid over one another. The 12-tone series is much rather a material; if one works with it thematically, not only does the series give the fictive “space” (drawn at right-angles to the time-axis) in which the theme is formed, but theme and series coincide at least virtually. Instead of the non-binding modulation scheme, we have the series with its transpositions and mirror-forms – that notorious table of all the 48 series, whose totality can still be constructed in a work. Such tables are in the serial method still more externalised but again more binding; they are the sole promoters of coherence; *space* has completely passed over into the succession of moments.

#### 4

That is already contained in the serial concept itself. In this, material and instrument are bound up one with the other. The series, as a succession of numbers, is substitutional, and blind to its own significance. Because it will be repeated and varied (according to exact definitions), and because, moreover, the controlled variation comes under the concept of permutation, even series conceived as successions of notes and durations must be replaced by successions of numbers, because otherwise they are not permutable. Not only historically, as a further development of dodecaphony, but also because the sensitivity against repetition has multiplied itself, the series became similar to each other (also because the basic law of the 12-tone series was mechanically extended to the other para-meters): just as the numerical substitution series for successions of events in the various parameters are hardly to be differentiated, so the constellation – conceived right from the start as a succession of numbers – can be freely

interpreted. Here a hierarchy of exactitude arises: the succession of durations three, two, five, one, six, and four seconds corresponds to the letter with the series 3 2 5 1 6 4, because the proportions are retained. If, in a small ensemble, the instruments violin, violoncello, trumpet, clarinet, vibraphone and harp are used and furnished for the sake of permutation with the numbers 1–6, this comparability is dispensed with. There are several stages between these extremes. If, for example, one supplies the numbers 1–12 to the chromatic scale, they correspond to it, it is true, in the sense of an approximate magnitude comparison, but not as a mathematical expression of the semitones; that would run thus:

1	1
$\sqrt[12]{2}$ or, expressed decimally:	1.059
$\sqrt[6]{2}$	1.122
$\sqrt[4]{2}$	1.189
.	.
.	.
.	.
$(\sqrt[12]{2})^{11}$	1.888

(The succession of whole numbers from 1–12 does correspond however, to the overtone series.) In most cases therefore the series is not used in a mathematical sense (i.e. as a designation of relationships) but rather to designate the sequence. As such it does not, of course, need to worry itself about proportions. But even the restriction to sequence does not exclude ambiguity: if harmonic relationships (as frequency- or time-spectra) are brought into the composition, the numbering of the terms corresponds at the same time to the magnitude relationships. On the other hand the transposition of the sequence belongs to the technique of permutation; in that transpositions are effected by intervals which themselves belong to the sequence, a proportionality of its terms is once again imputed to this. (Correctly, incidentally, in as far as the linear succession of numbers stands for the terms of a geometrical series.) One should differentiate between the real *series* (i.e. the proportion series, which does not necessarily give information about the *succession* of the terms, and hence can be written out according to the magnitude order of its terms – also called a scale), the relative series (which designates approximate magnitude relationships), and the serial *sequence*. The terms of a scale or relative series are given, it is true, a succession, so that each series appears, finally, as a sequence; but this is not always based on a proportional or relative series. – In the following only the expressions *series* and *sequence* will be used, depending on whether scale (including the relative one) or succession is meant.

The relationship of material and instrument is contained in the dual character of the series – as a "series" and as a sequence. The series, in the sphere of dynamics and frequency, combines intensities or pitches to form a closed shape. That which is unequivocally composed may not be taken apart, except to liquidate it. Indeed permutation, indifferent whether concurrent or subsequently used as a technique of variation, dissolves the meaning of succession (that is, that the terms are not immobilised within a fictive space – which they only forsake for the sake of a one-dimensional presentation in time – but rather succeed one another, so that the meaning is only registered in the succession, and not merely in a pretemporal aggregation); permutation, however, much as it may annul any decision, can not

overstep its own limits (the number and nature of its terms), and, in that it reflects the original series at the same time as its possibilities (these have more of similarity than surprise), it promotes a supra-ordered identity: the series, as a form-building instrument, reduces its unequivocalness to the status of material; its exclusiveness is liquidated. Its ambiguity resides in its independence of certain parameters, besides in its permutability. Because the permutation scheme does not itself appear as sound, but must rather be "instrumentated", it approximates to the material defined in parameters. However, the material is not affected; the context in which it is placed must be prescribed for the series and its alterations: that is, whether a succession, or the simultaneity of relations, or both shall be defined. That brings out once again the instrumental character of the series, which is, of course, chimerical in so far as the context all come to the same end: universal mediation. It acquires the ability to accommodate, by becoming insensitive to any reality defined under it; the more fungible and devoid of significance it becomes the more it tends to be material, from which, like the cryptograms of mathematics, any construction can be formed, without any alterations contradicting the construction elements. Numbers enjoy strict immunity.

## 5

At first, they were only accessories to dodecaphony. Tabular control was extended merely over one parameter, that of frequency, and the substituted number-series, whose emancipation marks the beginning of pointillist music, stood only for the sequence, not for the proportions. Sensitive composers who began composing at a time when the Schoenbergian era had already become legendary, submitted only with suspicion to the compulsion of the series but asked themselves, at the same time, whether the manipulation of the pitch-series didn't have to have consequences in the durations and intensities. The auxiliary scheme of numbers needed only a slight pointing up to reverse the relationship: namely, that notes be substituted for the numbers. The ordering of numbers corresponds to that of notes, which was settled for by a predodecaphonic consciousness which could not imagine the note (and the intervals formed by notes) except as a harmonic function: in that the differences between succeeding values are observed as a succession of intervals, allowances are made for the tonal relics from which dodecaphony lives, however allergic it may be to preponderances that threaten to relapse into tonality. A subsequent legitimacy falls to the still dodecaphonic conception of the all-interval series: the dimension of frequency can be described as a double-parameter: the 12 semitones must be so arranged that the 11 intervals are accommodated between them (the 12<sup>th</sup> interval – the octave – remains tabu). Now one conceives a 12-tone-series – or at least a material consisting of the 12 semitones – rather as a sequence of notes than one of numbers; the strength therefore with which the implied number-relationships draw attention to themselves allows the conception as a note-series to appear just as auxiliary as it did previously as a number-series. Any subdivision of the series inclines to the double-parameter: if four 3-note groups are identical in their double interval – so that four groups with, within them, three notes each are permutable – the necessary transposition of the groups within the whole series already takes on the character of a parameter; now that takes place again for the transpositions of the whole series. If we take it, in addition, that numerically (because functionally) the four sub-groups correspond to the four modes (original shape, inversion, retrograde, retrograde inversion), the 12-note series reveals itself as a rich matrix. That suspends the instrumental character of the series. It had retained, as a cycle, much of the function scheme of tonal music, in so far as cadential cycles are often joined like chains. Certainly the cadences are mostly so

## 6

closely knit that single chords form, as it were, hinges where the function is switched over. Graphically, that can be thought of thus: a simple cadence or a complex formation comes into existence between two vertical lines in which the cycles overlap. The density of a musical unfolding results from this, though, of course, motivic and rhythmic articulation also contributes to it. The series function similarly in a dodecaphonic structure; they can also be divided by vertical lines, or they move in and over one another so that complex connections of series take place between two lines. Provided that in such cells which grow together into larger fields where the cells are related to each other in a manner similar to that relating the elements within a single cell, the constructive unfolding of a composition continually starts afresh, the 12-tone series – however much dodecaphony lives off the substance of tonality in that it devours it – takes on the function of a mediator, particularly because it does not exhaust itself by running off its notes, but is completely dissolved into the articulation of motivic and rhythmic innervation. The numerical character that the 12-tone series must procure for itself is therefore already included in the tonal system. The steps by which modulation can move away, are contained in the circle of fifths; unchecked movement in either direction necessitates more and more enharmonic changes until, finally, each of the 12 steps is thought of as ambiguous from the start. Neither can dodecaphony step out of this circle; in that a modulatory capacity is no longer required of the fundamental-tones, their numerical character comes out into the open. As such it draws in everything it can get hold of; the numerical character frees itself from the 12-tone series. Dynamics and rhythm, only through which the functionalism of tonal music became possible, renounce their freedom and come under the numerical idea, in return for which they are allowed to take part in the construction. The universality of the sequence of numbers forces the splitting of the sound event into areas which can be articulated independently of one another. Parameters are physical components on the one hand, and on the other, formal. The former are frequency, time, intensity, colour; the latter differentiate methods by which single elements are summated to series, and series to supra-ordered units. Recently the attempt has been made to win space as a further parameter. Physical and formal parameters cannot dispense with each other, and on the whole, the mechanical grouping together of the parameters under the single heading serves to make the specific differences forgotten. No responsible composer, it is true, would overlook the fact that frequency, time and dynamics belong to different spheres of perception; but their unspecific treatment as parameters, in which the permutable sequence of numbers first gives the single heading, constantly revokes this recognition. Of course, the blindness with which one smites oneself, throws light on the situation; but from this it becomes clear, that the concept of the parameter is dependent on that of the instrument, which dodecaphony, already, and still more the succeeding serial principle, undertook to reduce to that of material. If the parameter really takes on the status of material, one must examine whether it is at all definable as such. Let us call, for comparison, the determinative data for a triangle its parameters; it is presupposed that the numerical alteration of individual data alters the category (e.g. *rightangle triangle*), while the numerical alteration of the *space*, in which the triangle is to be drawn – the 2-dimensional surface – leaves the triangle, as the relationship of its determinative data, unaltered; the surface is not a parameter of Euclidian Geometry, it is its presupposition. Just so, the variation of one parameter of a musical structure alters this structure as a whole, while the stretching or constricting of its “space”, of its one-dimensional times leaves the proportionality of its parameters untouched. But number-series within a parameter only establish relations; they are not themselves the acoustical reality. If the parameter serves for material, it manifests itself in time, which is itself not a parameter. But if one withdraws time

from the parameter presentation, space cannot be inserted in its place. In the mental conception, which presupposes only time as dimension, space has no room; when music is performed, the space in which the sound waves propagate themselves is a dimension. That which is composed as changes of amplitude in time, is not affected by the direction from which the sound reaches the ear; the faculty of differentiating directions is a sense of orientation, not a sensation. Rather, the total perception of music can be once again divided into two parameters: that of composition and that of performance. Much as the perception of the musical texture may go into its composition, the object of this perception is the dimension which music articulates; but frequency and intensity are not – as distance and size are – determinative data that could be drawn in the co-ordinate system of space. In space as a so called parameter of musical composition, a trace of interpretation creeps in, which – in electronic music – should just have been dissolved in composition. However, intensity and duration are real parameters; the first is the event which communicates itself to the sense of hearing, an energy quantum; the second determines the time-distance from one amplitude to the next. Frequency on the other hand is already a particular form of a duration-sequence: the periodic. Colour, finally, results from the combination of duration and amplitude relationships and is – like frequency – a formal-compositional concept. As long, of course, as this material status is not realisable and one must hold fast, rather, to the instrumental character, i.e. to categories that are already specific constellations of material, can frequency and colour, and space too, participate in the composition as parameters. The isolation into which they fall as concepts is, however, only apparent; they can by no means articulate themselves independently of each other. As pitch, loudness, colour, space, must, besides, relate themselves to time, this last is at the same time thought of as a parameter and, as such, the first and common dimension for the others. That means: the projected proportion-series for time is binding for all other parameters, even when they must be determined by series and sequences of their own. The necessity that, on the one side, forbids the omission of a parameter, and on the other, demands a common timelapse for all (so that in each note all the parameters coincide), makes a polyphony of parameters impossible; they march in step, rather. If the instrumental character of the parameter could at last be completely resolved into the material character, the question of polyphony, whose idea the process of vertical strata still bears witness to, can no longer be put: time as a dimension is, besides, one-dimensional, and the sequence of amplitudes would be purely a succession.

## 6

While the presentation till now has referred to series and sequences, whose terms are "dots" – i.e. they designated single frequency, duration and intensity values or intervals between single values – now the formal aspect of the serial principle should be considered. The *pack of series* (time-series and sequences for further parameters) establishes on the one hand a sequence for the time-dots which were fixed singly as to their properties, and on the other hand it has a total length, average total dynamic, etc. A single number, assembling the series into a dot, can be written for each parameter which was unfolded to begin with in a particular number of elements. Mostly this index has the form of a curve, because each parameter is altered as regards its dots, during the course of its serial unfolding. Characteristic forms are selected from the continuum of curves, just as previously dots were selected from the continuity of the Parameter. The single forms can be numbered and combined to form a sequence: the group series. This mechanism spreads finally over the whole piece: the group



series, once again, receives an index number making it usable as a term of another supra-ordered series. Thus the total form of the piece grows out of the dot; it is a single series of large sections.

In the reverse case, the dot is found by interpolation. The whole piece is broken down into sections, and each of these into sub-sections, etc., down to groups of series, series, and single terms. Both methods of integrating the various factors refer to the prescription that series (or sequences) be formed from *various* terms. Yet one parameter can be fixed in the pack of series; the fact that it does not change implies for the sequence a *reduction to a single number* (or to a horizontal line, for a curve), and for the series, the *multiplication of the single value* by the number of terms in a parameter that is not fixed. One is the less constrained to permute, the more parameters there are in play. Fixing all parameters simultaneously would be identical with the dot; the fact that each pack of series (for single parameters are not realisable) – comparable to a stopped film – can inhibit one of its factors, and that the dot can at any moment be resolved into the succession of a *flock of dots*, whose parameters are only recognizable as average-values, – these two facts virtually eliminate the difference between series and dot.

The necessary congruence of *dot-series* (with regard to the various parameters) makes room for free overlapping of group-series. Because each group consists of several time-dots as long as it does not pull itself in into a single time-dot –, the group formations of the parameters no longer need to refer to a common time-series. However, the time-grid (arising from successive time-series) presents a total number of available dots as a crowd. The groups of other parameters irrespective of how they overlap, must be defined as a selection from this crowd.

Finally it is possible for several time-series to run parallel. If they are singly articulated (through the other parameters), a serial variety of the old counterpoint arises – to which it holds true, in so far as a persuasive vertical correlation is achieved; if they are projected onto a common time-axis, the one-dimensional articulation (in each parameter) can be applied to a correspondingly complicated time-grid. So as to be able to keep within controllable relationships, one chooses, most often, overlapping periodic sequences of durations.

Thus altogether there are available:

- the dot
- the multiplied dot (periodic or aperiodic)
- the series (1 to n terms, that is including the dot)
- the multiplied series (series repetition)
- the permuted series
- the group characteristic of the series (the series as a dot [e.g. a length] or as a curve)
- the group of series (series of several series, designated by group-series)
- the multiplied group of series
- the permuted group of series, etc.

In addition there are coinciding or overlapping parameters and the simultaneity of several courses (contrapuntal or as a contamination).

The group principle – as it were the liquefaction of the rigid pointillist serial scheme – affects the serial principle. If there remains as a definition, only that a complex – defined in some way – must be varied (if possible by permutation of the parameters), and that the variation be numerical and proceed in the same sense as a series, then nothing remains except the control of conventions. If one thinks in categories of alterations without reference to that which is to be altered, a non-serial constellation of notes is just as good as a series. Such a constellation does not affirm so much the imagination's independence of the prescriptions of

a system; it fastens rather onto the traditioned phantom of the individual, instead of making the effort of constructing individuality out of something completely amorphous. A ruling is pointless where that which is ruled constitutes itself by virtue of its own unruliness. If the serial method has the intention of unfolding the genesis of a central constellation in the totality of the work or, reversed, of reproducing the formal law of the whole in the smallest particle, then no stage of the process can be left out without unmasking the method as a restraint. As an introduction to permanent variation, thinking in series is a mere rule of the game. If the constraint to permutate is so implanted in the structure that it remains irrelevant when not permuted, then the fungibility of the commodity triumphs in the numerical scheme. Yet (while) the deviation towards pre-serial formations accommodated to the instrument, testifies not only to the distaste for numbers ticking over: the primary parameters of pitch and colour are already pre-serial “properties”. Stolidly holding on to a bald principle is, of course, not the better alternative. The question is whether the technique of group-composition could not liquidate, by virtue of its contradiction, the remains of the “instrument”, and whether it could not completely estrange the misused concept of material from the ideas of nature and value-in-itself, in order by virtue of the intention to take up the concept of material, instead of deriving the intention from the concept.

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Colour is not only an instrumental idea, but also a pre-serial event. That of the usual orchestral instruments results from the superposition of periodic oscillations whose frequencies are in whole-number relationships. The frequencies are referred to a time-unit (1 second), while the note can have any length. If we break down the frequency into two parameters, the one is called the *duration of the phase* and the other the *number of phases*. By this definition, colour takes rise from the superposition of oscillations whose phase-durations are in harmonic relationships. If the sound is formed from the first six partials, these work out to be a half, a third, a quarter, a fifth and a sixth of the fundamental phase. If this, for example, is  $\frac{1}{440}$  " (=a'), the partial phases are

$$\frac{1}{440} \text{ "}, \frac{1}{880} \text{ "}, \frac{1}{1320} \text{ "}, \frac{1}{1760} \text{ "}, \frac{1}{2200} \text{ "}, \frac{1}{2640} \text{ "}$$

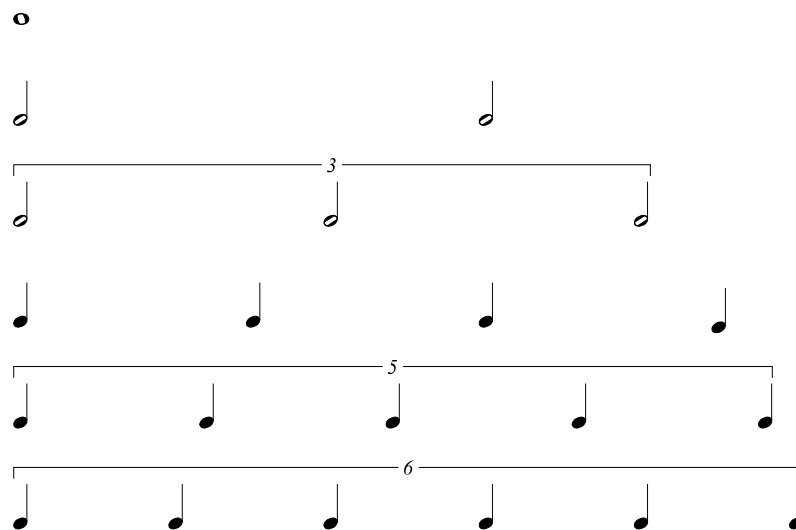
If the sound continues for one second, the partials oscillate 440, 880, 1320, 1760, 2200, 2640 times.

The series 3 2 5 1 6 4 could be so applied to the spectrum that the numbers give the differences between the partials that will be used. It would then contain the partials 1 4 6 11 12 18 and would run thus:

440  
1760  
2640  
4840  
5280  
7920 cps.

Permutations of the series would lead to further spectra each with 440 cps as the fundamental, each consisting of six partials lying between the first and the twenty-first. In this way the field-concept is involved in every series as the permutation programme.

The reproduction of colour with sinus tones does not only make possible its serial manipulation; further, its relationship to the time-lapse will be clear. If large enough phase-durations are chosen, time-spectra appear. The following duration-spectrum would correspond to the frequency-example above, consisting of the first six partials:



The frequency-spectrum, as opposed to this one set up on a single fundamental-phase, is only audible when several fundamental-phases succeed one another; but in practice its duration is not achieved by multiplying the fundamental-phase, rather by a length-determination in seconds (or centimeters of tape), made independently of the absolute duration of the fundamental-phase. The definition of colour as articulation of time – as "sound-rhythm" (op. cit. pp 21/22) – takes no notice of time as the absolute duration of the phases. Nonetheless the musical example does show how the sensation of *colour* comes about.

The projection of all partials onto a common time-axis is designated as *sound-rhythm*. In the musical example (duration 1") the following proportion-series of maxima results:

$$\frac{1}{6} " \frac{1}{30} " \frac{1}{20} " \frac{1}{12} " \frac{1}{15} " \frac{1}{10} " \frac{1}{10} " \frac{1}{15} " \frac{1}{12} " \frac{1}{20} " \frac{1}{30} " \left( \frac{1}{6} " \right).$$

If the fundamental-phase (1") is divided by 440 the a' of the previous example appears as the fundamental. If all the partials are equally loud, the amplitudes of the proportion-series obtained by projection are equal too, except for the cases where two, three, or all six maxima coincide. Thus the spectrum (the "colour") can be presented as a sequence of amplitudes in the sense of the above series, taking a few amplitude-additions into consideration. Each amplitude consists for its part of two flanks which – in a simplified presentation – would be defined by the angle from the x-axis and the value of y. These flanks would be elementary material. But while the repeated sequence of flanks (in the sense of the above proportion-series) releases the sensation a' (of a particular length and with a colour similar to an instrumental note), the single flank would only be noticed as an impulse, i.e. as a click. Material is not merely the reduced instrument, but a qualitatively different category. Only the properties of our sense-organs bring the elements to perception, in which the properties of the material are dissolved in those of an instrument. Theory, hurrying on ahead, does not only overtake the capabilities of the instrumentalists (and those of the composers working in the

electronic studio), but the category of the instrument. The formation of theory, which breaks the spell of the instrument, converges with composition.

## 8

Before it should come to that, the series already prepared to enmesh all thinkable connections within the composed piece. The instrumentalistic character of what is nowadays called a parameter is fitted into the series not only against its own definition, but even against the conscience of the composer. In the present state, an abyss which is not bridged by the reduction of claims to that which is possible at present, yawns between theory, which is indebted to the reflection on practice, and this itself, in that the former helplessly emulates the latter; in practice history and the future are meeting. Serial compositions of today smack therefore of housekeeping, not dissimilar to the layman's idea that the electronic studio is a dispensary of sounds and noises from which the components of the piece are extracted like the ingredients of a sauce. This in fact smelts down pre-serial, instrumental formations in to the dough, from which the most incommensurable are tasted out like currants in a cake. Not only is there a lack of parameters; they themselves are only sub-divisible within limits. The series must therefore get by with only a few terms, especially when the rococo rule of dodecaphonics forbids repetitions. Permutation is also hampered, because a good series does not guarantee the usability of its variants. Yet all this does not curtail the universality of the series. Without pretending completeness, the following can be governed by it:

- the simple time-series (subharmonic)
- every supra-ordered time-series
- the simple sequence of time-values (for which a harmonic or tempered scale is chosen)
- every supra-ordered sequence of time-values
- the (periodic) multiplication of time-values
- the sequence of previously chosen pitches (e.g. 12-note series)
- the sequence of transpositions of the proceeding
- the number of notes in a chord
- the number of repetitions of a note or chord
- the octave in which the note appears
- the register for a series
- the ambit of a series
- the ambit of a chord
- the sequence of dynamic values of a predetermined scale
- the repetition of intensity-values
- the manner of producing the note (bowing, pizzicato, tonguing, attack, etc.)
- the repetition of the method of production
- the sequence of colours (instruments)
- the repetition of colours
- the series or sequence of intervals
- group-characteristics in all parameters
- the number of permutations of a series (or sequence)
- the sequence of permutations of a series (or sequence)
- intervals of entry
- length and sequence of rests

- the sequence of supra-ordered categories (single notes, time-spectra, chords, grace-notes, clusters, etc.)
- magnitude and sequence of degrees of alteration
- degrees of density (horizontal and vertical)
- the sequence of various spatial directions
- degrees of freedom for the interpreter
- field-sizes for statistical structures

The astronomical number of connection possibilities comes into the picture when one works through one of the simplest constellations: let the parameters of a short sequence of notes be pitch, register, duration, interval of entry, dynamic, colour, and form of entry (attack and such); let each parameter have seven values and each series (formed from these seven values) seven permutations. The result is 823.543 different combinations. The differences between them are of course so tiny that only a considerably smaller number could be used. Even if only 50 distinctly distinguishable variants were selected, they could not be accommodated in a piece. But if the choice falls on only 7, where the parameters permute simultaneously and use only one of the seven possible values, that is the 117.649th part or approx. 0,00085% of all the possibilities. The more the serial principle is understood as a permutation programme (that includes permutation of the connections) and thus tends to become statistical, the more it opposes the composition of a piece of music; the more carefully the selection is chosen, the more the serial character is suspended: it is pleonastic to declare the data, connected according to the taste of the composer, as numerical relationships, presentations of parameters or series. This aporia is at the same time the propellant. First and foremost the serial institution always seems peculiarly fit to produce the preconceived style, the particular *sonorous image* that hovers before the composer. Music as a language cannot limit itself to communicating its vocabulary. Exclamation, distrust of the historical sediment, emancipation of strata to which motion can be imparted, finally reflection about division of work and total organisation; all these need a grammar that simultaneously dispenses the shock and places it. But if the composer first submerges himself in the web of all calculable strata, elements, reactions, he looks for durability when connecting the threads. The series is its own permutation-programme; parameters unfold in permutations of a common series; this expands into a group-series. The interval or sequence puts the object constructed from intervals or sequences into a relationship. This technique of augmentation has innervated much more from the development form than the composers would like to admit theoretically.

## 9

That is not finally evident in the surrender with which they devote themselves to instrumental – in spite of electronic – music. Electronic work did not it is true accomplish alone the unfolding of the serial principle to a totality, but certainly with more far-reaching consequences – at least potentially. These bit back into instrumental music, even if the composers had not worked in the electronic studio. Simultaneously however these composers made a move towards a conception – as if it were a substitute for the parameters that can not be realized with instruments – which seems to shunt off, if not directly to oppose, the determinism of serial music: the *open form*. This allows the interpreter – if not actually demands from him – to deal arbitrarily with a text whose closedness manifests itself in that pretemporal heaping up of its constituents – not in their succession – which the series sets out to oppose. The assignment to permutation, which every series contains, touches however on

the irrevocability of its time-structure; the open form retains with the series, which continues to promote coherence, the negation of its premise; the series' once static character switches to statistics. Characteristic, that it affects primarily the dimension of the series – time. No parameter is so radically written off to interpretative "chance", and none is so capable of overthrowing the musical *course*. Nonetheless the strength of the series produces an aftermath, in that the freedom, which the interpreter is given from case to case, succumbs to serial determination; at the very least it varies always between an equivocally notated text and – different from piece to piece – a maximum of possibilities for decision. Thus the freedom of the open form is degraded to serial degrees of freedom. It shares with the serial technique, besides, the shuntability of things that were composed in the form of strata. If the serial technique, by virtue of the unified mode of joining, converges more and more on the aesthetic judgement, this is dissolved by the open form by dint of a game ideology; while the interpreter, onto whom the aesthetic judgement is pushed off, is forced to fix his attention completely on the "time-table" which absorbs it. The open form claims to win a seat for freedom that it had forfeited in the serial system. But in reality the composers put it to no use by leaving the decision between several possibilities for the form-course to the interpreter, while the determinism of the total serial technique presupposes the constant choice from among a number of possibilities that is never expected from the interpreter of an open form.

While in Europe the consequences of the theoretical approach were not able to dissolve the antithesis of theory and composition, a development took place in America which negates rather than smoothes over the contradiction. In the compositional method of John Cage the composer and interpreter are thought of together; the *action* of the composer is in principle no different from that of the interpreter. But this action is nevertheless prepared for the interpreter. Both are steered by chance; both choose beforehand what chance is going to steer. The method abstains from any serial manipulation and does not want any part of time as a dimension. This is consistently defined by Cage as a parameter: their "sequence" be as much a property of several acoustical events as the pitch and colour progressions. That reproduces of course the same contradiction that the serial presentation of parameters fell into: The single note is not a succession that could serve as a property like its duration; the succession can be credited to several notes as a property but then their single properties (duration, colour, etc.) merge into this succession, which is just what they were not composed as. While the European development seeks to draw practice right into composition, Cage goes round the other way: composing settles down as practice having again no aim but itself. Cage, supported by Heinz-Klaus Metzger, would that this action with result unknown be designated by the concept of *experimental music* – not without a restrictive tendency with regard to the rigorosity with which, previously already, he had had to suffer to declassify serial, and particularly electronic music as unserious and in an experimental stage, or on the contrary to file it under technical progress which at the same time is obviously under suspicion in that the factor of untriedness is being accentuated. Should he hold to the specific difference from serial (i.e. determined) music, he must be ready for the definition of the concept in natural science. But as such, an experiment is a question, put as soon as one needs the answer. The exactitude of the answer for which one asked depends on the exactitude of the question. That requires precise experimental conditions. But part of the definition of this is the expectation that the answer (the result of the experiment) lies within a certain area. The issue of the experiment defines a particular point within (or outside) the probability-field of possible results, and there with the specific connection between the result and the experimental conditions. As a musical category it is just so: with compositional experimental conditions the composer seeks to obtain

illumination of the relationship of, say, technical (for example serial) presuppositions to experimental reality. He will be just as critical of the result as of the experimental conditions. The relationship sought need not only lie between compositional technique and performance, so that music can have an experimental character apart from action. Rather is the composition of the experimental conditions itself an action; the result enters into the further composition (which may again be of experimental conditions). As a collective for all that, compositionally, does not draw on familiar effects, *experimental music* goes definitely too far; in the present relationship of theory and composition however, a significance falls to this concept which cannot be narrowed down to that renunciation of decision implied by the open form, particularly in its radical aleatorics as practised by Cage. It was clear from the example of Stockhausen's "ideal instrument" to what an extent experiment (of course inspired by practice) obtains theoretical backing; let us here supply the theoretical components of the result: not every possibility of thought provoked by the state of an epoch is at the same time its realisation-programme. History is full of Utopias whose historical significance only becomes accessible when their time is past. Rundown Utopias cannot be postponed, like points of the day's schedule not attended to, till the next session; Utopias have their appointed times [allotted terms]; mostly only to hindsight do they unveil themselves as having been possible.

## 10

The electronic studio had actually already been founded long ago. Even if it does not fulfill by any means all the desires of the composers, the ideal instrument does impress as a wish that the interpreter too have something electronic. Also some hope is apparent that through him that Utopia is approached to which the studio still shuts its eyes. Where the attempt to articulate all thinkable parameters serially, foundered on the orchestral instrument, the electronic studio seemed to meet the attempt half-way. The equipment promised the solubility of the sound event into elementary processes. As opposed to the unalterable (or anyway only changeable in steps) colour of musical instruments, the sinus-tone – even if not colourless – is the simplest form of oscillation and is the basis of every complex colour. It exhibits the character of material which was missing in the instrument. During the first years, spectra was industriously tried out in the studio; the notion of *composed colour* appeared; that meant that the overtones of the sounds were to be placed in the same relationships as their fundamentals. Tempered sound-spectra therefore came to the fore – noises. In this way the transition from sound to noise, seen from the theoretical angle, became composable; colour, for a long time – like the painter's tubes of paint – the object with which one composed, became the result of composition. It remained of course the only category susceptible to reduction to something more elementary. The “pitch” of a note, without reference to its colour, can merely be more exactly determined electronically: more than 20,000 frequencies are available from the generator, instead of the 88 keys of the piano. Just as quantitative is the expansion of the dynamic scale from the, say, 7 degrees that one asks of an instrument, to the 40 that can be correctly adjusted in the studio with the aid of a measuring instrument. It is obvious that time as a dimension does not lead back to smaller units; it cannot even be called elementary. But even as a parameter – when it is misunderstood as such – no more elementary category has an opening for it. But after all, there is a further aspect to the concept of the elementary. The continuum in which music first becomes possible can be supra-ordered by the screening of all strata to which music is indebted for its development. The scale with twelve notes is mechanically built in to valve, key, and keyboard instruments; string-players – according to

the judgement, which has remained unheeded, of Rudolf Kolisch – are not only blinkered by the necessity of crossing the strings but also ideologically, in that they do not really want to recognize the tempered system as the basis of western music since Bach, let alone realize it; the family of stringed instruments remained stationary at the tonal level of the harp which actually has a more exact intonation. In the sphere of dynamics, continuous movement as crescendo and diminuendo has long been familiar. Colour actually made the individuation of the instrument possible; a continuum necessarily puts an end to the category of the instrument. Time, finally, is the constant frame of reference, from which the continuous or discontinuous articulation of the parameters can be read off. Something, not time itself, progresses continuously in time; the concept of continuity is not pretemporal, but rather built on time.

Nevertheless, if the concept of the element is to be carried through for electronic music, it must be applied to compositional dimensions somewhat in the same way as the serial concept. If the number constellations of electronic music ignore the sound event which – in whatever parameter – they must articulate, in order to retain aptability; they must articulate, in order to retain aptability; if they insist in this way on an elementary status in relation to the motif; then, as a complexity of their terms, they are themselves already the instrument to be applied to the elements (for example phase-durations or amplitudes). However, the universality of this instrument is not to be confused with elementariness.

## 11

Rather has the series quickly deprived itself of its application to elementaries. One soon got tired of the colouredness of the sinus-tone spectra; the sound, once produced, was inflexible and – in spite of the serial formulation of its components – more undifferentiated than that of the instrument; and not least, the technically inadequate production – making many copies of the single notes – subtracted from the sound a lot of the polish that it would have had, had sufficient generators been available. Filtered noise, toward which one turned, sounds more diffuse and at the same time is not so sensitive to technical failings in the apparatus; but with a major third filter the range of audibility can only be divided much more roughly than with sinus-tones: into about 50 areas. Lastly impulses were taken over, which – in pitch definable like the sinus-tone – can be joined to make complicated time structures. Finally composers and technicians put everything they had into eliciting new colours from the equipment, and one could console oneself with the instrumental character of these (when such a thing was perceptible), if only the method of production would fit into the serial scheme. The fact that listeners at electronic concerts – critics particularly – always associated these sounds with wind and water together or fancied themselves being run over by motor-cycles and locomotives, tells us more about the ears of the listeners than about that which did not find its way into them, but is on the other hand only the reverse picture of those composers who come fresh to the studio and want to know, first thing, what colours there are that can be written into their scores like orchestral instruments. The permanent revolution, about which Stockhausen once spoke over the radio, is literally a return to categories that seem to survive even at the height of development. Corresponding to it on the technical side is the route from the extensively automatised original set-up in the Cologne studio, all in the single room, to the present do-it-yourself kit stage – tables and chairs support apparatus which must in addition be transported hither and thither, for in the meantime the studio was divided between two rooms separated by six floors. Of course a confounded dialectic comes into play here: the first studio was adjusted wholly to the reproduction of instrumental sounds and quickly became illusory, for



only the sinus-tone was wooed; while only the present studio (according to how much one returns to instrumental formations) by virtue of technical perfection, makes these possible in that the acoustical material can be handled in a more elementary state than previously. It could be said with little exaggeration that electronic music is in danger in its present stage of reproducing the traditioned instrumental character of music, except that meantime the instruments have been reduced to three types of generator. One can see in this a refusal by the institution rather than by the composers, who rather showed themselves capable of coping with the relationship of theory and practice in that they persistently sought the consequences of a state of affairs whose contradictions they brought to light. Meanwhile it seems possible to push the intention, which originally materialised in the electronic studio, one step further. Its technical substratum could be described once again as a studio, but one whose set-up differed qualitatively from that of the present one.

## 12

Namely, if merely amplitude is defined – as proposed by Stockhausen – as the elementary parameter to which a particular duration is added within the time-dimension, then generators of periodic (e.g. sinus-tones) or aperiodic (according to fixed formulae – like the noise

amplitudes	durations
6	10
1	2
1	3
1	5
2	4
1	6
3	6
1	4
2	5
1	3
1	2
1	10

generator) processes are useless. An apparatus would have to be constructed able to produce single amplitudes of particular sizes and durations in a fixed sequence. As a simplified example let us once more show a harmonic spectrum. Let the total duration be 12 milliseconds (= 83,3 cps). The phases of the second partial would then last 6 ms each, of the third, 34 ms each, and of the fourth, 1,3 ms each. The sequence of time-intervals from maximum to maximum runs thus: 3 1 2 2 1 3 ms (the last value gives the time-interval to the beginning of the next fundamental-phase). Postulating that the maxima of all partials have a value 1, the sequence of maxima (taking into account the two instances of coincidence, at the beginning and in the middle) would run thus: 4 1 1 2 1 1. The two sequences can be put together in a table (see left). If this sound shall sound for one second, the whole process must be repeated correspondingly often (approx. 83 times).

This example contains only periodic processes and could therefore also be realised in a conventional studio whose capacity is exceeded, however, if one requires a different spectrum for each of the 83 fundamental-phases, so as to achieve a constantly fluctuating colour. The changing spectra could be differentiated by the overtone combinations, or by the sort of spectrum: harmonic could alternate with subharmonic or with tempered spectra. In the simplest case of a rapid succession of different harmonic spectra on the same fundamental, these different spectra would first have to be defined as in the table above and then their sequence defined; shall change of colour not proceed periodically, then a multiplication series gives the number of times a spectrum shall repeat itself before being relieved by the next. If a second process enters before the first has finished, its tables must be reckoned into those of the first, dissolving both sounds into a common table. One arrives at still more complicated tables if noise-colours are to be presented in this way.

For the realization of such processes a device would be needed consisting mainly of three parts: an electronic brain, a storage unit and a generator to convert the data into an alternating current. The work schedule would run something like this: the composer writes (as hitherto) a score containing all the details defined as superposed periodic and aperiodic processes. The electronic brain is programmed and works out the *sound-rhythm* (the intensity curve) which is retained in a suitable way by the storage unit. Finally the data are fed to the generator with the correct sequence and speed, and the alternating current – made audible by a loudspeaker – is collected from the output of the generator. Expediently, the results of the reckoning are retained in the form of perforated cards or magnetic tape before they are fed to the storage unit. In this way the piece can be filed for reference.

This differs from electronic work hitherto not only in the technical process but above all in the composer's score. Till now sinustone, noise and impulse counted as elementary material. In the new studio even this would have to be composed of amplitudes of different durations and sizes. The composer would no longer think in colours that already existed as such – i.e. before being composed – rather the compositional process could turn completely to elements whose specific constellations would be perceived acoustically as movements of the sound. If the parameter-presentation articulates the necessity of describing the sound as the complexity of its properties, just so the split-up into single interdependent parameters has not really dissolved the category of the instrument but multiplied it. In place of the instrument, the instrumental character of all its parameters emerges. These are only to be shaken off by resolving them into one-dimensional time – the opposite of the parameter. The sequence of amplitudes can, it is true, continue to be presented parametrically in that the tables merge into supra-ordered relationships; these parameters are however formal categories: group-series, multiplication-series etc. The numerical character becomes universal; it would of course no longer be substituted for the complex sound. In that it describes changes of intensity (in micro-time) whose single elements lie outside the range of perception, outside that which, as their totality, coagulates into a musical event, it is taken back to a stratum where it does not come into conflict with qualitative categories. If the number itself is not a concept whose formation is reflected rather in the number (compare Th. W. Adorno, *Zur Metakritik der Erkenntnistheorie*, Stuttgart 1956, pp 17/18, not translated), then music – as a language without concepts – must unite with it. With number, music retains the difference; whatever it says, communicates those moments in which language was schooled.

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