

Genesis of Form in Technically Conditioned Environments

I

I shall begin by recalling my first years in the electronic music studio at Cologne. I had met Stockhausen and become acquainted with the technique of electronic sound production. I was assisting Stockhausen in his work. He showed me a built-in cupboard with dozens of little compartments, evidently custom-made for the studio. Inside were small plastic bags containing pieces of tape with single sounds on them; the tapes were spliced into loops and rolled up, making it easy to play them on a tape recorder. Stockhausen remarked that each sound had its own unique place in an electronic composition, and could never be used in any other place in any other piece. The reason, he said, was that composing sound was directly linked with composing form; a sound could only perform its function in the place it was conceived for. In order to avoid misuse, he thought sounds ought to be destroyed after a production was ended.

The term "material fetishism" dates from that period, and there would have been some justification in equating it with "form fetishism". Oddly enough, the Cologne studio looked down on composers who "only" had form problems. It is also odd that form was scarcely mentioned at all; things focussed on "material". Everything was material: sounds as well as the serial method of composition, in accordance with which sounds were constructed and then arranged to constitute the form. I assume that form was seen more as an automatic consequence of the treatment of material than as an independent category to which the fashioning of sounds ought to be subordinate. When forms were exposed at all, they were simple concepts such as the crossform (in *Kreuzspiel*) or the group (in *Gruppen*); in both cases, into the bargain, they were derived from the treatment of the material.

I mention all this because the nineteen-fifties had a crucial influence on my development as a composer. I referred to Stockhausen because he was a member of the musical avant garde, and convincing as a composer. Other composers were in Cologne in the fifties though, composers such as Kagel or Ligeti, Evangelisti or Cardew, theorists such as Metzger, literary figures such as Helms, as well as painters and architects. Our common experiences consisted of attending concerts of new music and visiting art galleries, followed by discussions on art and politics. The focal point of this circle was the music that was assuming concrete shape in the electronic studio. As I said, form was not mentioned; not explicitly, I ought to add. Form was taken for granted, a layman's term, I might say, because formlessness, the reproach most commonly levelled at new trends in art, was not thought worthy of discussion. There was no such thing as formless art, we tacitly agreed; art emerges from its surroundings, otherwise it would not be recognized as such, and does so because of its form. Modesty compelled us to speak about material instead. Material was held to be the substratum of every artistic endeavour; artistic endeavour seemed impossible without a precise definition of the material.

Form was a negative concept, I think. What we wanted to avoid was form as the reflection of a bourgeois concert culture which we regarded as passé. We tended to identify form with the cliché, not only with the recognizability of a fugue or sonata, but also with the performance ritual of a solo concerto or sonata. The discussion of form linked on to Webern, not Schoenberg; form was the epitome of the new and could hence only be newly created, not inherited. Although the

total form of a work and all its individual sounds were to be mediated, the first step was still the duration of its performance or the number of form sections. Form had necessarily to emerge in the course of its mediation; for even the individual sound was regarded as something formed, a group of individual sounds to an even greater extent, followed by the supra-group. Seen in this light, form grows increasingly "formal" as one moves further away from the form of the single entity and approaches its own epitome: total form.

In the confrontation of material and form, material is palpable, manipulatable. Material offered resistance: both as atonal harmony in instrumental music and in the realm of sinus tones and decibels in electronic music. It presented itself as something unformed, not sheltered by tradition. In the further course of these remarks I should like to trace the material aspect in electronic music first, and then in algorithmic composition. In both cases I shall be talking about my personal experiences. We shall observe a state of suspension in which aspects of material and of form balance one another.

II

All this talk about material fetishism notwithstanding, form was what it was all about. There is no point to material if it does not at least render contours visible – or audible. A sinus tone, for instance, has to have a duration, a frequency and a volume. None of these definitions can be given without previous grounds. Improvisation was out of the question at first in Cologne. The studio did not even have its own sine-wave generator in those days. To record sinus tones you needed two people: one in a maintenance workshop to set the frequencies at a generator, the other in the electronic studio to operate the faders and the tape recorder. Such working conditions, which soon improved, however, were not regarded as an encumbrance to music-making, but rather as a condition dictated by production technique, which has always determined people's work in other walks of life.

The grounds for defining the sinus tone were found in the so-called serial composition technique. This technique, although derived from Schoenberg's twelve-tone method, sees the actual score as a symbolic instruction to produce individual sounds which in their turn can be dissected into their parameters. It leads to the aspect of pitch treatment (as opposed to melodic writing), of duration treatment (as opposed to rhythm), of dynamics treatment (as opposed to phrasing). When, then, a frequency is needed for a sinus tone, a table of frequencies is drawn up and a method conceived for retrieving the individual frequencies from the table. When the table is divided up into smaller sections for this purpose, work on the musical form is already under way: the frequencies of such a section – regardless of the order – are presented, thus presenting the section as a whole, a micro-totality which can be embedded in totalities of a higher order. The table-section has to be shown, otherwise there would be no point in subdividing the table; on the other hand the frequency taken from the section obtains its meaning by virtue of being an absolute prerequisite for the representation of the entire section. By thus assigning meaning step by step, it doesn't matter whether the composer envisaged the whole composition when he drew up the frequency table, or whether he hopes in this fashion to discover grounds subsequently for every decision about the material. In the latter case, an experimental intention might be hazarded behind the setting-up of the frequency table: trying out an unusual subdivision of the octave, for

instance.

On this elementary level of material treatment there is no difference between instrumental and electronic music. The material and formal parameters of the musical structure are worked out on paper before manifesting themselves on tape or the pages of a score. Practical difficulties do not occur until the next level up: the score parts must be played by musicians, the instructions in the electronic score must be realized in the studio. An experienced composer anticipates these difficulties in the very first phase of conception. In electronic music, though, this is only limitedly feasible. Its sonic world was not intended to fit into any traditional categories of musical context such as melodic writing, harmonic progressions, phrasing tailored to the breath or the length of a bow, etc. Instead, the peculiarities of the production process are revealed. Many combinations of studio apparatus produce complex, often endless sounds for which no form of notation exists. The counterpart of the "part" in an instrumental score is the "patch", at any rate as a sonic form; for the patch only produces a sound, but not a sequence of sounds. The conversion of the score's instruction into the sound process is hence more analogous than literal; the sounds start to lead a life of their own as the working processes pile up. – I ought to stress that I am still talking about the early days of electronic music and not the modern synthesizer with its keyboard, on which it is easy to imitate both the sound and action of instrumental music.

III

My electronic compositions have always been prompted by the technical facilities in a studio. I was out to use the machines not just in a rational but in a musical fashion; they were meant to assume formative tasks, the way musicians do. By "formative" I mean the creation of neighbouring relationships, vertical and horizontal. Vertical relationships are simultaneity or temporal juxtaposition, relationships consciously heard. Horizontal relationships occur in the middle range of time-perception, the range in which sonic correspondences have to be most distinct in order to be grasped by the listener, at least at a first hearing. Horizontal relationships also pervade an entire work, or large sections of it, when features common to the sound structures are perceived distinctly enough to maintain the feeling – even if one's attention is momentarily distracted – of still listening to the same piece.

Neighbouring relationships, which give a work its aesthetic unity, can be penetrated by individual characters sounding like comments on the basic thesis, but also enhancing the common aspect of the material responsible for the unity. My purpose was to derive the individual characters, no matter how distinctly they stood out against the sonic background, from that background.

This aesthetic task of obtaining variety from unity resulted in workable techniques of sound production and sound derivation. For this purpose, studio equipment may be divided into a number of groups: those which simplify a complex structure and those which complicate a simple structure, those which preserve a structure's characteristics and those which more or less destroy them, those which lend themselves to lengthy phrasing and those suitable for highlighting details. – I should like to present a few examples of this production technique.

1. *Klangfiguren*. – The form-generating and form-multiplying instrument of this piece is the ring-

modulator. I used it as a sound-mirror, reflecting the differences of two high-frequent signals back into the audio range, and filtering out their sums, when they were in the audio range at all. One of the two signals is a control signal and consists optionally of a sinus tone or a tone mixture, a narrowly filtered noise, a narrowly filtered impulse structure or a combination of two or three of these signals. The other signal is a composed sequence of sounds defined "archwise" in two parameters: like a garland or an archway. The arched forms are displayed in time as "fast-slow-fast" or "slow-fast-slow" and in pitch as "rising-falling" or "falling-rising". According to what control signal is used, they appear after ring-modulation as a continuous, periodic signal (sinus tone), as a continuous, aperiodic signal (noise) or as a discontinuous signal (impulses), the rhythm of the sound-points corresponding with the controlling impulse pattern. In order to deform the arched sound sequence still further, I divided it into sound-groups by editing the tape; I changed the order of these groups and occasionally separated them by rests.

2. *Essay*. – Movement in *Essay* (rising, falling, horizontal) is confined to the pitch domain. Each form-section is based on a typical combination of such movements; I put the sections together by splicing separately recorded sounds. The rhythm for this kind of tone-form consists of variously arranged durations of different lengths. The formative idea in this piece is based on the augmentation of diminution to scale of a pitch or time grid. For instance, the typical pitch progression in a section (e.g. a combination of a straight line with an ascending or descending one) was divided into parts and articulated by other progressions prominent in other sections; this articulation took place in frequency grids which were "shrunk" to varying degrees. I organized the time in a similar fashion, resulting in a wide variety of speeds at which the groups were presented. As this cumbersome verbal description shows, I took great pains in realizing the sound material on which a form-section was based, the idea being to leave further treatment to mechanical transformations. These notably included transposition, ring-modulation, filtering and reverberation. I synchronized all the thus produced variants of the material tape and united them in the respective form-sections. The density of the formal neighbouring relationships was chiefly the result of the basic material of all the variants, the occasionally considerably different derivations being a consequence of the mechanical operations.

3. *Terminus*. – In *Terminus*, finally, I endeavoured to reduce "handcraft" – by which I mean recording and editing single sounds – as far as possible in favour of mechanical production processes. It cannot be dispensed with entirely if one has high standards of articulation in time and cannot, or does not, wish to intervene in real time. With this objective in mind I started experimenting with sinus glissandi; I transposed and amplitude-modulated them until the undulating fluctuations of the pitch and dynamics had attained a certain degree of complexity. At this juncture I picked up the scissors, cut out pieces of these sounds and combined them into a simple model, rather like the basic material for *Essay*, but much simpler. This was followed by a mechanical derivation procedure which I call "serial" (as opposed to the "parallel" derivations in *Essay*): each derivation (e.g. filtering, modulation, chopping or reverberation) formed the basis for the next one. In this fashion I created "generations" possessing degrees of kinship which grow weaker, the greater the distance between the generations. The compositional principle of *Terminus* differs from my previous pieces in not being based on an overall form to be filled in eventually with single sounds. The compositional principle here consists solely of the systematic

derivation of material structures which due to the mechanical procedure are structurally related; neighbouring relationships are not formally established but appear as the derived materials are presented – successively or simultaneously. This shows the form problem in a very mediated guise, because the possible form-sections (the prefabricated derivations, whose number can be increased at will) are closely linked, owing to their past history in terms of production technique, without having a goal-oriented relationship to each other. It is therefore feasible to present them in an order which places the existing neighbouring relationships at the service of an overall form unfurling in time (superpositions not excluded).

IV

4. *Funktionen*. – The series of pieces with this collective title occupy a special position. *Klangfiguren*, *Essay* and *Terminus* were produced with the manually operated equipment of the "classic" electronic studio; melodic configurations could only be achieved by editing the tape. At the Institute of Sonology, where I worked after leaving Cologne, a voltage control system was developed which opened up new vistas, not only of sound production but also of shaping form, which by my standards are closely linked. As well as by the increased technical possibilities I was particularly fascinated by the idea of treating control signals in the same way as sound signals, of taping them and using them for various purposes. With a sequencer developed during this same period (and known at the Institute as a variable function generator), voltage levels could be set and scanned at different speeds or by random control. This took me a step closer towards my goal of restricting tape manipulation to a minimum. And indeed, the sound material for the *Funktionen* was generated fully automatically by a single preset curve on the function generator; all other derivations were obtained by using control signals produced from that same curve and taped. I relied to a greater extent than in *Terminus* on the formative power of sound structures which in all their material and formal aspects proved to be "permeable"; by permeability I mean a property of sound sequences that renders them porous and hence interpretable by other, simultaneous sound sequences. I have always regarded this permeability as paramount for algorithmic composition, as long as the composition progress is not based on psychological criteria, but on material criteria, and on properties of acoustic material which the history of music has endowed with meaning. The arrangement of the sounds constituting the *Funktionen* was consequently left largely to chance.

I am aware that these statements about form and form generation have a highly personal strain. The idea of form a composer has, and tries to realize in a piece, is not necessarily identical with the form he actually produces. Things are similar for the listener, who experiences and evaluates the form as he sees fit. One may even ask whether the listener is interested in the form at all; when listeners label a new work as formless, they probably do not mean form as such, but something else. Form as I see it – especially after the post-1945 New Music – is not the result of an auditory process, like feeling full after a meal. It is, rather, the way in which music is experienced in time; a piece of music may seem to have more or less form according to the listener's mood, concentration and susceptibility to form, and may also appear in a different kind of form - except of course for pieces which are well-known and already classified. (Such classification, however, tends to impede an open-minded new evaluation, or new experience). I

experience form as a process as soon as I start working in the studio or at my desk; every bar on paper, every sound on tape changes its formal function every time I look at it, like the light in a landscape under scudding clouds. I rarely hear a work twice in exactly the same way, as identical. Something in me balks at pinning things down, and so when I compose I try to arrange the details of the score in such a way that they can be interpreted in different ways, but can also be pinned down formally by those so inclined. The term "open form" comes involuntarily to mind. I would rather reserve it for works which leave the actual order of the sounds open until the beginning of the performance or even later. Otherwise the opposite of open forms would be closed ones, a category in which I do not feel comfortable.

v

It must have been in about 1962 that I showed the score of *Essay* to an archeologist friend. He surmised that its systematic structure must have been generated by a computer, not realizing that electronic and even instrumental serial music possessed systematic, indeed mechanical, traits. Acting on my friend's advice, I attended a course in computer programming at Bonn University, during which I naturally busied myself with questions of algorithmic composition. What I really wanted was to recruit the computer in order to continue what I had been attempting in *Essay* and had temporarily brought to a close in *Terminus*: the immediate conversion of the underlying musical form into the moving sound; not, I must stress, into sequences of tones or rhythmic patterns, not into layers of sounds fraught with spatial associations, not even into work-processes, but into the acoustic representation of what can only be described in formal terms: the movement of musical elements designed by the composer and re-experienced by the listener - if the two are at all on the same wavelength.

Since this castle in the air could not be built for technical reasons, I began to probe the extent to which compositional strategies could be represented in instrumental music with the aid of algorithms. I started to develop my first composing program, "Project 1", which is now a good 20 years old and has been used for the composition of many works.

"Project 1" was primarily intended to cope with the desire for form-variants. Form-variants are not open or variable forms, but variants of an initial position which is described algorithmically and – rather like an idea not yet executed in detail – represents the anticipated generalization of all ensuing concretizations. Seen as a whole, "Project 1" was such an initial position. The strategy on which the program is based was supposed to be sufficiently general to produce a large number of variants, but also specific enough to impress on every variant the features of an individual work.

This places the question of the genesis of musical form in a new light. Normally, form is regarded as the unique concretization of a unique idea, or as the multiple realization of a more general, supra-personal idea of form. Form also emerges when musicians improvise, form always being both desired and born, desired by the composer, born during performance. Here, in the "variant-form", it withdraws, so to speak, into the obscurity of variant-creation, while remaining lucidly and comprehensibly reproducible as an algorithm. It exists neither merely as an idea, nor as concrete execution, but reveals the formative law which links the elements of the concretizations it has spawned. I felt that "form" could now be discussed again. For although the

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form of an individual work can be analyzed in every detail, it is at the same time taboo if one is not to commit plagiarism. Form when still an idea is obscure; it is only illuminated by concretization, whereby it ceases to be an idea. Furthermore, it is linked with the individual, and hence just as taboo as the unique work. Form could thus only be discussed as the properties of the material into which it had breathed life; the consideration of electronic music has demonstrated this.

Subsequently, the variant-form as represented by a computer algorithm sheds a light on the production methods of electronic music. Every transformation to which a sequence of sounds on tape can be subjected is really a variant inside a group of transformations; often transformations do not occur singly, but systematically, as a formative principle for formal relationships. With the introduction of voltage control, the aforementioned series of *Funktionen* had enabled me to produce form-variants once the basic model was stored on tape in the form of control signals. Nonetheless, electronic music sound production is confined to manufacturing final products. The "Project 1" computer program, on the other hand, does not design concrete progressions of sounds but only performance instructions for musicians which the composer first has to transcribe from tables of figures into an interpretable score.

VI

At this juncture I should like to mention my sound synthesis program, "SSP", although, chronologically speaking, it is not its turn yet. At the end of 1970 the Institute of Sonology got its first computer, a PDP-15. Due to lack of funds we could not afford mass storage, which precluded the use of programs like MUSIC4 or MUSIC5. We decided to concentrate on real-time processes instead. Barry Truax' POD system became a well-known example, Paul Berg developed the preliminary stages of his "PILE" program and Robert Rowe his "RECUR" system.

"SSP" was an attempt to apply the composition method of "Project 1" to sound synthesis. Time and amplitude values were my only "material". Composer-controlled algorithms pair off the time and amplitude values, thus defining a digital sound signal. This consists of any number of sound segments whose order can be defined algorithmically in terms of variant formation.

This shifted the form question into a twilight zone which lack of facilities and time prevented me from exploring properly. It would have taken bigger computers, far beyond the Institute of Sonology's means, to exploit the potential of such a method - especially in terms of musical language. Scrutiny of the method on which "SSP" is based reveals a chasm between the relatively simple strategy for describing the sound signal and the aural impression it creates. I resigned myself to the chasm in order to be able to pose the form question as pointedly as possible. In electronic music the sound is usually produced while the studio apparatus is being manipulated, and the "Project 1" composing program involves the familiar world of scales and rhythms, musicians and conductors, scores and their interpretation. The algorithmically produced sound, though, based not on an acoustic model but only on a formal variant-model, cannot rely on familiar acoustic phenomena, but only on the hope that the material context will inspire the listener with the courage to explore terra nova. What on earth am I saying: not just the listener – *the composer*. I hope to be able to pursue this problem in the coming years at the new Institute of Sonology at the Royal Hague Conservatory.

VII

"Project 2", my second composing program, was a critical reaction to "Project 1", and was intended to be a twofold improvement on the first one. I decided to write it soon after composing two pieces with "Project 1". In those days I had no computer-controlled sound synthesis system for quickly and systematically monitoring the possibilities of my program. Even so, after converting only a few drafts into scores, I soon became aware of the program's peculiarities.

a) First of all there was the Program's restriction to only a few parameters which - apart from the odd exception ~ were independent of one another. The values of each parameter therefore had to be distributed in time in such a way as to remain permeable for the other parameters; no parameter could bear the sole responsibility for the formal progression. The restriction to just a few parameters was coupled with a fixed size of the parameter lists. There were 9 instruments, 28 durations, 8 dynamic values, 4 registers. (I did away with these restrictions in a later version.) Finally, the arrangement of the parameter values was left largely to chance; the overall form of a piece composed with "Project 1" was meant, by way of several intermediary steps, to achieve a balance between irregular events and more predictable ones.

In "Project 2" I increased the number of parameters. All of them – with a few exceptions – are interdependent; the composer himself determines the order in which they are treated. It is therefore appropriate in "Project 2" to speak of a main parameter which determines the formal course of events to a major extent, supported by auxiliary parameters. There is no limit to the length of the parameter lists. The composer defines not only the contents of the lists, but also the method by which the values in the lists are selected for the score.

b) In the second place, there was the pre-established formal progression. Although this catered to the linking of variants, the variants had to satisfy a criterion of completeness: since the range between irregular and more predictable events was divided into 7 steps, the overall form of a "Project 1" piece invariably consisted of 7 sections, so as to permit each parameter to display itself once in each of its 7 guises.

There is no pre-established overall form in "Project 2"; the program is arranged so as to enable the composer to work out structure-variants systematically. I envisaged a method by which the composer designs variant-groups, scrutinizes the individual variants once they are composed, decides to have more variants, or programs a new group. As the work proceeds, the significance of the variants may change: some become superfluous, others qualify for a particular place in the course of the gradually emerging form. The more distinctly the form crystallizes, the more obvious the reason for further variants becomes. I also toyed with the idea, instead of grouping selected variants into a form which would present itself as definitive, of publishing all variants necessarily resulting from the chosen strategy as a "catalogue" instead of a "work".

Composing with algorithms reveals a fresh aspect of the material. The electronic studio confronted the composer with musically unformed acoustic elements like the sinus tone or white noise, and also with a method consisting basically of the appropriate use of machines – generators, tape recorders, switches. Especially composers with no studio experience could scarcely hope to realize their preformed ideas in the studio in the same way they would have written an orchestral score. The composing program confronts the composer with preformed

items of musical language which are searching for their formal status. The composer is not spared the learning process here either. In the end, his creativity proves its calibre by his ability to find the right constructional elements for the formal idea, and also by his recognition of the formal potential of the constructional elements. Studio work and computer work facilitate in mechanized fashion the experience of musical form as a process: not just as an aural process, but as a procedure which anticipates the aural process and which, if the aural process is not to be determined beforehand, will point out possible directions.