Layers and Variants

The notion that a musical structure can consist of *layers* or assume the form of numerous *variants* has often been a valuable compositional aid; it also proved to be extremely useful when I wanted to generalize compositional strategies into algorithms. It was particularly beneficial in the light of serial composition technique, where the accent is more on the "sequence" of events than on their simultaneity.

I first encountered **layers** in the electronic studio at Cologne, where the term denoted spliced tapes intended for "synchronization". All sounds which overlapped in time had to be "synchronized"; overlappings were the result of the serial method, in which each sound's entry and duration were established independently of one another. We synchronized sectionwise, after producing all the individual sounds for a section. All non-overlapping sounds were stuck together with the aid of leader tape (for the rests). Two of these tapes were then started synchronously on two tape recorders and the result of that synchronization was recorded on a third machine. This procedure was repeated until all the layers had been transferred to a single tape.

We also used the synchronization technique to produce "tone-mixtures", meaning all the sinewave superimpositions which - unlike triangular or square waves - could not be obtained from a generator and therefore had to be built up from single oscillations. The normal solution would have been simply to patch several sinewave generators together. In those early days, however, there was only one generator in the Cologne studio. Our technician, Heinz Schütz, had the bright idea of re-ordering the tape recorder heads: playback, erase, record (instead of the normal sequence of erase, record, playback). The ends of the tape to be recorded were gummed together, producing an endless loop; at every pass of the loop another tone was added to those already recorded, until the complete sound was on the loop.

When I made my first electronic piece, which was only four minutes long[1], I spliced all the sounds onto several four-minute tapes which were then synchronized with the aforementioned "copy head". I thus had the pleasure of hearing my piece emerge layer by layer during this process without having to lift a finger myself. "Layering" turned out to produce structures which were eventually heard only as a "sequence" of sonic events. Conversely, the legitimate conclusion is that every sequence of sounds – a progression of changing *densities* – may be regarded as the result of layering.

Building "layers" resulted from the technical necessity for synchronization, not from the conception of the music prior to its realization. But in my next electronic piece[2] superimposed layers were already a built-in part of the plan. In the first place the piece was composed for four loudspeakers disposed round the concert hall so that the polyphony of the sounds would be enhanced by the spatial polyphony of the sound sources. In the second place I employed the device of "fine transposition", meaning transposition by a small interval (a second or a third, for instance). In the noise-like sounds that were subjected to this treatment the difference in pitch was barely perceptible, and with short sequences of sounds the difference in time was only tenths of seconds. When different fine-transposed sequences start simultaneously, the "definition" is slightly blurred towards the end of a sequence; this diminished definition is audible in sounds of medium duration, and in long sounds there is a marked blurring before a kind of canonic effect is heard. (Something similar happens in transpositions which end simultaneously or are symmetrically superimposed.)

My first deliberate use of layering in a formal construction was in a piano piece.[3] Fig. 1 shows two bars of this piece in the lower stave, and above it layers 3-12 prior to their combination (layers 1 and 2 are empty here). Each layer contains material which was distributed over that

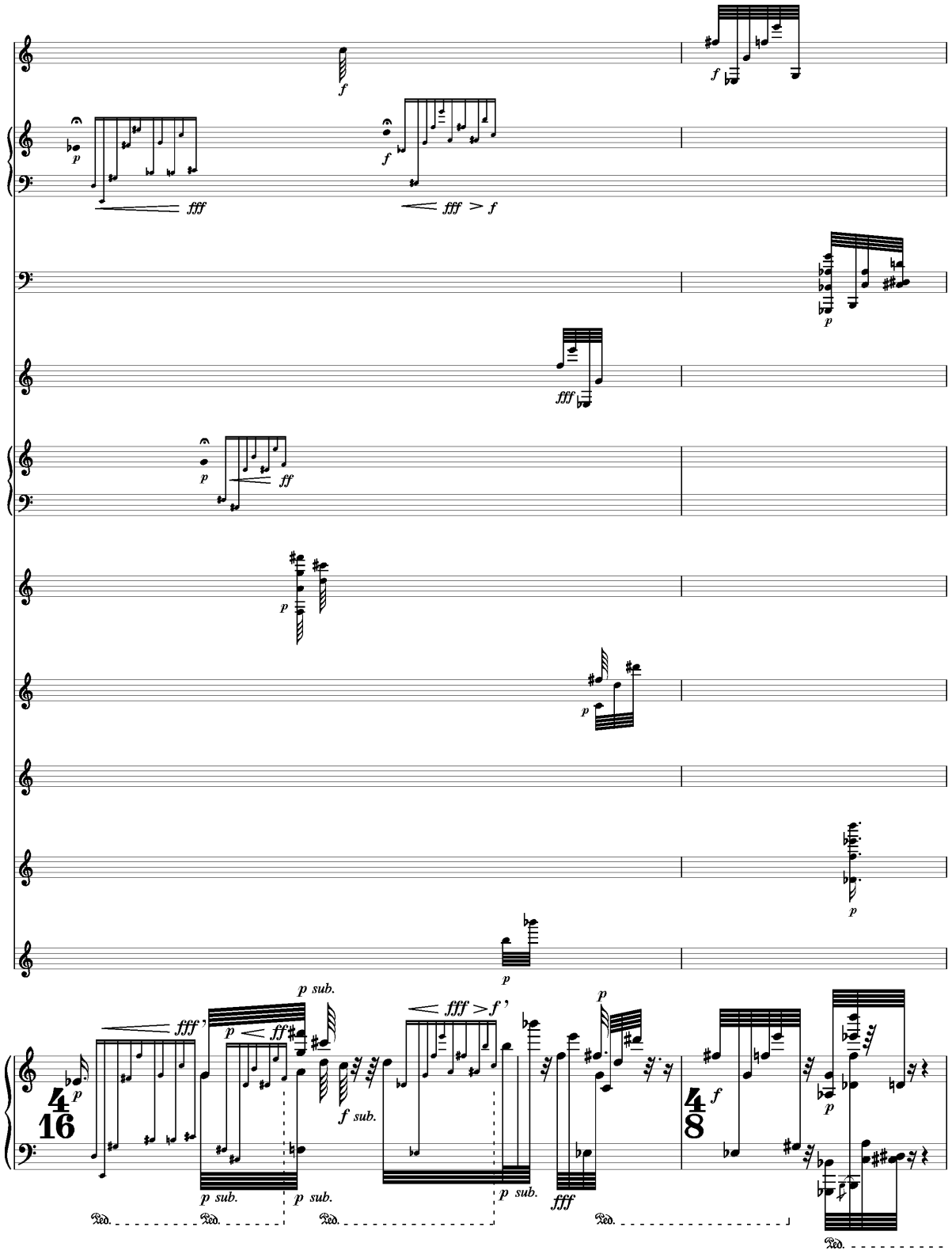


Fig. 1, *Two Piano Pieces*

in accordance with a preconceived time-plan: single tones, chords, groups of tones, grace-notes, including their dynamics. The planning of the layers was supposed to ensure that the different kinds of material occur in an intended frequency and time distribution, thereby undergoing characteristic alterations. In the eleventh layer, for example, there are single tones with fermatas, followed by grace-notes to be played "as fast as possible". Here, transposition is the "characteristic alteration". Layer 8 contains the same combination, but with a different (shorter) group of grace-notes. The structural principles of the other layers are not apparent in this short example. The fermatas may be freely interpreted, and are occasionally ignored.

The piano piece from which fig. 1 is taken exemplifies an extended serial technique. Extended, because it departs from Schönberg's (and also Webern's) model and even from the model of "orthodox" serial music, which applies the dodecaphonic method as best it can to every musical "parameter". Serial music is based on "rows"; rows are organized sequences of parameter values. Inherent to this method is the superimposition of several runs of rows (i.e. parameters). Layering remains in the domain of twelve-tone rows, from which sequences of tones and chords are formed in accordance with ideas about form which do not usually derive from serialism. Superimposition phenomena of a higher order (in the transition to the overall form) are not directly defined by the serial system, but nor are they excluded. (Compare the rhythm conception in Stockhausen's *Gruppen für drei Orchester*.) Serial music is basically monophonic in that it defines the one-dimensional sequence. My conception of "layering" is primarily orientated towards simultaneity of several events, while residues of serial experience are confined to the formulation of the individual layers. The fact that twelve layers were planned for the above example is not fortuitous, but neither does it have anything to do with the twelve semitones. However, the grace-note groups are rudimentary twelve-tone rows. The organization of the layers (what happens in them and how their contents are rhythmically organized) is based on serial considerations.

Another example of layering is found in my *Quintet for Woodwind Instruments*.[4] Fig. 2 shows a few bars from the score at the bottom, and above them four of the five layers. They contain (from top to bottom) single tones, groups of grace-notes, "time spectra" and chords, all with their assigned dynamics. Time spectra are superimposed subdivisions of the metre, in the example 4:5:6 and 3:4:5. In the Quintet, too, the distribution of the material in a layer was governed by serial aspects. The time is not organized in bars, however, but is based on the idea of a continuous temporal flow. This was probably influenced by my experiences with electronic music techniques. I calculated the durations in seconds and only later fitted them into a bar structure which of necessity involved frequent changes of time signature.

In both cases (the piano piece and the quintet) combining several layers implies a certain degree of "interpretation". On the one hand the material, due to its irregular distribution over the layers, is expected to form constantly new constellations; on the other hand there is often a greater concentration of material than five musicians can play. In order to cope with both situations, the context resulting from superimposition must be rendered playable; it must be arranged. This gives the composer the opportunity to emphasize characteristic moments, to diminish or enhance contrasts and so forth.

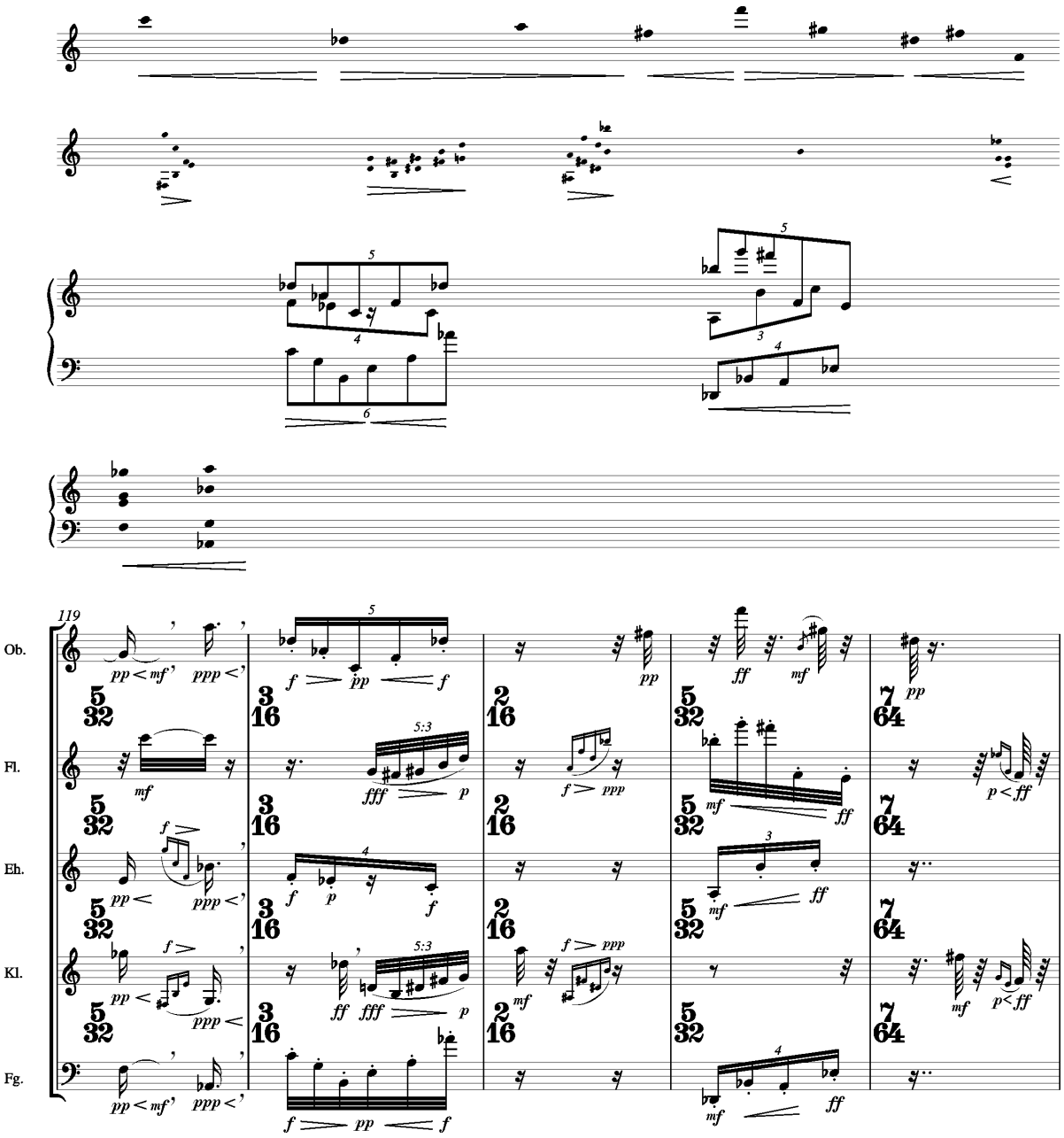


Fig. 2, *Quintet for Woodwind Instruments*

In the quintet, combining layers produced only a provisional context which had to be made "playable", whereas in my *String Quartet 1959*[5] the layers were conceived as parts from the outset and superimposed without any further interpretation.

As fig. 3 shows, the parts are independent in terms of rhythm, dynamics and bowing. They are held together, however, by being divided into groups separated by rests; the groups, whose sizes in the example are 8, 4, 6, 5, 8, 4 ... , have the same order in each part. Basically, each instrument has its own metric basic value (1st vl. quintuplet sixteenths, 2nd vl. quintuplet eighths, vla. triplet eighths, vc. eighths), which may however increase and/or decrease stepwise

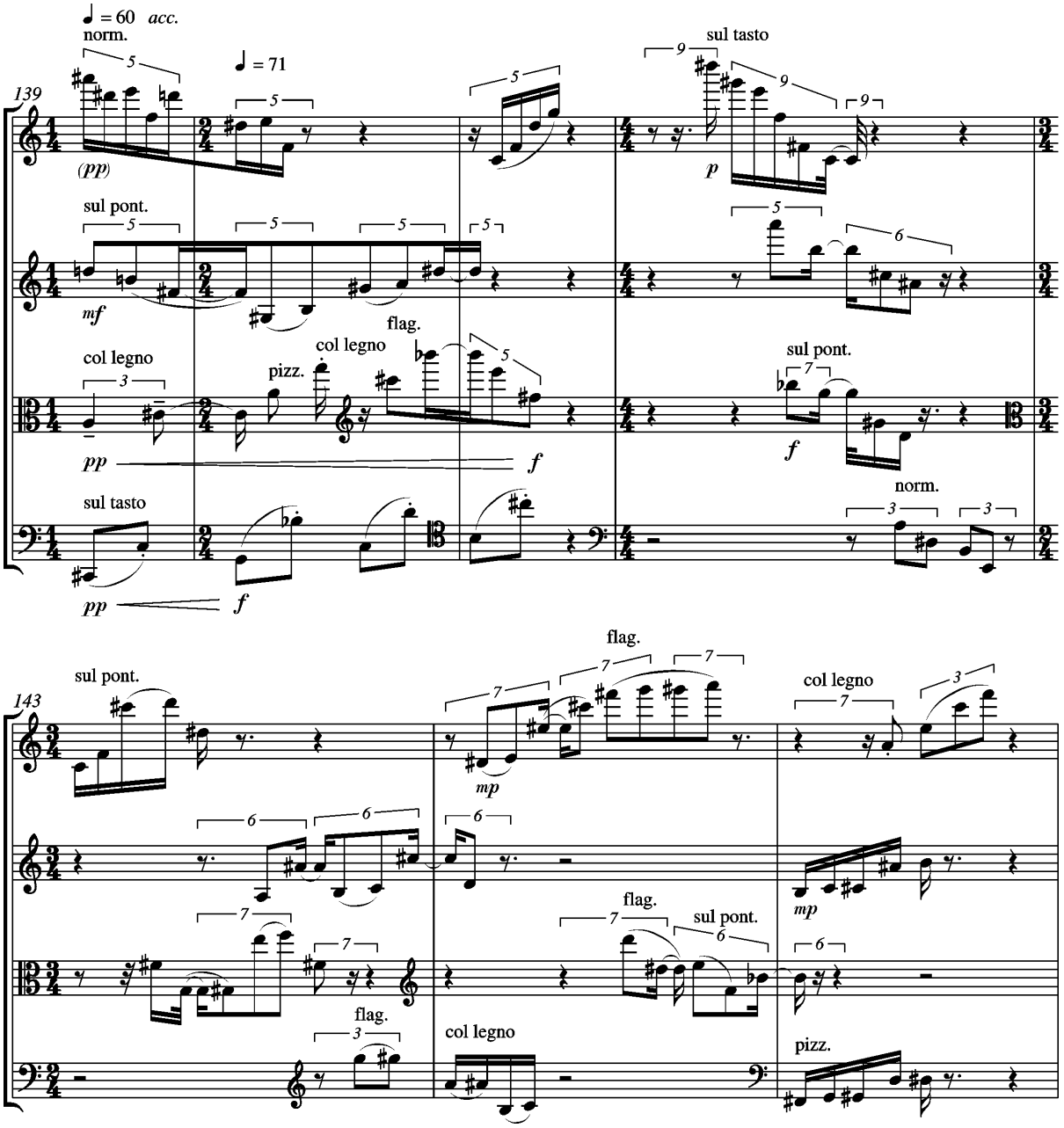


Fig. 3, *String Quartet 1959*

in the course of the form section. The example shows subdivisions of the quarter-note into 5 - 4.5 - 4 - 3.5 - 3 parts (1st vl.), 2.5 - 3 - 4 parts (2nd vl.), 1.5 - 2 - 2.5 - (3) - 3.5 - 4 - 3.5 - 3 parts (vla.) and 2 - 3 - 4 parts (vc.). Similar "transitions" can be observed in the bowing changes. Unity is also established by the harmony, sequences of transposed intervals (major thirds shifted upwards chromatically, duly producing fourths as in the example: e c f d-flat f-sharp d ...) being distributed chronologically over the entries. The original tone sequence is "broken" as it were by its chronological distribution, so that the individual parts are given different tone sequences. The intervallic construction emerges more clearly in solo passages.

More examples of layering are found in *Essay*[6] and *Terminus 1*[7], two electronic compositions. In *Essay* I produced characteristic sound sequences for each form section and subjected them to multiple transformations. Transformations of the same sound *sequence* differ in duration, mean pitch and sonic character; they were superimposed into the form sections according to a serial time plan. This method establishes coherence in the individual sections; coherence in the overall form is buttressed by the similarity of the sound sequences on which the sections are based and by the fact that they were in most cases subjected to the same transformations. *Terminus 1* is more a case of a transition to *variants*; layering is less pronounced, its only function being to present the derivations of a given sound sequence in the course of the overall form.

The idea of **variants** crops up when *layers* are employed not merely for technical reasons as in *Klangfiguren*. In the *Two Piano Pieces* and to a greater extent in the *Quintet*, the layer already acts as a container for related sound complexes (tones, chords, passages etc.), so that as well as the vertical context resulting from mutually influencing layers, a horizontal context results from variant formation. Another way of using the variant principle is found in the *Function* series [8], several four-channel electronic pieces in which layers are abandoned. Variants occur in the form of basic sounds and control signals; I taped the control signals in a frequency-modulated form and, for different types of sounds, fed them into voltage-controlled studio machines after frequency demodulation, along with the basic sounds.

Variants became more important while I was studying programming and tried to write a programme that would compose music. The phenomenon (perhaps not in theory, but in practice) had long been familiar to me from my work with transformations in the electronic studio, but also from instrumental music. Even as a boy, analysing one of Bach's two-part inventions, I was struck by the fact that the musical material could be classified into "stockpiles": rhythm (sixteenth, eighth and quarter notes), figuration (broken triads, passages, leaps), harmony (related keys), variation (easily recognizable motivic relationships). The piece was assembled with the elements from such stockpiles in a fluent, smooth (not startling), plausible and unpredictable manner. The logical conclusion was that other, different combinations ought to produce kindred compositions. – This concept lodged permanently in my mind; I never tried it out on Bach's model. I realized that the materials could not be subjected to random operations, for which they were unsuited. There had to be a procedural domain, though, a framework within which random operations would be legitimate. At the time I did not feel tempted to construct such a framework.

When I came to design the composing program (*Project One* – or PR1), I was forced to construct that random framework after all. I had to establish boundary conditions which would provide scope for chance without falsifying the content of the respective framework. Instead of a twelve-tone row, for instance, an aleatoric choice could be made among twelve chromatic semitones, each of which, once selected, would be blocked; the block would not be lifted until all twelve tones had been used. The method could however result in unwanted progressions. To avoid this, I decided on three-tone groups which could be transposed in such a way that a group and its transpositions produced exactly a twelve-tone row. Random selection from other "stockpiles" such as dynamic or time values seemed less problematic to me. The variant principle now appeared in a different guise: instead of variants being produced and then placed in a formal context, a context was now generated which was based on the variant idea and highly likely to contain variants or be interpreted in terms of variants. On the other hand, the idea of layers receded. PR1 might be said to reduce superimposition to a single layer which

displays "nodes" of various thicknesses. These nodes are interpreted as chords. The horizontal extent of a node level being read as a duration, the nodes appear as a rhythmicized sequence of chords.

Fig. 4 shows a short section from a PR1 structure. The harmony is based on the interval sequence "major third/minor second (descending)", as is illustrated by the first twelve tones: g-sharp e d-sharp, b g f-sharp, f d-flat c, d b-flat a. The second row is c a-flat g, e-flat b b-flat, f-sharp d c-sharp, a f e. Each chord is assigned a duration, a dynamic value and a number which can be used for purposes of instrumentation; these numbers, too, represent a "stockpile" defined by the composer. The durations in the example come from a default list in the program containing the values 1/8, 1/6, 1/5, 1/4, 1/3, 1/2 and 1/1. The listed values appear in random

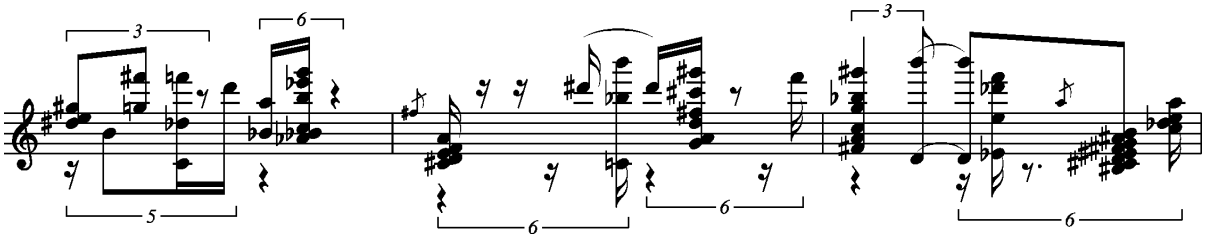


Fig. 4

order, but could also have appeared in groups of equal values. The dynamics are omitted, as are the instrument numbers. –0 Each tone in a chord is allocated an octave range. Only three octaves are used for the example. The allocation is "mixed": sometimes all the tones of a chord are in the same octave, sometimes they are distributed over two or three. The duration repertoire can also contain grace-notes: f-sharp in the second bar of the example, a in the third.

In *Project Two* (PR2) the PR1 concept was expanded to provide any number of simultaneous, rhythmicized chord sequences (twelve in the current version) instead of only one. This not only revives the old layer concept but also facilitates the composition of polyphonic structures.

This is exemplified in fig. 5[11], which shows the first "variant" of the sixth "structure" of a work for piano consisting of 12 structures and 3 variants per structure. The example shows two layers: long single tones and staccato chords.

In both programs the composer defines lists of data for various parameters. PR1 takes only a few parameters into account and generates only one layer which, although homophonic, can be split up into polyphonic voices by the composer. PR2 takes more parameters into account and generates more layers, thus being inherently polyphonic. The selection of individual elements is performed automatically in PR1 after the composer has decided on a particular degree of regularity (or irregularity) for each parameter. In PR2 this selection is performed by selection principles of the following basic types:

a) the selected element is used only once (with or without repetition check)
b) the selected element is used several times (group formation)
c) tendential selection by sliding mask
d) user-defined sequence

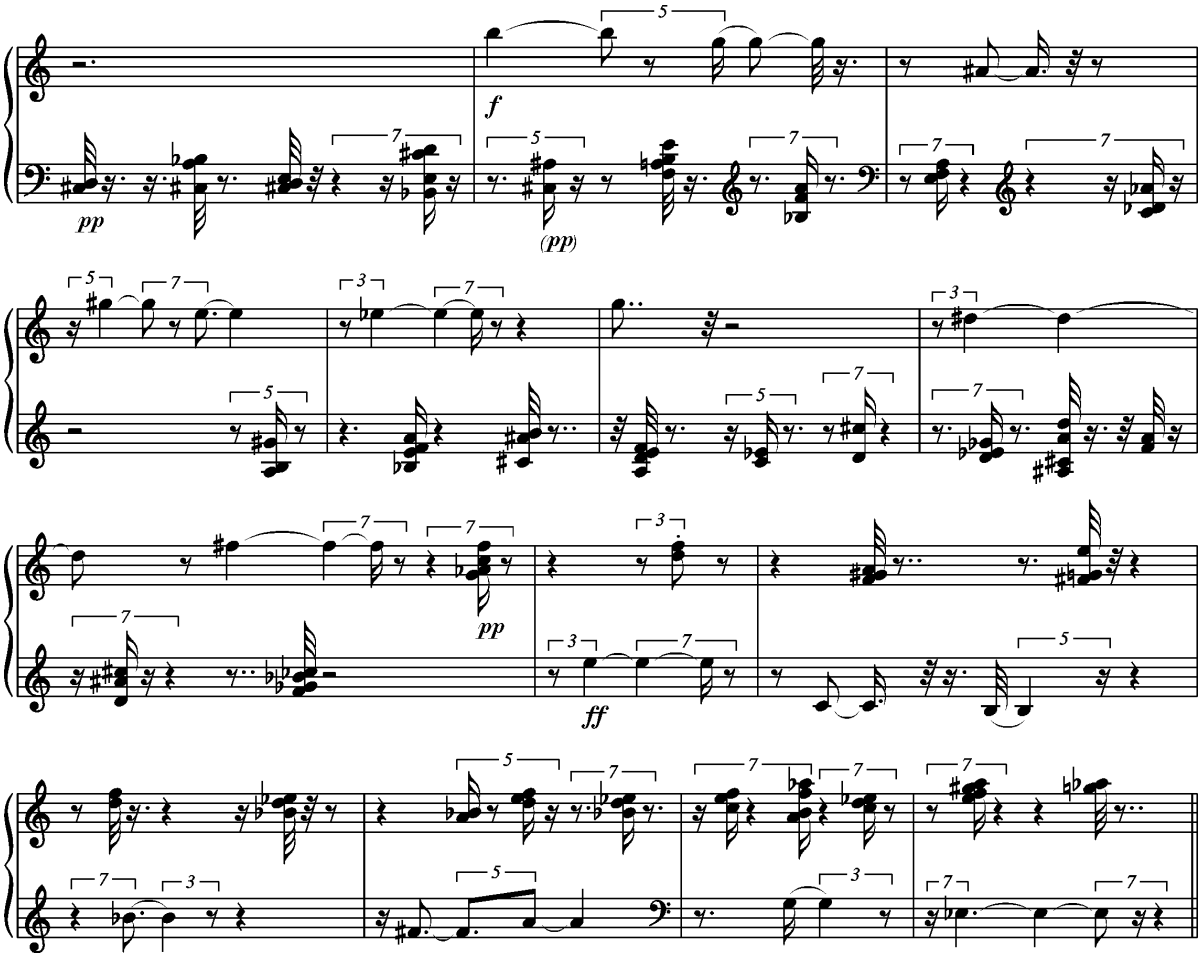


Fig. 5, *Exercise for Piano*

Selection, largely random in a and b and limitedly random in c, replaces the rows and permutations of serial technique.

The conception of PR1 was still influenced by the idea of a closed work designed to display, if possible, all the structure-generating techniques in every program run; in a way this produces variants which due to the algorithm are interrelated and embrace all the structural aspects at once. PR2 exercises no such claims. It is subtitled "a computer program for the calculation of musical structure variants". The parameter data are collected in lists and pre-sorted in tables. In many short program runs the data can be used in different preliminary sortings and combined with the aid of different selection algorithms. This enables the composer not only to rapidly survey the constellations of material but to design the work on the basis of related material variants.[12]

The variant principle can also be rendered **graphically** by replacing the time axis of the music by spatial coordinates. I was inspired to perform graphic experiments by a DEC computer with a BASIC program which could instruct my matrix printer to print each screen as it came. I was not interested in programming prescribed figures but wanted to observe whether and how figurations resulted from the controlled data flow. With this in mind, I proceeded from a line, or

rather from groups of lines which behaved towards one another like variants. The groups of lines are separated by leaps. The individual line in a group begins where the last individual line stops, and is extended towards a new pair of coordinates. The new pair of coordinates is found by incrementing the old x/y values by an amount found aleatorically between limit values applying to the entire drawing.

A typical example of this method can be seen in fig. 6. The horizontal increments are very large, the vertical ones very small. Leaps occur after at least 20 and at most 80 line-sections (in other words, a line consists of 20 to 80 sections); the leaps cover from 100 and 400 units. The crumbly character of the lines is caused by the circumstance that an existing line is erased where a new one intersects it.

Fig.6, *WB 88/44*, *detail*

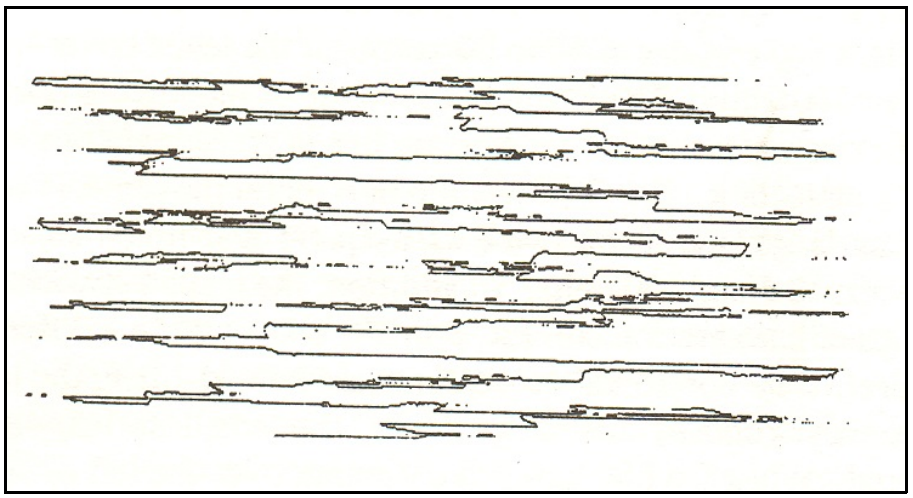


Fig. 7, *WB88/8a, detail*

In fig. 7 the horizontal movements are only half as large, the leaps twice as frequent and much smaller (between 12.5 and 100 units). In addition, the leaps between the groups of lines are traced.

Fig. 8, finally, shows quite a different picture. The horizontal movements are halved again, the leap frequency remains unchanged and the smallest leaps are ignored (only leaps between 50 and 100 units). When the line looks like running over the left or right edge, its movement is reversed. (This applied to the two previous examples as well.)

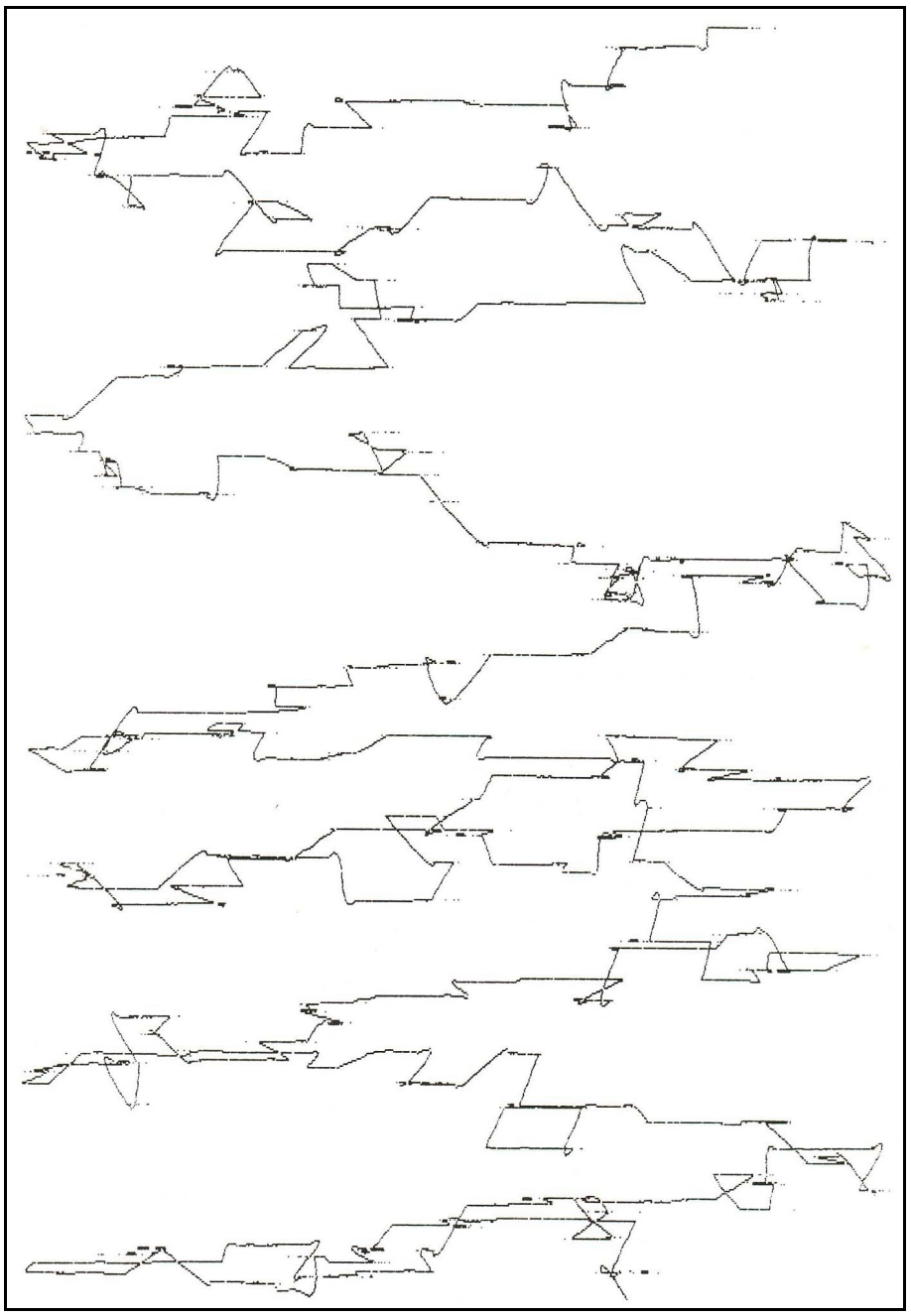


Fig. 8, *WB88/38*

In the above examples vertical movement was relatively small (between 0-.1 and 0.2 units). Quite different imgaes are produced by increasing vertical movement and reducing leap frequency.

Fig. 9, for instance, shows a vertical movement of about 3 units, a magnitude applying to the horizontal movement too. Leap frequency corresponds roughly with that in fig. 6 (between 100 and 300 single lines per group), while the leaps are small (always 25 units). The line has a tendency to tangle; leaps from group to group are easy to recognize by the vertical connecting lines.

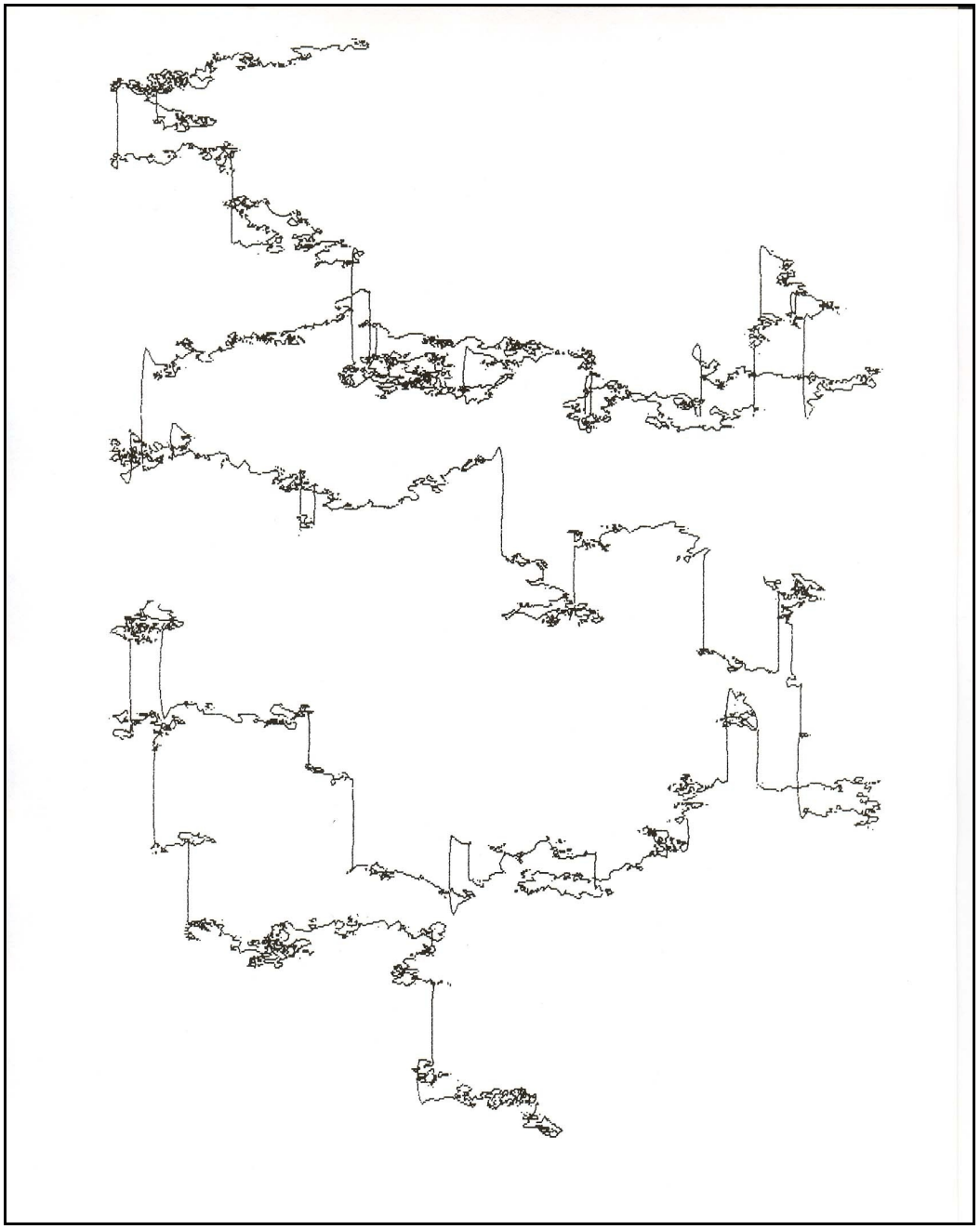
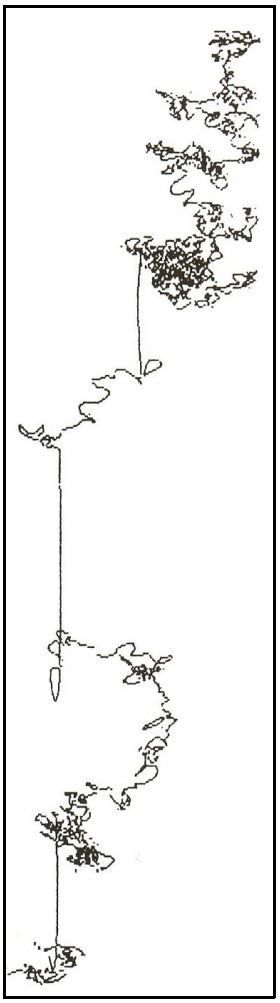


Fig. 9, *Iceland 3d*



The tangles increase as leaps become less frequent. In fig. 10 they occur after 500 single lines at the earliest and after 1000 at the latest. Vertical movement has risen to values around 5, horizontal movement remaining about the same. The constant leap size has also become much larger.

As vertical movement decreases (to approximately 1.5 units) and horizontal movement increases (to approximately 10.5 units), formations like those in fig. 11 appear.

Fig.10, *Iceland 10(a)*, detail

Fig.11, *Iceland 17a*, detail

Finally, a more pronounced descending tendency can be seen in fig. 12, in which vertical movement is slightly increased (to 1.7) and horizontal movement is markedly reduced (3.5). There are more lines in a group (800-1200) and the leaps, too, are larger (400 units).

Variants occur not only as complexes of lines in a drawing but also in the form of series of drawings. As large quantities of such graphics can be produced much faster than musical compositions, they are particularly useful for studying the phenomena that occur. Producing drawings has provided subsequent confirmation of procedures which I had earlier developed for musical composition. Of course there can never be a congruent comparison of music and graphics; it must remain in the domain of aesthetic experiences.

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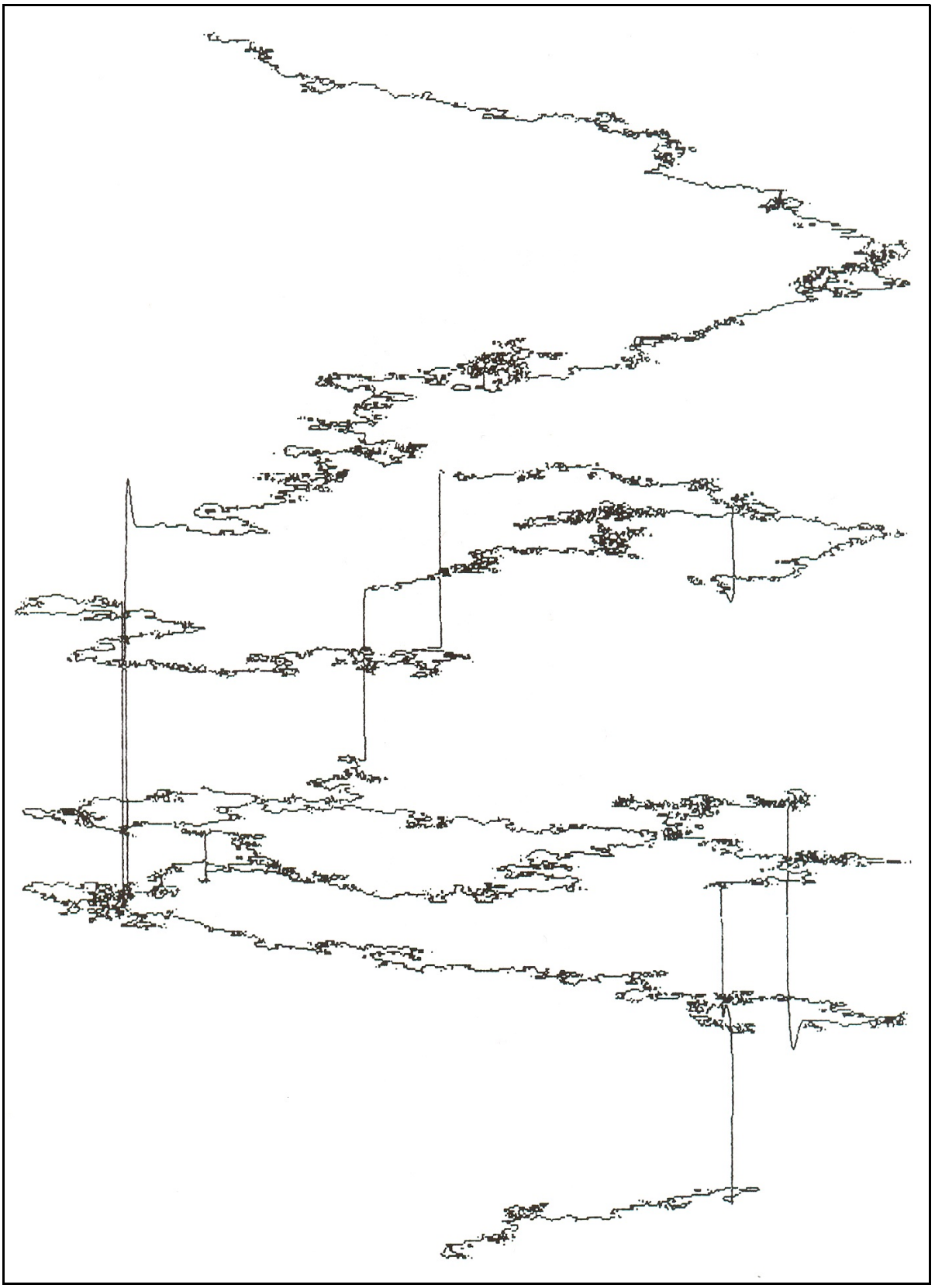

Fig.12, *Iceland 23q*

Notes

[1] *Klangfiguren I*, 1955, on CD BVHAAST 9106 "WDR: Cologne - Early Electronic Music".
[2] *Klangfiguren II*, 1955/56, on CD BVHAAST 9001/2 "Gottfried Michael Koenig".
[3] *Two Piano Pieces*, 1957. The example is taken from the second piece.
[4] *Quintet for Woodwind Instruments* (flute, oboe, clarinet, cor anglais, bassoon), 1958/59. The example shows the end of the second section.
[5] *String Quartet 1959*, 1959. *Cf.* Karlheinz Essl's analysis of the quartet, "Zufall und Notwendigkeit", in *Musik-Konzepte*, 66, Munich 1989.
[6] *Essay*, 1957/58, on CD BVHAAST 9001/2. Score available from PFAU-Verlag, Saarbrücken (Germany).
[7] *Terminus 1*. 1962, on CD BVHAAST 9001/2.
[8] *Funktionen*, 1967/69, *Rot, Grau, Blau, Indigo* and *Violett* on CD BVHAAST 9001/2.
[9] *Project 1*, 1964/65. First described in *Electronic Music Reports #2*, Institute of Sonology, Utrecht University, July 1970. - See also G.M. Koenig, *PR1XM Manual*, Institute of Sonology, Utrecht University, December 1979/80.
[10] *Project 2*, 1966/68. First described in *Electronic Music Reports #3*, Institute of Sonology, Utrecht University, December 1970. - See also G.M. Koenig, *Project 2/82, a program for musical composition*, Royal Conservatory, The Hague 1984.
[11] *Übung für Klavier*, 1969/70.
[12] More material pertaining to serial and electronic music and to PR1 and PR2 in: G.M. Koenig, *Ästhetische Praxis. Texte zur Musik*, 3 vols appeared to date, PFAU-Verlag, Saarbrücken (Germany).