The Second Phase of Electronic Music

To talk about the second phase of electronic music means that the first one must be defined first. Of course, such a distinction has nothing to do with any musicological terminology; neither are the phases, if one does want to talk about them, always clearly distinguished from one another. If my view is that there are already two phases of electronic music, will there be any more? I think I may safely assume that there will be a third, and shall refer to this at the end of my talk. The first two phases could have the following titles:

First phase: the beginning and first development of electronic music,
Second phase: the extension of various types of studios, the transition to automation.

I

My connection with electronic music dates from 1954. The first electronic studio had been established at the Cologne radio station six months before. Herbert Eimert and Robert Beyer had made their first experiments, Stockhausen had realised his electronic studies I and II, Pousseur and Gredinger had been working there. – I hope you will permit me to speak to you as a composer, as one who has experienced the entire development up to now. The creative aspect of this music has always interested and fascinated me; the scientific one to a lesser extent. The technical phenomena stimulated my fantasy just as did the electric railroad set I had as a child. Today I still expect essential stimulation and assistance from the technical phenomena, but I mean assistance and not instructions. I am sceptical about the theories that especially today accompany music so noisily, although I myself have been guilty of theoretical digressions. I also believe that the second phase of electronic music, and the third even more so, will require much theoretical effort.

Whereas the first phase of electronic music was connected with a particular compositional technique, or even better, took its point of departure from it, many composers have already abandoned this compositional technique during the second phase. Perhaps this accounts for the occasionally indecisive, and in any case diverging features of the newer studios when they embark on the automation of production technique. I am speaking of serial technique. It is unnecessary to repeat that it found its starting-point in dodecaphony. Anton Webern was called upon most often as chief witness. Although a pupil of Schoenberg he did not simply take over the compositional rules of twelve-tone technique, but rather guided them into the systematism which then impressed the first serial composers. I should like to show you as an example Webern's orchestration of the *Ricercata* from the *Musical Offering*. Schoenberg's compositional methods had succeeded in exposing the finest ramifications of counterpoint and motivic work, and at least since Mahler the most elaborate art of orchestration was available. We could therefore expect that these very means would be used to reveal the most subtle intentions of Bach's fugue. But the first exposition of the *Ricercata* shows us how strongly Webern was attracted by schematic methods.

Figure 1 shows the theme with Webern's phrasing marks. The brackets above indicate tones played by the same instrument. There are seven groups of tones, yet only three instruments. The numbers over the brackets show the order in which the instruments are employed. This distribution of the tones among the instruments remains the same, as does the order in which the instruments are employed.

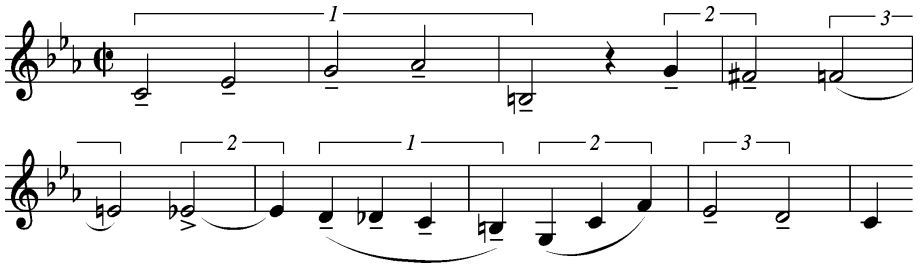

Fig. 1 (Ricercata)

	1	2	3
1	Trombone	Horn	Trumpet
2	Flute	Clarinet	Oboe
3	Bassclarinet	Trombone	Bassoon
4	English Horn	Horn	Bassclarinet
5	Trumpet	Oboe	Clarinet
6	Bassclarinet	Bassoon	Violoncello

Figure 2

Figure 2 shows the groupings for the first exposition. The theme is divided up in the same way every time, and three instruments are employed in the same order every time. As soon as the second voice enters with the theme, the first voice continues in a counterpoint which is also kept to with only slight alterations. It is also divided by Webern into seven groups, which, however, are only distributed between two different instruments (see fig.3). The bottom line shows the melodic line of the fourth passage.

When the theme enters for the third time another counterpoint occurs, again divided among three instruments (second violin, cello and horn), in the order 1 2 3 1 2 1 3. Although this second counterpoint is not kept up at the fourth entry, the voice corresponding to it is still divided among three instruments: flute, oboe and clarinet. It can be observed how the scheme of scoring is abandoned to the same extent that Bach abandons his strictness in the forming of the melody. This is easily understood. But it seems to me to be characteristic of Webern to follow strictly the schematism of the prescribed composition without making the deeper layers of the music audible by means of the scoring. I am certain that this systematics, which is much more surprising in a
non-dodecaphonic work than in serial technique itself, made a much greater impression on the first serial composers than did the twelve-tone method, which of itself does not always strive towards systematism to the extent I have just described.

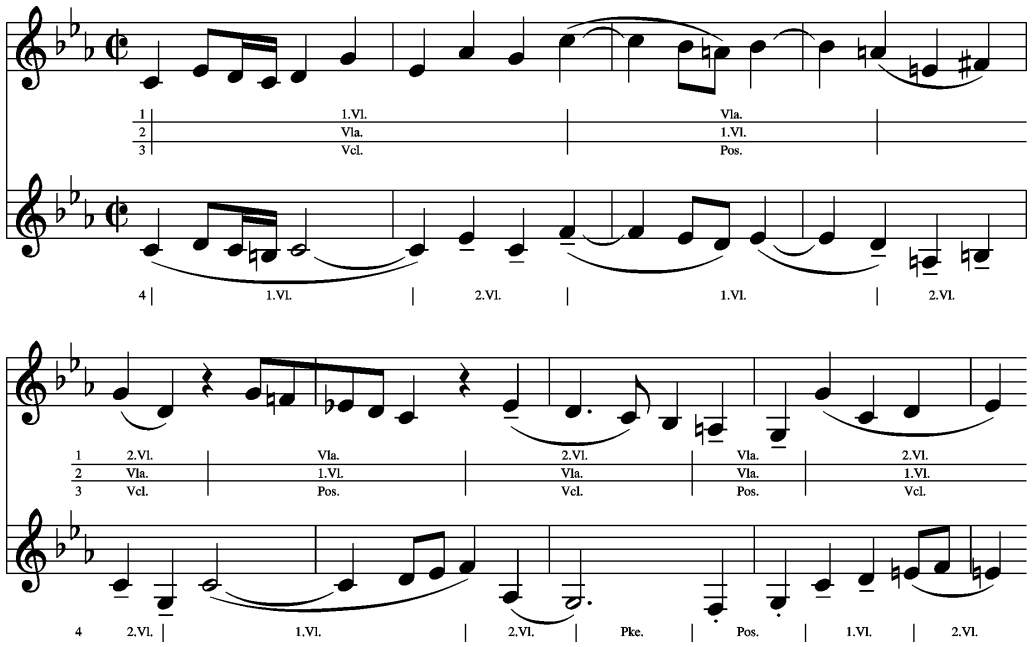

Fig. 3

This detaching of individual characteristics from the totality of the acoustical impression is called the division into parameters. Timbre is one of them, in instrumental music at least. Others are, for example, pitch, duration or volume. In serial music, these parameters have been subjected to the most exact control, that is to a scheme not unlike Webern's, as just demonstrated. It was shown that the various pitches; durations and dynamics could easily be arranged in scales, whereas the timbres could not. In electronic studios, a remedy for this deficiency was sought, and I call all efforts undertaken in this direction the first phase. The basic equipment of the first electronic studios therefore consisted, in addition to tape-recorders, of sinus-wave generators, as scales of timbres can be synthetically produced from sinus tones. Certain sinus tone spectra acquired a noise-like character, and it was thus only a small step to the so-called white noise, a bright, vigorous hissing, from which various colour-ranges can be sifted out by means of electrical filters. Finally the electrical impulse acquired great significance, for composers became aware of the fact that an acoustical event can be altered in nuances which are all the more subtle when it is composed of smaller particles.

Before I embark on a description of the construction and working methods of such a studio, I should like you to hear a section of a typical composition of this first phase. It is composed according to strict rules and consists entirely of sinus tones. Etüde über Tongemische by Herbert Eimert.

(Tape example: Etüde über Tongemische)

The first phase of electronic music is characterised not only by the serial compositional principle, but also by a particular technique of working, which in its turn is connected with the recording of sound by means of tape. The initial material is as elementary as possible and is extracted from electric generators: sinus tone, white noise, impulse. In a second work-process, the initial sounds are subjected to various transformations; for instance, transposition, filtering, chopping, frequency modulation, amplitude modulation, ring modulation, reverberation, and so on. Finally, the completed sounds are assembled to form the piece, whereby each sound,

according to the rhythmic structure of the score, must occur at a certain point in time; we call this process synchronisation.

All the studios of the first phase were equipped in such a way as to facilitate these production processes. In retrospect, I should like to describe the conception of electronic music that prevailed at that time as being an almost instrumental one. Properties were – and usually still are today – attributed to the electronically produced sounds that are constant, unmistakable and temporally limited: the electronic sound – like its instrumental predecessor – also has a particular colour, a particular time at which it has to begin and one at which it has to end. The production technique corresponds to this: elementary sound-material is produced and possibly altered by later transformation. A certain length of tape is cut out of the result and stuck to other little pieces of tape of the same sort. It could be said that a previously existing time-score is "scored" for sounds.

I don't know how conscious the composer is of the instrumental aspect of this work. Anyhow, the energy with which new sounds – and of course new forms of electronic works – were sought, soon diminished; all sorts of reasons for combining electronic and instrumental sounds began to be heard. One reason which keeps thrusting itself on me was never mentioned, however: that the electronic sounds of this first phase were still very strongly inspired by the idea of instrumental sounds, and that therefore the combination with traditional musical instruments obeyed an inherent logic which wouldn't have needed any avant-garde argument at all.

To illustrate this instrumental aspect, I should like to play an excerpt from "Kontakte" by Karlheinz Stockhausen, a piece for electronic sounds, piano and percussion.

(Tape example: Kontakte)

I said that the second phase was characterised by the transition to automation; also, I should like to add, by the preparation for fully automatic methods of production, for the production of sounds by means of the computer.

The ways in which work had to be carried out in the first phase wasted a lot of time. Someone hit upon the idea of having the studio apparatus controlled by punched tape, instead of by hand. In the SIEMENS studio in Munich, for instance, four parameters are coded on four separate punched tapes: pitch, octave-register, volume and timbre. In the earlier version of this lay-out, which has now been extended, twelve pitches per octave were available, represented by piano-keys. You see how strong is the aftermath of instrumental pattern, even in the most modern studios. There have been twelve sine-wave generators in the Utrecht studio, too, since it was established, with a piano keyboard with the range of an octave with which the generators can be switched on singly or simultaneously.

However, the desire for an essential easing of working conditions was not fulfilled. Although the punching apparatus is very practical, punching takes time. A more speedy production can only be achieved by punching shorter structures, gumming them into a loop and playing this repeatedly.

My experience has shown me that the most time in the electronic studio is spent in consideration and experiment, not in the mechanical movements of the hand. Attempts should be made to build studios in which the results of thorough consideration can also be realised, regardless of how long it takes.

In the SIEMENS studio there are, apart from the punched tape, also a Vocoder and a scanner. Both machines – a technical description cannot be gone into here – permit the production of complex sounds. This purpose is also served by a frequency converter, which

is usually replaced in other studios by a ring modulator. Of course, complex sounds were the aim from the very beginning. Sinus tones and sinus-tone spectra were the means by which – in a sort of model experiment – we got onto the track of the growth of sound; I should like to say, of the serial growth of sound. However, these sounds were not aesthetically satisfying in the long run. But complexity of sound in the usual studio technique is equivalent to manifold treatment and transformation of initial material. Here exact control over the physical course of events, over the exact form of the vibration-curve and its serial determination, is lost. The complex sound was not only defined by serial assembly of its components, but to a greater extent by subsequent intervention deforming the initial material. The studio apparatus which produces this deformation can be described, as can the action of the composer at this apparatus, but not the effects on the sound which has to be transformed in terms of the rules of serial composition. In other words, the aesthetic valuation by the ear has taken the place of serial construction. You will say that this is no calamity. Neither would I think it one, if the compositional-technical premises which set electronic music in motion didn't have to be abandoned in the process.

The complex sound also created a new notation problem. As long as sinus tones were superposed to form sounds, the course of the sound could be accurately drawn in a frequency-time diagram. A good example of this is provided by Stockhausen's "Studie II". In the upper stave the sounds are drawn in according to their width and pitch, in the middle the indications in centimetres for the duration, in the lower stave the volume for each sound: becoming louder or softer.

(Tape example: Stockhausen, Studie II)

On the other hand, complex sounds necessitate a complex description. Figure 4 shows a page from the score of my own electronic piece, "Essay". The production and transformation of each sound are exactly described. The score contains all the data necessary for producing the piece. They are arranged in such a way as to make an analysis of the work possible. – Of course, this score can't be followed when the music is heard.

(Tape example: Koenig, Essay)

II

Whilst the first phase of electronic music was to a certain extent its pioneer time, the second phase is under the sign of production. Whilst the composers were discovering terra nova in the first phase, the second generation is already tilling fertile land. The studios have found a form which has been adapted to the necessities of production. There are even didactic studios where young composers may learn the special craft of electronic music. In Paris, the school connected with the studio for concrete music has been in existence for a long time; in Bilthoven, Holland, there is the didactic studio belonging to the University of Utrecht, in Cologne, a studio has been set up at the Musikhochschule under the direction of Herbert Eimert, a similar plan exists for the studio at The Hague; in Stockholm, too, not only a large production studio is being built, but at the same time a studio for purposes of instruction.

Whereas electronic music was greatly criticised in the first phase, and regarded as the reservation of a few members of the avant-garde, it has now become respectable and is making

210	MATERIAL A	MATERIAL A
211	Ringmodulationen:	Ringmodulations:
.1	S 750 Hz/cps	
.2	S 1200	
.3	S 5400	
.4	S 900	
.5	S 675	
.6	S 3000	
.7	S 1800	
212	Transpositionen:	Transpositions:
.1	x 200 /50)	(19)
.2	-----)	
.3	x 6.25/50)	
.4	x 100 /50)	(Quotient: 2) (20)
.5	x 400 /50)	
.6	x 12.5 /50)	
.7	x 25 /50)	
	Resultierende Längen:	Resulting lengths:
	.1 96.2 cm	
	.2 384.7	
	.3 3078.0	
	.4 192.4	
	.5 48.1	
	.6 1539.0	
	.7 769.5	
213	Filterungen:	Filterings:
.1-2	400-800 Hz/cps	
.3	-------	
.4-7	400-800	
214	Verhallungen:	Reverberations:
.1-2	-----	-----
.3	konstante Verhallung	constant reverberation
.4-6	-----	-----
.7	zunehmende Verhallung (hauptsächlich am Schluss)	increasing reverberation (chiefly at the end)
	----------	----------
	(19) Aus technischen Gründen sind alle Intervalle auf den Nenner 50 bezogen (vergl. 432).	(19) For technical reasons all intervals have the denominator 50 (compare 432).
	(20) Die Quotienten zur Transposition der Materialien unterliegen keiner seriellen Ordnung; sie sind der Vollständigkeit halber angemerkt.	(20) The quotients for the transpositions of the materials are not ruled by any serial ordering; they are given for the sake of completeness.

Fig. 4

an entry into musical pedagogy. Here it is difficult to say exactly what electronic music is. Some critics want to regard it as a thing apart from "music", giving as their reason for this that music

consists of tones and not noises. If they were to be given the answer that music is everything that is acoustically perceptible and arranged according to artistic laws, the specific newness would be overlooked. There are, it is true, instrumental works which have completely turned their backs on familiar gesture and which appear to have been inspired by the effect of electronically produced sounds, "Atmosphères" by Ligeti, for example. But the difference is deeper: it is – I think – in the form.

Musical form, for the purpose of lessons in music schools, is not only simply arrangement, but typical arrangement. Form-types have names like sonata-form, rondo-form, and so on. Confronted by the new music written since the war, this conception of form fails. This music was therefore said to be formless. This is unjust; for the classical form-types were already more than that which was typical of them. The form of an individual work is not only what is general about it, but much more what is special, untypical about it. As the works of present-day young composers also embody arrangements which are certainly perceived by practised listeners, we must find a concept of form which is not limited to the description of types. I am not a form theorist and do not want to suggest new definitions. But what I do find important is to give point to a characteristic of electronic music which is coherent with the form-concept, however it may be defined.

The forms of instrumental music surely have one thing in common: they are composed of single sounds. These sounds have characteristics such as pitch or timbre, and when analysing forms, we are frequently forced to pay attention to just these characteristics: the extent to which melodies
or harmonic structures or those of timbre are engaged on the form as a whole. We are always dealing with sounds following a particular arrangement, and this arrangement – not the sounds comprising it – is what we call form.

It goes without saying that there are also sounds in electronic music which are in an arrangement, and we could call this arrangement – analogous to instrumental music – form. However, the electronically produced sound is not only within a form but is furthermore in itself the result of being formed. I don't mean its instrumental aspect – what we could call attack or decay or intonation. For whereas the characteristics of an instrumental sound are determined to a great extent by the mechanical texture of the musical instrument, the characteristics of an electronic sound are determined by the actions of the composer producing it. Everything about it is artificial, made with artifice directly derived from the musical idea of the entire work.

In this manner, the borders between the sound and the form consisting of sounds disappear. Every sound already has a form, the work is put together with forms – sound-forms. Here the sound-form obeys laws other than those of the classical form-types. The sound-form is indubitably a sort of audio-visual aid, not so much articulated in itself like a period or an exposition or even like a motif. Sound-form is rather the turning towards the outside of what is inside, an object, a variable acoustic element. This electronic sound represents something flowing, streaming, comparable to a river that keeps on forming eddies. Its flow is held up by invisible resistances and accelerated by the omnipresent force of gravity. In a similar manner, the acoustical shape of a variable electronic sound is the perceptible effect of unrecognisable causes. Does this already define its form? Certainly not. The known characteristics of musical sounds which are static throughout are joined, however, by a dynamic characteristic which keeps the difference between two sounds just as much in suspense as the detachable form of each single one. The sound in motion is characterised by the special manner of its motion, which cannot always be unequivocally described, but which can be perceived. This characteristic becomes clearer, the further the work proceeds. Some characters only occur

singly, others find correspondences, even establish themselves as recurring patterns. One could say that the individual sound, although the result of being formed, has nonetheless no actual form, but that it does acquire its form in the sequence of many similar or dissimilar sound-forms. The form of the sound and the form of the work are mediated by each other.

Perhaps I should try to clarify this by means of an example. Let me play you an excerpt from my latest electronic work, entitled "Terminus".

(Tape example: Terminus)

In this piece I have attempted to make the form come into existence in the same way as each individual sound came into being in the course of several work-processes. I don't know whether I have succeeded in this. But this experiment seems to me to be characteristic of the second phase of electronic music as a transition from the pioneer stage to controlled complexity.

In this work, the individual sounds are not bits of decoration turning a stage into a landscape or the front parlour. The sounds tell no story other than their own. This is why the piece is not based on a form-plan in which sounds were inserted. There was rather only one single scheme: that of the production of sounds which gradually become forms of various complexity.

The circles in fig. 5 indicate sounds, the connecting lines show whether several sounds are to be synchronised or several variants are derived from one single sound. The way in which this derivation is accomplished is not shown in this scheme. The five circles in the top line, for example, indicate five different sinus-tone glissandi. They are superposed to make the one sound
below. This is in its turn transposed to several pitches, represented by the seven circles in the third line. These are multiplied by three, and further down by three again (indicated by large dots). In this way the big central block of the scheme is made, an initial material which does not occur in the piece. But from it the sounds which later comprise the piece are derived. Below the double line, E 3, a line runs out to the left, indicating that all sounds of the work process E 3 are to be synchronised. From this result four variants are produced, shown by four circles at the left edge of the scheme outlined with a dotted line and marked D 4. These sounds occur in the work, the same goes for their derivatives and finally for everything; that can be seen on the right-hand lower part of the scheme.

I can't explain the work-process in detail now. But it is clear that the resulting sounds do not have an illustrative function, that they were not selected in order to form melodic or harmonic configurations as are the instruments for an orchestral or chamber work. In other words, there are no sounds whose characteristics such as pitch or timbre were placed into references, references which we then call the form of the work. The work-processes, composed in detail, are related to each other, and these relationships come into evidence at the surface of the sounds. Each sound is therefore not a blotch of colour but itself a form, as it owes its existence to a formal construction, to a form process.

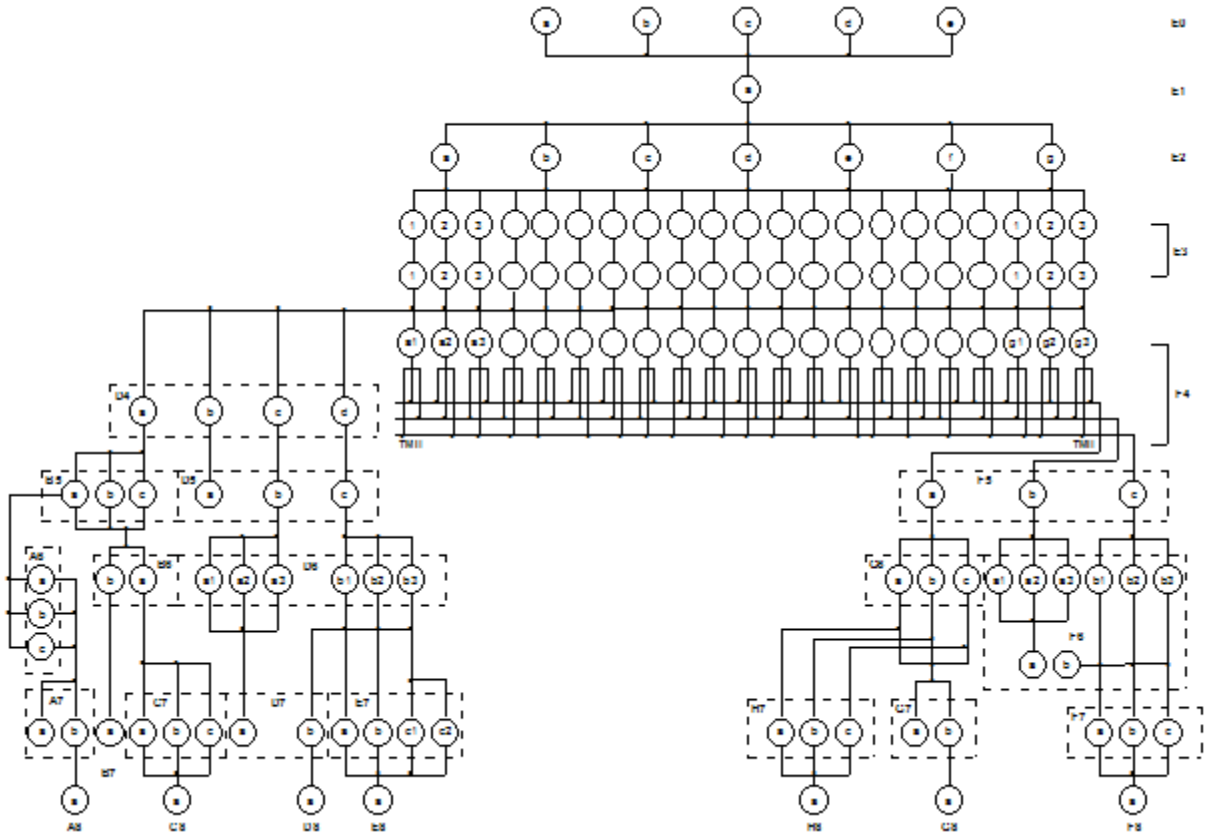

Fig 5

The order of these sounds in the finished work follows only methodical points of view; they have been arranged in such a way as to make the form-process to which the sounds have been subjected as audible as possible. In this work there is no form outside the form of the sounds themselves and the form of the production processes.

I should like you to listen to another excerpt which will show you the manner in which it is not the individual sounds that constitute the piece but simply sound itself in noticeable and unnoticeable transition.

(Tape example: Terminus 1)

III

Whoever is at the end of this second phase, whether an automatic studio is at his disposal or not, and surveys the possibilities of producing complex material by using multifarious transformations, will entertain the desire to articulate in detail this complexity of the sound-form according to compositional viewpoints too, that is with particular compositional techniques having already learnt to evaluate these sound-forms by ear. The composer who has worked in a studio for any length of time can soon fix production processes at his desk. These will certainly result in sound-forms corresponding to the composer's musical idea. But he is also aware of the limits to this method of working. All transformations are rough transformations, they are not extended over the whole sound or an entire sequence of sounds. The principle of each transformation can not be altered in just any lengths of time. It would

be nice to have a generator capable of realising any desired sound-form without the composer's toiling to feel his way to the desired sound without ever reaching it. We must not shut our eyes to the fact that most sounds are compromises, the composer in the electronic studio in usually forced – whether he admits it or not – to accept finally the sound coming into existence the way it issues from the apparatus. However, if the sound is supposed to be formed according to compositional rules in all its phases, these compositional rules must first be known.

They are not known to the extent that one might think. Although music has always tended towards theory, the composer is always forced to adopt an empirical method of working, he goes on trying until he has found what he is looking for. But if a machine is supposed to obey compositional rules in order to realise a particular sound-form, the rules must be imparted to the machine, for I do not need to emphasise that a computer is empty before it is fed, and for this the composer must first be acquainted with the rules. We can easily check whether this is the case; he only needs to attempt to impart these rules to a completely unmusical collaborator (which a computer is) in such a way that, if the latter just abides strictly by the rules, there will be a result corresponding to the composer's compositional standards. This is not so simple, and the composer who tries it soon realises that he knows less about his own methods of working than he thought.

As such problems result directly from the second phase of electronic music and will govern the third, we have begun with compositional-theoretical experiments in Utrecht. The aim is not to analyse already-existing music but to make prognoses for the future, that is to fix compositional processes which, it is true, draw their consequences from music already written, but which can cope with the tasks of the future. This work can therefore not be left only to musicologists or programmers from the mathematical institute. The cooperation of the composer himself, the only one who can formulate each new problem, is necessary.

Such compositional processes are fixed in the form of computer programmes and tested by computers. Here the main thing is not so much to compose entire works with the help of computers (although of course this is not entirely out of the question), but rather to collect building-stones which can be used every time a composer is confronted by recurring situations and sees that he is capable of making recurring decisions.

It is obvious that serial compositional technique be analysed for this purpose as to standardised functions or those which can be standardised. I should like to show you a few very simple examples of this. First, let us put ourselves in the position of a composer who wants to set up a twelve-tone series. As already mentioned, he must present this exercise in a form that can be understood and executed by an unmusical collaborator, a computer, for instance.

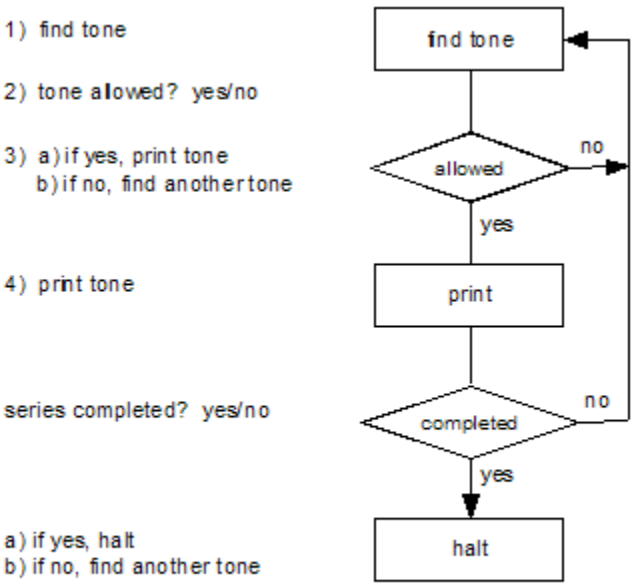

Fig. 6

On the left-hand side of figure 6 is a series of instructions, questions and answers. First instruction: find a tone, that means select anyone of the twelve tone, for it is immaterial with which tone the series begins. Secondly, a

question: is this tone allowed? At the beginning this question will be answered positively, later perhaps negatively. If the tone is allowed, it may be written down, otherwise another one must be found. We continue in this manner until the series is complete. But how do we know when this is? At each tone, we must ask if all the tones are assembled. If this is not the case, another tone must be found.

On the right-hand side of this diagram, this process appears in a simplified form, as a data flow chart. The rectangular boxes contain instructions, the diamond-shaped ones questions. The connecting lines indicate which instruction should be proceeded to, according to the answer to the question.

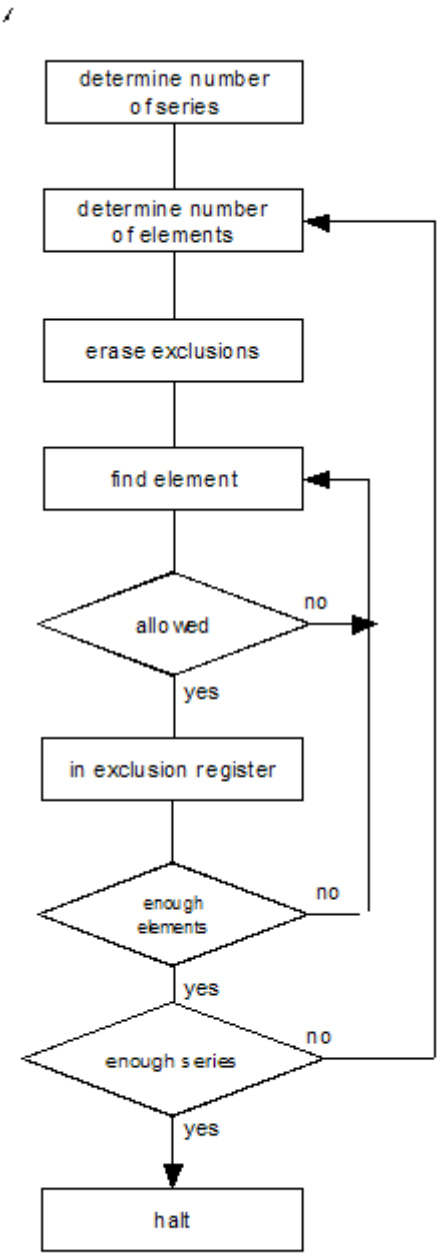

Fig. 7

Thus this chart shows in a greatly simplified form how the composer proceeds when setting up a twelve-tone series. But it must be said that series based on this programme will hardly be satisfactory to the composer. For there is no insurance against undesirable tone-sequences; for example, triads can occur without ado, which would not fit into atonal musical language very well. The question as to whether the new tone is allowed should therefore be added to by further questions as to whether it fulfills other conditions, too.

The following question arises: how does one recognise whether a tone is allowed or not? Such questions crop up frequently and can often be answered with the help of the chart in figure 7.

The exercise consists of setting up several series with a varying number of elements. First the number of series is defined, then the number of elements in the first series. The exclusion register is erased and the first element sought. If it is allowed, it is written down and at the same time entered in the exclusion register. As long as the series is not complete, we jump back and seek another element. The question "allowed?" means that the exclusion register is examined as to whether the element that has just been found is already there or not. When the series is complete, we ask again if enough series are already present. If not, we jump quite a long way back in order to determine another number of elements for the next series. The exclusion register is erased and we begin all over again.

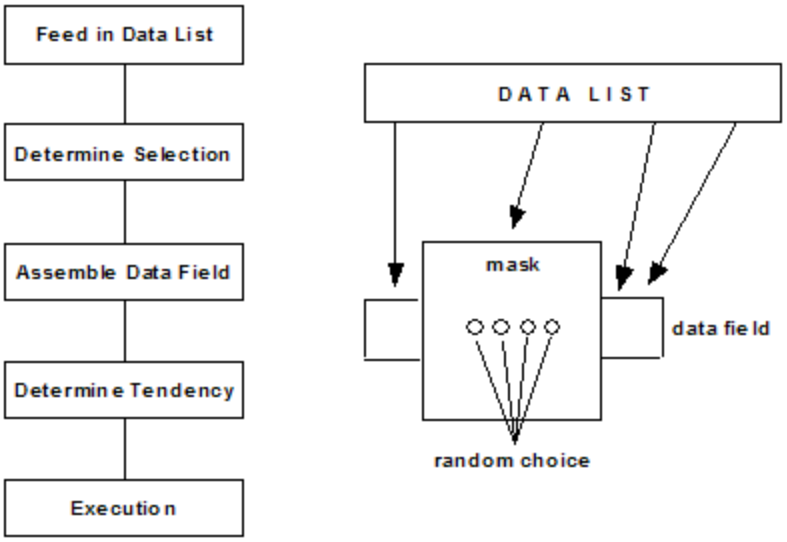

Fig 8

Another question arises: how is an element found? There are several possibilities; either there is already a definite order according to which the elements are cited one after the other, or the following element is calculated according to a particular formula, or we leave it to chance. The first two possibilities are not very sensible, because a previous decision as to the correct order has already been met, which leads to conflict with the special conditions which occur when a series is set up. The third method leaves the choice of an element to chance and sifts out the undesirable
then formed which could do justice to the serial claims.

Chance in music is frequently misinterpreted. It is often believed that anything at all can happen and that the composer abandons all control. This is usually not the case. First, elements must be available in order to establish an order among them at all. This is taken care of by a random generator, which used to be called idea or inspiration. For an idea, too, must be tested as to whether it is useful under certain conditions, useful when modified, or useless.

Chance can however be serviceable if a process is described only in rough features because the details are unimportant or because variants should be formed when the programme is performed several times. In this case the details are not important but their variability is. For example, perhaps an irregular alteration of the speed of the musical flow is desired. The irregularity as such and the framework in which it takes place are important; the actual little jumps that the speed makes are unimportant – but desired in their variability. The plan for this could look something like figure 8.

On the left-hand side of this figure is a list of the work processes. First a data list, containing all the elements, in this case time-values, allowed at all, is made. Now a first selection could be made because the final result is not supposed to make use of all conceivable elements; for example, maybe only the left or right half of the list is used, or only every third value, or perhaps only elements obeying certain conditions may occur. In any case, a data field is formed by means of this list; its elements are then actually used. The alterations in speed could finally follow a certain tendency, still to be indicated before the execution can begin.

On the right-hand side, the elements of the data list are removed to the data field. A mask is now placed over this field, leaving only a small section visible. The two edges of this mask can be moved over the data field together or independently of one another, so that new

elements become visible or so that the visible amount is enlarged or reduced. Within the just visible part of the data field, a random generator makes one or several decisions before the edges of the mask move. The success of this is clear: the data field describes the amount of alteration; the speed at which the mask moves gives the speed of the alterations and the random generator takes care that alteration is not constant.

Exercises like this are not far-fetched. Not only in serial, but also in post-serial music, structures are formulated which are characterised by particular properties and which because of these properties are distinguished from one another. A characteristic property is its own alteration, to various extents and at various speeds.

As you can see, the compositional processes have not been attired in mathematical guise. An attempt was rather made to divide the composer's thought-process into steps that can be performed by a computer. These steps are at the same time ones within the composer's imaginative sphere. In order to write down such a programme, the composer must analyse his own intentions and at the same time the way which should lead him to his destination. It is not the music of a past epoch that is being analysed but the future in the form of a planned work or at least of a particular one of its characteristics.

One could ask whether perhaps all the same it would not be useful to extract the quintessence from important works of the past in order always to be able to use what has already stood the test of time. But this view would miss the essence of artistic work. The works of the past are not machines which were once invented in order to perform useful work in a producing business for a long periods of time. These works moreover were analysed a long time ago by musicologists, music-philosophers and last but not least the composers themselves as to the characteristics explaining the essence of music or of a particular work. Further analyses revealing hitherto undiscovered features and indicating in mathematical terms the probability, for instance, with which certain characteristics or recurrences or combinations are encountered in the works of a particular composer or a particular epoch or a particular category of form may have their justification within scientific enquiries, but are worthless for the composer. Only in the rarest cases will he see a possibility of indicating the form of a new work in probability values or averages. As everything could also be different in each work, he reserves the right to overthrow rules at any instant during the work, to break resolutions, to tryout constellations and then to make a selection from among them, in short: to keep to rules which appear to him to be correct, and then again to break them if he wants to.

In view of this it seems superfluous to put compositional work processes into the form of programmes. It is only sensible to do this on condition that there are recurring situations in which recurring decisions must be made. It would also be sensible to work out the variants of a variable structure, the plan of which is in the form of a programme, several times, in order to be able to choose from among the various results. The composer is surely only theoretically interested in knowing how a composer of the past acted in recurring situations; it is just as certain that he is practically interested in getting to know the mechanism of his own creative psychology. Composers tending to work systematically will find much that is programmable in their habits of working; others will reject the idea of composing with the aid of a computer from the first. In any case the working-out of compositional algorithms could be an important contribution to the present musical situation – but also for the future if electronic sounds are going to be produced with the help of computers. May I finally give you a short outline of how this will probably be done in the studio at Utrecht University.

Since the beginning of electronic music we have known that the sound-spectra of orchestral instruments cannot be adequately imitated by using sinus tones; neither is this of course the

purpose of electronic music. However, the spectra of familiar sources of sound offer a lead for certain laws valid in the audible world. In their generalised form they have rendered electronic music service, they have helped to determine the basic equipment of an electronic studio and to systemise production technique. Up to a limit which, I think, has been reached in the second phase of electronic music, it was also possible to reconcile the systematism of sound production with the systematism of composing. But for some time the ways have been seeming to divide. The richer, more complex sounds with which composers want to work can only be achieved with traditional practices at the price of serial control. In this manner it will be difficult to relate the sounds to one another in a way corresponding to the ideal conception of the composer who for this very reason goes to an electronic studio. The challenge to the studio of the third phase is therefore: the production of sounds of any desired degree of complexity, but always controllable and reproducible in all details. The technical promises for this are to be conjectured in the production of sounds with the help of electronic calculators. Of course the composer can hardly be expected to penetrate so deeply into the technique of the computer and the technique of programming as to be able to programme any sound himself. It is my idea that the studio should do the preparatory work of making basic programmes. A basic programme describes the context of certain musical parameters and leaves it to the composer to determine initial values or the limits of statistical distribution. Each basic programme represents the algorithm for a particular musical characteristic – which is always a characteristic of context or form. In the course of time a small library of such basic programmes should be set up with the collaboration of the composers using the studio. Characteristic results of these programmes are recorded on tape and can be used by the composers for purposes of orientation. The composer desirous of producing sounds using these basic programmes – sounds, let me emphasise, that could never be produced with the traditional studio equipment – is shown which programmes are available and how to work with them. Instead of studying the traditional apparatus, he studies the basic programmes. The production of the final computer programme combining the selected basic programmes is the duty of a member of the studio staff.

After the computer has worked out the sounds, the sound-data is transformed by a digital-to-analog converter into a curve which is directly audible at the loudspeaker or recorded on tape. The advantage over the traditional methods of working is not only that new sounds can be produced but also that these sounds are not the result of manifold transformation and copying but as fresh as a microphone recording.

I hope that I have given you an approximate view of the second phase of electronic music – a phase which has standardised production technique and made it flexible, which has brought forth real works, thereby leaving the experimental stage – but also a phase that has pointed out the limits of the possibilities. Neither the productive ardour of the composer nor the curiosity of the researcher and theoretician has relaxed. Compositional-theoretical knowledge will always be felt to be insufficient and show the way to new territory. Thus we stand, armed with the necessary experience, before the third phase, but also before difficulties which we partly know, and partly do not yet know. There is no doubt that the efforts of the composers and studio technicians will overcome them.

[Summer 1965]