

## My Experiences with Programmed Music

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By programmed music I mean music that is made with the aid of a program. I distinguish a program as to its strategy and the compositional idea behind it. To start with the latter: the *compositional idea* is the starting-point of a composition; it is what a composer has in mind before working it out. The idea can be inspired by a genre (opera, song, chamber music, a work for large orchestra) or by a form (musical miniature, improvisation, reactions of musicians to one another or to an audience, a "closed" work with a normal duration) or by an ensemble (instrumental group, electronic sounds, a combination of the two) or by the composition process (the linking together of individual ideas in terms of a psychogram, strict formal development, a computer program or electronic apparatus as the source of inspiration or of the sounds) and so forth. The compositional idea causes a composer to conceive a new work, a specific work – I do not mean external inducements such as commissions. The compositional idea does not impart anything about the way in which it will be implemented; it contains no details as to genre, form, ensemble or process; it is more a question of indicating a general direction in which the musical idea is supposed to develop – and at the same time the ultimate goal. We know that in working on a composition the musical idea will have to be tested by the possibilities for realising it, and that it can be subjected to several modifications.

The musical idea is frequently not corrected until the second phase, the strategic phase. The *strategy* indicates the ways and means employed for reaching the proposed goal. Here are a few random examples to illustrate this. Strategic considerations can result in the choice of a tone-system (tonality, dodecaphony), in work with thematic cells (chiefly in the pitch and rhythm parameters), in the invention of easily recognised formulas to facilitate the listener's comprehension, or in infinite re-shufflings in terms of a general variant technique; in an open form the conductor might be instructed to give cues to groups of instruments if the players are not to react to each other or surrounding events (which might be accompanying tapes); strategic considerations can also be aimed at specific production equipment in an electronic studio (additive and subtractive sound synthesis, tape-loops, voltage control and so on). The selected strategy can even take the place of the compositional idea, particularly in experimental situations, if the composer's main purpose is to try out a new strategy.

Just as the compositional idea proceeds to strategy, strategy itself occasionally proceeds to a *program*. The concept of a program has a multitude of nuances.

In its most free sense a program is simply a plan which registers the different strategic phases of the work. The stages of such a plan are not always clearly separated, and above all they can be modified in various ways as the work proceeds. In other words: this type of plan has a provisional character; the composer does not feel that he has to abide by it.

In a narrower sense a program can be, say, a twelve-tone series with its derivations, possibly supplemented by rules for combining or restricting the series or by thematic connections of the series and the like; the program can contain details as to series and combinations, transpositions and permutations of series for a serial composition; it can allow chance to operate and indicate the interpretation of random numbers in terms of musical quantities; a program can finally refer to production techniques in electronic studios (specification of the initial material, sound processing and derivation techniques, instructions

for the final montage). These are only a few examples which everybody can supplement with examples from his own experience. This narrower concept of the program makes a composer feel more strictly tied down: he prepares twelve-tone series, sound synthesis techniques, random selection instructions, because he introduces them as rules for a formal construction directly depending on these rules. It is always possible to depart from the rules if required by the circumstances. Programs in this middle category are formulated less strictly so as to allow for possible deviations.

This brings us to programs in the strictest sense: computer programs or instructions to which the composer wishes to adhere exactly. We are familiar with enough examples from serial composition technique, but we might still spare a thought here for the process in the electronic studio, because apparatus such as tape recorders, generators, filters can – like programs – function predictably; complicated circuits of a synthesizer for the production of a composition or as an aid during a live performance can certainly count as programs in the strictest sense.

I hope that this attempt to classify the activities preceding composition has clarified what I mean by a program. Programmed music is accordingly music composed with the aid of programs – and I mean programs in the strictest sense. As I already mentioned, a composer works with programs if he wishes to abide strictly by prepared sequences of decisions. He is often faced with a *dilemma* here, if the text produced by the program is in contradiction to his compositional standards. He is slightly tempted to adjust this programmatically produced text to his own standards by means of editorial intervention. Another consequence might be to go on improving the program until it satisfies his standards.

In the former example I would classify the program among programs in the more restricted sense; the composer's readiness to modify the result permits deductions to be made as to the standards he applied to his program. The second example is what I would call a program in the strictest sense.

In this respect, too, I only consider programmed music from the aspect of the program in its strictest sense. However, we shall see that in the light of programmed music, strategy and program dovetail particularly closely, at any rate when the program is not only used to perform a partial task such as the synthesis of a few sounds. We might even say that a composition program really describes a strategy.

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*My own experience* with programmed music goes back to my childhood when, after recorder and piano lessons, I wrote my first composition. It was a canon for two recorders, a classic example of programmed music. First I composed a few bars for the upper part, and then copied them for the second part, inventing a continuation of the upper part, and whilst it did not fix the upper part, it did restrict it to a great extent. Even as a child I thought of music as being in independent parts; when I later did my first harmony exercises I was glad at having to find four parts all the way through; I wouldn't have had the faintest idea how to deal with a random alternation between three and four-part chords.

A few years later – I must have been about fourteen or fifteen – I played the violin in a youth orchestra. I had written quite a lot of music in the meantime, generally for small groups of instruments that could be played in the family circle or by friends. They, too, were contrapuntal in character. I was especially intrigued by fugues, and I analysed several of

Bach's in an attempt to solve the secret of how to compose music that is full of expression and variety by applying strict rules. It was hard work, and I used my eraser more than my pencil.

One day the leader of our little orchestra brought one of his own compositions to a rehearsal, and we tried it out at once. He was an extremely talented violin player who could toss off difficult passages effortlessly; he changed parts of his score without much puzzling during the rehearsal, promised to compose a second movement by the following week and did not seem to envisage any difficulties in composing even longer movements. I understood the reason for his dexterity at once: the upper part had a pleasing melody in scales, broken chords and occasional chromatic passing-notes, the accompaniment taking care of the harmony in quavers, supported by the odd pizzicato from the double-basses. I had no difficulty in recalling musical models in the divertimento-like works of the Mannheim School, but I was disconcerted by the simple way this boy's piece was made and at the same time angry at not being able to discover the program – I might almost say the algorithm – with which it was possible to compose music so easily and quickly. The "program" consisted simply of the instruction to change the harmonic function slowly (not more than one change in each bar), and only in simple harmonic progressions: tonic, dominant, mediant and so on. The melody had to keep within the respective function, which only made the whole affair still easier, and it was child's play to work out an accompaniment.

I was possessed by conflicting emotions, for I was accustomed to avoiding broken chords and scales in my melodic technique, which resulted in rapid harmonic progressions; I did not know whether to be enraged in my capacity of contrapuntalist or to envy my colleague and try to learn something from him. In any case I did learn something then which much later was to consolidate itself into the concept of the composition program.

My third encounter with programmed music was during my musical studies at Detmold; it must have been in 1948. In the instrumentation class we were asked one day to set any chorale we wanted for brass; the harmony could be either tonal or atonal. In the next lesson we had to imagine this chorale as a solemn stretto in a symphonic movement and to compose a woodwind accompaniment, contrasting with the brass chorale by a higher register and more lively movement. After we had done this, we were told to add a rapid figure for strings, passing through all the registers and supposed to make the whole thing sound more brilliant.

The educative intention was to teach us how to write suitably for woodwind, brass and strings, although what struck me was the programmatic aspect. The added woodwind and string parts were thematically unconnected, and those who had chosen an atonal chorale were fairly free as to the harmony. What remained were typical forms of movement, and it was easy to formulate the differences between them even in strict rules without spoiling the final effect.

Two years later dodecaphony hit me. I had been composing tonal and quasi-tonal music, stimulated by Stravinsky and all kinds of liberties I had thought out for myself. We students used to have lively discussions about twelve-tone music; I was against it because I didn't see any point in having all the semitones one after another. I had spent years studying tonal harmony, and had covered the walls of my room with yards of drawings of my harmonic analyses of music, mainly Bach's. Chord functions did not interest me as a means of harmonising a given melody but as a means of giving form; the "space" of a composition was divided up into harmonic fields in which thematic characters were embedded. To me, it

seemed as though this architectonic aspect was sacrificed in twelve-tone technique without anything being gained in return as far as I could see. Whether you are for a thing or against it: the constant pre-occupation with it turns you into an expert, even if you resist.

And so I woke up one morning, sat down at my desk and wrote my first twelve-tone piece. Admittedly, it was not the way Schoenberg would have done it; once more the programmatic aspect gained the upper hand. I saw the twelve-tone series as a reservoir of relationships which could be developed in the course of a composition, but the series also represented the material in which the relationships are expressed. In other words, one only had to write down the series again and again (including its retrograde, inverted and transposed versions), emphasising its characteristics (neighbouring relationships in different arrangements). This strategy did Schoenberg injustice, but it helped me to expand the concept of the composition program, finally leading me – again programmatically – to serial technique.

Who invented *serialism*? – Nobody, or rather, everyone for himself. When I first met Stockhausen at Cologne in 1954 and he explained the composition principles of his electronic *Studies* to me, I realised that this confirmed the experiments which I myself had been making in my instrumental pieces for the previous year or two. True, I had not proceeded from series, but from composition rules which could be applied mechanically; they mainly covered the pitch movement and the time-flow. In this way many other composers who came to Cologne studio in the fifties or got together at the International Vacation Courses at Darmstadt brought along their composition techniques which were endlessly discussed, finally becoming absorbed into the collective concept of serial technique.

What induces a composer to make rules for composing which can be applied mechanically? I remember a remark which Heinz-Klaus Metzger once made during a conversation. He said: Schoenberg is supposed to have composed with twelve tones related to one another, but that is not true, because the relationships of the twelve tones are already given in the form of the series so that the composer no longer has to bother about them; this makes it easier for him to bother about the other characteristics of the musical material and that is exactly what Schoenberg did.

I mentioned the canon as an example of mechanical composing, and there are many more examples like that. We have only to think of the fixed configurations (such as cadences) of tonal music. In a minuet the first section modulates to the dominant, the second back to the tonic. This harmonic movement is not composed, it is given as the formal scheme. Every work of music could be divided up into given quantities which a composer uses to refer to the works of his predecessors, to musical idiom, and into variable quantities in which the composer's inventivity becomes apparent. I shouldn't be surprised if such an analysis showed that well over the half of what is written in most scores consists of "given" quantities, and that composers are much less original than they think. I am not concerned with originality here but with the acknowledgment of the fact that the composer has a large stockpile of feasible musical configurations at his disposal and uses this knowledge with the recklessness of a sleepwalker, without thinking about it, mechanically.

It was hardly a coincidence that I came into contact with serial composition technique in its stricter sense in an electronic studio. After all, the electronic studio was supposed to be the place where all serial problems of instrumental music (such as those of timbre) could be solved. Still, it was the programmatic aspect that fascinated me again. If you switch on an

oscillator, you cause a program to be executed that is partly fixed in the oscillator and partly given by the way you set the knobs. This aspect becomes even more obvious if several pieces of apparatus are connected, nowadays particularly by means of voltage control; anyone operating a synthesizer is programming music. In the first studios, though, there was not much equipment; every sound was produced and stored individually. In order to assemble the individual sounds you had to distribute them over "layers", the number of resulting tapes being the same as the number of layers required. A layer only contained successive sounds, not overlapping ones.

This method opened up new perspectives of polyphony: first, the distribution of the sounds among the "voices" (the "layers") was no longer dictated by musical logic but by technical circumstances, and second, the suspicion arose that polyphony did not just mean the simultaneity of independent parts requiring several players to perform them, but that the desire of several players to perform together produces polyphony. Peculiarities of musical language are then defined as the consequence of technical circumstances.

With all this at the back of my mind I realised my electronic compositions by first of all creating the technical premises (making a program), and then taking the consequences for musical language, or rather letting the consequences be taken – by the technical arrangement that I had prepared for the realisation of sounds and sound-structures.

I was nudged further towards programmed music when I finished my electronic piece *Essay* (in 1958) and showed the score, which was later published, to an American geologist acquaintance.

He was struck by the strict regularity with which the original series was permuted and with which I had applied the permutations to the various parameters. He asked me why I hadn't used a computer to work out the score – he might just as well have asked why I hadn't composed the piece with a computer. He knew someone who worked at the computer centre of Bonn University and advised me to enrol for a programming course there. I did as he said and wrote my first program for setting up twelve-tone series, all-interval series and other harmonic control functions. I immediately understood that it ought to be possible to produce sounds directly with a computer; the man I just mentioned who worked at the computer centre was at once prepared to help me with the anticipated difficulties.

Nothing came of these plans however, because there were no convertors, which are necessary for sound production. I therefore decided to give up the idea of sound generation for the time being and to concentrate instead on the question as to what can be programmed in music – a question that can just as well be asked in the area of instrumental music.

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In the course of my research into what can be programmed in music I have written two programs up to now. I called the first one *Project 1*, and the second one, since I still felt that I was in an experimental phase, *Project 2*. This second program became so well-known that I felt it inadvisable to change the title.

Unfortunately the two similar titles conceal the specific differences between the programs. I shall only touch on the first one briefly here, and deal with the second in more detail with the help of slides.

In *Project 1* only five parameters are distinguished: instrument, time-flow, pitch, register and dynamics. A particular number of elements is provided for each of these parameters: 9

instruments, 28 durations, 12 pitches, 4 registers and 6 dynamic values. The instruments are numbered from 1 to 9, allowing the user to define them at his own discretion. The 28 durations are read in before the program starts, and are thus left to the user's discretion too. The 12 pitches are taken care of by a program-section which forms twelve-tone constellations from four similar three-tone groups, the maximum chord density being 6 tones. The four registers are numbered, and for the six dynamic values the current symbols ranging from triple fortissimo to triple pianissimo are produced.

One program run results in seven structures of equal length, the duration of a structure, expressed in the number of time-points, being determined by the user. I decided on seven structures so as to be able to subdivide the range between regular and irregular events; by regular I mean: as many repetitions as possible (same instrument, same duration, etc., in one word: group formation); by irregular I mean: that the elements change as frequently as possible.

For the subdivision I just mentioned there are seven subprograms: three for regular events ranging from maximum repetition via restricted to minimum repetition, three for irregular events ranging from maximum irregularity via restricted to minimum irregularity. The seventh subprogram is an attempt to bridge the two poles: every group of series from one category is complemented by a corresponding group from the other one. The distribution of these seven subprograms over the seven formal structures is random, but in such a way that for each of the seven formal structures each sub-program can only be selected once.

After the durations and the structure-duration have been read in, the program runs completely automatically and produces a score in the form of tables which the user has to transcribe into some form of musical notation.

As you can see, the user can hardly exert any influence on this program; he cannot express any particular wishes; he can only decide whether to accept the resulting score or to reject it if he does not want to try to steer the data print-out towards the lines of his own musical understanding by interpreting the data very freely. This, incidentally, is one of the chief problems of programmed music, at any rate in its guise of the computer composing program. If the structural data assembled by the computer are of a very general nature, more or less restricted to musical basic facts, they will not interest a composer unduly; perhaps he might ask why a computer should be used at all. If on the other hand the composed data are to attain any higher degree of complexity, the author of the program must design this complexity, resorting to his own musical understanding, which might easily be in contradiction to the expectations of other composers using the program.

Before designing a composing program, then, we have to ask ourselves what is expected of the program, what standards it can be set, which form of musical understanding it should reflect. There are apparently two ways:

if the first is adopted, musical tradition must be consulted, and as many scores as possible must be analysed so as to isolate the constants of musical language. These constants can then be united in a synthesis program with the certainty that evidence from musical literature can be produced for every synthetic constellation resulting from the composing program.

The second way involves the mobilisation of our own musical understanding in the hope that we shall succeed in eliminating personal characteristics. The composing program is a model for testing a particular rule of whose correctness we are convinced.

For a number of reasons which it would take too long to enumerate here, I principally decided for the second way.

[Sound example: Project 1 – Version 3 (excerpt)  
composed with Project 1]

As we have seen, the *Project 1* program represents a combination of composition rules which the user can only slightly modify with regard to the length of the score and the duration values. The choice of the individual parameter values is governed either by aleatoric randomness (that is random selection without further control within given limits) or by serial randomness (random selection with repetition control within given limits, resulting in complete "series"). Criticism of the limited compositional possibilities of this program led me to ask myself whether the user might not be given greater freedom, on the one hand with regard to the individual parameter values, on the other hand with regard to the combinatorial rules. I shall briefly outline the considerations involved by these questions which finally culminated in the conception of my *Project 2* program.

The first thing I did was to expand the catalogue of parameters. The number of instruments is now free, each instrument being defined according to its range, permitted durations and dynamics. There are three possibilities for the harmony: working with chords, with a series or according to a matrix for checking pairs of intervals. The user also uses his own discretion to determine the registers (octave ranges or other limit intervals), durations and entry delays, as well as the dynamic indications. A special rest program inserts rests in the given rhythmic context; finally there is a parameter for the manner of performance, but which can be used for any other compositional quantity not defined by the other parameters.

Besides the expanded parameter catalogue I also established a hierarchy of parameters; it is defined by the user and makes the parameters dependent on one another. For example, if the instrument parameter is at the head of the hierarchy, pitches can only be inserted for melody instruments in the pitch parameter; and vice versa, if the pitches are distributed first, melody instruments can only be used where a specific pitch was already intended, otherwise percussion instruments are used.

Finally I expanded the methods of element selection. Besides aleatoric and serial selection (as in *Project 1*) there are now four more selection principles for group-repetition of individual elements, for aleatoric distribution according to weighting factors, for the gradual transition from one end of the list of elements to the other (composed ritardandi, accelerandi, crescendi, decrescendi, etc.) and lastly the user can also determine the order himself instead of leaving it to random operations.

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Before showing you a few slides to illustrate the program, I should like to tell you of the further experience with programmed music which I had acquired in the meantime and which was ultimately to be responsible for the conception of the *Project 2* program.

Between 1957 and 1963 I composed as well as electronic pieces two piano pieces, a wind quintet, a string quartet and three orchestral pieces, applying composing methods which could one and all be performed with the aid of computer programs.

[Sound examples: Woodwind Quintet (excerpt)  
String Quartet (excerpt)]

They can be said to have prepared the ground in which the formalism of *Project 2* could be anchored. At one's desk, however, one easily tends to deviate from set rules, no matter how

firmly determined one is to abide by them. One reassures oneself with the thought that the rules could have been different, that it is easier to modify the text under the existing rules instead of correcting the rules and re-writing the composition.

The correctness of this idea cannot be contradicted unless one has a colleague or a machine carry out the rules. Whilst I was working on the instrumental pieces I just referred to – and the same applies to my experiences in the electronic studio – I was struck by the fact that even when given rules are strictly applied musical contexts are produced which are apparently not covered by those rules. This gave me the idea of looking for the reason in the generality of such rules, but also in the powers of resistance of a musical text worked out in all the parameters in the face of defects or deviations, generally speaking in its redundancy. Both assumptions justify in my opinion the attempt to base the working out of a musical text solely on rules with a certain degree of generality in the expectation that our familiarity with the musical language will make us capable of establishing those very relationships between the individual sound events which no score contains anyhow, but which are only revealed by proper analysis.

[Slides of Project 2 procedures (with explanations)  
Sound example: Übung für Klavier (excerpt)  
composed with Project 2]

Although *Project 2* was preceded by a whole series of experiences with programmed music, I don't find it easy to talk about my experiences with the program. After I had finished the first version of the program and it had been tried out a few times (my *Übung für Klavier* and other composers' experiments), I revised the program and expanded it. Shortly afterwards a new computer was installed at the computer centre of Utrecht University, involving a lengthy period of adaptation of the program to a new system. Organisational innovations at the computer centre meant that the turn-around time became considerably longer, and so it has become a protracted and sometimes discouraging business to test input data. I am therefore planning a new and further improved version for our own PDP computer, my aim being to make an interactive program which would be available at all times and also permit a loudspeaker playback of the pitch-time-amplitude field.

Apart from these difficulties, on the basis of my own experiments with this program and talks with those of our students who have used the program, I can summarise my comments as follows:

Composers are in general inadequately prepared to use a composing program. During their composition studies and after them too, composing freely and in contact with performers, conductors and critics, they have become acquainted with elements of musical language empirically, not systematically, and have assembled them into a repertory that can be called upon without any trouble once the total plan of a composition is there and is to be, shall we say, "furnished" with such elements. Decisions about details of the process are made and revoked on the spot. Anticipatory decisions determining the features of a long passage are kept within easily surveyable limits. Inevitably, the memorised elements and the instructions for their use are marked by stylistic considerations so that they can be withdrawn if necessary and replaced by more "modern" ones. It is obvious that a composing program can only contain basic rules which are unaffected by rapidly changing aesthetic trends, not to mention the composer's individual taste. It appears that most composers don't really know what to do with a composing program and are soon discouraged because the program turns out to be



incapable of imitating a composer's personal style, and what the program produces instead does not "appeal" to him. This would not be so bad if experience with programmed music did not have to be gained in the area beyond the individual. For this, the collaboration of as many composers as possible is indispensable.

Those composers who in spite of insufficient preparation are still interested in experimenting with a composing program frequently lack the capacity to think abstractly, at least in the area of musical composition, and they also lack the capacity of self-analysis. A computer program cannot be instructed if there is no clarity as to the recurring conditions under which decisions are made and as to the extent to which a composer is accustomed to making the same decisions under recurring circumstances, or as to what the different decisions are made to depend on. The main thing is not the planning of unpredictable events but far more an analysis of these elements of musical language, which are what comprise one's craft.

Composers who face up to all these difficulties, and by dint of patient application acquire an understanding for the required abstraction, step into a new dimension of musical ideas. I do not have any written proof of how many of them profited from this for their further composition activities. Perhaps one ought even to beware of expecting a direct influence on composing from theoretical knowledge – which is often more observation than knowledge.

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I should like to close by attempting to summarise any possible conclusions of what I have been saying in two questions:

The first one is: Is a composing program like *Project 2* a convenient means of composing new works of music? I tend to answer this question generally in the negative, because the difficulty of writing a more or less satisfactory program is enormous, and the probability that it can be used for lots of different types of compositions is slight; it is wearisome work to get into a program of any complexity, and there are many disillusionments.

My answer specifically is in the affirmative if one is prepared to lower one's sights and be satisfied with, say, the programmed elaboration of formal frameworks which can be a source of inspiration for free elaboration.

The second question is: Can a composing program indicate new ways of investigating musical language?

Here I would say "yes" immediately, although with a few reservations: one must be prepared to invest a lot of time in this investigation, one must have access to computers, one must learn how to program, one must be prepared to reduce one's demands on the musical material to a large extent, to generalise and try out numerous categories for judging the results, and finally one needs cooperation (in the form of colleagues, pupils) whose interest in scientific observation is not stifled by the urge to create new compositions. The fact that computer programs can compose music has been proved by many pieces that have been composed with computers. Only the future can show whether investigation into musical language along the lines I have indicated will produce generally accepted results.

[1975]