

Notes on the Computer in Music

Although the computer has only just begun to be employed in the field of music, the following possibilities for its application have already been recognized: the analysis of musical compositions, the composition of music, the production of musical sounds and scores.

While the printing of music only raises problems of mechanics and of the legible disposition of musical symbols, analysis presupposes a great deal of musical and historical information which is difficult to programme. Nonetheless, preparatory tasks such as numerical operations, the drawing up of lists, and comparisons between quantities that can be represented by numbers, can easily be performed by a computer. Quantitative analysis is more obvious in music than in painting or literature, since its audibly perceptible structure usually consists of distinct elements (pitch, volume, duration, etc.), which are also composed as such, while the phonetic structure of a poem is only meaningful as the bearer of semantic values. In painting it is hardly possible to break down the visible structure into punctiform quanta and to state when a certain number of dots represents an optical unit or even when it acquires a meaning (as a concrete representation). It would of course be possible to limit the investigation to phonetic literature and constructivist painting in order to obtain comparable premises, however the analysis of musical works would be free from such restrictions.

When producing musical sounds with a computer the sole question that arises is, what is a musical sound?

The composition of music with a computer would seem, however, to be impossible since composition goes far beyond mechanical and regulated procedures. Various experiments in this direction have been carried out by mathematicians and computer programmers, and this could give cause for simply putting them on the shelf. But some composers have also written computer-programmes, and it may be assumed that valid reasons prompted them to do so, no less valid, at least, than the motives that induce a composer to write a score. Before we ask ourselves what functions a computer can have in the composition in a piece or in the production of sounds (i.e. in composing sounds), we shall briefly consider the composition of music (as a creative activity) and the computer.

It is self-evident that imagination and experience (*métier*) are essential for composing music. It is, however, less well understood that imagination not only invests new artistic media but also continually discovers fresh combinations of the same objects. For example, tonal harmony knows relatively few combinations of thirds (triads and four-note chords); the chords can be inverted, the notes forming the chords can be closely or widely spaced, and the chords can be transposed (modulation). From the relationships of all imaginable chords to the general tonality (compulsary for the whole piece) or specific tonality (dominating the formal aspect), there finally emerges a harmonic perspective: chords are closely or distantly related to one another. Tonal music arises from these simple premises, at any rate as far as its harmonic content is concerned. Composers of the tonal epoch can be distinguished in regard to harmony by their preference for particular chordal associations and relationships, to mention only two criteria. This affords a point of departure for analysis (and for answering the question, to which author a work should be attributed), and also for synthesis. A composer who analyses a number of his own works from the point of view of recurring chords or chordal associations, would certainly find constants that could be summarized in an individual text-book on harmony. The same naturally applies to melodic shaping, rhythm, instrumentation and other dimensions. It could be said that these constants or characteristics in the work of a composer arise out of recurring decisions in recurring situations. The composer not only requires the habit of continually

reacting in the same manner but constantly manoeuvres himself into similar situations. Within such situations, and against the background of his method of behaviour that has become a habit, the composer's imagination has always sufficient scope to say something different and new, to devise new configurations and contexts, and over a long period of time even to modify his language. This description of the procedure of composition also applies to twelve-note rows, serial and aleatory music, and the electronic production of sound.

It could be asked if, in the case of similar or even identical decisions, the computer does not become the agent of an introverted authority. According to the way in which this condition is assessed, one must wish the composer an intellectual grasp of all conceivable decisions in a given context and deliverance from some of the irksome labour of writing. This grasp, however, is hampered by the above mentioned authority and by obdurate habit, and no composer who still senses an artistic satisfaction in the subtlest deviations feels the task of writing as a burden.

It is unnecessary to add that the foregoing account of the process of composition is a simplification. In the invention of new artistic techniques, mechanisms, also simplified, can be discovered that guide the imagination and thereby establish a sort of authority. But this is not the place to attempt to elucidate the process of artistic creation or how to show how it can be simplified or enriched by the use of computers. Only very few composers may be inclined to schematize their work, but when out of sheer curiosity they try to compose with the aid of a computer, they are forced to do so, in the same way that curiosity drew them into the electronic studio and serial music possessed fascinating aspects for many composers, precisely because of the regulated combination of musical processes with results that cannot always be foreseen. These are two contacts between the composer and the musical material that forcibly led to reflection on the craft of composing and to the formulation of new musical theories.

The theory of tonal harmony could only be written because composers, consciously or unconsciously, always develop ways of behaviour and are guided by these; this also applies to twelve-note technique and the serial system. The only question is, what functions do habitual decisions have in composing and to what extent can these be extrapolated. Every composer must answer this for himself. Nonetheless, traits of regularity in the technique of composition can be discerned and therefore described.

The computer presents two aspects to the composer that can engage his attention. It is known that the computer differentiates only between two symbols (0 and 1) that can be arranged to form larger structures, or so-called words. These two symbols can be converted into their respective opposite, added together, or shunted back and forth within a word. The word can be interpreted in various ways: as numbers, as "commands" (according to a fixed code), as "logical" arrangements that have no numerical meaning. From this it results that every act of composition, calculation, permutation of a given arrangement, and all assessments and dependencies, must be broken down into numerous small separate steps. We find here a certain similarity with the splitting up of sound into its sound parameters and of musical form into its form parameters, and with a splitting up that is used in the electronic studio to build a synthesis of sound from elementary units of construction. The other aspect of the computer that attracts the composer is the speed with which the binary symbols can be transported (in millionths of a second). The high speed in calculation of the computer permits the composer to extend his control over relationships about which he had previously not even dared to think for reasons of time, economy of work, and "bureaucratic" expenditure. It also permits him to select from many conceivable configurations those which come nearest to the aesthetic purpose, or to compare several versions with one another, to choose that which to him appears the best. When the composer begins to channel his musical ideas into the generalized form of a programme (on the

premise that they can be generalized, otherwise he would not have had recourse to the computer), the working of the machine, the splitting up of demands and dependencies into the smallest steps, the extended possibilities and also the restrictions connected with these, all exert an influence on the technique of composition and the aesthetic idea.

There exists a kind of demarcation line between fixed and free "parameters", for only in the rarest cases do the rules of composition extend to the last phrasing mark. It is easy to deceive oneself over the course taken by this boundary when the system of rules is manipulated in a broad-minded fashion (against which few objections can be raised when experience takes control). The computer, however, discloses where the boundary lies. Since it follows instructions more reliably than the cleverest Eulenspiegel, the composer has only to add the non-programmed musical dimensions. In this way the computer can inform the composer as to what effects the rules really have and what scope remains for the missing decisions, which must sometimes be implemented against the existing context. On these grounds a function could be assigned to the computer in the teaching of composition. In cases where in electronic music the mechanical character of the method of production sometimes became audible, it was urged that the missing flexibility be restored through the interference of the composer instead of by attempts at improvement using the volume control or the echo chamber. The unwieldiness which can indeed be inherent in results obtained with a computer could also be countered by refining the technique of composition. It is self-evident that in the "memory" of the computer no composer's brain can be stored, and therefore only data relevant to the particular problem can be processed. From this it will be seen that there is a clear distinction between the intention to compose a piece of music and the preparations and detailed realizations that can be effected by a computer (sometimes only by a computer).

The frequent application of chance operations appears to be characteristic of composition of and by computer-programmes. Since rules only can be programmed (i.e. instructions that adapt themselves to different situations and are always meaningful), it would be assumed that only serial concepts can be devised. But what is a serial concept? It is something that must be thought out and handled with imagination, imbued with spontaneity in observation of manifold possibilities of combination. This spontaneity can only arise through chance decisions, whereby in given contexts elements are arbitrarily taken up and then compared with the requirements of the formal plan.

Chance decisions are easily suspected of coarsening the musical form, if not of sabotaging the composer's control. In fact the musical form has always shown itself capable of parrying coarseness (improvisation, autocratic interpretation, distortion by mechanical reproduction, atonal harmony etc.), and of throwing the coarsened elements into a contrast that is all the more acute. Rules of composition determine not only the individual note but also its environment, not only the chord but also its function, not so much the formal element but rather the formal process that can also be worked out with other elements. The classical doctrine of form analyses patterns of notes rather than auditory impressions, and the circumstance that a text-book on form in temporary music has not yet been written is due not so much to the absence of form-patterns but to the difficulties in reading modern scores – not to mention "musical graphics".

These short observations cannot explain why a composer writes a computer-programme or how he does this, neither can they prove that a computer can compose music. But perhaps they can throw light on some points of departure. Composing with a computer is not a philosophy of life. Many composers have written an electronic piece without ever entering the studio again, but not without having gained experience that fertilized their subsequent work. The programming of problems in composition can also provide stimuli, point out wrong

directions, create order and open up new perspectives. The desire to generalize a problem or simply to break free from familiar patterns causes no alteration in the aesthetic concept, but is a consequence of it. Aesthetic concepts are efforts to render resistant material tractable; as soon as this is overcome, it loses its pertinence for "creative man "; what is already soft soon dissolves into a mash. The history of music records the search for resistances in material, not for comfortable middle ways. Musical matter and its sonorous and linguistic forms appear at present to show in the computer-programme one of their most impenetrable aspects; it is no wonder that more and more composers are attempting to try out with the aid of the musical "programme " their disciplinary systems, their assessment of chance, their mathematical analysis of music, or simply their spirit of adventure.

[1967]