Electronic and Instrumental Music

KARLHEINZ STOCKHAUSEN

Karlheinz Stockhausen (1928– ) is perhaps the most important and influential of the European avant-garde composers who emerged after World War II. He quickly rose to prominence in the early 1950s as a proponent of "total serialism," which sought to organize all the parameters of music according to the rules of serial composition. Stockhausen studied briefly at Pierre Schaeffer's Paris studio, but quickly rejected Schaeffer's concrète approach in favor of electronic music generated from scratch. In 1953, along with Herbert Eimert, Stockhausen founded the Westdeutscher Rundfunk (WDR) studio for electronic music in Cologne, where he produced some of the first purely electronic compositions and important works such as Gesang der Jünglinge (1955–56), Kontakte (1959–60), Telemusik (1966) and Hymnen (1966–67). Concurrent with his early electronic work, he composed Klavierstück XI (1956), among the first and most important examples of "aleatory" composition. In this article—originally delivered as a lecture in 1958 and newly translated by Jerome Kohl in collaboration with Suzanne Stephens and John McGuire—Stockhausen explains the origins and nature of electronic music, and defends its revolutionary features. The essay hearkens back to Edgard Varèse's call for the "liberation of sound" and to Pierre Schaeffer's call for a pure music freed from traditional instruments, sonorities, and modes of listening.

Since 1950—setting out from the study of scores that were written in the first half of this century—everything that makes European music what it is has been called into question: not only musical language (its grammar, its vocabulary) but also the sound material employed until now, the tones themselves. The historical development of instruments was closely tied to a music that is no longer our music. Since the turn of the century the idea of saying something new has existed, but the old sound symbols continued to be used. In this way a contradiction came into being between the physical nature of the heretofore employed instrumental tones on the one hand, and the new musical conceptions of form on the other.

In "harmonic" ("tonal") music the sound material and the mode of construction of the instruments were in intimate agreement with musical form. The harmony between structure of material and form was definitively destroyed by 12-tone music and its broader consequences in the realm of instrumental music. Precisely for this reason the radical 12-tone music of the first half of this century seems "out of tune," because one operated nonfunctionally with traditional sound material. This contradiction has gained for Expressionist music its best results. In 12-tone composition the harmonic and melodic relationships between the fundamental tones have nothing in common with the microacoustic relationships in the interior of instrumental sounds.

What are the consequences?

What constitutes the difference between instrumental tones, between any perceptible sound events whatever—the violin, the piano, the vowel a, the consonant sh, the wind?

In 1952–53, in the Groupe pour Musique Concrète in Paris, I made many analyses of instrumental sounds—especially percussion sounds, which were recorded on tape in the Musée de l'Homme—of speech sounds and noises of all kinds. The sounds and noises were recorded in various spaces (anechoic chamber, normally damped room, echo chamber). Electro-acoustic apparatuses (filters, oscillographs, etc.) served to determine attributes of sound. What in music is ordinarily called a "tone"—without questioning what it actually is—proved to be a mere or less complex vibrating structure that reaches our ear. Acousticians speak of "sound spectra," and describe them by means of a series of factors in a space-time diagram. Sound analysis with electrical filters is comparable to the analysis of light with the aid of prisms. Physicists today are only slightly interested in the investigation of sound. For theoretical studies in this area, the literature of phonetics has been the most prolific for a long time now.

So the musician—for whom the question of research in sound had become acute for the first time—had to rely to a large extent upon his own practical investigations. He had to enlarge his métier and study acoustics in order to get to know his material better. This will become indispensable for all those composers who are not content to accept the sound phenomena as given, but rather wish to resist the dictatorship of the material and extend their own formal conceptions as far as possible into the sounds in order to arrive at a new concordance of material and form: of acoustical microstructure and musical macrostructure.

The existing instrumental sounds are something already preformed, dependent on the construction of the instruments and the manner of playing them: they are "objects." Did today's composers build the piano, the violin or the trumpet? Did they determine how these instruments ought to be played? What does an architect
do when he is to build a cantilever bridge, a skyscraper or an aircraft hangar? Does he still use clay, wood and bricks? New forms require prestressed concrete, glass, aluminium—aluminium, glass, and prestressed concrete make the new forms possible.

So the thought arose of giving up preformed instrumental sounds and composing the sounds themselves for a particular composition: artificially assembling them according to the formal laws of this and no other composition. Composing goes one step further than before. The structure of a given composition and the structure of the material employed in it are derived from a single musical idea: structure of material and structure of the work ought to be one.

In short: it has become technically feasible to realize this aim. Practical analyses and studies led us to the idea: if sound spectra can be analysed, perhaps they can also be synthetically generated. Goeyvaerts wrote me at the time in Paris, that he had made inquiries in Brussels and learned something about generators of sine waves: By all means I ought to set about assembling sound spectra with the aid of such sine generators. In the Paris Club d’Essai, I made the first experiments in the synthetic composition of a sound spectrum with sine oscillators.

In 1953 my work at the Cologne Radio began. Among the sound sources of the Cologne Studio were first of all electronic performance instruments—a melochord and a Trautonium—which served as sound sources in some experiments, but then, soon after the idea of sound-spectrum synthesis was adopted, were no longer used.

Before the particulars of this work are described here, I would like first to refer to some compositions for instruments that came into being at this time. They should act as a reminder that the language of new instrumental music and of electronic music is the same (up to now; however, in the long run it will scarcely be possible to keep electronic music free of vulgarization). When visitors come to the Cologne studio to hear electronic music, they very quickly get over the initial shock caused by the unfamiliar sounds and ask why there is no rhythm (they of course mean regular metres with bars having three or four beats), why no melodies, no repetitions, etc. And so the discussion usually doesn’t deal at all with electronic music as such, but rather with the manner in which it is composed—the language. For this reason we first play tape recordings of works by Anton Webern that, for example, he had already composed in the year 1910. Then we play newer instrumental compositions by Edgar Varèse, John Cage, Pierre Boulez, Henri Pousseur.

In some instrumental compositions that I had written shortly before beginning to compose with electronic sounds, I made the attempt to integrate all the characteristics of the material into one uniform musical organization—with the exception of instrumental timbres. I had to accept these timbres as given, and it was not possible to produce a relationship, let alone a continuum, between a clarinet tone and a piano tone. The only option was to arrange these instrumental colours in a succession of contrasts—analogue to a colour succession like red—yellow—blue—or by mixtures, something like composing timbral intervals or timbral chords. It was impossible to have all of the various timbres issue from a common embryo, so that a clarinet tone and a piano tone could appear as two different exemplars within one “sound family”—a more comprehensive sound continuum: what a utopian scheme, as long as one has to write for a classical orchestra.

III

What technique was employed in the sound synthesis for the first electronic studies?

For some decades already there have been electro-acoustic generators, or oscillators, in acoustical laboratories and in the technical divisions of broadcasting institutions. In the beginning we worked only with sine-tone generators. They are called sine-tone generators because the oscillations produced satisfy the sine function. In comparison with any instrumental tone, which has a certain number and a certain selection of “partials” (also called “overtones”) in addition to the “fundamental tone,” the “sine tone” is a “pure tone” (without “partials”); each “partial” in a “stationary sound spectrum” is such a “sine tone.”

The number of partials in a sound spectrum, the frequency of each partial, the amplitude curve of each partial, the duration of each partial in relation to the other partials in their “onset transient” and “decay”: these characteristics enable the differentiation of one sound spectrum from another. A sine tone in the middle register sounds somewhat like a flute, which, amongst the orchestral instruments, has the lowest number of partials. Such sine tones were therefore the first elements with which we “com-posed”—in the literal sense: put together—various spectra according to the structural demands of a particular composition. Therefore every sound is the product of a compositional act. The composer determines the various properties (also called “parameters”).

Practically, the work with sine tones proceeded as follows (even at present, in Cologne we are still forced to work in this complicated manner due to a lack of more suitable equipment): a sine wave is recorded on tape, a second, third and so on are added. In the process, each sine wave receives its own intensity progression through electrical regulation, and then the intensity progression of the entire wave-complex (the “envelope curve”) is adjusted once again. The sound’s duration is determined by measuring and cutting the tape in centimetre lengths—proceeding from the tape speed, which is 76.2 or 38.1 centimetres per second. In this way, sound after sound is assembled and archived. When all the sounds for a composition have been prepared on tape, the pieces of tape are spliced together according to the score and, if necessary, copied again superimposed by using several synchronized tape recorders. Once the realization of a piece has been completed, the archived sounds and all intermediate results are erased again; there is therefore no sound catalogue which, after completion of a composition, might perhaps be enriched by some hundred or thousand more sounds “for general use.”

It was necessary for the composer of electronic music to have found an adequate form of graphic notation, in order to describe all the details of sound production and assembly.

Obviously, therefore, no instruments—played by some interpreter according to a score—are employed. In electronic music, the interpreter no longer has any function. The composer, in collaboration with some technicians, realizes the entire work. Each working operation can be repeated until the desired precision has been achieved. The first results of the work just described were Eimert’s Glockenspiel.
Goeyvaert’s *Composition No. 5*, Pousseur’s *Seismogramme*, Gredinger’s *Formanten*, and my *Study I* and *Study II*.

This music can only be played back over loudspeakers.

IV

It is clear that a composer of electronic music should not try to imitate timbres of the traditional instrumentarium or familiar sounds and noises. If, exceptionally, a sound of this kind is required, it would be unfunctional to generate it synthetically, it is recorded where it can most easily be found. If a speechlike sound is to be employed, then it is better to record speech rather than to generate it synthetically. In general, one can already recognize a first criterion of quality in an electronic composition in the extent to which it is kept free of all instrumental or other sound associations. Such associations distract the listener’s mind from the autonomy of each sound world presented to him, because he is reminded of bells, organs, birds, or water-taps. Associations are created through our experiences and fade away again; they say nothing about the form of a piece of music or about the meaning of the sounds or noises in a particular composition. Hence we ought to draw the obvious conclusion that electronic music sounds best only as electronic music, which is to say that it includes as far as possible only sounds and sound relationships that are unique and free of associations, and that make us believe that we have never heard them before.

However, it is also clear that the diversity of sounds that can be produced electronically is not unlimited. Electronic music as a genre has—in defiance of all our initial notions of abolishing “genres” in the realm of music and of including all possible sound processes—its own phenomenology of sound, which is conditioned not least by loudspeaker playback.

Let’s take as an example *Artikulation* by Ligeti. When this piece is performed, the audience always laughs at three points: at the first point heartily, at the second somewhat less so and at the third, they roar with laughter. As they were working on the piece in the studio, the composer and his collaborators laughed as well. Also in new instrumental music, unusual sound combinations stimulate laughter—for example, in the works of the American, Cage. Why is this? Certain sound events are associated with the place and circumstances where they ordinarily occur, and the unusual juxtaposition of sounds and noises that have such associations, as ingredients in the same piece of music, seems comical to begin with. The sound of a pea whistle and the sound of a piano—each by itself—doesn’t cause any laughter, but piano tones and pea-whistle tones together in one of Cage’s compositions create a comical effect for the audience.

V

In the existing compositions of electronic music, sounds with harmonic partial-relationships—which by way of comparison can also be described as “vowel sounds”—have been used much less than noises. In Western music, noises have been employed only rarely, and most musicians regard such consonant-like sound events as musically inferior material. Percussion instruments, which produce sound events with only approximate or entirely indeterminate pitch, have been given very little attention until now. For this reason, they have remained at an extremely primitive level in the development of instrument construction. This is accounted for by the one-sided harmonic-melodic development in the realm of fixed fundamental pitches with harmonic partial-tone relationships. For this reason, it can be said that Western music up to this point has been principally a music of vowel sounds, a “music of pitch.” The final stage in this development was 12-tone music.

Schönberg wrote a treatise on harmony that referred only to the relationships of fixed frequencies; in the perspective of his time it was of no consequence to take the “consonantal” sound events into consideration and attend, in inseparable connection with harmony, to the questions of metrics, rhythm and dynamics, much less those of sound colouristics. So he and his school were occupied all their lives with problems of a new composition of pitches, in which new laws of equality of rights were formulated, whereas they carried on being slaves of classical metrics, rhythms, dynamics and colouristics which, in virtue of their hierarchical laws, stand in flagrant contradiction to dodecaphonic harmony and melody. For this reason Schönberg’s allergy to the concept of “atonal music” is understandable. Today one recognizes that this concept is a harbinger of a fundamental alteration of the concept of musical material: namely, that music with “tones” is a special case as soon as sonic events with constant periodic fundamental vibrations and harmonic partials are fitted into the continuum of all “timbres.” In an “atonal” music, then, “tones” simply do not occur, but rather sonic events that are described with the comprehensive term “noises”—therefore aperiodic, “complex” vibrations. For us, vowels and consonants—sounds and noises—are in the first instance nothing but material. Neither the one nor the other of these acoustical phenomena is by nature good or bad. The only crucial thing is what one makes out of them.

Already in the first half of the century the compositions *Ionisation* by Edgar Varèse and *Construction in Metal* by John Cage paved the way for a completely new development, independent of music with tones. The beginnings of *musique concrète* were stimulated by Varèse and Cage, as well.

The category of noises is no less subtly differentiated than the category of sound spectra. On the contrary: in some languages, for example, we find a predominance of unvoiced consonants over vocals. It is natural that in the new musical language the aperiodic phase relationships determine all aspects of the form—in its details as well as on a larger scale; in this way periodicity becomes an extreme case of the aperiodic. Consonantal—hence noise-like—sonic phenomena play an especially important role in this; and their significance will increase still further.

As an example I might mention *Scambi* by Henri Pousseur. In this piece, only noises of more or less determinable pitch-register are employed. We speak of noises with different frequency bandwidths and call them “coloured noises.” For the production of such “coloured noises” we can in each case superimpose sine waves in dense bundles, but generally we choose a more direct method: the initial material is supplied by a so-called noise generator, which produces “white noise” (the concepts of “white” and “coloured” are borrowed from optics). “White noise” can be described as the simultaneity of all audible vibrations: it sounds like the roar of the sea. From this “white noise” we can filter out frequency bands using all sorts of electronic filters—hence “coloured noises” (consonants like sh, f, s, ch etc.)
are such "noise spectra"). The sound continuum between the "pure tone" and "white noise" can—for now—be defined such that the "pure tone" is the narrowest "noise band" or, vice versa, that "white noise" is the densest superimposition of "pure tones."

VI

Where is electronic music produced?

The first studio, as has been said, was founded at the Cologne Radio. This is characteristic. The present-day acoustical communications media at our disposal—and perhaps we are also at theirs—are in the main, radio and gramophone record. Tape, gramophone record and radio have profoundly changed the relationship between music and listener. Most music is heard on loudspeakers.

And what have record and radio producers done up to this point? They have reproduced: reproduced music which in past ages was written for the concert hall and opera house; exactly as if the cinema had been content only with photographing old stage plays. And the radio attempts to give these concert and opera novels such technical perfection that for the listener differentiating between the original and the copy should become ever less possible: the illusion must be complete. This conscious deception has become ever more perfect, just as with modern printing techniques Rembrandt productions are made nowadays which not even an expert can tell from the original any longer. All this is heading toward a society that lives, even culturally, out of cans.

Even though radio had now come to resemble a canning factory, something unforeseen happened: electronic music came into play—a music that proceeded completely functionally out of the specific conditions of broadcasting. It is not recorded with microphones on a stage somewhere in order to be preserved and later reproduced, but rather it comes into existence with the aid of thermionic valves and on tape, and can only be heard over loudspeakers.

Exactly what the birth of a legitimate, functional loudspeaker music means can only be appreciated by those who have once looked through the glass window of a radio- or gramophone-record recording studio where, as in an aquarium, the musicians play literally to the walls for hours on end; with great precision and without spontaneity; without any contact with an audience. And what do they play? Music that was written for quite different purposes, without any thoughts about the radio.

Regardless of how electronic music may presently be judged: its necessity already consists in the sole fact that it shows the way for radiophonic music production. Electronic music no longer employs tape and loudspeaker for reproduction, but rather for production.

The listener at the loudspeaker will sooner or later understand that it makes more sense that music coming from a loudspeaker be music that can be heard only over a loudspeaker and by no other means.

Incidentally, the same problem poses itself today in the case of television. For some time to come we will see television producers employing the new medium unfunctionally, that is to say, wrongly. It will only be used functionally when the camera—which corresponds to the microphone of radio—is used only for topical "live reporting" or not at all, and television-specific electronic-optical compositions are transmitted instead.

VII

Since the founding of the Cologne studio, further studios for electronic music have been set up: at the Milan radio station under the direction of the composer Luciano Berio, who works there together with the composer Bruno Maderna; at Radio Tokyo, where the young Japanese Toshiro Mayuzumi and Makoto Moroi work; at the Philips factory in Eindhoven, where the composers Henk Badings and Edgar Varèse have worked; at the APELAC company in Brussels—which produces electronic equipment—where the composer Henri Pousseur works; at the Warsaw radio station, where the composers Kotonsky, Krenz and Soncier works; at the Southwest German Radio, Baden-Baden, where the composer Pierre Boulez has recently started to work; at the French Radio, whose studio for musique concrète in recent days has ever more frequently been designing itself as a studio for electronic music; at Columbia University, where the composers Vladimir Ussachevsky and Otto Neuning work. More radio stations are currently preparing studios: Radio Stockholm, Radio Helsinki, Radio Copenhagen and the BBC in London.

All of these studios currently work at a very primitive level with equipment that was built for other purposes—for sound analysis or technical measurement—and which are to be found in all electro-acoustic laboratories and broadcasting institutions. This provisional condition is inhibiting, because the imagination of musicians is far in advance of the possibilities for technical realisation, and time and effort do not stand in a reasonable relationship to the result. For purely financial reasons it is still not possible to develop a standardization for studio facilities, even though it is an urgent necessity. In the USA, above all an apparatus has been developed by RCA, the "RCA Mark II Electronic Music Synthesizer," which in my opinion complies very well with the requirements of an electronic music studio. The studio of Columbia University recently obtained the necessary funding and has therefore become the first to have this apparatus at its disposal.

The first experiments with computers (Massachusetts Institute of Technology and the University of Wisconsin, Madison) seem important to me, in that they concentrate composition exclusively on the planning of a work and wish to leave the working out of the realisation, including the automatic production of a structural pattern, to the machines. Perhaps one of the most extreme consequences would be that composers would have to learn to completely change their way of thinking. Whereas heretofore the act of composing in fact consisted in the selection of very specific elements and constellations of elements according to the sonic conception and its presentation in accordance with the material, in the planning for electronic compositional automatons, one would be much less concerned with determining the axioms that define desired results than with determining the axioms of those structures that are not desirable. The electronic automaton is constructed for the purpose of composing pieces from a number of elements and rules for associating all possible combinations defined by the composer; therefore the planning work must eliminate all the undesirable combinations down to a few, or even just one, which are to be employed.
Does the rise of electronic music foreshadow the end of the era of interpreters? Are performing musicians to be condemned in the future to go on playing only old instrumental music for some “collegium musicum” concerts and in tape-recordings for music museums?

It is a fact that in the evolution of instrumental music the performing musician has been subjected to more complexity and more to converting increasingly complicated scores into tones. Musicians became a sort of machine substitute, and finally there is no longer any room for “free decision,” for interpretation in the best sense of the word. It was an entirely natural development that the realisation of sounds was finally transferred to electronic apparatuses and machines. These apparatuses produce the desired results exactly according to technical data, and besides, one does not have to persuade them for hours on end in discussions about the meaning of new music before they will produce a single note.

But it is noteworthy that the same composers who had called electronic music to life, parallel to this work in the years since 1956–57, published compositions which present the performing musician with a completely new responsibility. In contrast to electronic music, in which all sonic events are predetermined down to the smallest details and are fixed by technical criteria, in this new instrumental music the performer is granted fields for free, spontaneous decisions, to which machines are not amenable. Human beings have qualities that can never be replaced by a robot; and robots have possibilities that exceed certain limits of human capability, even though—or, more precisely, because—they were invented by humans; they ought to assist humans to obtain ever more more time for the properly human, for creative responsibilities.

Directed chance has recently grown in significance for such compositions, which are to be played by people in the presence of the listeners. The uniqueness of a performance (unrepeatable like the performer himself, who is never the same); the various degrees of freedom of action, experienced by the composer and described in a composition (which the performer responds to intellectually, instinctively or intellectually-instinctively); the determination of the performance duration of a work and even the choice of the number of musicians who are to take part in a performance: all of these are criteria that depend on the performing musicians and give them a degree of responsibility that they never have previously had.

Examples are the Concert for Piano and Orchestra (1957–58) by John Cage, which made use of “chance operations” in composition for the first time; the Third Piano Sonata (1958) by Pierre Boulez; the work for two pianos, Mobile (1968), by Henri Pousseur; and my Klavierstück XI (1956).

Apropos of this new instrumental music it has often been said that it involves musical improvisation, such as is familiar from the thorough-bass period or from jazz music. In the works just mentioned, however, it is not the case that the instrumentalist invents something to add to some basic scheme or otherwise provided by the composer—like melodies over a figured bass, like variations on a given basic melody, or like melodic inventions within a given basic rhythmic and harmonic scheme in jazz. The composers of the works mentioned have determined all the elements and the rules of connection. But they have formulated their scores in such a way that at certain points in the course of a work there exists not just one valid option for moving on but rather several equally valid paths are often left open, which can be pursued either during composition or, analogously, in the moment of performance as well (the choice of one path may also be further dependent upon what a simultaneously performing musician is doing, as in Pousseur’s piece).

This new kind of instrumental music still must operate with classical instruments. Therefore it momentarily cannot be helped that the initially mentioned contradiction between construction and manner of playing these instruments (as well as the physical structure of their sounds) on the one hand, and the new formal conceptions on the other, now become even more clearly evident than at the time electronic music came into being. This situation is not changed in the least when Cage dismantles classical instruments and has the separate parts blown, knocked, rubbed or bowed. Today it is passed to wish to demonstrate by such methods the “damaging of the world” and “total anarchy.” We don’t need any more scandals. What we need now more than anything else is a continuum instrument. Through the emergence of a new instrumental music, in fact, it has become meaningful to think about new, suitable instruments, and only now are we slowly realizing how these new instruments might be constructed.

If one believes in the idea of a new instrumental music, one must accept the fact that it will have even more difficulty in prevailing than electronic music. The whole question of whether we are capable of finding and animating a new, irreplaceable form of collective listening through listening to the radio will be dependent exclusively on the composers who work on this new instrumental music. In a way similar to spatial electronic music, some of the new instrumental works functionally incorporate into composition the direction and movement of the sounds in space. A radio transmission—even a two-channel one, as is already possible today—can only convey an approximate idea of this “three-dimensional” music, and people must go into the space where the musicians are playing, if they really want to experience this music.

In this way instrumental music could hold its own alongside electronic music. In every realm one has to work functionally; every device ought to be employed productively: generators, tape recorders, loudspeakers ought to be brought forth what no instrumentalist could ever be capable of playing (and microphones should handed over to the news reporters); score, performer and instrument ought to produce what no electronic apparatus could ever bring forth or imitate or repeat.

Composing electronic music means: describing that which sounds in mechanical and electro-acoustical dimensions and thinking only in terms of machines, electrical apparatuses and circuit diagrams; reckoning with single production and unlimited repeatability of the composition.

Writing instrumental music—now once more—means: inducing the performer’s action by means of optical symbols and appealing directly to the living organism of the musician, to his creative, ever-variable capacity for reaction; enabling multifarious production and repeatability from performance to performance.

Then electronic and instrumental music would mutually complement one another, distance themselves ever further and faster from each other—only to awaken the hope of actually meeting occasionally in one work.