

## **Some Observations on the Impact of Technology on Music**

Being a member of the staff at the Institute of Sonology in Utrecht, Holland, means that my position in the world of music and technology is only a modest one. The Institute is preoccupied with how to gain insight into the properties of musical structures and musical creativity by resorting to models and techniques of description. The Institute does not belong to a music department and is consequently not in constant contact with composers and musicians; it does not participate in the musical scene by organizing concerts or other musical manifestations – apart from occasional presentations of electronic pieces produced in the Institute and other studios. The Institute has no facilities for studying market mechanisms or for embarking on investigations of music-sociology. In other words, my assessment of the impact of music and technology on each other depends on a particular point of view obtained from the battlements of an ivory tower.

The ivory tower metaphor alludes to the privileged position of institutes which are able to observe the reciprocal effects of music and modern techniques regardless of commercialism such as electronic and computer studios at universities, radio stations, foundations and schools. The problems that arise in such laboratory situations are not mentioned in the newspapers, at festivals or on the everyday musical scene. This does not mean that they are less substantive, less applied to reality. The possibility that is tested today in the seclusion of the laboratory can be on sale tomorrow on the electronics counter of a department store.

I am supposed to be talking about the impact of technology on music. This compels me to remind us all that music, unlike visual art, does not describe subjects, nor refer to subjects on an abstract level. Technology, then, can neither be its subject nor assume the task of illustrating subjects. Like speech, music occurs in time; its subject is therefore its temporality – the relationship, unambiguous at all times, between "before" and "after." This relationship is not affected by technology; it cannot be produced by technical means because it consists in brain functions. It has no material object to which it can refer outside perception-time – independently of time. On the other hand, however, music requires technical effort, such as a performer's ability to hit the right pitch, to play "in time," and the more universally familiar world of music instruments right up to the microphone and loud-speaker if it is to sound. The impact of technique on music is therefore limited to the production of sounds, and only becomes fruitful for the conception of music (we call it composition) by way of this detour. Things are more complicated than that, though, because musical language cannot develop independently of the organs which utter it. The technical circumstances of sound-production react upon the formulation of musical language – they are preconceived in it, so to speak; the same applies to the social circumstances of producing sound or, in more general terms, of the performance of music. What we call composition technique does not only cover disciplines such as counterpoint or form, but to an equal extent performance technique as well, because the score should not only be grammatically correct, intellectually and emotionally intelligible, but performable on instruments as well and, where several performers are involved, coordinated in time.

This dual nature renders music susceptible – and receptive also – to technical innovations. Developments in instrument-building (one need only think of the modern piano, the Wagner orchestra, exotic percussion instruments) have had a marked influence on musical language, and the instruments themselves have developed as a consequence of the demands of composition technique (for equal temperament, for instance, for purposes of modulation from one key to another). Musical instruments resemble extended human organs in that they are operated by muscular power controlled by the human player – although they are tools really, even machines sometimes. The mechanical character of music is at times also seen in the scores as demonstrated not only by certain constellations of notes resembling technical instructions more than emotional stimuli, but also by classical pieces of which there are synthesizer or computer versions without any appreciable detriment to a correct interpretation of the score. Mechanical musical boxes come to mind as well, not that they have had a particularly striking impact on the history of music, but they do demonstrate musical language's affinity to technical, that is soulless, processes and to the readiness with which composers resort to them. Willingness to introduce technical structures does not result in a break with tradition until the player is replaced by a loud-speaker and the instrument by the electric generator. Both these conditions have to be met; for nobody is upset at hearing a violin concerto through a loud-speaker any more. There had already been a break in composition technique when Schoenberg arranged the tones of the chromatic scale in rows after tonality had fallen apart, and when thirty years later the serial principle was applied to all musical dimensions. Seen in this light, the first phase of electronic music makes the objectified technique of electro-acoustics seem to be in a hurry to catch up with the subjective achievements of composition technique. Of course, electronic music was preceded by pioneers of electric music, such as Cahill, Theremin, Trautwein and Martenot having designed new instruments to build a kind of bridge between instrument and generator.

There is little point in musing on the origins of the techniques that have infiltrated music; techniques are as old as man, who would not be man without them. The course of musical history cannot be said to have been catastrophically curtailed by technical intervention. Worldchanging man appears to be better able to adapt to change than is Nature, which he himself has polluted and destroyed. In our modern collective forms of society, however, we ought to seek not only to protect the environment, but also to guarantee scope to artists and to all those involved in the art which is our intellectual environment. Since I do not represent the long arm of the law, I can only try, as one directly involved in creative processes, to shed a little light on a scene in which art and technology meet – or better, in which art seems to be required not just to reflect technology but to involve it in the strategies of art.

When I came to the electronic studio at Cologne Radio Station in 1954, I was not totally unprepared. Analysis of Bach's music on the one hand and my own compositional experiments with musical material eschewing tonality and dodecaphony on the other hand had provided me with ideas about constructing musical forms which were hard, or even impossible, to carry out with traditional instrumental resources. On hearing the first Cologne experiments on the radio, I thought I would be able to overcome the limitations of human

performers by technical means. I still had no idea of the close connection between the way to "utter" music and the organ of utterance. A score which I had already written, in anticipation of realizing it in the studio, turned out to be useless once I got there; and I made a makeshift version of it into a piece for an instrumental ensemble.

Before I go on, I should like to make two remarks. The first one is about "uttering" music, about the musical text or context. By this I mean the continuous context of acoustic events which retroactively complement and hence explain each other; retroactively, because a person can remember, but not see into the future. Retroactive explanation is aided by looking forward, however, if one is already acquainted with a piece. A performer, too, looks forward when he is playing, and is therefore able to arrange his interpretation in such a way as to optimize reciprocal complementation and to benefit explanation as far as possible. Reciprocal complementation and explanation of successive acoustic events are conveyed by the uttering organ, which must be capable not only of reproducing the sequence of events acoustically but also of uttering them in such a way as to achieve the complementary and explanatory effect. In order to do this, the uttering organ has to know what it is saying, and for this the text to be uttered must be intelligible. You can see what I'm getting at: a musician understands the music he plays, a generator or computer doesn't. We have here a problem of interpretation in a case caused by technology, in which the instances involved in producing musical communication have partly been replaced by machines. My second remark has to do with the close connection between text and speaker. This connection is governed not so much by nature or tradition, as by the sensitivity with which the artist controls the proper expression. If this connection is disturbed, communication can be disrupted, but if such disturbances are intentional, they can themselves be expressive.

Back to the electronic studio, one of the places where one can study the intellectual altercation between music and technique, as well as their perpetual interdependence. The altercation becomes obvious the minute one tries to produce single sound phenomena, and far more so when whole works are to be conceived. Needless to say, nobody is forced to adopt this course; relatively few composers made use of the studio's resources in the fifties, and one can assume that few felt a need for such altercation, which occurred, as I observed in 1955 in an article on studio technique, at the intersection of musical and technical development. The dispersion of the traditional relationships between harmony and melody and consequently of traditional formal construction, was responsible for the search for new forms of musical context, of musical expression. The search started with the sound, which could be divided technically into its components: pitch, spectrum, loudness. Assembling the parts opened up a wide field to musical productive power. To achieve this efficiently, it was necessary and, because of the technical means, also possible to carry out systematic investigation of the host of possible combinations in order to obtain a clear picture and to create order. The new material turned out not to possess any traditional characteristics, nor was it possible conveniently to invest it with them – not that anyone had really expected this to be the case. Attention was focussed on the new methods of sound production, not just on the sounds as such with which one could allegedly do no more than extend the musical palette. The

musician knows that sounds alone do not constitute music, and that sound production alone will not result in music if it does not terminate in the production of form.

Here – at the constitution of the musical context – is where electronic sound production attained its second flowering after first having brought about the variable relationship of the physical data inherent in the sound; both areas (of the sound and of form) could even be related to each other on the basis of the same method: reaching to the virtual absorption of the sound as a limitable category constituting instrumental music in the continuum of fluctuating sound-fields. It quickly transpired that the sound produced in the studio and recorded on tape obeyed esthetic rules different from those governing the instrumental sound; exhaustive measures were necessary in order to combine the two, as in Stockhausen's "Gesang der Jünglinge." What connects sounds is not so much their apposition in time as their acoustic consistence and the common medium of "utterance." Ways of constructing contexts – that is, of producing related sounds and families of sounds, as well as connecting sounds so as to create flowing sequences and superpositions – were investigated just as systematically as the production of individual sounds. Above all, ways had to be found of placing studio technique at the service of constructing contexts; this heralded the automation of the production of musical structures, several years before the development of voltage control, the popular synthesizer. The main incentive was not to save time, even though the first pieces of electronic music took a relatively long time to produce. More important was the esthetic integration: the correspondence of method and sounding result, of means and end.

I have already mentioned the division of the sound into its parts. This provided composers with an opportunity to create relationships in each individual sound, which were to be constitutive for the relationships among the elements of the musical form. Pre-planned, technified production of sound-sequence allows for a denser tissue of individual musical data, a greater wealth of relationships than the twelve-tone composers of the Schoenberg school had envisaged. The resultant problems for the listener were neither undiscerned nor overestimated. In contrast to traditional concert-going, listening to electronic music relies on mechanical reproduction by means of radio or gramophone record. The latter enables pieces to be heard several times and the musical structure to be penetrated gradually. It will not have escaped the observer, however, that the development of information transport since the '50s has not provided the listener with more leisure to cope with this information. One is tempted to say that what technical development gives people with one hand, it takes away with the other. At any rate, it is still hard to say where technology becomes active. A considerable part of musical production and consumption, at least in the field of serious music, has remained unaffected by technical developments apart from the gramophone record which, however, is older than electronic music. Due to network congestion and aether-pirates, radio – in Europe – is as good as useless for broadcasting music. In view of all this, it is hard to describe the effect of technology on the art of music. Composers of electronic music, particularly in the beginning, saw in it not only a new instrument, not only the liberation from the music scene, not only the occasionally necessary contemplation of basic musical experiences in the calm of their studios, but a revolutionary phase too, not just because the nineteenth century had ended or because the world had been devastated by two wars, but because the progress of

electro-acoustics and world-wide communication seemed to provide unheard-of musical effects and prospects.

What remains of electronic music? No musical revolution, no "mediagenic" music, just some background for films, television and traditional instruments played live. After all, it is not technology that affects music, but finally the economy, as the basic condition of all human society. Nowadays there seems to be a far stronger aversion to all technical intervention, a greater pull towards direct human confrontation without mediation, without mechanisms controlling and governing everything.

This brings us to the epitome of anonymous rule: to the computer. For some time it has been playing an ever-increasing part in music, although the roots of computer music go back to the beginnings of electronic music: Hiller composed his *Illiac Suite* in 1957. I personally regarded working with computers as a consequence of electronic music; in the meantime many young composers who are fascinated by the possibilities of the computer look back on electronic music as a kind of technical Stone Age. It is typical how rapidly techniques become obsolete, how few traces they leave in the phases of their development. Computers are used for sound synthesis, but also in order to cope with compositional tasks.

Sound synthesis has led to more spectacular results, and is more accessible to computer scientists, who have not always enjoyed a musical training. The advantages of computer sound synthesis over analog techniques in an electronic studio are obvious: greater precision, absolute reproducibility, no need for equipment prone to breakdowns and obsolescence, and formalization on a scientific-mathematical basis. Although any conceivable sound can be described in computer programs, developments concentrate on isolated techniques. The electronic studio was the godfather; the first computer programs described the processes in studio equipment which could be simulated singly as well as in combination: generators, filters, modulators. Reverberation and the pseudo-movement of sounds in space came later. Calculating such simulated sounds is time-consuming and hard to reconcile with the incomprehensible haste encountered in computer centres. A counter-action was to concentrate on methods which do not imitate existing studio apparatus or musical instruments, but use the computer as what it is: a machine which can admittedly change its state extremely fast, but only by means of a few operations. By forgoing the complicated calculations necessary for imitation, one can produce sounds in real-time, sounds which are radically different, unknown. They are proof of the composer's altercation with his material in a way no different from the situation at the beginning of electronic music, which soon calmed down and retreated from its advanced positions. The solution to the conflict between the lengthy calculation of tens of thousands of figures for a second's worth of sound and the "instant sounds" with no further structuring was found when computer-controlled generators were built. They, too, work in realtime, but make it possible to have an extremely large variety of soundtypes. New mathematical methods have also been found, and still have to be tested. It is clear that the computer has had a crucial impact on sound production, and that it will continue to exert increasing influence.

My own preoccupation with computers in music is more in the area of composing music; a reason for this could be sought in my familiarity with electronic music, in which the

possibilities of intentional and planned combination of sound and form have not yet been equalled by the computer. The idea is to formulate models for separating objective or objectifiable data from subjective or spontaneous data. Objective data are the broad statements which can be made about music in general or about a concrete context; subjective data occupy empty spaces in such a context and are inserted spontaneously depending on the context and its subjective evaluation; they apply, one might say, to the rhetorical character. When such models are produced with a synthesizer, the spontaneous data are fed in during sound production by twiddling knobs; patching makes the synthesizer into a playable instrument. A computer algorithm, requiring a certain amount of calculation time, cannot be affected while the score is being computed; the empty spaces which an algorithm could reserve for spontaneous data might be filled in with random data or chosen later by the composer when transcribing the score or producing a tape. The separation of objective from subjective data is not new; it is familiar to us from improvised music and from the interpretation or staging of mainly fixed pieces of music or music-theatre.

What is new is the constraint imposed by synthesizer or computer technique to divide into fixed and variable terms not only the musical "utterance," which has always required a certain degree of planning, but now the so-called "material" too.

This kind of research with models can show what layers of decision in the composition of music are already formalized to such an extent in the composer's mind that it is possible to describe them as algorithms. In my own work, they are simply the continuation of practical and theoretical investigations which I have been carrying out for about fifteen years in the field of electronic music. The confrontation between music and technique was a natural concomitant; in fact it was necessary to the extent to which transforming a musical conception into performance data (the score) and ultimately into the actual sound, demands step-by-step transformation of an idea into its technical equivalents. Composers are interested in new performance techniques on mechanical instruments, in electronic studios, in electroacoustic ways of amplifying or modifying a sound during performance, and in possibilities of computer-aided composition. The experience that a composer acquires in the technical world of musical performance penetrates his material; material is the sediment of experience, and consequently gives utterance to that experience.

In a radio broadcast I gave in 1963, I described the boundary between the musical text and its interpretation, a boundary which is constantly in need of new formulation. I should like to quote two passages from it to demonstrate that not much has changed in the relationship of music and technical media in the past twenty years. The first passage refers to electronic music:

Anyone who has seen a composer working in an electronic studio will understand its attraction for the composer to work on a piece undisturbed and not pressed by deadlines, putting it together tone for tone. The mechanical playing of tapes becomes a source of certainty: once the composer is satisfied with what he has taped, it is there to stay; its creator need not fear that what went well at rehearsal will go wrong on the night. The composer of an instrumental piece hands over his work to the players; the more he has taken into account the way they are accustomed to play, and the better the players he has

found to play his composition, the greater his peace of mind at the prospect of the performance. Once he leaves the accustomed situation, however, uncertainty grows; his piece, still unfinished since the score does not sound by itself, is made to sound by people who cannot or will not understand it; its completion is wrong. He has to let go of his work and yet is loath to do so.

The second passage was an attempt to make a prognosis:

If we finally take a brief look into the future, we see the automatic studio. In it, as in industrial production, the various working processes will not be performed by hand, but controlled electronically. The data and processes might conceivably be programmed by data processing equipment. As soon as the program is run, the finished work will be heard. I shall not go into the technical and compositional problems here. However, the question of interpretation will obviously be affected. The finished program [...] will be in fact run through in the way many people today imagine – wrongly – an electronic piece is realized or presented. Manual modification of the characteristics of the sounds at the moment of their production is eliminated. Tryouts, experiments would have to take place at an earlier stage, enabling the envisaged sound to emerge at the pressing of a button. Even then, though, the composer will find another way of gaining control of the machine; he will not trade his relationship with his own piece for mere economical arrangement of data, for the role of a musical machine master. Tomorrow will be no different from today: interpretation – the last process of composition, so to speak – will still be entrusted to interpreters or rendered by the composer himself, in any case by a specialist whose expertise and authority will "utter" the musical conception and convey it to the listeners.

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