

PART I

While a student at the "Staatliche Akademische Hochschule für Musik", Berlin, I began, during the year 1930, my first studies in the domain of electronic music. At that time, at the "Rundfunkversuchsstelle" of the Berlin Academy, Dr. Ing. Friedrich Trautwein developed the "Trautonium" on which, already then, synthetic sound production could be demonstrated.

Following the political events of the later years, I had to discontinue my studies in this domain, and, only on the occasion of a concert tour to Europe in 1954-55 could I again renew my contact with electronic music. It became clear to me then to what extent I was behind the developments which had occurred in the meantime, both in composition and in the instrumental technique. I therefore looked for a way to catch up on the developments which I had missed. First, I found full support at the Israel National Commission for UNESCO and further, the admirable support of the UNESCO Authorities in Paris. The fellowship for a research in the domain of electronic music has now made it possible for me, not only to fill the gap in my knowledge, but also to do independent electronic composition work.

PART III

Some Thoughts on the Present Position of Electronic Music

The experiences gathered by me on a UNESCO fellowship, which enabled me to study electronic music in Europe, the United States and Canada, impel me to try to clear up a few phenomena which have been created by this new medium.

First and foremost there are the physico-electrical problems arising from the new instruments. Directly linked to them are some psycho-physiological reactions which have not yet been properly organized and have therefore been relatively little affected by the new principle of musical production. What I mean here is, first of all, the co-operation of the human ear in its capacity as a music transforming-instrument. Moreover, the effect of the loud-speaker system which has gradually become a mediator of entirely new music production, giving rise to sounds which exact a new approach to the acoustic measurements performed by the ear.

On another level there occurs the transformation of musical communication. In our generation the theory of music is based on the following technical terms: atonal, twelve-tone system, and serial music, with the latter extending its persistent systematization of the twelve-tone technics on the four-dimensional continuance of time, pitch, intensity and colour. The gradual disintegration of tonality, as caused by the necessary simplification of the tempered system, has brought about a complete rupture of all relations with a fundamental tone, thus giving rise to vagueness as to phenomena such as "enharmonic equivalents" or "diminished seventh chords". The compromising solution of the tempered system has produced a specific ambiguity in the harmonic system, namely a vagueness in its creative interpretation. Beethoven, for instance, allotted to the diminished seventh chord opening of the Piano Sonata opus 111, a function, entirely different from that allotted by Mendelssohn to any of the diminished seventh chords in his "Lieder ohne Worte". Only the tempered system created the possibility of properly exploiting this

wealth of harmonic interpretation though, actually, through this usage, tonality was dealt a mortal blow.

Thus the anarchical conception "atonal" sprung up. In the vertical domain the outlook was directed towards the future. Every atonal chord in itself, as well as in relation to a neighbouring chord, meant an entirely new domain and constituted some kind of stimulus to continue in a new direction, opening up new sound conceptions. In an empirical way, the composer had to learn the new material gradually. Similarly melodic thinking followed "atonal" ways. Instead of relying on a fundamental tone, the composers now tried to get hold of other basic relations. The électrical accentuation of linear voice-leading, gave rise to new clauses, which had to keep structural elements together and finish up phrases. This explains why there was a lot of talk about "Bach Renaissance"; this appraisal, however, was absolutely superficial.

The musical spirit thus went bravely forth; not, however, without impediments, there were always restraining phenomena. The intonation of intervals not related to a tonic complicated interpretation. The instruments followed the tonal relations within the tempered system. Practical considerations often set limits to a soaring fantasy. As early as in the critical days of the breakthrough of tonality, it was Ferruccio Busoni who wrote: "As a matter of fact, even if most of our composers do not transgress the given possibilities, it can not be denied that 1) the imperfection of orchestral instruments in particular, and of composition of an orchestra in general, have a restraining influence on imagination and on creative power, 2) there may still exist now, and will probably exist in future, musical minds that will strive to go far beyond the present limitations set. (It is more than a mere anticipation that they will, one day, transgress the boundaries of form, harmony, and even of the entire tonal system)".¹⁾ In his time, Busoni knew all about the construction of a musical instrument whose sounds were electrically produced. The name of this instrument was the "Dynamaphone" and it was built in America by its inventor, Dr. Thaddeus Cahill. Particulars about it were published in a magazine (July, 1906) where it was described as "an extraordinary electrical invention for producing scientifically perfect music."²⁾

Time was ripe for the electronic music instrument.

Technical developments led up to the construction of electronic instruments as we know them today. Unfortunately, the term "electronic music" is not very adequate. We talk about "electronic" music as if piano or organ music were "mechanical" music. Because of this term the impression is created that electronic music is composed in some automatic way, that is to say, though emanating from the composer, little determined by him in its eventual course. (It is true, of course, that electronic instruments make possible a rather far-reaching, pre-calculated realization of sound relations.)

Amidst this disintegration of all conceptions, musical theory kept striving for new systematization. Atonality, merely as an antithesis of tonality could no longer give satisfaction. The finding of a positive approach was absolutely necessary, but this new approach had to avoid any fundamental-tone authority since the fundamental tone-principle led into a blind alley, not only in the domain of harmony, but also with regard to the form-giving elements. Arnold Schoenberg found a solution of this problem in the twelve-tone system. It was no longer a single tone, but the entire row, which determined the assumed rule of relationship. This idea was latent in tonal music even before. Herman Scherchen proves in his book, "The Nature of Music", the existence of the twelve-tone row in Beethoven's Ninth Symphony, ("Ihr Stuerzt Nieder Millionen"). Latently, the function of the twelve-tone system exists whenever the structure of a valid motive forms the tone-row skeleton which determines the rise of an extensive work (like Beethoven's Fifth Symphony) from the first tone up to the last. In the same sense, the modal motives of eastern music could be considered as constituting given tone rows for musical evolution. In western music, however, Schoenberg's twelve-tone system no longer permits any interference with tonality and exacts the row in rhythmic neutrality; only the sequence of intervals originates from intuition. Additionally, a quick thinking process makes itself felt comparable, for instance, to Bach's fugue themes which were ingeniously preconceived with the manipulations of counterpoint techniques in mind. The twelve-tone principle, within the tempered system, and its newly won systematization, are the result of a process which has been going on for many years.

Schoenberg finally gave this process a decisive turn: The tonic link was replaced by a link to the row sequence. Only in this way could the homogeneity of the composition be maintained. Via

Bach-Beethoven-Schoenberg, the composition reached new heights. Not only among musicians, but also in other quarters, thinking was now ripe for this systematization. A century of quick scientific progress had already educated several generations to an exact understanding of musical phenomena. It was now possible to differentiate all kinds of "Abstracta" and new contents could be revealed. In spite of these changes, however, Schoenberg's twelve-tone music seemed unintelligible to the public at large since they still had difficulty grasping Bach's "mathematical abstractions". On the other hand the young, technically minded generation of creative musicians played with these new rational tone combinations and, led by the Master's method, actually gained independence. A few years after Schoenberg's death it was Henri Pousseur³⁾ who wrote the following:

"Because of its being a historical transition, Schoenberg's music is, one might say, the paragon of a semantically ambiguous, vague and partly contradictory structure. Whether or not he wished it Schoenberg constantly appeals to the traditional organising power. He constantly looks back to formulations which he had actually tried to abolish and again and again relationships intervene between the listening ear and the originally intended structures." This criticism originates from the approach to music prevailing in our day. Before I go back to the few sentences I have quoted from Pousseur, however, I should like to formulate a few principles with regard to electronic music.

We must clarify to ourselves to what extent exist (a) an influence of the electrically, synthetically produced sound on musical imagination; (the new sounds require, of course, proper evaluation) and (b) an adaptation of the given electronic instruments to a musical theory. I wish to add that (b) is far more prevalent than (a). This fact is due to our way of thinking today. Electronic instruments create the possibility to determine very exactly the physical characteristics of sound. The strong endeavour to overcome individual ~~sensation~~ by means of logical conceptions, in the domain of music, finds its realization here. One now speaks about "pure" electronic music, based on the sequence of serial music. "Pure" points, in any case, to a preferential use of the sinus tone. The exclusion of overtone mixtures is to protect from "impure" sentimental colouring. Practically, there exists, of course, no such thing as "pure" tones, since neither an instrument nor the human ear is able to react "purely". It is, therefore, a problematic aesthetic conception. On the other hand, ^{for} the

logistical development of the series, the sinus tone is the most rational sound material. In addition to the pitch, the intensity is maintained and the time is most strictly taken into account. All this can be effected consistently only through electronic instruments which are the ideal executors of serial techniques.

Now let us examine the errors that have brought us to a situation where ideas can no longer develop freely. If the serial tone is entirely deprived of its individual character, and so evades voluntary discipline, the result is the pseudo-mathematical programme, a counterpiece to the romantic programme music. Our culture is so saturated with the scientific approach, that the non-scientist, whatever his inclination may be, must of necessity become a "pseudo-scientist" in order that he may be able to voice his point of view. The fashionable language of music theory today is symptomatic of this pseudo-scientific approach. Genuine mathematical thinking is expressed by Newton in his term for variable quantities, "Fluents"; the idea of mathematical thinking, however, loses genuineness, if it is restricted to "function" and "derivation".⁴⁾ It is quite natural that mathematical thinking becomes, in the music of the 20th century, different from what it was in Bach's day. This difference, however, can also be viewed as a difference of quantity. Let us consider the developments of our day not from the point of view of theory of music but from the cultural-political stand point; here we see a realization of Aldous Huxley's "Brave New World". It is an irony of fate that the democratic countries were the first ones to follow this trend.

Healthy instincts, however, also claim their rights. Improvisation has found its way into serial music. Music is now composed in which the player, or players, find a possibility for active co-operation in production itself. In these parts of composition, dedicated to active co-operation, the strict functions of serial music are hardly respected anymore. On the contrary - the springing up of new constellation are left to chance similar to the ^{musical}/dice-throwing of the 18th century. Ars combinatoria can be viewed here as against creative improvisation. But improvisation is based on a complete mastering of the craft, and on strict discipline in the elaboration of ideas. The correction of errors, which can be effected only after additional examination, is, of course, impossible in improvisation. In any case, it is worthwhile noting that today the tendency is to increase improvisation. It is probably felt that it would be desirable for the composer to make those personal decisions which in the past have been greatly hampered by strict rules of ~~harmony~~ theory.

Here I should like to go back to the criticism which I quoted above with regard to Schoenberg's music. Henry Pousseur's remarks are correct only if we take them superficially. If a man of Arnold Schoenberg's stature builds, in his best creative period, all those "ambiguous, unsure, partly contradictory" structures, surely there must be a good reason. Schoenberg's "lack of assurance" seems rather to me to be the result of a heightened responsibility. He was, first and foremost, a composer and only after he had done his composing work did he view it theoretically. Generally speaking this is an organic process, since the threads of creation in art are woven from the past via the present and into the future. In the past, in the time of tonal thinking, melody and harmony formed a unity insofar as melody reflected harmony projected into space; the common element was the scale. In the composition of rows, in our day, horizontal and vertical elaboration is linked in the same way. Schoenberg spoke about a "Magic Square"⁵⁾ with regard to time and space. This square supplied, of course, tectonic elements, just as the cadence tonic-dominant-tonic represents the song-form a-b-a. Through the co-ordination of space and time form results. It is then quite natural that twelve-tone forms and tonal forms have in common the constantly modified results of co-ordinated thinking processes. Such form planning must be variable and capable of several meanings; stiffness would show a lack of creativity. The "ambiguity" in Schoenberg's music is the very quality which characterizes it as creative art. It is not a coincidence that double and multiple meanings evolved in the composer's mature music. Actually a certain rigidity was conceivable only in the opening stage of systematization of the twelve tempered half-tones, at a time when the aim was to find a strict formulation. In the struggle to abandon tonality strict formulation was necessary. The same fact can be found today in the strict theoretical formulations of serial music. Careful formulation generally guards the new; the dogmatic is enlisted to preserve the "pure". No experimentation can substitute for a variety of expression. I think I recall Rufer having quoted Schoenberg as saying: "It is regrettable that so many contemporary composers are concerned to a great extent with style and neglect ideas."

All these things were on my mind before I started on the second part of my study tour, to the United States. I therefore carefully separated the instrumental, technical problems from all considerations of musical theory. Later on, in practical composition, both problems will eventually be interwoven.

As to the instruments: I divided my task into two separate areas, (a) creation of the single sound and (b) elaboration of the sound. The single sound, as a sinus tone, can only now and then be used with a particular purpose; but I should like to draw special attention to the careful formation of sound in its three phases - transient, steady, decay (plus the composition of the overtones). The reason is that from the very first tone the springing up of co-ordination between time and space may be expected, a co-ordination heralding the first form-elements. Experience will teach us to what extent strict discipline is capable of establishing music, so far unknown, and thus contributing to the enrichment of our musical language. So far no electronic instrument exists which would satisfactorily solve the problem of recording the transient process which occurs when a sound is formed. It is not only with a view to imitating the existing instrumental colours that a transient process should be mastered - though nothing can be said, in principle, against occasionally emulating known types of colour - it is in order to allow the peculiarity of the composer's work to come through that this is desirable. What we superficially describe as tone colour should no longer be the outer ornament but rather the basic material with which to build. The sound should arise from the hardly discernible primary position of the tone. The sound itself should be meaningful; to make it so is one of the most important tasks of the engineer of the electronic instrument.

With regard to the elaboration of the sound and its possible alteration and development, I am fortunately able to say that I came to know the highly developed instruments constructed by Chief Engineer Dr. Hugh Le Caine and his assistant, Mr. John Bowsher, in the Microwave Section of the National Research Council in Ottawa, Canada. It was there that, for the first time, I found an approach, born of the spirit of the new music, to all these complex problems. Mr. Le Caine's enlightened work has proved to me how important it is for the inventor of such instruments to know a lot about electronic music. Mr. Le Caine's work is not only a technical draft, a plan to which the composer will be forced to fit a new theory, but it is an ensemble of technical procedures, the merging of which have an extraordinary effect on the composer's imagination. Both Dr. Le Caine and Mr. Bowsher impressed me with the enthusiasm and great knowledge with which they carried out their research, and their positive attitude seems to justify my optimism concerning the future of electronic music. Should there be a composer one day who would fully grasp the possibilities of this instrument and would make full use of it for expressing his own ideas, thus stimulating further research, then we could hope that the

art of creation would again arise from sources of genuine inspiration, clearly organized and formed and free from the "pathology" of theoretical distortions.

Of no lesser importance than the sound-producing and the sound-elaborating instrument is the sound-reproducing instrument. It seems to me that with this instrument new factors appear in the forefront of electronic composing work, factors which will replace recognized values of interpretation. Some of these factors have been indicated for a long time. Thus, for instance, the appeal made by a composer to a small or a large audience; real chamber music, in the full sense of the word, or a "symphony for the thousands" meant for a large audience is obliterated by the modern loudspeaker installations which have long since changed the original conception of this music. From the acoustic point of view there exist no more limits for the size of a concert hall, be it for a solo instrument or for a large orchestra with a chorus. The planning of a composition, either chamber music or orchestral music, may appeal to the public in different ways: either to the individual listener or to a large group of listeners whose experience is enriched by the joint experience of the individuals of which it is comprised. One can listen, too, to a symphony composed for a large audience, ^F in a small room, in this case the fantasy of the listener brings forth the image of the concert hall. Then in the same room, however, one listen to a symphony composed for a large orchestra and recorded in the studio; then it can be said that a work intended for a large mass of listeners addresses itself to one individual; thus the original conditions become distorted. There is no doubt that electronic music can properly differentiate between the two mediums, and by the conception of the work, as well as by its proper reproduction, can restore the original concept of chamber and orchestra music.

In San Francisco I listened to music performed by means of the Vortex reproduction instruments. Jordan Belson and Henry Jacobs are the founders of this system. The following is quoted from Vortex programme 4: "Vortex is a new form of theater based on the combination of electronics, optics and architecture. Its purpose is to reach an audience as a pure theater appealing directly to the senses. The elements of Vortex are sound, light, colour, and movement in their most comprehensive theatrical expression. These audio-visual combinations are presented in a circular domed theater equipped with special projectors and sound systems..."

F broadcast from a public concert

"With the thirty eight high-fidelity speakers, actual movement and gyration of sound was made possible by means of a special rotary console". In this particular case it is then a matter of a combined audio-visual presentation whose artistic purposes I would not like to discuss here. I would like to mention, however, a technical device of great interest, the "rotary console" which is linked with a loudspeaker, by means of a rotary switch, provided with a rotating handle, and lets the sound emanate at any desirable rate of speed, or, by means of a keyboard, makes possible counterpointal exchange from different directions. The reproduction of a work conceived for acoustic projection into a hall is greatly influenced by the Vortex installation. It is quite possible that this will eventually become a starting point for a reproduction instrument whose specific characteristics the composer will take into account.

Under this same heading we must mention also the construction of a new electronic instrument designed by Professor Melvin Clark, Jr. of the Massachusetts Institute of Technology, Boston. Here we deal with an instrument for playing music (contrary to the electronic instruments for ~~composing~~ music). With this ~~music~~ instrument, the music lover has the chance to familiarize himself with electronic sound production. Out of a very stimulating and enlightening talk with Professor Clark it became clear to me that here an instrument was developing which would give a direction to future pedagogical thoughts. Furthermore, this instrument can be mastered not only by the privileged Priests of Music, but through it every music lover may participate in creative production. The work of Professor Clark seems to me, therefore, to be one of the same historical importance as the work of Dr. Le Caine; each one a vital nerve of the new musical system.

And with regard to music notation: concurrently with the writing of this report, I am also occupied with a music notation draft on which I have been working recently. Therefore, because of lack of experience, I can hardly say anything definite about the subject at this stage. I should mention, however, a few cardinal points about the matter: After the composer has solidly grasped the idea of the new sound, by way of assiduous systematic experimentation with electronic music instruments, he will, of course, write down his score just as before; he will have to think about it critically, give it the last polish and then execute it on electronic instruments. Since it is not a matter of playing, the mode of notation does not necessarily have to afford an easy general view on the whole score. Pitch, time and intensity must be coordinated into a single system which itself must be adapted to a second system, showing the transient process

as well as overtones. Practice will show whether both systems can be graphically coordinated one to the other or whether they should be kept apart. The pitch should be marked by a black point which will thus symbolize the exact actuality of the sound while the continuity should be marked by a line until a new distinct sound is reached. The five line system will be abolished and a calibrated millimeter paper will be used in order to afford writing space to the finest subtleties of sound.

For reproduction, it may become necessary to use an easily surveyable script as, for instance, when instruments suited to the above mentioned Vortex process are used or also for singers or for choruses at the performance of plays. In that case, it is necessary, first of all, to rewrite the part record^{ed} on tape, in its essence, similar to the procedure in traditional music (but new symbols must be introduced) just as in a piano edition the voice part will be printed above the orchestra part). For practice and rehearsal the singer will be supplied with the tape on which the electronic part is recorded. He will then be able to follow it up by means of a resumé of the music.

And now let me add a few words concerning a draft of the Electronic Music Copyright Law. In Jerusalem some time ago, in the presence of Government experts in matters of copyright, I stated some of my opinions on this subject; they are, briefly, as follows: The composer must master the technics of electronic music and know how to use the instruments involved so that he may be able to carry out fully the entire process of composition, dispensing with the engineer's help. The latter may be necessary for scientific research, for further development of the instruments and for their maintenance...in particular instances he may give technical assistance to the composer, but he should never help or advise in the creation of the composed score itself. It would then be altogether illogical to let the engineer participate in the copyright for the composition. It may still happen today that the engineers actually take an active part in composing work, since either the engineer and the composer are one and the same, or the composer is dependent on the engineer because of his ignorance of the technical aspects. In such cases, the engineer and composer should reach a "gentlemen's agreement". The present situation will, in my view, last only for a short transition period. In any case, the law must take into account the lack of definiteness in the present conditions or else, it could happen that my piano tuner would be given a part in my copyright, if I should compose a piano sonata!

To sum up: the mostly sensual perception of music, as well as the material over-valuation of sound, find their expression in the electronic music of our day. The former in the surrealisms of the "musique concrète" and the latter in the "pure" electronic music. I am far from underrating devoted composing work in both styles and I have full respect for pioneering achievements; however, we must see to it that we are constantly alert to the many possibilities of future developments. Let us think over what Paul Klee said one day to his students: "the trend of abstraction has produced something which has nothing whatever to do with reality. In the realm of association, there appear stimuli awakening the fantastic and thus forming vivid pictures in the mind. This world of semblance is nevertheless something real. It exists in the domain of the human."⁶⁾

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PART IV

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MEMORANDUM ON ELECTRONIC MUSIC

By

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There are today in Europe two main schools of electronic music; the French "music concrete" and the German so to say "pure electronic music". There are, of course, other ways of expression in this medium. I, myself, belong neither to the French nor to the German school. Let me explain briefly how I came to electronic music as a composer.

A creative artist always has to strive to keep his production within a triad formed by the past, the present, and the future. This is a unity within which the blood-stream of composition circulates. What does this triad mean in practice? The past is education based on tradition. The present is the actual environment, society and education based on experience. The future is the drive by nature for rejuvenation mentally and physically as far as you can distinguish between them. The balance of this triad is disturbed in our time because of a one-sided tremendous progress in technology. We are accustomed to using in the course of our daily lives numerous complicated technological devices. Education and what we call culture lags far behind. As a result the gulf between technical progress and cultural appreciation is becoming wider and wider.

I wish to look at the effect of this situation on the creative expression we call modern music. Since we are dealing with abstract sounds, there has always been a tendency to master the musical language with the help of a strong structural approach. The individual emotional drive which has a primary influence on all particulars of the composition served as a counterbalance to the structural approach. This very familiar picture of the music of past centuries has changed into a more or less unbalanced situation. Science, or we may better say technology, found its counterpart in music. It started with the twelve tone row system which came as a savior in a time of complete degeneration of the major-minor scale system. But the genius, Arnold Schoenberg, invented a row by intuition. Most of our "technicians" in music, however, construct rows with the help of learned information rather than intuition. This process is very similar to the function of a computer machine. No wonder that the two European schools in electronic music approach musical composition by purely constructive designs of sound patterns: the "concrete" through sound-improvisations modulated by means of electronic instruments; the "pure" by logarithmical development of a given frequency avoiding on purpose any subjective, emotional expression. Although these two schools approach

electronic composition from different directions, their works have one thing in common. This is the absence of any personal prior decision in the artist's statement. The "concrete" rely on the result of improvisation by chance; the "pure" on the result of arithmetical formula. In addition, the non-electronic music composers rely on the given rules of twelve tone row combinations. Therefore, these artists are compelled to break tradition systematically in search of originality. This very often leads to a kind of eccentric vandalism. The texture of the music becomes extremely difficult on purpose. In the future only a few virtuosos will be able to perform these works.

The difficulty in texture may also have another, positive, reason. Gradually, our musical consciousness has developed in its ability to recognize most complex and sensitive patterns of sounds. Our traditional orchestra is still the best instrument to realize the intention of a contemporary composer. But there are already sure signs that the mechanical quality of instruments as well as the limitation by nature of a performer will eventually lead to the development of a new medium through which the modern composer can more effectively express his ideas. Here is where electronic sound production comes in. We may expect, in time, a new Stradivarius who will certainly be an electrical engineer cooperating with his musical advisor. The balance of the triad will then be regenerated. Nothing genuine will be considered old-fashioned. Based on tradition, the composer will express the society of his days and will lead the way to new movements undisturbed by the varieties of dadaism. This idea must guide the building of our electronic sound production instrument. The instrument must be able to realize the imagination of the composer in sound-color, sound-time, and sound-volume. It should be a professional instrument which responds easily to the artists' creative mind. It should have as its counterpart a simplified electronic play-instrument for the amateur, to educate the public in the new communicative idioms of the future musical language. One will be the composer's instrument and the other the amateur's instrument.

The UNESCO Fellowship I have been granted has made it possible for me to discuss the wide complex of technical and aesthetic problems involved in the construction of such instruments with engineers and musicians in Europe, the United States and Canada. I have reached the point where the realization of this project has become possible in practice.