

SPACE IN ELECTRONIC MUSIC

by

KURT BLAUKOPF

INTRODUCTION

THIS paper, prepared upon Unesco's invitation, is a preliminary survey of contemporary attempts at « restoring the spatial dimension of musical sound » (1); it discusses their aesthetic implications and their relevance to experimental art in general. In 1959, Michel Philippot suggested that the spatial projection of sound will eventually provide the real picture of musical efficacy (« la projection spatiale des sons sera l'image réelle de la virtualité musicale ») and, in 1967, Gisèle Brelet insisted on the aesthetic significance of the « imaginary space » created by electro-acoustic means and capable of liberating the composer from the stringency of real space. The material presented here suggests that this argument also has a bearing on arts other than music, especially in relation to their development under the impact of the technical (audio-visual) media.

1. Space and distance in live music and recorded music

The traditional sound ideal, as determined by live performances in concert halls and opera houses, involves a rigid separation of performer and listener. The person who receives the aesthetic message finds himself opposite the performer : the sound source is spatially separated from the listener, who is exposed to the sound that reaches him from the rostrum, the stage or the orchestral pit.

This relationship emerged during the classical and romantic periods in western music. Sociologically it is linked with the building of permanent opera houses and concert halls and with the establishment of the « musical

(1) Gisèle BRELET, « Musicalization of space in contemporary music » (see bibliography).

performance » as a commodity which could be acquired by those who paid the price of admission.

Most of the classical and romantic composers accepted contemporary architectural acoustics. Earlier distinctions for theatrical, chamber music and church purposes — the stylistic implications of performance in buildings of different sizes, varying in length and reverberation frequency response — strictly observed by such composers as Purcell or J.S. Bach, seem to have lost their significance during the nineteenth century, although there were notable exceptions (e.g. theories and scores of Berlioz, construction of the Bayreuth Festspielhaus, which Wagner conceived in a manner that would acoustically suit the Ring of the Nibelungen).

In musical theory, accordingly, the score was the result of a creative act, while the actual production of sound was considered an « interpretation » of the « work ». Traditional notation was concerned with three « dimensions » only : pitch, intensity and duration ; other dimensions (« parameters ») such as timbre and localization (= the listener) were not integral to the theory, but purely aesthetic factors, manipulated subjectively by the composer rather than in accordance with hard and fast rules. Arnold Schoenberg, in his « Harmonielehre » (1911), remarked that no such rules could yet be established for what he called « timbre melody » (« Klangfarbenmelodie »); similarly, the various sound sources which Gustav Mahler introduced in his scores (« Fernorchester » and solo instruments to be played « from afar »).

Electro-acoustic recording, and especially the stereophonic recording of music intended for the opera house and concert hall, has heightened the general awareness of architectural acoustics. Early attempts at recreating the « natural sound » of live performances soon gave way to the conviction that, technically and aesthetically, the recording must effect a transformation, paying special attention to balance and to the localization of sound sources.

Entirely new methods were accordingly developed for dealing with these acoustics problems in recordings, and they go far beyond what « live music » can offer. The placing of microphones, artificial reverberation, the audio mixer, amplification procedures within specific frequency ranges, and many other technical devices allow kinds and degrees of definition, transparency and balance that are unknown in live music.

The development of new sound structures has been hastened by the generalization of such methods in commercial recording. Entirely new types of instrumental and vocal balance have become familiar to a very large public ; the dialogue, for instance, between a guitar and a trumpet would not have been possible at the same volume in live music, but is now common in recorded sound.

Hence also a major change in the listener, increasingly hearing sound that has no counterpart in « live » experience.

This is a new phenomenon : the listener does not expect an imitation of a concert hall or opera performance ; he is not involved in a musical performance taking place within well-defined architectural surroundings. The « sound perspective » of a concert hall or opera house is replaced by a new experience, that of an artificial « architecture of sound ». Recording technique goes beyond traditional three-dimensional architectural acoustics and establishes its own frame of spatial reference, which can be manipulated by the recording crew and can be continuously modified or suddenly changed at will.

The possibilities of electronic music, especially with regard to space manipulation (which, besides reverberation, includes the manipulation of intensity, timbre, balance and so on) should be seen against this general background. Even outside electronic music proper, a new way of perceiving the « architecture of sound » — the distance of sound sources from the listener and the topography of sound sources (« balance ») — has become prevalent.

This new « collective perception of distances » (cf. in another, but relevant context, the French sociologist Georges Gurvitch) prepares the ground for various experiments in electronic music, which people accept partly at least, because of this new and apparently unprecedented manner of perception. However, a thorough examination of this perception has not yet been undertaken ; some data from psycho-acoustic research may allow new insights.

2. Electro-acoustic manipulation of space in music and theatre

Electronic music must establish an entirely new frame for « spatial reference ». Although, for some electronic music, the conventional frame of reference is possible, it seems necessary to create a new kind of topographic relationship between the various « sound sources », in order to help the listener to find his way.

The most obvious method seems to consist in the systematic placing of the loudspeakers through which the electronic music reproduction reaches the listener — methods advocated by Stockhausen and others. In his book on electronic music, Werner Kaegi suggests three principles :

(a) one-dimensional reproduction with two loudspeakers in front of the listener (two channels) ;

(b) two-dimensional reproduction with three loudspeakers (channels) around the listener ;

(c) three-dimensional reproduction with six loudspeakers (channels) surrounding the listener on all sides, including from below and above.

Three-dimensional reproduction puts an end to the « peepshow », (« Guckkastenbühne » in German), experimental music here converging with attempts to create a new type of theatre, a new type of relationship between the public and the stage.

Attempts at liberating the theatre from the rigid conventional relationship between the public and the stage obviously demand a new approach to theatre acoustics, a point to which the advocates of theatrical reforms did not at first pay much attention. Now, however, experts are becoming increasingly aware of these implications.

The new technical approach is that each production needs its own « frame of spatial reference »; hence the attempts at transforming the traditional theatrical architecture which forces the attention of spectators towards a single « vanishing point ».

A common feature in many of the reforms recently proposed is freeing the stage of visual elements that give the spectator a pictorial perspective, orientated towards a vanishing point. Peter Brook's book on the modern theatre (« *The Empty Space* ») suggests that every empty space can be considered « a naked stage ». This follows Gordon Craig who, in a note in the catalogue of the International Theatre Exhibition in Amsterdam in 1922, said that « the theatre should be an empty space » and that, for each theatrical production, a new kind of stage and a new kind of temporary auditorium should be created.

This variable relationship makes demands upon the architect. Roger Planchon complained in 1959 that what the architects provide for the producer is rigid (« *un outil fixe* »), whereas theatrical art needs transformable buildings (« *susceptible de transformation* »).

The challenge has been taken up by several architects. Frank Lloyd Wright, writing on the Kalita Humphrey Theater project in Dallas, stressed the need to liberate the stage from the shackles of tradition and permit more effective and intimate dramatic presentation.

However, some very prominent artists and playwrights have stated their objections (e.g. Eugène Ionesco) to architects : « You pay attention to the buildings ; I think first of the text » ; Max Frisch does not want to see the peepshow-stage disappear : « The poet needs the separation between the play and the world. »

The demand for transformable buildings can more easily be met by electro-acoustic arrangements. Multivariable space created by electronic control can be put at the disposal of the modern theatre. Fritz Winckel mentions various techniques which have a bearing on the subject of this paper.

First, the artificial extension of the audio panorama by a juxtaposition of sound elements with different reverberation characteristics.

Second, the creation of « imaginary space » and of « space within space ».

Third, changing the timbre of vocal and instrumental sound and of noise ; the decrease or increase of speech understandibility ; the artificial detachment of the sound from its source, i.e. separation of the sound from the singer, actor or instrument.

Fourth, using elements of a public address system as part of the stage representation. Winckel mentions a passage in R. Haubenstock-Ramati's opera « Amerika », where a confused din of voices made audible within the auditorium is used to create suspense among the public.

Electronic control applied to theatre acoustics is to a large extent capable of creating the impression of variable space.

It can also help to destroy the dimensional impression inherent in the existing architectural characteristics.

It provides a freedom from the traditional spatial rigidity which is deplored by many theatre artists.

3. Architectural implications

The corollary to changing the spatial frame of reference is to construct halls that will meet the demands of « electronic and instrumental space music », enumerated by Stockhausen in a lecture (« Music and Space »). These include equipment for electronically-controlled reverberation.

On several occasions the « activation » of the listener in some special manner has been advocated, e.g. that he should be invited to move about (either freely or in accordance with instructions supplied by the composer) in order to be exposed to sound emanating from various loudspeaker systems. Eric Satie's « Musique d'ameublement » represents a pre-electronic anticipation of this procedure.

4. Factors determining spatial impression

Reverberation and the creation of artificial space have so far been considered only in connexion with sound reproduction. The question now arises, can the composer of electronic music using them rely on more or less firmly established rules ?

It is of paramount importance to assess the possibilities of gradating spatial impression ; if the composer wants to define acoustic space, he must know how this parameter can be handled.

The ability to perceive various sizes of acoustic space is being investigated by psycho-acoustic research. Tests are made in « acoustically dry » rooms, i.e. rooms with practically no sound reflection and hence practically no reverberation. By reproducing sounds carrying various amounts and types of reverberation, it can be established whether or not the human ear is capable of noticing the variations.

Results published by W. Reichardt and W. Schmidt in 1967 indicate that the average human ear can distinguish fourteen degrees of spatialization. This, however, is valid only in the experimental studio ; in the concert hall or theatre, the number is smaller.

This evidence, supported by a series of tests, gives the composer of electronic music an empirical scale of spatial perception, to supplement the traditional scales in three parameters (pitch, dynamics, duration).

The scale of spatial perception, divided roughly into ten degrees that can be distinguished by the human ear, is not in itself enough to provide a comprehensive explanation of spatial impression : reverberation is of paramount importance, but only one of the elements that goes into its making.

First, the length of reverberation time has to be considered in connexion with the frequency response. The application of reverberation to the lower frequency range gives an impression of « darkened space » ; lengthening reverberation within the higher frequency range produces an impression of « brighter space ». A combination of the two and their systematic application to various frequency ranges, together with the juxtaposition of sound elements having different reverberation characteristics, allows the introduction of new elements into experimental composition (e.g. the creation of « space within space »).

However, brightness and darkness were also present in live, conventional music. Bessler, Schering Dart and other musicologists have remarked on the « brighter » character of music performed in Baroque churches (where the wooden interior tended to lengthen reverberation within the higher frequency range) as opposed to the « dark » character of music performed in Gothic cathedrals (characterized by a longer reverberation time within the lower frequency range). But there is one essential difference : the degree of brightness or darkness is a constant in live music and can be changed only by moving the performance to another building, whereas the gradation of light and shade in electronic music can be changed within the framework of a single musical structure.

The foregoing may justify the addition of yet another parameter to pitch, dynamics, duration and spatial gradation : « light and shade » (brightness and darkness) may also be relevant to the composition of electronic music.

Reverberation creates only a « general impression of spatiality ». A more precise frame of spatial reference is set by the topographical definition of the sound sources, i.e. when the listener can localize the sound source (stereophony). This localization is limited to the frequency range above 500 Hz (for reasons which need not be explained here).

The stereophonic presentation of sound material (« *matière sonore* » in the French terminology used by Pierre Schaeffer, Abraham Moles and others) allows the possibility of shifting the imagined position of the sound source without changing its real position. The topographical definition of sound material in electronic music, therefore, becomes a necessity, and a systematic theory of experimental music may have to include *topographical definition* in the list of parameters (« dimensions », « co-ordinates »).

As far as experimental electronic music is concerned, the study of music should be based on :

- (a) the examination of the sound material ;
- (b) the psycho-acoustic relevance of the various properties of sound material.

This the available literature corroborates — cf. Moles : « A new study of music must consequently start no longer from the score, nor from the properties of musical instruments, but directly from the sound material defined by its three co-ordinates : level, pitch and time, which an instrument such as the Sonograph displays. »

The limitation to level (dynamics), pitch (frequency) and time (duration) advocated by Moles may not be justified. A more exhaustive list of parameters — relevant both to the creation and the study of experimental music — might include :

- (a) dynamics ;
- (b) pitch ;
- (c) duration ;
- (d) spatial gradation ;
- (e) light and shade (brightness-darkness) ;
- (f) topographical definition.

The additions in the above paragraph (spatial gradation, light and shade, topographical definition) to the traditional parameters all have one feature in common : they all refer to the spatial characteristics of sound material.

5. Real space and variable space

The electro-acoustic presentation of sound material is responsible for a new mode of spatial perception. The « natural feeling for space », Winckel explains, is destroyed by recent technical developments. The rigidity of real space (« gebundener Raum ») is replaced by variable space (« variabler Raum »).

The aesthetic evaluation of variable space in electronic music still needs research and experiment — which should be interdisciplinary, as spatial variability also exists in other arts. The research should include painting, film and television.

6. Space in music and painting

The introduction of perspective in painting has a close socio-cultural parallel in western civilization in the separation that took place between music

performer and music public. The establishment of functional harmony on the basis of the equally tempered scale, and the general acceptance of pictorial perspective both depend upon the same social and technological conditions; ample evidence on this point is provided by musicologists (Curt Sachs, Heinrich Besseler) and art historians (Wilhelm Wölfflin, E.H. Gombrich).

Sociologically, the development of perspective in painting and of functional harmony in music can be described as the establishment of aesthetic patterns endowed with social validity. The very fact that several types of civilization other than the one commonly described as « modern western civilization » are bound up with « non-perspective » painting and « non-harmonic » music can be taken as an indication that both « perspective painting » and « functional harmony » represent historical categories or, in other words should be regarded as aesthetic patterns which may again lose their social validity.

Socially-accepted aesthetic patterns create a kind of social inertia, since the sociological mechanisms of « internalization » help to perpetuate the patterns once they have been accepted. The terms « listening habit », introduced by sociologists, and « viewing habit » describe the result of such internalization (psychological acceptance of a social pattern).

Pictorial perspective (which, incidentally, was not invented by painters, but by architects of the Italian Renaissance), has acquired the force of a socially-accepted pattern. It invites the viewer to « read » the picture in an accepted way, in the same way as functional harmony in music invites the listener to follow the cadential process. It is almost universally accepted that no physical law demands the division of the octave into twelve equal steps; nor is there any scientific justification for the universal acceptance of functional harmony based on such equal temperament. Max Weber has shown that the (limited) social validity of these patterns should be clearly distinguished from their logical validity (which cannot be proved).

In the same way, the theory of visual perception cannot offer a basis for the logical validity of perspective painting although, sociologically, the temporary validity of pictorial perspective seems to be evident.

Cubist painting and Cubist aesthetic theories — to mention but one of the decisive movements in twentieth century painting — have contributed to the destruction of traditional viewing habits and the decomposition of traditional space concepts. The development of post-cubist viewing habits is described in detail by Gombrich in his book « Art and Illusion » (see especially Chapter 8).

The creation of variable space in electronic music and attempts to break down accepted patterns of pictorial perspective seem to have a common aesthetic target : the freeing of artistic expression from perceptive (listening and viewing) habits.

Seen in this context, « action painting » is another attempt to do away with the conventional approach of the viewer and the static rigidity of the

picture. Gombrich explains (« Art and Illusion ») that action painting tries to convey a feeling of movement to the viewer by making him follow the direction of the painter's brush.

If movement is included as an element in modern painting, can the frame of the picture preserve its traditional function ? The question has been considered by art historians. The interdisciplinary implications would appear to deserve a more thorough examination ; from the point of view of general aesthetic theory, there are certain affinities between the attempt to do away with the frame and the desire to overcome the « peepshow » limitations of the theatre. The replacement of « closed form » by « open form » in experimental music may also have parallels in modern painting.

The changing function of the picture frame and the expression of movement in painting suggest a new evaluation of space. Perspective is described as but one possibility of pictorial representation. « Space is a product of the human mind, an invention of man » (Reimer Jochims).

In evaluating the various individual and historical types of spatiality in painting, the lessons to be drawn from psychology of perception must be kept in mind. Jean Piaget (« La représentation de l'espace chez l'enfant ») has suggested the following distinctions :

(a) autistic space (« étendue autique »), which identifies itself with the subject ;

(b) egocentric space (« étendue égocentrique ») limited to the immediate surroundings of the subject ;

(c) projective space (« étendue projective ») which tends towards enlargement and allows differentiation, but is still dominated by emotion ;

(d) Euclidian space (« espace euclidien ») which represents quantified space and is reached in stages.

This ontogenetic scheme also has phylogenetic significance. Whether it can serve as a basis for the changing modes of spatialization in art is a question that would deserve a more thorough investigation.

Psychological considerations (cf. paragraph above) seem to stress the active rôle of the individual in « creating space ». Perspective painting would accordingly appear to be a creation of the human mind which has gained social validity at a certain stage of historical development and which may be replaced by a new creative idea of spatialization (the parallel evolution from Euclidian towards non-Euclidian space in modern physics is striking, although no valid reason is apparent for such parallelism between art and science).

Artists and critics are contributing their own observations and theories regarding the changing evaluation of space. Thus, Reimer Jochims maintains that space does not « exist » but is « taking place » ; today, man is not

surveying pictorial scenery that conveys an impression of depth and distance, but rather becoming part of a spatial entity which comprises the picture and the viewer.

The classic relationship between subject and object as defined by European rationalism and the Enlightenment does not seem to apply to recent experimental art, and may need modification within the context of present-day artistic development.

7. Space in film and television

In retrospect, certain trends in painting at the beginning of the twentieth century seem anticipations of what the development of film and television techniques later made possible. Hans Richter described the film as a fulfilment of certain methods initiated by painting which cannot be attained by painting itself.

The combination of film and electronic music contributed a great deal to the awareness of the spatial problems inherent in modern aesthetics. In an essay on « Moving Pictures and Electronic Music », John Whitney puts forward some ideas that are relevant. « To begin with, graphic structures that move in space must not be confused with the representational space that belongs to the long tradition of perspective drawing, etc. This was the reason we avoided photographing three-dimensional geometrical bodies, because a spatial negative would be illustrated and this would mean forfeiting all the possibilities of the moving picture. Illusion is destroyed in this sort of space; we know exactly what it means to see a film about, e.g. a piece of sculpture, that moves to and fro « somehow ». Space does not exist without movement. Movement defines its depth. In general, a movement is directed towards the place of perception, or away from it. It is remarkable that in a graphic time-structure one has no time to take in at leisure the space surrounding the object as one has in painting. Something that moves in the depth of any space seems to lead the eye in whatever direction it moves. This faculty was similar to the route followed voluntarily by the eye when contemplating the motionless objects in a painting or a piece of architecture. The classical conception of painting rests largely on a kinaesthetic experience in the space that surrounds the painted object. Still more important is the fact that the ear can be guided by a sound in the same way that the eye follows the route of the object. We found that these two routes could run parallel, or in contrary motion, or canonically. »

The distinction advocated by Whitney between the conception of space and « the long tradition of perspective drawing » seems to tie in with several characteristic trends in music, in painting and in present-day theatre.

The application of television techniques to the combination of electronic music with visual art results in a new relationship between the macrostructure (the aesthetic result) and its microstructural components. « The aesthetic result

created by these means is calculable in advance, but cannot be foreseen, since its structuralization is achieved on a microstructural level and consists of a chain of electrical impulses and combinations of frequencies in a certain chronological order. The temporal character of these microstructural units is transformed electronically into the kinetic visual phenomena of the macrostructure. Aesthetic control is only possible at this macro-level, but the corrections considered necessary upon examination of the macrostructure can again be effected only at the micro-level » (K.O. Götz in an essay : « Gemaltes Bild - Kinetisches Bild »). This observation on the relationship between the aesthetic macrostructure and the aesthetic microstructure in « electronic painting » is also valid for the greater part of electronic music.

The critical examination of the macrostructure is fed back into the mechanism controlling the manipulation of the microstructure. Although this kind of feed-back also occurs in conventional live music (e.g. the changes in orchestration a composer makes after hearing a first performance) it gains a new significance in experimental electronic composition : the critical examination of segments or « takes » becomes part and parcel of the creative process.

This critical review of the segments, indispensable for the establishment and the improvement of the draft schedule (score), accounts for the laboratory-like character of experimental electronic art ; the approach is by trial and error to a far greater extent than in traditional art.

This is especially true of the spatial elements, since electronic spatialization offers possibilities which have no parallel in « live experience ».

8. Ballet

Electronic methods and electronic music in ballet introduce another parameter not so far considered : the position of the camera, and the movement of the camera.

Live ballet, created for the stage, is seen by the viewer from a fixed position. In film or television ballet, the viewer (which is the camera) moves, and such movement naturally affects choreography originally devised for the stage and the peepshow-theatre.

Television ballet thus needs a choreography which takes account of the camera's rôle in « creating space ».

Shooting and editing then become part of the choreography. Spatialization in television ballet therefore depends, to a large extent, on the choreography of the camera, the cutter, etc.

The inclusion of electronic music in television ballet raises the question of co-ordination as between video space and audio space. It is known that visual impressions, carefully planned, can be made imperceptible by concomitant, contradicting aural impressions. (Robert Emmett Dolan, in « Music in Modern Media », page 52, offers a very instructive basic example.)

9. Multiple messages

The question raised with regard to ballet in the above paragraph becomes relevant generally in connexion with the study of multiple artistic messages and multi-media art. « The essential problem posed by multiple messages », Moles writes (« Information Theory and Aesthetic Perception »), « is the fluctuations and modalities of the receptor's attention. How does the receptor perceive the different kinds of information transmitted to him by the message, and what law governs the direction of this attention to each kind ? ».

The answer can be found by systematic experiment, on the law of the « apperceptual limit ».

The experiments can be aesthetic or psychological.

With regard to their validity, it should be noted that the maximum rate of perceptible information is determined not only by psychophysiological laws but also by the « socio-cultural past of the individual considered » (Moles).

The results can thus not be taken at their face value. A certain enrichment of the artistic vocabulary by the technical media may not be perceptible at one stage of (individual and social) development, whilst it may become perceptible at another.

10. Experiments and tests

Based on the considerations set out above, a series of technical space manipulation experiments could usefully be planned.

They would cover : electronic music, electronic painting, electronic ballet, live theatre endowed with multivariable space, multiple messages of other kinds, multi-media theatre, and so on.

The results should be evaluated in conjunction with :

(a) the lessons to be drawn from a study of aesthetic perception based on information theory ;

(b) recent research on the biological factors that determine visual and aural perception ;

(c) aesthetic theories concerning the manipulation and representation of space in various arts.

The bibliography attached offers a first introduction to the vast amount of literature available ; to some extent, it reflects the interdisciplinary character of the subject of this paper.

KURT BLAUKOPF

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KURT BLAUKOPF is Professor at the Academy of Music in Vienna, and Director of the International Institute for Music, Dance and Theatre in the Audio-Visual Media.