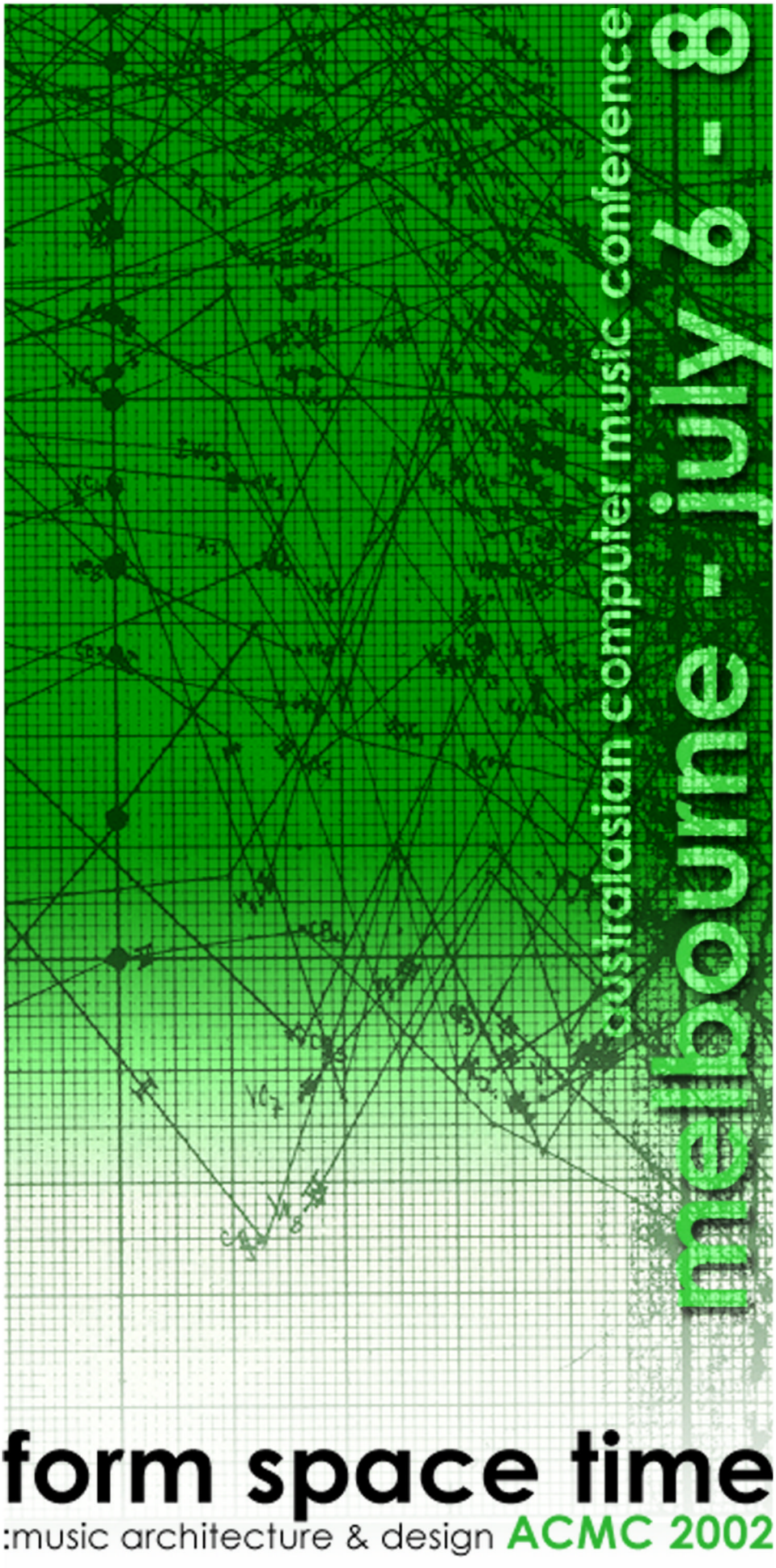

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:music architecture & design ACMC 2002

Proceedings of the Australasian Computer Music Conference 2002

6th – 8th July 2002

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Welcome from the Organising Committee

We are extremely happy and honoured to welcome this delegation to Melbourne. It is with great anticipation that the ACMC 2002 Organising Committee expects to share the exciting work of the ACMA membership, and, indeed, practitioners of computer music worldwide. It is your efforts and creativity that makes the ACMC what it is: the region's largest and most important showcase of state-of-the-art work, both artistic and scientific, related to music and technology.

From time to time, advancements in technology make possible new achievements in our area of endeavour, or make some things more easily possible. We are at such a time with sound spatialisation. Music has always had a function in space, indeed there is no such thing as non-spatial hearing. While electronic and computer music has been concerned with space and spatialisation since its inception, the proliferation of consumer-format, multi-channel sound, and thus the ready availability of tools and systems to work on, has brought new emphasis on this area in recent times. This recent emphasis has again led composers who use technology to look at form in terms of space. The conference theme of "Form, Space, Time: Music Architecture and Design" makes this connection, and another important one with the discipline of architecture and design, which has always approached the concept of form in terms of space. Many papers and discussions in the conference will take place around this theme, including some significant international work, and we hope you find this stimulating and enlightening.

We wish to thank the authors for sharing their exciting work and thoughts, and also all delegates. It is because of you that we have this community, and it is through the efforts of the community that we are able to support each other, learn, and grow this field we all love.

This conference would not have been possible without the close cooperation and support of RMIT University and the Victorian College of the Arts. We wish to thank them for their assistance, and at times indulgence, to allow this conference to proceed. Coordinating the process was only possible through the enthusiastic and untiring efforts of all concerned and I would like to personally thank everyone involved.

We wish you a wonderful time at ACMC 2002, and we hope you also enjoy your stay in Melbourne.

Welcome!

Paul Doornbusch, for the ACMC 2002 Organising Committee
Roger Alsop, Lawrence Harvey, Tim Kreger, Peter McIlwain

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Space As Structural Function In Electroacoustic Music

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Abstract

This paper tries to demonstrate some of the strategies used by different composers to create their compositional spatial models. Throughout our lecture, we will hear some examples of space organization and demonstrate their physical parameters by means of Fourier analysis. We will see different methods of spatialization by temporal pitch changes, amplitude panning changes, spectral transformations, re-synthesis by convolution and transposition, expansion, granulation etc) on works by the composers J.C.Risset, H.Vaggione, B.Truax and others.

Introduction

The use of space as an element of organization is one of the new preoccupations for composers of electroacoustic music. This spatial dialectic is the most relevant topic in electroacoustic music. Space has acquired a structural role that was absent in instrumental music. However, the morphological analysis of this aspect is difficult, not only because we have not the appropriate tools to measure it, but also because we are confronted by multiple spaces.

This new alternative of considering space as a musical and structural phenomenon requires a different kind of hearing, more demanding from a physiological and psychological point of view.

It is useful to look at the works themselves and to try to extract descriptions of the different behavior of materials in relation to space in electroacoustic music. We can perhaps determine a kind of syntax of space.

1. Internal and external spaces

To begin with, we must consider two principal aspects: the internal and the external spaces. Both phases of space operate on our perception in a way that is at the same time both centrifugal and centripetal. There is a diversity of criteria about the importance of space and its role of articulation in electroacoustic music, but in any case the interaction between time, space and timbre constitutes the crux of a new conception of musical structure. This most ancient tendency is intended to give different types of expressive relief to music by manipulating the sound parameters. They were inspired on the instrumental music concept that space amplitude is a result of the combination of frequency, intensity and harmonic spectra. In fact, the differences in spectral field between low and high sounds (that is the consequence of absorption rate of partials), as well as relationships between duration and registers, are determining agents of space in instrumental music.

Most acousmatic composers talk to us about virtual and real space, that is: the space created during the composition, and the space of performance. In the first case, the internal space will be incorporated to the material and stay fixed in the support. The external space will enter into action at the moment of projection, during the concert. This space is then a composition act, as well as an interpretation one. In this way both spaces become complementary. The audience will have the sensation of an imaginary space emerging from the environment all around. The composer, however, is conscious of the physical reality of space, in both forms, even if he applies his own flow of imagination to the composition. In fact, it is by means of perception that space acquires a symbolic sense, because brain mechanisms award it subjacent signification.

1.1 Models of internal space

There are numerous resources, but even by means of spectral analysis, we cannot determine which techniques were employed to obtain these effects. Nevertheless our experience with computer treatments can help us, by simple hearing, to know how composers achieved such results.

We have several very simple procedures, applied in the mixing of tracks. For example to slide elements in both stereo tracks, or to give different amplitude panning to each track in order to get larger or narrow perceptive spaces.

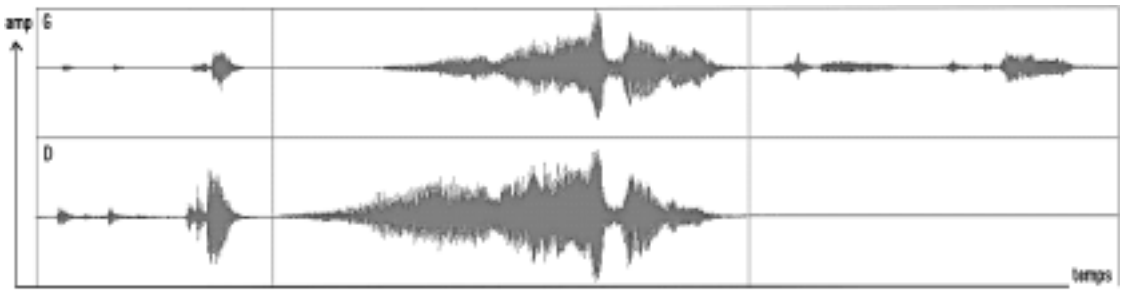


Figure 1 - Savouret : “Scène d'intérieur” [1]

The design of both stereo tracks makes evident the manipulations with the mixing table. We can observe that the evolution of amplitude curves represents objects and voice displacements in the space. The first two segments show a movement from right to left and the third segment represents a vocal sound fixed clearly at left.

We detected a similar mixing situation in “Petit Poucet Magazine” de B. Ferreyra[2].

In figure 2 we can observe a shifting at the same time temporal and of amplitude, between both stereo tracks.

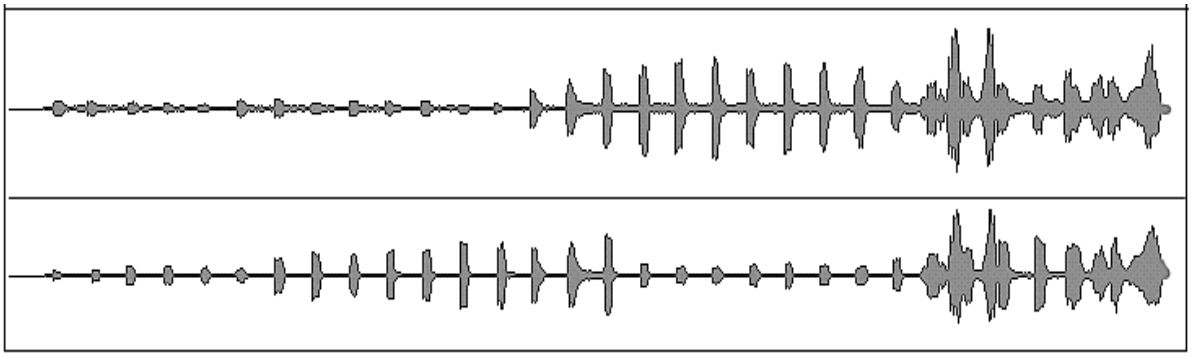


Figure 2 - Ferreyra : “Petit Poucet Magazine”

Besides, in spite of the similarity between both voices, we can see that there is still another additional shifting: this of pitches. I mean, both melodic lines have the same common elements but they are not identical. Melodic lines have an oblique trajectory: they begin at the same pitch and then they cross to go in opposite directions.

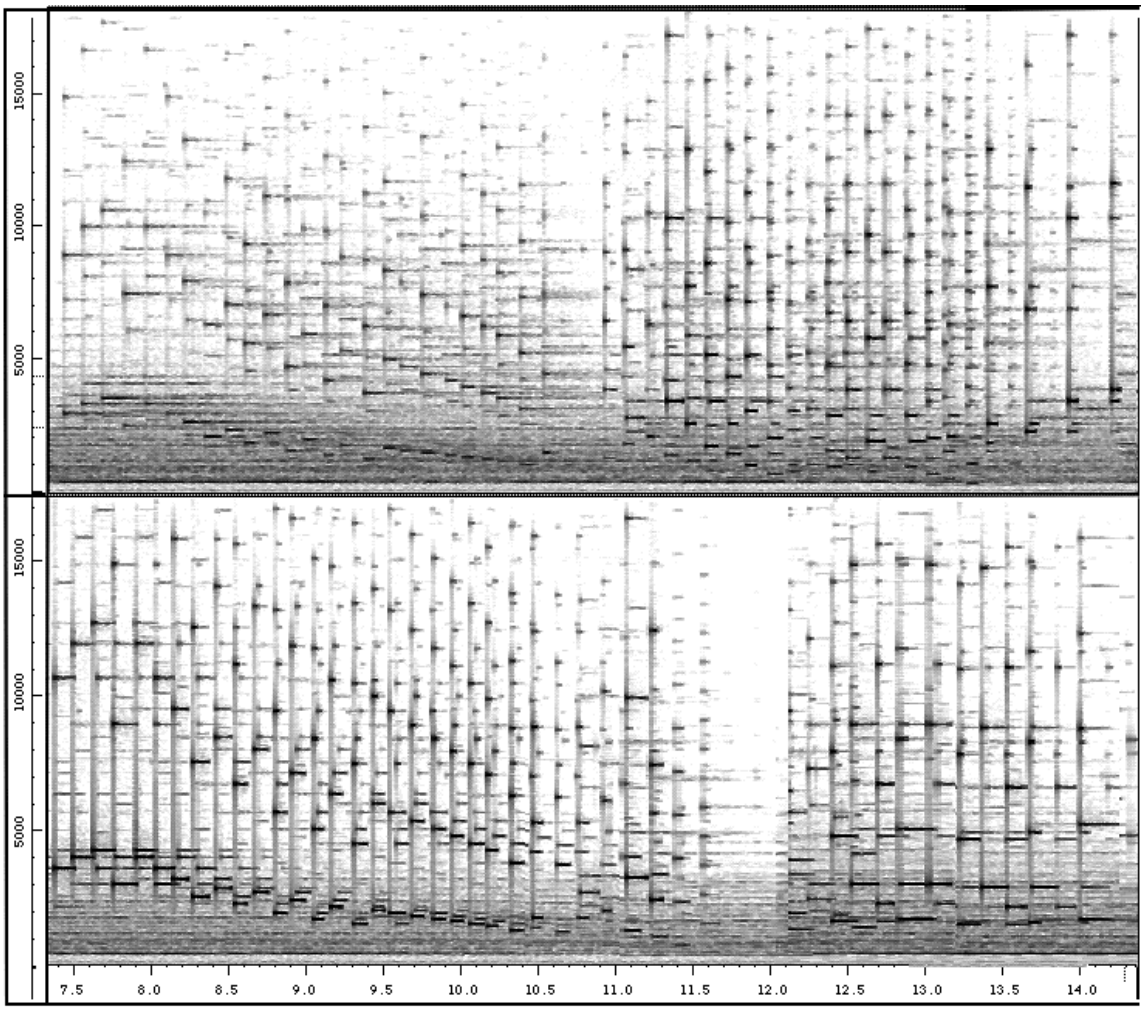


Figure 3 [3]

Another way to produce sensations of virtual space is by using temporal pitch changes. The classical examples are Little Boy and Mutations of J. C. Risset [4-5], based on Shepard's [6] experience with the illusion of indefinite glissando. Using an additive synthesis program, Risset produced an ascendant one octave scale in which each partial is doubled one octave higher. So that in a loop we have a sensation of infinitely descending pitch because when one component reaches the end of the curve a new component appears at the beginning.

……

Other more complex procedures are those which apply transformations into the spectral components. We know that perceptual magnitude of sound depends on its spectral richness, its duration and non-synchronized temporal partials.

We will now see an example of composer H.Vaggione [7]. In this figure we can see three instrumental sound spectra. Sounds 1 and 2 belong to Double bass and sound 3 is a pizzicato of cello.

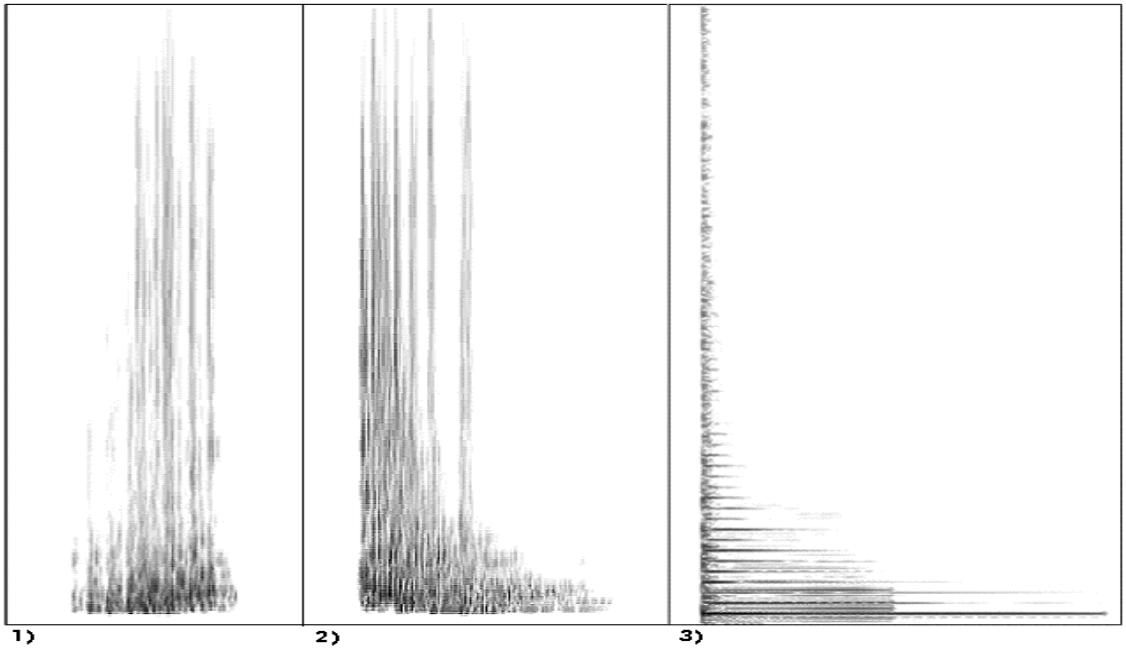


Figure 4

Let's see how the composer transforms sound 2. By means of re-synthesis by convolution the composer obtains a kind of filter that raises higher partials of spectra. (5a)

We can see the doubled vertical lines after the attack, these are the higher harmonics. As high frequencies are more piercing as far as perception is concerned, we have the sensation that the Double bass sound is nearer in this example, even if it has still the same qualities of timbre and duration, as the original.

The example that shows fig. 5b corresponds to the same sound, in this case with a slight panoramic shifting. We can see a kind of "out of phase" spectra in the attack transient and in the first partials. On the other hand we also observe that superior harmonics fall down faster than in example a.). Besides, the design seems to be flattened and the whole ensemble of the object seems larger. However its duration is still the same (1s750ms). The perceptual sensation is of a trajectory going from right to left.

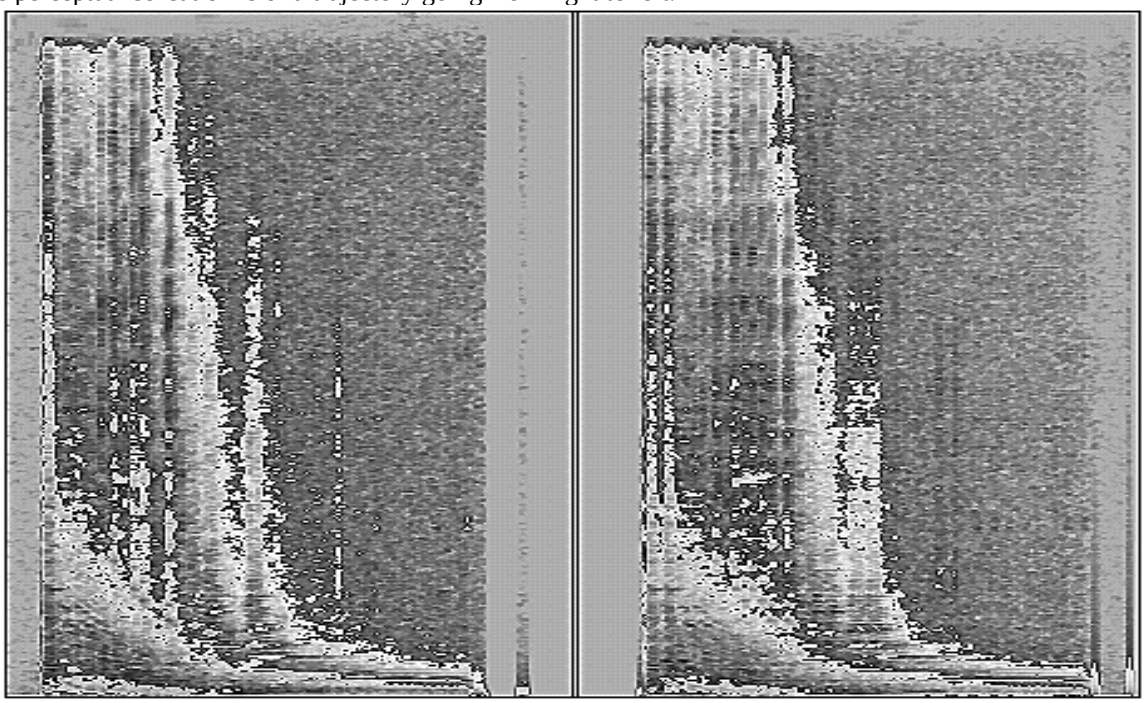


Figure 5.a Figure 5.b

The expansion process is also interesting, because in special conditions it can produce a sensation of being far away. Figure 6 shows sound 1) transformed by expansion. This kind of process sometimes produces little deformations in signal. Comparing this spectra with its original, we can see that both have the same

morphodynamic aspect. In fact, frequencies are the same but the object format is larger and we perceive it as being far away.

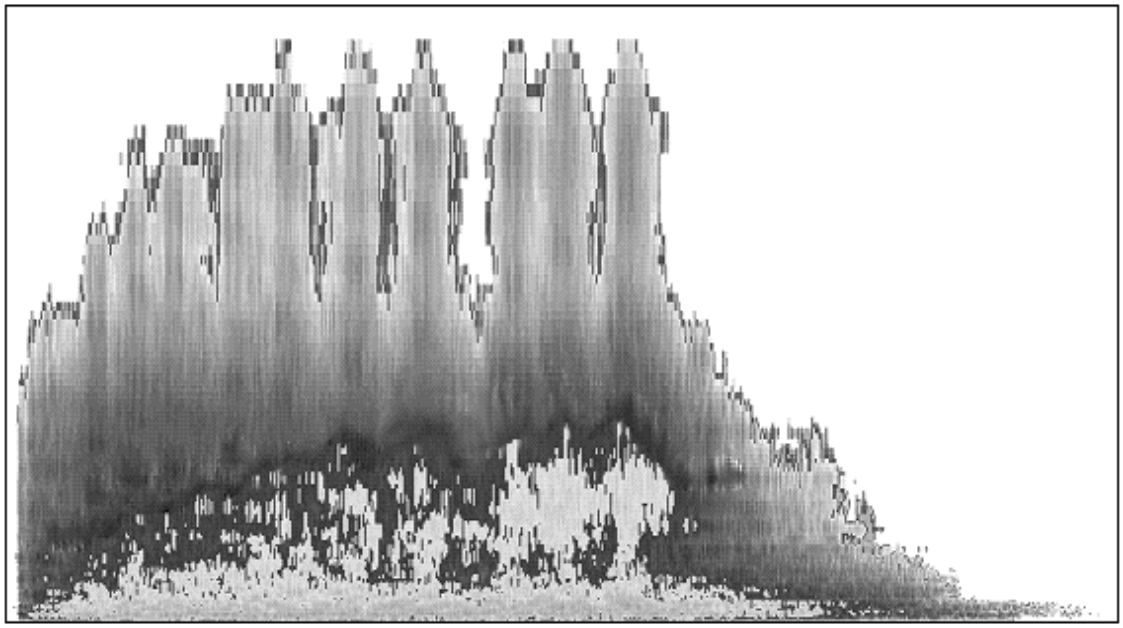


Figure 6

By granular methods we can obtain effects of polyphonic space. Spectra in Figure 7, correspond to a counter-tenor voice sound (belonging to the piece of B. Truax [8] “Powers of two”). Over those spectra, the composer used effects of granulation, expansion and transposition. (Figure 8) As a result of these treatments Truax obtained a thick mass that evolves very slowly. This mass shows a remarkable contrast with the original sound whose spectral quality is mostly pure. In that way, the composer got a perceptual illusion that embraces a large spatial field. We can verify that enlargement of spatial field in the extension of signal as well as in thickness of spectral lines. That means that we perceive a larger space both in field depth and in density of material.

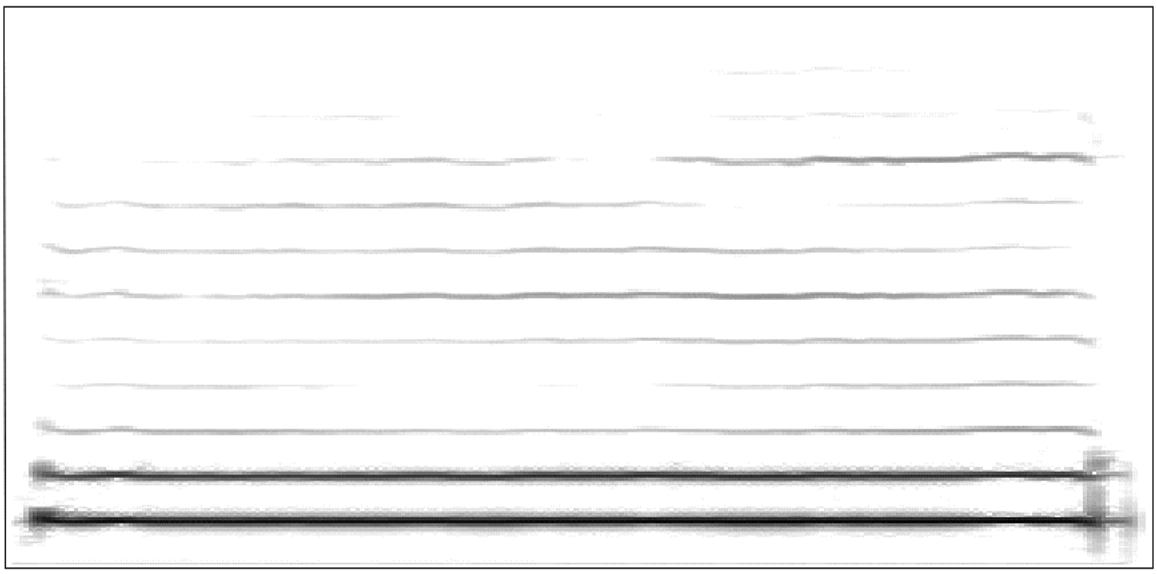


Figure 7

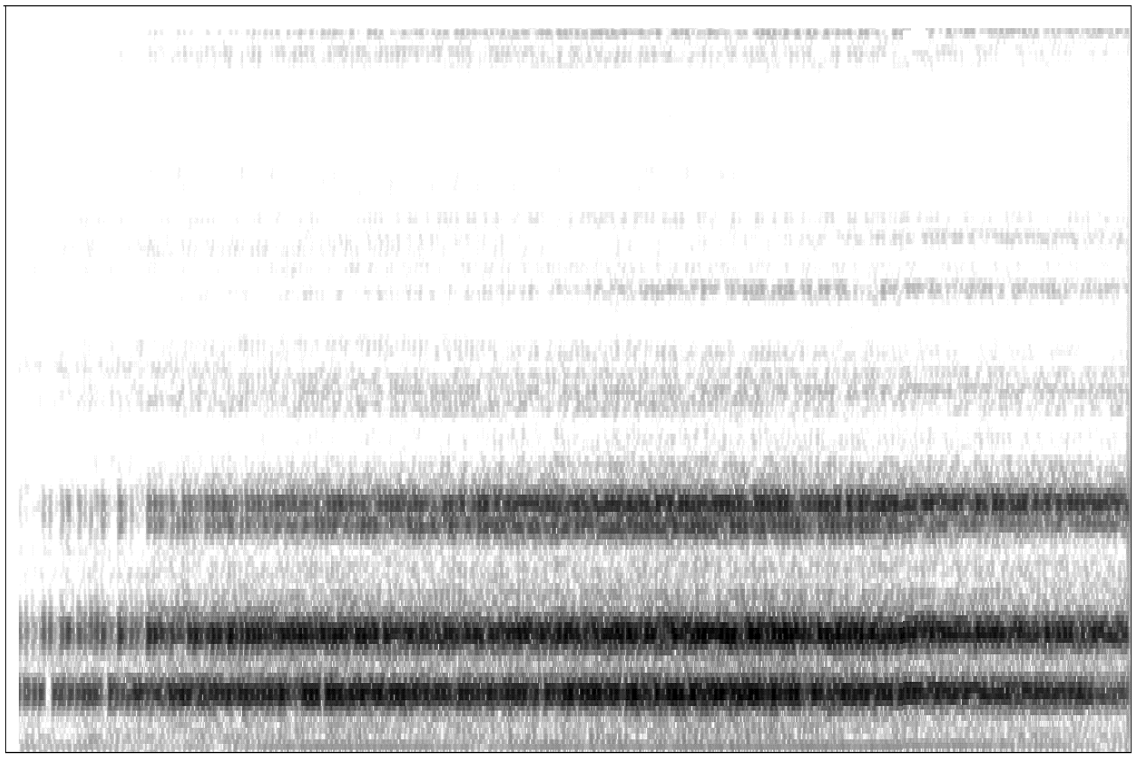


Figure 8

These and many other models of sound space can be integrated with music in a functional way. We can hear the example of C. Zanési in Arkheion [9], who uses a characteristic spatial scheme as a kind of "leit-motiv". This scheme is constituted by lateral trajectories and fixed points in different plans of space. The composer always uses the same scheme to delimitate sequences and to create a good balance between different articulations. Thus it is evident that the composer thinks in terms of a structural element. (Figure 9)

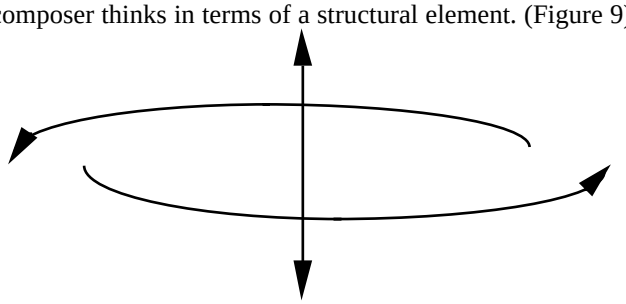


Figure 9

The gradual temporal transformation is one of the preferred resources of electroacoustic music composers. This aspect, as polyphonic structure, is closely connected with spatial sensations. We will analyze two examples of the piece "Elementa" of J. C. Risset[10], in which the composer uses instrumental and natural sounds to create a material that mutates permanently. In this way, he creates a floating atmosphere in which material evolves in an infinite space.

……

In the third movement of Aer, the composer develops a complex structure, using a great number of different materials: flute sounds (slaps, aeolian sounds, melodies etc), wind sound, insects and little animal voices. The whole movement is a long series of metamorphosis.

This movement can be compared to Mauritius Escher [11] "Metamorphosis" (Figure 10). This Dutch graphic artist was also preoccupied by notions of space and time emerging from bi-dimensional figures; in this case, engravings. We can observe how bees go out of hives towards the birds that become fishes and then horses, and so on. In ìAerî we find similar transformations, when wind sound changes the register and then becomes the melody of a flute which gradually disintegrates to become crickets songs... then, all is again transformed to become a complex mass.

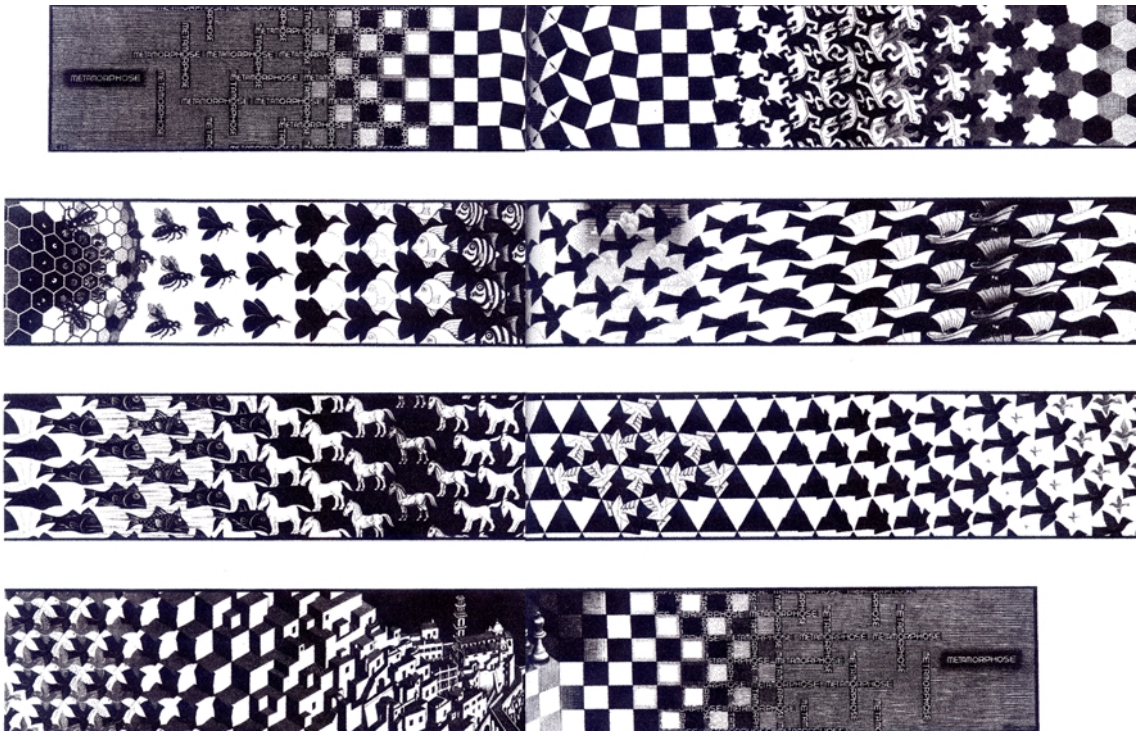


Figure 10

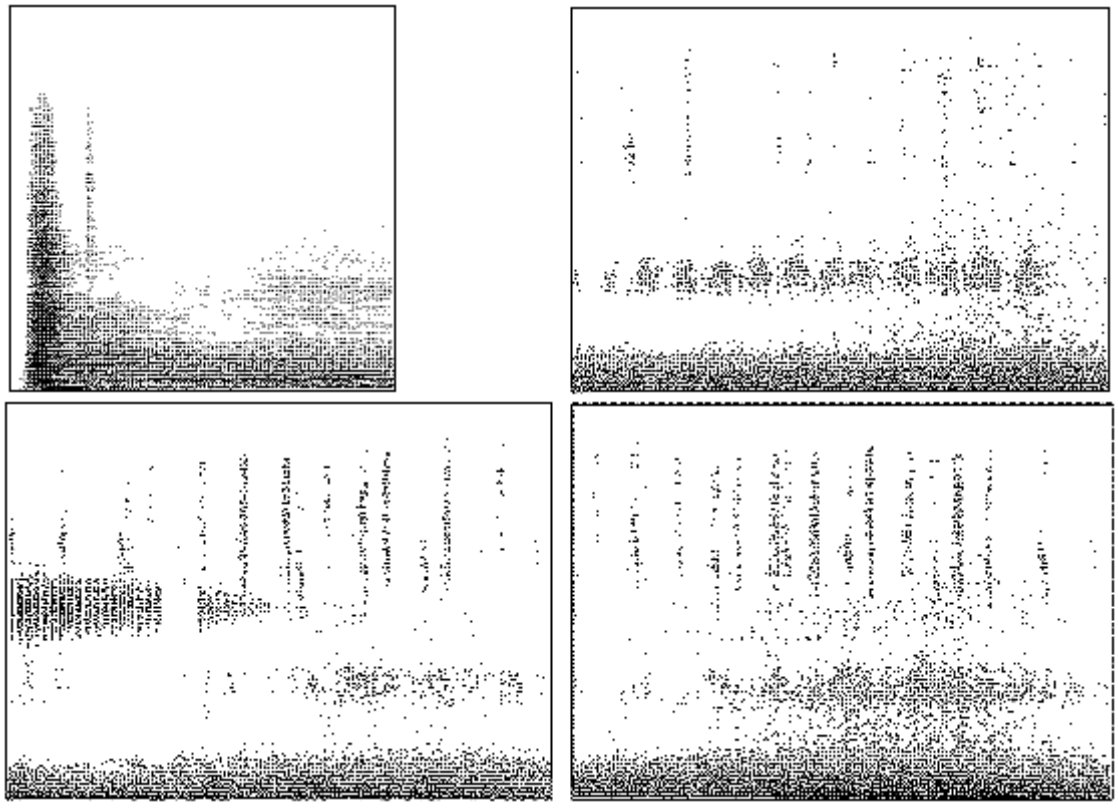


Figure 11

In Figure 11 we can observe: in the top left square, the characteristic spectra of a flute slap.

The figure on the right shows us two layers that represent the sounds of wind and flute respectively. In the lower squares we have: on the left: the same elements superposed to a new object that represents the cricket sound. In the final square on the right we can observe an heterogeneous group of elements of different classes.

The most important characteristic of this movement is the fusion of surfaces, particularly those of wind and flute. This complex surface is present during the entire fragment describing a continuum of streamer figures. This is, in fact, another good example of the phenomenon linking material and space.

As in Escher's “Moebius band” (Figure 12a) and "Magic cube with ribbons" (Fig.12b) the external and internal surfaces of the band, are blurred. So our perception catches alternatively the harmonic sound and the white noise, without realizing when they are muted.

Figure 12a

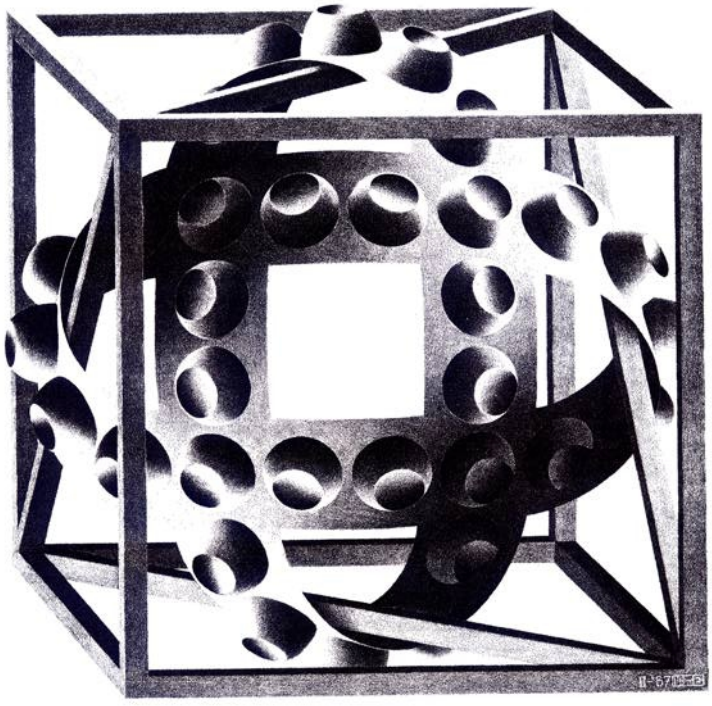


Figure 12b

In these visual labyrinths the observer cannot establish whether he/she is seeing the internal or external face of the figure. In Rissetís piece this notion of virtual space also leads to a reversing of perceptive phenomenon and at the same time it suggests a reflection on the symbolic sense of music.

This notion of spatial architecture is present all throughout the piece Elementa. The whole piece is recorded in four tracks. This aspect, evidently contributes to enhance polyphonic structures and consequently also spatial aspect.

We will analyze two fragments of the first movement: Aqua. In the following scheme we can observe the first segment of 1'30, in which there are four levels of spatial depth, that we numbered from forward to backwards from 1 to 4. Events of different density are superposed and interwoven. Some of these events are in fix plans of space, others move into right/left and forward to backward trajectories, simultaneously.

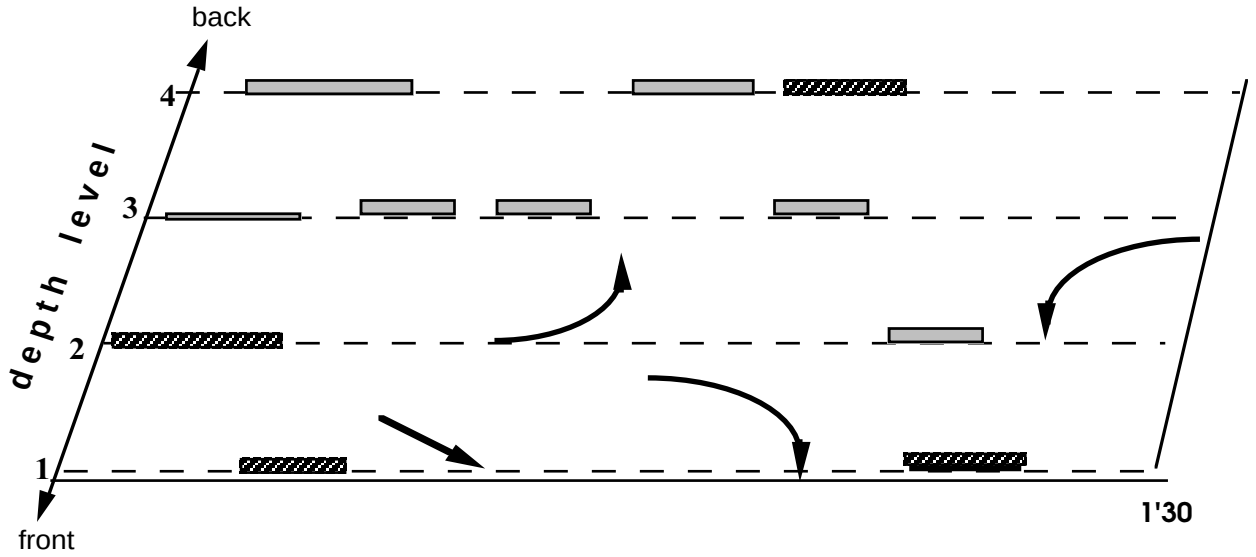


Figure 13

After one region of great activity there is a release and then a new moment of shaking (between 2' and 3'30) - Figure 14

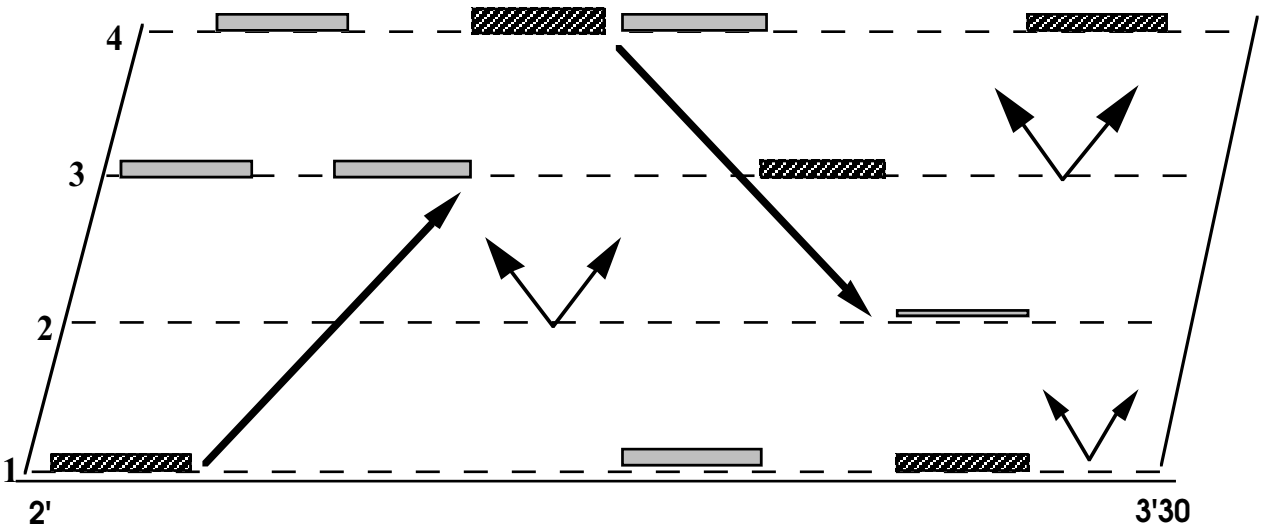
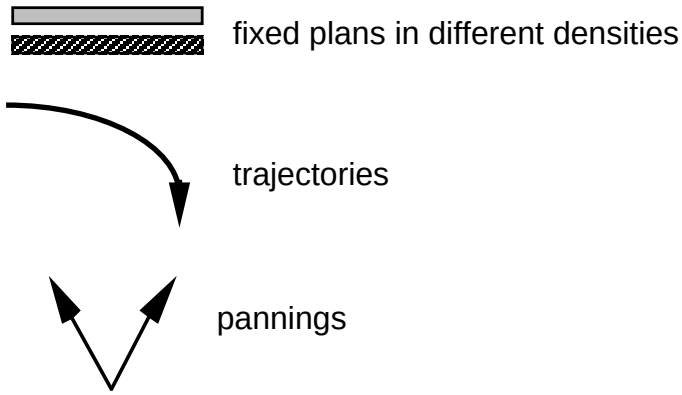


Figure 14

Graphic symbols:



The diagram shows the complexity of the fragment where long trajectories cross events at different levels. At the same time, events on fixed plans placed in the center of the scene, are juxtaposed to textures embracing a larger panoramic field. All these elements added to material diversity of the fragment, let us imagine the richness of texture and movement of the piece. The moving character of both space and material, interwoven, can be compared again with functions of figures and backgrounds in Escher's engravings. The ear, as the eye, has a tendency to fix on a precise object, leaving in the background all of the surrounding.

Figure 15 can be an example of graphic representation for the movement Aqua.

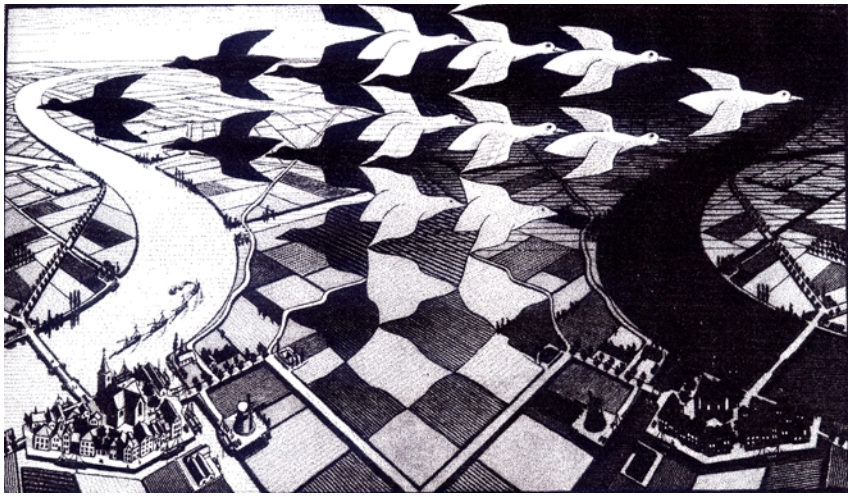


Figure 15

Day and Night: (1938) "At the top of the image, the gray rectangular fields become figures of black and white birds. Black birds fly to the left and white ones to the right in two opposed rows. On the left of the image, white birds fusion to become the light of the day and at the same time a landscape. On the right, the black birds become the night. The clear and dark landscapes constitutes the inverse of the other and they are linked by the gray field that become again birds."

Space of performance

The French school of acousmatic music has given one of the first models in real time spatialization, with the systems Cybernophone and Acousmonium. This type of system, composed of multiple loudspeakers, allows the composer/performer to "color" and spatialize the diffusion of electroacoustic music. In this way, the disposition contributes not only to ornament to the music but also to go deeply in the sense of the work. Nevertheless, this type of system is not convenient for all kinds of music. For example, in the piece "Turenas" de J. Chowning [12] needs four identical sound sources, with flat phase response and a minimum of intermodulation distortion.

In any case it is necessary to consider several conditions, such as; the quality of loud speakers, the form and size of the hall, the absorptive surfaces and the regulation of diffusion mechanisms. If all these conditions are adequate, the diffusion can enable the realization of spatial figures, and produce important changes into the musical texture.

It is important to note that the reverberation is a very important element in the structure of electroacoustic music. So, the composer must take care of the influence of hall reverberation at the moment of using it. The combination of both reverberations can be a disconcerting element for perception. It would be interesting if the composer could study the hall characteristics before beginning the composition.

Readingness of space

All these reflections give us an idea of the interrelation between internal and external spaces. If we can say that the projection contributes to a better "reading" of musical structure, it is important to know that this "reading" is related to the perception phenomenon and to the acoustic conditions.

As an example of these interrelations we can mention the studies on timbre by Risset and Wessel. The phase difference between two spectrally identical sounds, for example, is one of the problems for the "reading" of projected sound. It is very well known that two sounds of the same timbre and harmonic amplitude, may have a phase difference from the acoustic point of view, that is not perceivable by the ear.

The research by Mathews, MacAdams and Deutsch [13-14], among others, on separation of auditive flux, had allowed us to establish models of perception behavior, which enables us to clarify some aspects of musical prosody.

The composer should be able to govern this type of phenomenon such that a discourse is perceptible. The tools of analysis and synthesis can help, even if they are not absolutely perfect.

We believe that a collaborative and interdisciplinary work between scientists and artists will be important to resolve these conflicts.

Aesthetics of space

The last point, but not the less important, is the esthetic of space. All throughout our paper we have mentioned the word structure. It means that we have penetrated the esthetic domain. In fact, in the spatial conception there are two dimensions: the acoustical and the musical. Between both of them it must exist a transmutation able to create a consolidation of musical discourse. It means that we must consider two correlation factors:

a) the interaction between the components of emission, that is source parameters (such as timbre, duration, amplitude), and the propagation conditions (the hall characteristics such as reflection, distance, reverberation etc).

b) the implication of these factors for the structural organization of music. That is; the awareness of these external interactions in musical project.

On the other hand, spatialization can be used as:

1) An esthetical ornament; we can mention the examples of circular trajectories and revolving effects in Little Boy of Risset or in Gesang der Jungling of Stockhausen.

2) Or as a construction element; in this sense the knowledge of physical reality of sound material is important to obtain the most interesting spatial effects.

3) Or still as metaphor in order to create sound images, as in anecdotal music tendency.

We can add to those conceptions the criteria of those who attribute to diffusion an aesthetic function. They consider that it is during the performance that the work takes its real sense because it is re-composed and loaded of sense by means of interpretation.

Conclusion

We have shown, by all these assertions, that composers, in spite of their conceptual divergences, stay loyal to the final objective: the musical work. The different points of view in relation to space or to its operational form or even to its aesthetic function, are only theoretical deviations over one single plan.

Acknowledgments

Thanks to all composers mentioned in this paper who authorised us to publish the analysis of their pieces.

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