

SPATIAL ASPECTS IN XENAKIS' INSTRUMENTAL WORKS

Boris Hofmann: Technical University Berlin, Institut für Sprache und Kommunikation,
boris.hofmann@gmx.de

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ABSTRACT

In this paper, Xenakis' idea of space which plays an important role in his works will be presented. For two of his compositions with spatial distribution of the musicians, *Terretektorh* and *Persephassa*, I have developed a model for spatial analysis which will be illustrated with a few examples taken from these works. In contrast to other starting points this one is not based on mathematics but puts the listener in the focus of attention. The question is: what does the listener really perceive during the performance? After introducing a virtual three-dimensional space as an analytical tool a certain number of spatial environments which constitute the main material of the two pieces will be presented. Afterwards I will show how their succession is essential for the overall structure of these compositions. Finally I will point out the typical aspects of the Xenakian concept and outline his aesthetics of space in combination with his theoretical background and in correspondance to architecture.

1. INTRODUCTION

Space has become more and more important in the history of music since World War II. There are numerous reasons for this: modernity had already put into question the traditional concert hall of the 19th century as a model for musical reception because it made the listener – with the fixed disposition stage-audience – only a passive consumer. Since then new concert halls have been built or performances have been moved to unusual rooms which were not designed for that purpose. Furthermore the development of audio technique has given the opportunity to preserve sounds, to edit them in multiple ways and to diffuse them by loudspeakers so that new spatial conditions in the space of the performance could be created. Last but not least music history with its development of harmony and thematic construction had reached a dead end, from which new musical concepts had arisen. Aleatoric forms were more flexible also concerning their disposition in space. Serial music conquered the space and used it to present its various simultaneous processes which otherwise would not be perceptible to the audience.[5: 245-249]

So Iannis Xenakis does not stand alone with space playing an important part in his works. However he occupied himself with space automatically more intensively than any other composer, especially due to his parallel work as an architect. As a result he achieved in his musical works a new kind of spatial integration.

2. TERRETEKTORH

Even the orchestral disposition of *Terretektorh* (1965/66) makes obvious the revolutionary qualities of the piece (Figure 1): The former relationship stage-audience has been eliminated in favour of a new placement of the musicians and spectators who in fact merge with each other. So the recipient does not receive a form of presentation from one single point anymore but is simply present together with a large group of musicians who occupy the whole space. Ideally each listener is placed isolated from the other and at a special place inside the orchestra¹, so he indeed perceives a very special sound image, which differs from that of any other listener. This is in fact a very democratic opinion of musical presentation.

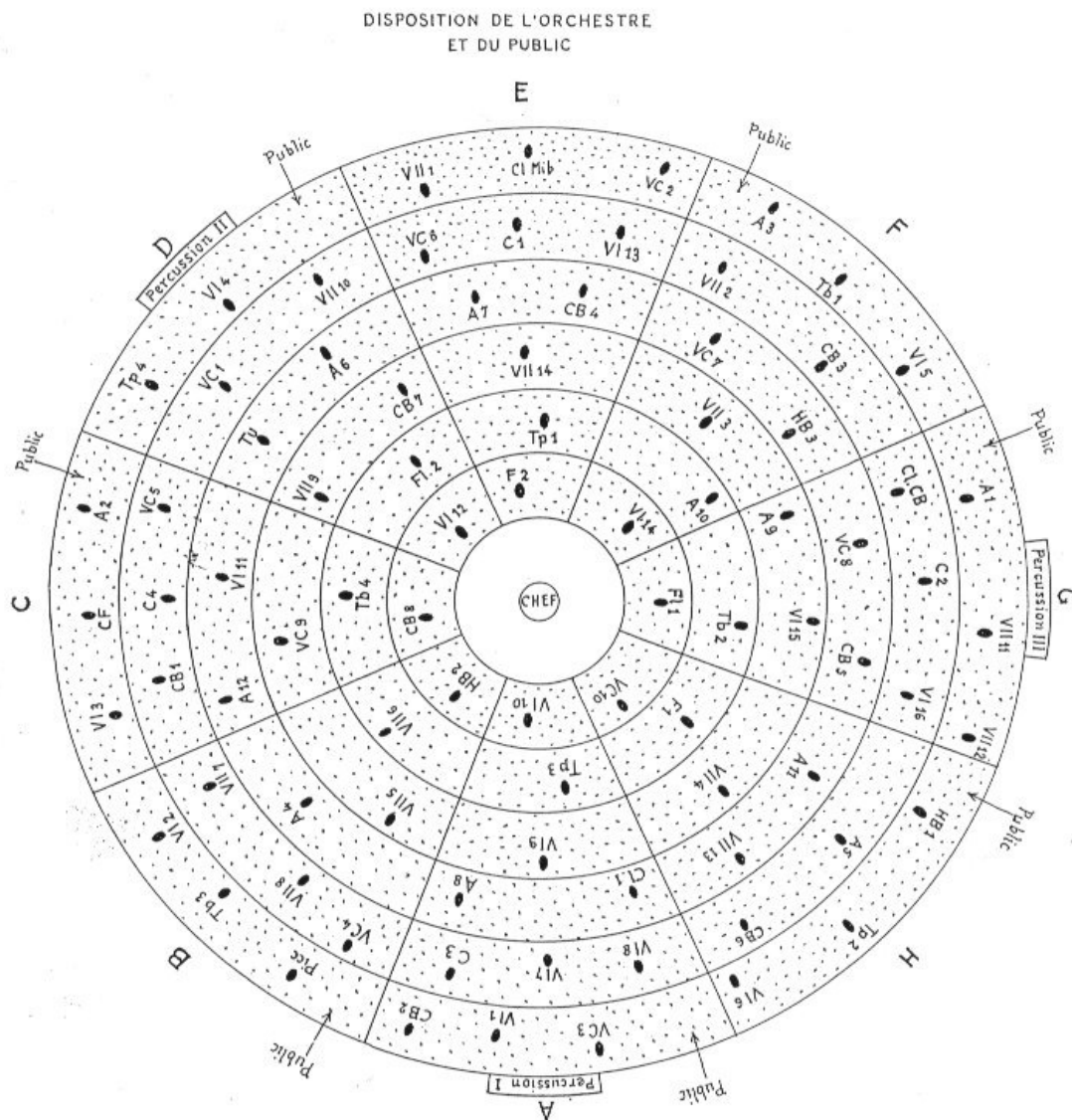


Figure 1 Orchestral disposition of *Terretektorh*

¹ This is not easy to realize in a performance so that one has sometimes to find a compromise by joining musicians or listeners to little groups.

By providing each player with four additional percussion instruments (woodblock, maracas, whip and siren), Xenakis is able to achieve a more pointillistic texture. In the program notes he speaks of certain experiences or impressions of nature which can be evoked that way: “the listener [...] will find himself either perched on top of a mountain in the middle of a storm [...] or in a frail barque tossing on the open sea”. [11:237] So virtual spaces can be the result of the interpretation of this music.

For Xenakis, it is obviously important to make the whole space of performance sound and to give the listener a direct experience of this. What is the space like and how is it structured? The musicians are, as shown in Figure 1, divided into eight groups of approximately the same size in six concentric rings. This disposition refers to the real space of representation which is a plane: It has only two dimensions of relevance. To demonstrate spatial phenomena in this work in a better way I have developed a spatial model which adds to this circular, two-dimensional space a vertical dimension, the traditional tonal spectrum, and therefore creates a virtual three-dimensional space. This appears to be justified also because pitch plays a decisive role in distinguishing important spatial environments in this piece.

2.1 Spatial environments in *Terretektorh*

The virtual three-dimensional space is stretched by several “spatial environments” which can be referred principally on the basic sonorities like sound point and glissando. In *Terretektorh* there are five spatial environments which essentially form the whole musical material:

- a. stochastically distributed points which form a sound-field
- b. sound-planes with internal movement
- c. static sounds or –chords
- d. densely woven chromatic lines in the low register
- e. continuously rising and descending pitches (e.g. glissandi)

a., c. and e. are the three basic Xenakian sonorities according to Makis Solomos [8:135]: point, static sound, glissando.
b. and d. are forms of mixture or transition which however gain independence in this piece.

2.1.1 Stochastically distributed points which form a sound field

The “sound points” which are so typical for Xenakis are created here exclusively by the four percussion instruments assigned to each player, especially by woodblock, whip and maracas. The points mostly occur united in a sound-field: these fields seize horizontally the complete space of performance, but they belong to the medium register, i.e. they have a vertical extension of zero. In *Terretektorh* they can be found in large parts of the middle section. The clearest example begins in measure 117: In the following 70 bars the percussive timbre changes as a mass phenomenon. The sound-fields which appear in this passage are stationary but also permanently changing. In the sketches in Xenakis’ estate in the French National Library in Paris, one can find very figurative drawings where terms like “whirlwind” or “tempest” occur.

2.1.2 Sound-planes with internal movement

Moving sound-planes also consist mainly of sound points, however, they are not distributed stochastically but organised in a strict polyrhythmic matter. Furthermore the instruments which are used are less appropriate for pointillistic sounds: Sirens and maracas (as rolls) are better classified as continuous sounds. So the sound-planes occupy an intermediate position between punctual and static sounds. They are moving in several respects: On the one hand, superimposing several rhythms and bar divisions leads to an inner movement, i.e. repetitions in different tempi, a kind of “rhythmic cluster”. On the other hand, inner movement can also be caused by “rotating dynamics”, when the plane seizes the whole orchestra, i.e. at m. 176, where maraca-rolls start to spread over all eight groups. As “Rotating dynamics” I will name the effect of fading between the groups, where dynamic maxima move in circles. This will become more obvious in the description of the next category.

2.1.3 Static sounds or chords

Static sounds and their sounding together as chords are very important for the piece. Static chords consist of continuous sounds which are placed in different spatial heights. They are a static spatial environment which, however, can be moved in space:

Terretektorh starts with a static sound “e” in the strings of the two outer rings and its multiple rotation around the orchestra and audience. In the first 74 bars Xenakis varies this circle movement or rotation. [7:142-146] The listener – at least the one which is best placed (in the middle) – gets the impression of a moving sound by the fading of a note from one group to another. At the moment when both groups have reached the same level, the sound is located in the middle between them². After having completed a turn in constant tempo until m. 8, Xenakis begins alternately accelerating and slowing down the tempo. The sketches show the occurrence of archimedian, logarithmic and hyperbolic spirals. The principle of sound rotation which is exemplarily presented here will be varied in multiple ways.

In the same way as static sounds, static chords, as a multiplication of a single note, are moved in space. As all participants are playing constantly the rotation is achieved by rotating dynamics so that the chord also changes permanently his timbre. This becomes evident in the passage from mm. 119 to 195 where a chord, played by eight woodwinds, is sustained over the whole time. [3:302]

2.1.4 Densely woven chromatic lines in the low register

This is a “sound-layer” with internal movement which covers mainly the low register and which plays an important role in the middle section of the piece. The first two instruments of low frequency starting at m. 146 are double bassoon and bass clarinet, which are joined gradually by the low brass, the double basses and finally the remaining bassoons. This group plays chromatically and narrowly spaced melodic lines in the low register and does not show any correlation between the single voices in melodic or rhythmic respect which becomes also obvious in the sketches. There the lines are drawn like a dense tangle of cords, or like waves which form the basis for the events taking place above. Later, when all the voices move up and down together in a homophonic manner, this corresponds to a gradual rising and falling of the whole sound-layer in space.

² That phenomenon is known in acoustics and audio technique as “Phantomschallquelle”. This procedure is not new: In 1956 Karlheinz Stockhausen had faded a sound from one orchestra to another, in his GRUPPEN for three orchestras. In *Terretektorh* there is a much more gentle division of the orchestra and a smaller spatial distance so the desired effect can be better reached.

2.1.5 Continuously rising and descending pitches (e.g. glissandi)

This category is represented mainly by the glissandi. They might be the most typical feature of Xenakis' music in general. In a two-dimensional coordinate system of pitch and time they can be drawn as straight lines which incidentally becomes obvious by our conventional notation. Examining the virtual three-dimensional space over time, each glissando can be drawn as a vertical line because its place in the real space is constant. As there are many glissandi with different coinciding straight lines, space is filled mainly with those lines.

The glissandi constitute, together with static sounds or clusters, the material of a layer in mm. 205-302 played by the high strings. This layer covers the whole orchestra, but remains restricted – in vertical direction – to the high register. Furthermore, glissandi appear as a means of transition, they indeed take over dramaturgical functions: In m. 97 and again in m.433, a string chord consisting of 60 voices is reached by a large “fan” of glissandi. They start both times on the same pitch, the one-line c, which lets us think of *Metastaseis*, where a small g is the starting point of the first complex of glissandi at the beginning of the piece. Before m. 97, the glissandi open the tonal spectrum which had been reduced to an unison at the beginning, to its full extension, but they are still separated and distributed to single groups. Their second appearance at the end of the piece marks a reminiscence as well as a new interpretation of the same material.

2.2 Structure of *Terretektorh*

How are the spatial environments placed in the piece? Are there developments or interactions between them? And is it possible to develop a model for a general structure from it?

Though it first appears to be a sequence of relatively independent parts, *Terretektorh* is marked by precedent spatial developments: during the first 74 measures the piece is limited to a single pitch and conquers the horizontal space in its full extension, before the vertical dimension opens itself at all: The tonal spectrum is afterwards, starting on e, completely and homogenous filled. The two-dimensional space is extended to a virtual three-dimensional one. In the following main part from m. 97 on, both the horizontal and the tonal space are traversed and illustrated in multiple ways, e.g. with a lot of rotations taking place. In the vertical dimension there are several layers which are distinguished by their position in the frequency spectrum. As they are spatially distributed at the same time, there is inevitably interaction between the two spaces. The middle section of the piece is dominated by a division of the orchestra in three layers which are placed in the vertical dimension on top of each other: between the chromatic lines in the low register (from m. 146 on) and the eight-voiced woodwind-chord in the discant one can find moving sound-fields and planes with points of alternating woodblock, whip and maracas. Metrical order is added by the three percussionists who are sitting outside the outer rings and playing here tom-tom beats which move in circles.

One after another, several combinations of spatial environments are tried out; the environments have sometimes an influence on each other. So certain features of an environment can be adapted to another one to combine them or to treat them in a “contrapuntal” way. The result is a large increase of tension during the whole middle section which at first (m. 275) has the character of several ascents and falls (in the layer of the low register) but which is afterwards characterized by increasing energy and velocity. Rotations with accelerations are whirling the space more and more in disorder. The rotations lead to a climax at m. 331, when the tonal spectrum has been minimized in the very high register with only sirens remaining. The space is now exposed to strong forces, it gets inflated and distracted by a new type of sound movements which now follow the diameter of the circle (from ring 6 to ring 1 and back).

Finally an “explosion” opens the final section where a new general condition is reached: Everything seems to be at a standstill, static sounds have spread in all dimensions and give the listener a new notion of space. The former spaces are at the same time combined and overcome. With this new consciousness the listener is now able to understand the final “fan” of glissandi as establishing a virtual space, a kind of perception which had not been possible at its first appearance at m. 90 but requires the spatial developments and transformations in the meantime as a listening experience. Xenakis enables the audience to obtain a new understanding of space; the listeners’ consciousness of its importance and its true perception has increased.

3. PERSEPHASSA

Space does not play the single main role in this piece for six percussionists (1969) who are placed around the audience (Figure 2) – periodicities, sieves and ritual aspects are also very important. But space does influence the work significantly, due to the spatial disposition of the musicians. In comparison with *Terretektorh* one can notice a more mathematical, analytical approach to the topic of space: *Persephassa* is a study of the possibilities to organize and combine sound points and static sounds in space. The phenomenon of time becomes the subject of the spatial experiment.

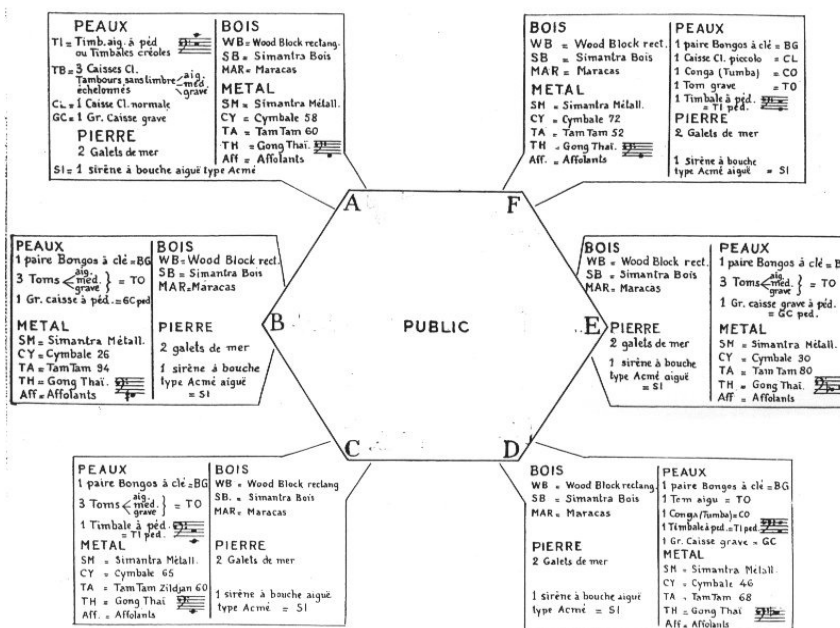


Figure 2 Disposition of *Persephassa*

The number of spatial environments already known from *Terretektorh* is reduced: there are now only two – sound points or single beats on the one hand, rolls or tremoli with a quasi-stationary character on the other. As a comparison of the roll one can consider the cloud of sound (“nuage”): The roll possesses a distinguished pitch and is undiscriminated only in rhythmic and metric respect, but concerning the “nuages” Xenakis demands the use of all the pitches of the prevailing instrument. The part of the sound-planes of *Terretektorh* which had consisted mainly of repetitions is now, in this much more rhythmical labelled composition, taken over by combinations of single attacks, namely by motives.

I would like to present two decisive passages which are related to each other and which represent two different realizations of the same problem.

3.1 Simultaneous periodicities

The first main part starting in m. 62 works with sound points of different periodicity. Each player starts with an equal pulsation of two beats per bar (on the 1st and 3rd beat). Each player also has its own pitch, which – in addition to the spatial separation – makes him distinguishable from the other players. One musician after another now leaves this scheme by playing attacks with new regular intervals and beginning a new periodicity. Thus the basic pulsation becomes more and more frayed and complicated and is soon not noticeable anymore because each player is changing his periodicities several times – the intervals can go from a third of a bar up to 23/10 bars. So there is a structure of single hits which are approximately stochastically distributed. Makis Solomos examines the temporal distances between the hits and calls them “rhythmical cells” («cellules rythmiques»). [9:13] Figure 3 shows that passage in a schematic way, the periodicities are marked as fractions:

measure 62	70	80	90
A (6) 2/4		23/10	4/10
B (3) 2/4 9/10		4/10	
C (1) 2/4		4/3	
D (5) 2/4			14/10
E (4) 2/4 5/6			
F (2) 2/4			11/8
measure	100	110	
A	17/10	16/10	
B		7/10 3/10	
C 7/6 2/6		5/6	
D		4/10	
E	2/6	1/4	1/6
F	3/8		2/6

Figure 3 The numbers in brackets specify the pitch assigned to the player. For reasons of clarity this diagram stops at the moment where these fixed assignments are given up.

In this passage the spatial disposition of the players and of their beat structures not only serves to illustrate the composition and to make it more audible, but allows further conclusions: At each point in space there is another periodicity and therefore another metre and notion of time. Time is not of universal validity but depends on space and the position of the recipient. That understanding is generally known since Einstein’s theory of relativity but Xenakis makes it possible to experience it directly with musical means: Also in music there is no reliable time, each listener gets

his own experience. The result is a “relativity of the temporal perception”, («relativité de la perception temporelle») as Anne-Sylvie Barthel-Calvet calls it. [1:167]

Gradually a rhythmical acceleration takes place, the long intervals disappear in favour of the short ones and finally there are 10 to 12 beats per measure and player. [9:14] At the end of this passage it becomes obvious that the unique time of each point in space does not even have to be constant. Starting in m. 114, the fixed assignment of the six pitches to a single player is given up: The pitches and the periodicities which are connected to them turn in circles clockwise with a velocity of one player per measure. So Xenakis permutes the six periodicities through the six players. After one circle is completed, a second series is added which is distributed, after the double-bar in m. 131, always alternating to the first one. Finally the energy breaks out in m. 145 in a dense cloud of sound on the drums. [2:17]

3.2 Simultaneous tempi

The passage at m. 191 is the counterpart of the one at m. 62: It is characterized by the general absence of time in the meaning of a metronome value which is valid for each player: Instead of a common tempo each player is gradually assigned a tempo of his own, according to six metronome settings ($\downarrow = 38, 40, 42, 58, 74$ and 78). Here a similar result to the first section is achieved, but with totally different technical and compositional methods. First there is no special dynamics or pitch: all the percussionists play equal unison quarter beats at $\downarrow = 40$. Two bars later, three of the six players change their metronome slightly to $\downarrow = 42$, keeping the same pulsation. The resulting time lag is not noticeable at once, but beat by beat: The two halves separate themselves from each other temporally.

But Xenakis does not leave it at two independent tempi. By letting another four players leave the current tempi and taking over a metronome setting of their own, there are six different tempi at m. 200. The result is a structure of single beats which becomes gradually more complex. In the last bars before m. 205 a quasi-stochastical distribution of the beats is achieved. In comparison to the passage at m. 62 one gets a similar rhythmic result, in fact it is reached each time in a very different way. This procedure shows the relativity of time in even greater light than the previous section at m. 62. There is no general tempo anymore: each player has his own temporal order.

This thesis is the focus of attention in *Persephassa*, so these passages are – for spatial considerations – the decisive ones. They steal the limelight even from the highly effective ending because it does only vary the known phenomenon of sound rotation and brings it to a new climax³.

4. XENAKIS' AESTHETICS OF SPACE

By disproving the general validity of time and making it dependant on the unique placement of the listener or musician, Xenakis comes very close to the results of Jean Piaget that in human perception time is derived from space. Piaget had shown that time perception requires space perception to develop and is therefore manifesting relatively late in human adolescence.[6] This is also an important aspect of Xenakis' aesthetics of space which becomes especially evident in *Persephassa*.

³ The last section (starting at m.352) shows seven different rotations on different instruments superimposed on each other, going alternately clockwise and anticlockwise. The increasing tension and virtuosity result from the general tempo increasing from $\downarrow = 30$ to $\downarrow = 200$ and to $\downarrow = 88$ in m. 425. Dynamics increase from mf (which is always reached from pp by fading in and out) gradually to ffff. Finally the whole energy of motion breaks out in large clouds of sound. In the whole ending there is a three-dimensional space consisting of several superimposed layers. It has an internal multi-layered movement because the single rotations can be assigned to certain heights of space due to their different frequencies.

Furthermore, his compositions illustrate space as such and give the spectator a better feeling or understanding of the space in which he is situated. As music develops in time, time is necessary for this kind of spatial recognition. So the space of *Terretektorh* is not perceptible in a single moment but requires the course of the performance to become clear to the listener. Space is not something static but changes with time. This dynamic interpretation of space became obvious even in Xenakis' first architectural work, the monastery of La Tourette with its *pans de verre ondulatoires* and the lightning of the local church which changes according to the movement of the sun. We can now consider the perception of space as dependant on time and therefore dependant on the singular placement of the listener. Each spectator gets a different impression of space. The question arises if there is an ideal place to listen to such a work. From the view of a sound engineer the listener should be placed ideally in the middle of the circle, i.e. where the conductor stands⁴. But as Xenakis encourages the recipient to listen to the piece several times at different positions in space [10:96], one can assume that there is no ideal place at all: each place gives one singular impression of space; a global perception could only result from their combination.

That method of perception is also valid for architecture. But a building can be perceived best by walking around inside and therefore getting an impression of it. This possibility is neither given during a presentation of music nor during the shows in the pavillons or polytopes created by Xenakis. So the music itself has to take over this role – as a kind of “architectonic construction unfolded in time” [4:7] – and must deliver to the listener a complete impression of space, even though he is fixed at a single place. In this respect the spatial compositions by Xenakis represent a link between his musical and architectural works and thus reach beyond the usual horizons of contemporary spatial music.

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⁴ Compare with the „sweet spot“ at the reproduction of surround sound.