

Elisavet Kiourtsoglou

13 rue Clavel, 75019, Paris, France
ellikiour@gmail.com

An Architect Draws Sound and Light: New Perspectives on Iannis Xenakis's *Diatope* and *La Légende d'Eer* (1978)

Abstract: This article examines the creative process of *Diatope*, a multimedia project created by Iannis Xenakis in 1978 for the inauguration of the Centre Pompidou in Paris, utilizing analytical research of sources found in several archives. By interpreting Xenakis's sketches and plans, the article elucidates for the first time the spatialization of *La Légende d'Eer*, the music featured in the *Diatope*. The findings of the research underline the importance of graphic and geometric representation for understanding Xenakis's thinking, and they highlight the continuity and evolution of his theory and practice over time. Furthermore, the research findings present the means by which this key work of electroacoustic music might be spatialized today, now that the original space of the *Diatope* no longer exists.

Iannis Xenakis (1922–2001) was trained as a civil engineer at the Polytechnic University of Athens (NTUA) and became an architect during his collaboration with Le Corbusier (1947–1959). Later on, Xenakis devoted himself mainly to the composition of music, with the exception of purely architectural projects sporadically conceived for his friends and for other composers. Examples of these include François-Bernard Mâche's house (1967–1974), the Scherchen Auditorium (1961), Karen and Roger Reynolds' house (1994), his proposal for the architectural competition organized by La Cité de la Musique in Paris (1984), and his utopian city of *La Ville cosmique* (1964). Nevertheless, he maintained a particular interest in space throughout his artistic activities. Beyond elaborate spatializations for his works of music, he also conceived a series of works called *polytopes*, where sound, light, and space were merged to offer a multisensory experience.

This article examines the creative process of *Diatope*, Xenakis's most complex polytope, conceived and constructed in 1978 for the inauguration of the Centre Georges Pompidou in Paris. What was distinct about this project was the fact that Xenakis worked—almost concurrently—on the architecture of the pavilion, the music of *La Légende d'Eer* (along with its spatialization), and the light show. These

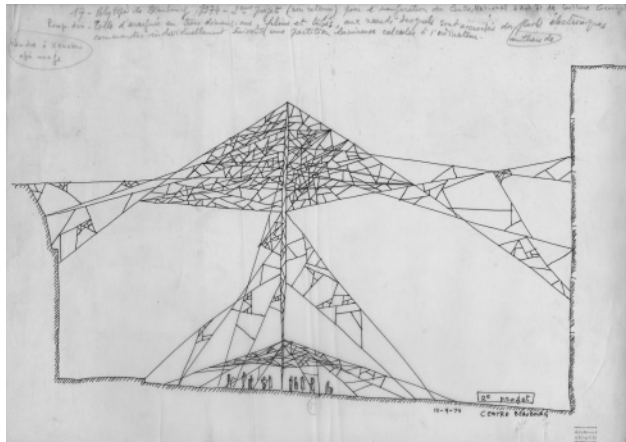
distinct levels of *Diatope*—architecture, music, and light—were neither interdependent elements of the work nor merely disparate artistic projects merged together. Xenakis presented a four-dimensional spectacle based upon analogies between diverse aspects of space–time reality. To achieve this he used elementary geometry (points and lines) as a conceptual tool, based on the premise that this kind of representation could be abstract enough to simultaneously refer to architectural forms and to the distance covered by light and sound.

In this article, I focus on the pavilion's architecture and the music's spatialization, which have remained hitherto undiscussed in related analysis (e.g., Harley 1998; Sterken 2001; Barrett 2002; Harley 2002; Solomos 2006), in light of new findings from several archives, specifically, the Collection famille Xenakis, the archives of the Centre Pompidou, and the Archives du CEMAMu and the Audio Collection Iannis Xenakis (the last two both housed in the Bibliothèque Nationale de France). Because the music of *La Légende d'Eer* has already been the object of extended analysis, I will not analyze it here; neither will I analyze the light show, other than with regard to its connection with the other elements of the event. I begin by looking at the architecture of the *Diatope* pavilion and then turn to the spatialization of *La Légende d'Eer*; next I will discuss the light show presented inside the *Diatope* pavillion; finally, the article concludes by underlining the continuity and the evolution of Xenakis's thought and practice.

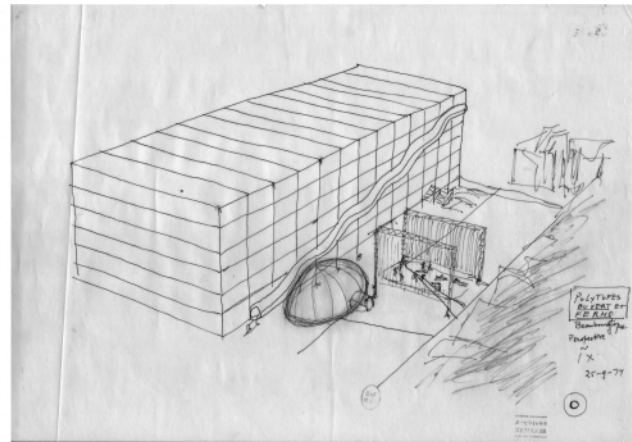
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Figure 1. Earlier versions of the Diatope project (a and b) and its final form (c). (Reprinted with kind permission of the

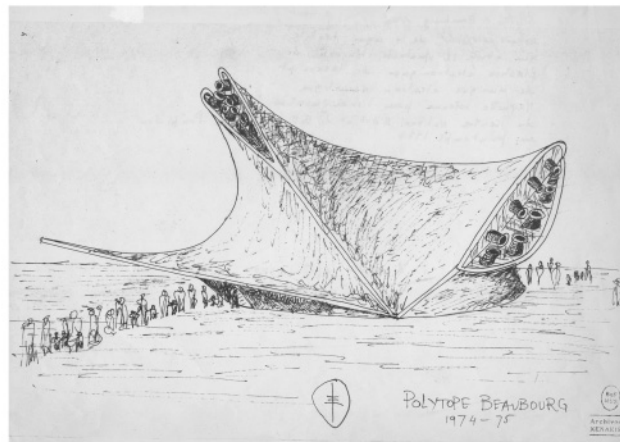
Collection famille Xenakis from X[A] 11-12, X[A] 11-3, and X[A] 11-1. All rights reserved.)



(a)



(b)



(c)

The Architecture of *Diatope*

In 1974, two years after the success of the *Polytope de Cluny*, the president of the Centre Pompidou, Robert Bordaz, commissioned Xenakis

to create a project of light and sound designed to animate the plaza and the Center of Beaubourg's plateau (its facade and possibly some of the exterior parties) for its inauguration (Bordaz 1974).

Diatope, initially called *Polytope de Beaubourg*, was the sixth of Xenakis's polytopes: *Polytope de Montreal* (1967), *Hibiki Hana Ma* (1970), *Polytope de Persepolis* (1971), *Polytope de Cluny* (1972), *Polytope Mondial* (1974, not completed), *Diatope*

du Centre Georges Pompidou (1978), *Polytope de Mycènes* (1978), *Polytope de Mexique* (1979–1981, not completed), and *Polytope d'Athènes* (1985, not completed). It went through three preliminary versions before its final form of 1978.

According to Xenakis (1974), the early versions of *Diatope* presented audacious ideas: using the city's sirens to diffuse music and anti-aircraft lights to illuminate the most important buildings of Paris, including the new edifice; covering the center's facades with a network of flashing lights and "wrapping" them with music; and even constructing a three-dimensional spider's web of flashing lights hanging from the center's facade and the neighboring buildings (see Figure 1). The fourth and final version

consisted of two different locations for the spectacle: an open-air and an enclosed space. The first location would include two parallel matrices of flashing lights perpendicular to the Centre Pompidou, within which people could walk, watching light events computed using mathematical theories, and the second location would house the musical performance. Over and above financial concerns, reservations were expressed by the architects designing the Centre Pompidou, Piano and Rogers (1974), who feared that Xenakis's extravagant project would constitute "a very important visual break as well as a physically disturbing congestion for any kind of exterior activity," and continued that it was not "integrated into the conception" of the new building. It was the enclosed space that was finally chosen for construction.

According to Xenakis (1978), working on this last version, he had to answer the question of what would be the appropriate shape of an architectural shell to house a musical event. In 1958, while he was working with Le Corbusier on the Philips Pavilion for the World's Fair in Brussels, he had suggested the use of surfaces of double curvature (hyperbolic paraboloids and conoids) as a solution to that question. For *Diatope*, he also faced a second question: What three-dimensional shape has the highest volume to allow for the laser show while occupying the least surface area? Xenakis considered the answer to that geometrical problem to be the sphere. Indeed, in his archives we find a few sketches of a spherical space wherein Xenakis would probably house *Diatope* (see Figure 2). "But the sphere, in itself beautiful, is bad acoustically and less rich in tactility than others forms of double curvature" (Xenakis 1978, p. 9). (It seems that this was not an obstacle for Karlheinz Stockhausen, however, when he imagined and realized a sound distribution in the spherical concert hall of Expo '70 in Osaka.) After this experiment, Xenakis turned again towards hyperbolic paraboloids, knowing their reverberational qualities. In the *Diatope* pavillion, however, he did not use precast concrete, as at the Philips Pavilion, but designed a metallic framework that bore a red plastic membrane, because *Diatope* was also intended to travel around the world as

the "Centre Pompidou's cultural ambassador" (see Figure 3).

From spring 1974 to June 1978, the engineering offices of Groupe Arcora and of Esmery-Caron were charged with designing and constructing the architectural shell for *Diatope*, following Xenakis's preparatory sketches and collaborating with him for the final plans. To fix the red tent overlapping the three hyperbolic paraboloids of the metallic structure, 134 blocks of pig iron would be borrowed from the French army. The structure would appear at the end of February of 1978 at the plaza outside the Centre Pompidou.

Regarding the acoustics of this tent, on 20 June 2017 I interviewed Marc Malinowsky, the civil engineer from the construction office Arcora responsible for final construction of the *Diatope*'s shell. Malinowsky stated that the selected double-coated PVC fabric (red outside, gray inside, 900 g/m²) was a pure "sieve" with no acoustical function, its primary purpose being to offer a dark environment for the light show. This membrane let all of the low-frequency sounds of the three daily performances of *La Légende d'Eer* escape to the environment, and although high-frequency sounds were slightly attenuated, the ultrasonic frequencies coming out of the tent attracted stray cats, who watched the show from the upper openings of the *Diatope*'s structure. "Only sharp sounds above 500 to 1000 Hz were likely to be attenuated to a level close to 20 dB," Malinowsky explained, "but under 250 Hz, the mass law remained unavoidable and a maximum attenuation of about 3 dB would be expected." Because of the great amount of high-frequency sound, performed very loudly as Xenakis was prone to do for all of his electroacoustic works, Malinowsky recalls that mothers were covering their children with coats during the performance and neighbors were constantly complaining about the noise. Environmental sounds penetrated the red tent equally easily, but as the *Diatope* pavillion was placed on the inclined plaza outside the Centre Pompidou, at the crossroads of a pedestrian zone and away from the main Parisian traffic arteries, this fact did not have a great effect on the sound performance. In addition, owing to the initial acoustic permeability

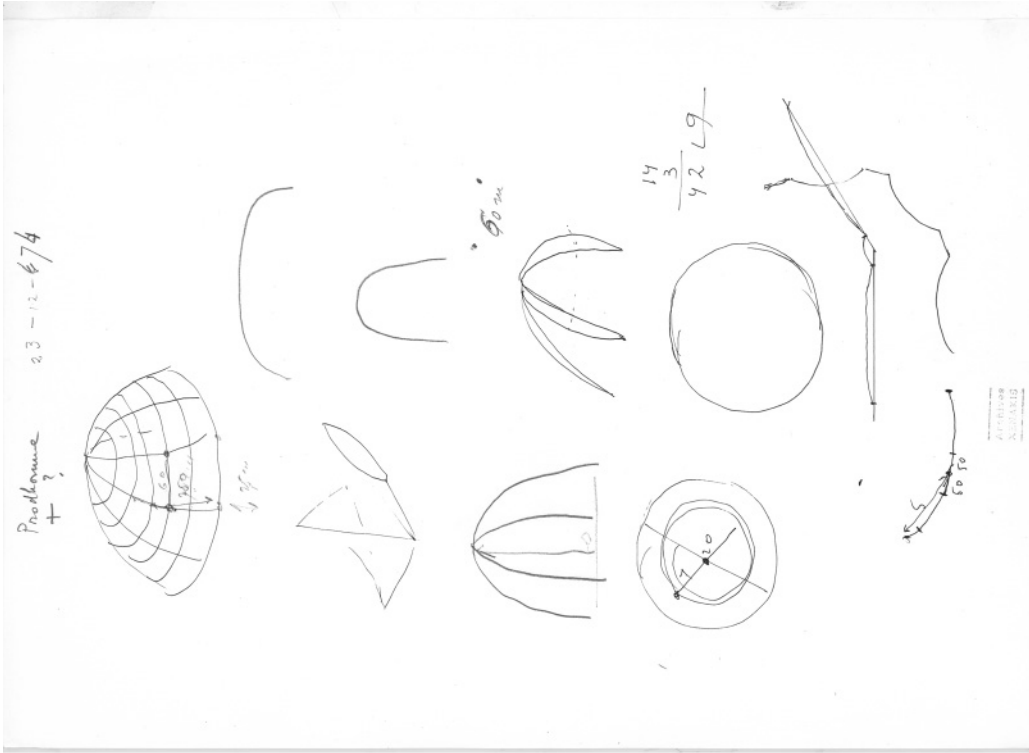
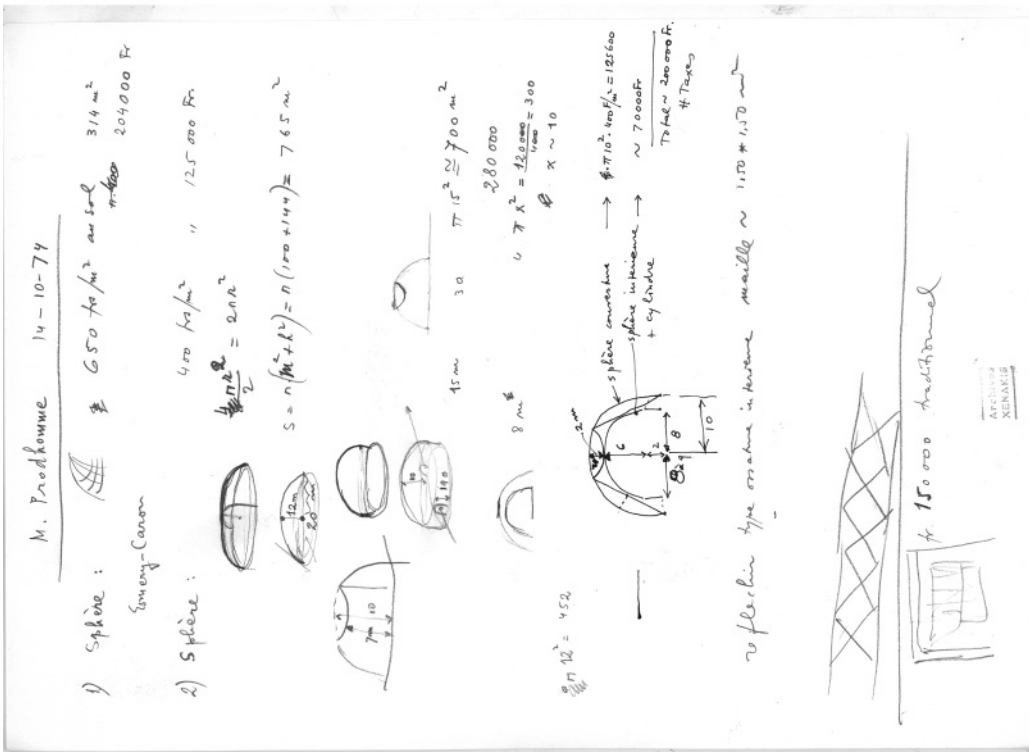


Figure 2. Sketches of a spherical space where Xenakis intended to house Diatope, 23 December 1974. (Reprinted with kind permission of the Collection famille Xenakis from X[A] 12-1. All rights reserved.)

Figure 3. *The Diatope on the plaza of the Center Pompidou, 1978.* (Photo by Bruno Rastoin, Collection famille Xenakis. All rights reserved.)



of the membrane inside *Diatope*, little reflection or reverberation was produced except for specific places on the surfaces of double curvature (e.g., the parabola's focal point). Malinowsky also recalled the perforated acoustic panels of 15-cm-thick fiberglass, suspended from the metallic structure to provide sound absorption.

While the *Diatope's* shell was under construction, *La Légende d'Eer* was presented on 11 February 1978 by the Westdeutscher Rundfunk (WDR) at the planetarium in Bochum, Germany, as part of WDR's festival Musik der Zeit IV (Xenakis 1995; Solomos 2006, p. 162). According to the official invitations found in the archives, the Parisian premiere of the *son et lumière* show was programmed to take place on 14 June 1978. *Diatope* would not be opened to the public, however, until the following month, owing to the countless technical problems relating to the automation program (Matossian 2005, p. 276).

Diatope would stay in Paris from July until January 1979, and afterwards it would be hosted by Das sommerlange Blumenfest in Bonn from 2 May to 28 October 1979.

Owing to the high expense of transporting the show and of the show's realization, it would not be easy for Xenakis to find another city to host *Diatope*, despite his intense efforts. The architectural shell and the electronic equipment would, after Bonn, be returned to Paris and stored in a public warehouse at La Villette. Meanwhile, Xenakis would try to give *Diatope* new life through extensive correspondence with numerous organizations and cities (Athens, Lyon, London, Strasbourg, Bordeaux, Chicago, La Defense in Paris, and the Fondation d'Arc et Senans). It wasn't until 1981 that *Diatope* would finally be bought by the Regional Office of Culture of Provence-Alpes-Côte d'Azur, for the symbolic sum of FF 1,000, to be installed at Marseilles. Despite the

initial plan, the cost of installation was prohibitive, and the *Diatope* structure would stay unused in a regional warehouse in Vitrolles. Later, the metallic structure would be sold and the rest discarded (Sabatier 1984; Collection famille Xenakis, X[A] 12-6; supplemented by personal correspondence with Jacky Sabatier).

The Spatialization of *La Légende d'Eer*

At the same time, Xenakis was working on the music. For the 46 minutes of the seven-track tape of *La Légende d'Eer* (whose title was inspired by Plato's *Republic*) Xenakis (1978, p. 10) used the following families of sounds:

1. Instrumental sounds coming from Japanese and African instruments
2. "Concrete" sounds, such as scraping on cardboard or the clash of bricks
3. Sounds computed and generated by mathematical functions (probabilities)

According to notes apparently written by Cornelia Colyer, Xenakis's assistant for computer programming during this period, the computed sounds were

written on digital tape in numerical form, then converted into sound by a 16-bit D/A converter at the CEMAMu laboratory in Paris. The resulting sounds were mixed together, track by track, in the Electronische Music Studio [*sic*] at the WDR, Cologne (Collection famille Xenakis, X[A] 13-1).

Concerning the spatialization of *La Légende d'Eer*, Xenakis makes a brief reference:

The music is on a tape of seven tracks. Each track is distributed over eleven high-quality loudspeakers spread under the shell of *Diatope*. The distribution, static or kinematic, is realized by a special computer program (Xenakis 1978, p. 11).

Here the sound's diffusion apparently followed the principles described in the 1958 article "Notes pour un 'geste électronique,'" where Xenakis (1971,

pp. 143–150) explained the notions of *static* and *kinematic* stereophony in an electroacoustic piece. In static stereophony, each track plays over a specific loudspeaker and the spatial effect is produced by the simultaneous performance of all the tracks. On the other hand, kinematic stereophony is made up of gradual fade-outs and fade-ins of each track as it moves from one loudspeaker to the other, having constant or varying speed. Here the spatial effect is produced by the movement of the sound of each track.

This use of complex sound movements, in addition to the piece's duration (at 46 minutes, unusually long for Xenakis) and the requirements of the light show, demanded computer automation. This was partially practiced by Xenakis in his earlier polytopes. At that time, the electronic infrastructure was still a tool, whose function was worth mentioning:

The recorded music of the seven tracks is distributed automatically by the program-score, in continuous movements, over the eleven high quality loudspeakers. The command is passed by a nine-track digital tape player that decodes an "image" of the totality of simultaneous commands (about 2,000) every 1/25 of a second, which are distributed by cables to their destination into the space. The performance, with a duration of 46 minutes, involves 140,500,000 binary commands (Xenakis 1982).

Nouritza Matossian (2005, p. 270) adds:

The distribution of the sound as well as the relative changes of volume in the seven independent channels was also digitally coded on the command tape. Any combination of outputs could be directed to any one or combination of channels.

Colyer described the automatic production of the performance in some of her notes addressed to Xenakis:

The production of the spectacle:

- A. 7-track music tape as described before
- B. 9-track computer-programmed and computer-generated digital tape:

flash+laser score written by you, coded in parametric form and submitted as data to our computer program.

Program is executed and generates the numerical information corresponding to score and writes it onto the tapes, separating it into blocks of information, one block being the amount of information needed for the 1/25 sec of running the spectacle. So, 9,000 blocks produce 45 minutes of spectacle.

The distribution of each track to any one of the loudspeakers is computer-programmed according to a distribution score and the necessary information stored with the flash-laser commands on the digital tape of the spectacle, that is, the second tape necessary for the production of the spectacle (Collection famille Xenakis, X[A] 13-1).

This means there was a seven-track tape of music accompanied by a nine-track digital tape of commands (which concerned light paths, sound intensity, and spatial distribution). Daniel Teige, in a letter to me, explained that an eighth track accompanied the seven-track tape of music and served as a time-code trigger to the second, digital nine-track tape. This same eighth track appears in the version provided today by Éditions Salabert in their publication of *La Légende d'Eer* (1977, for eight-track, 1-in., 39-cm/sec magnetic tape). Teige also suggested that a similar technology had already been used by Xenakis for the *Polytope de Cluny* (cf. Teige's film, available at <https://youtu.be/KpWGLJODI30>). In the English text, *La légende d'Eer, New Version*, probably also written by Colyer, we find a similar description:

The visual composition itself, as well as the distribution of the seven-track sound tape generated by a computer program which, by controlling the more than 2,000 above-mentioned elements 25 times a second during the 45 minutes making up the presentation, translates the visual score and the plan of sound distribution as created by Xenakis into numerical form, computing some 135,000,000 numbers and storing them on the tape (Collection famille Xenakis, X[A] 13-1).

According to this passage, we may assume that Xenakis probably made a plan of the sound movements for the seven tracks of *La Légende d'Eer* before Colyer transformed them into digital form and added them to the computer program that controlled the whole performance.

In Paris, Xenakis spent the period from September 1975 to September 1976 recording sounds computed and generated from mathematical functions in the studio at CEMAMu (Centre d'Etudes de Mathématique et d'Automatique Musicale). The tapes, labeled either "Function Unit" or "Logistic Rerun" followed by consecutive numbers, contain these sounds, and the dates are spoken at the beginning of each recording (Audio Collection Iannis Xenakis).

On 7 September 1976, Xenakis accepted an invitation from Wolfgang Becker, director of the Studio for Electronic Music at the WDR in Cologne and in charge of music production, to use that studio's facilities from 24 January to 24 February 1977, assisted by the sound engineer Volker Müller and the American composer James Whitman (Collection famille Xenakis, X[A] 11-13). Beside mathematically generated sounds, Xenakis brought to the WDR studio sounds he had already used in some of his polytopes (Solomos 2006, p. 174), and together with Volker Müller he produced a family of sounds called "Müller" that open and close the piece. James Whitman performed a double-bass improvisation that was also recorded and used in *La Légende d'Eer* (Solomos 2006, p. 176; Friedl 2015, p. 112). These materials underwent sound manipulations such as filtering, transposition by altering tape speed, and addition of echo and reverberation. They were then merged into seven different monophonic tracks, which were combined in three different settings, offering different versions of the piece. For the first setting (the one Xenakis took back to Paris) a one-to-one synchronization of the seven monophonic tracks was created on an eight-track tape, saving the eighth track to control the spatialization and the light show (Friedl 2015, p. 114).

On 30 January 1977, when Xenakis was probably already at the WDR, in a document showing an early "score" of *Diatope's* three different elements (flashing lights, lasers, and music), in which words

describe their temporal evolution, the composer noted in Greek for the first five minutes of the music: “galactic dust, white noise, . . . stochastic sounding from the upper loudspeakers” (Collection famille Xenakis, X[A] 11-7, p. 11).

Later, on 8 February 1977, in a document describing the evolution over time of the seven tracks, Xenakis also noted in Greek: “On the upper four and then circle,” referring to the path the sound had to follow between the sixth and seventh minutes (Collection famille Xenakis, X[A] 11-7, p. 14). According to the last two documents, it seems probable that Xenakis arrived at WDR to compose and mix the tracks of *La Légende d’Eer* already having an idea about the loudspeaker positions in the space of *Diatope*.

At the end of 1977, the Groupe Arcora, one of the firms responsible for construction of the *Diatope* shell, produced two plans (dated 21 November) with the position of the loudspeakers inside the shell (see Figure 4). According to these plans, the first four loudspeakers were to be hung from the metallic structure at different heights, each one forming a specific angle with the ceiling, as shown in Figure 4a. The other seven loudspeakers are not shown in these plans, suggesting that they may have been positioned on the floor. These two plans can explain the only sketch published to date, drafted by Makis Solomos (2006, p. 167) and reproduced in Figure 5, particularly regarding the spatialization of the seven tracks, where ten of the numbered loudspeakers appeared inside a curve as dots, while one (number 3) lies outside the curve. This curve is revealed to correspond to the projected curve labeled QBPAQ of *Diatope’s* shell, shown in Figure 4b. The confusion here is caused by Xenakis’s use of principles from architectural drawing. Loudspeaker 3, as shown in cross section (Figure 4a), falls outside the curve QBPAQ when it is projected onto a plane (cf. Figure 4b, where this loudspeaker is labeled P1), but it remains inside the *Diatope’s* shell. I am going to use these two plans as basis for the diagrams of sound movement presented later in this article.

While writing the English summary for *Diatope*, Colyer also confirmed the spatial placement of the loudspeakers: “The seven-track sound tape is distributed over eleven 75-watt J. B. Lansing loudspeakers suspended on two levels throughout

the shell” (Collection famille Xenakis, X[A] 13-1). Obviously, here Colyer refers to the upper-level loudspeakers and the floor-based loudspeakers.

Another eight-track version of *La Légende d’Eer* was produced in Germany for the unofficial premiere given in the Bochum Planetarium on 11 February 1978. At that time, Xenakis did not have access to the automation software that he would create for *Diatope* in Paris four months later, so the spatialization in Bochum was in great part improvised and manually coordinated. The so-called Bochum Version was an eight-track version, in which

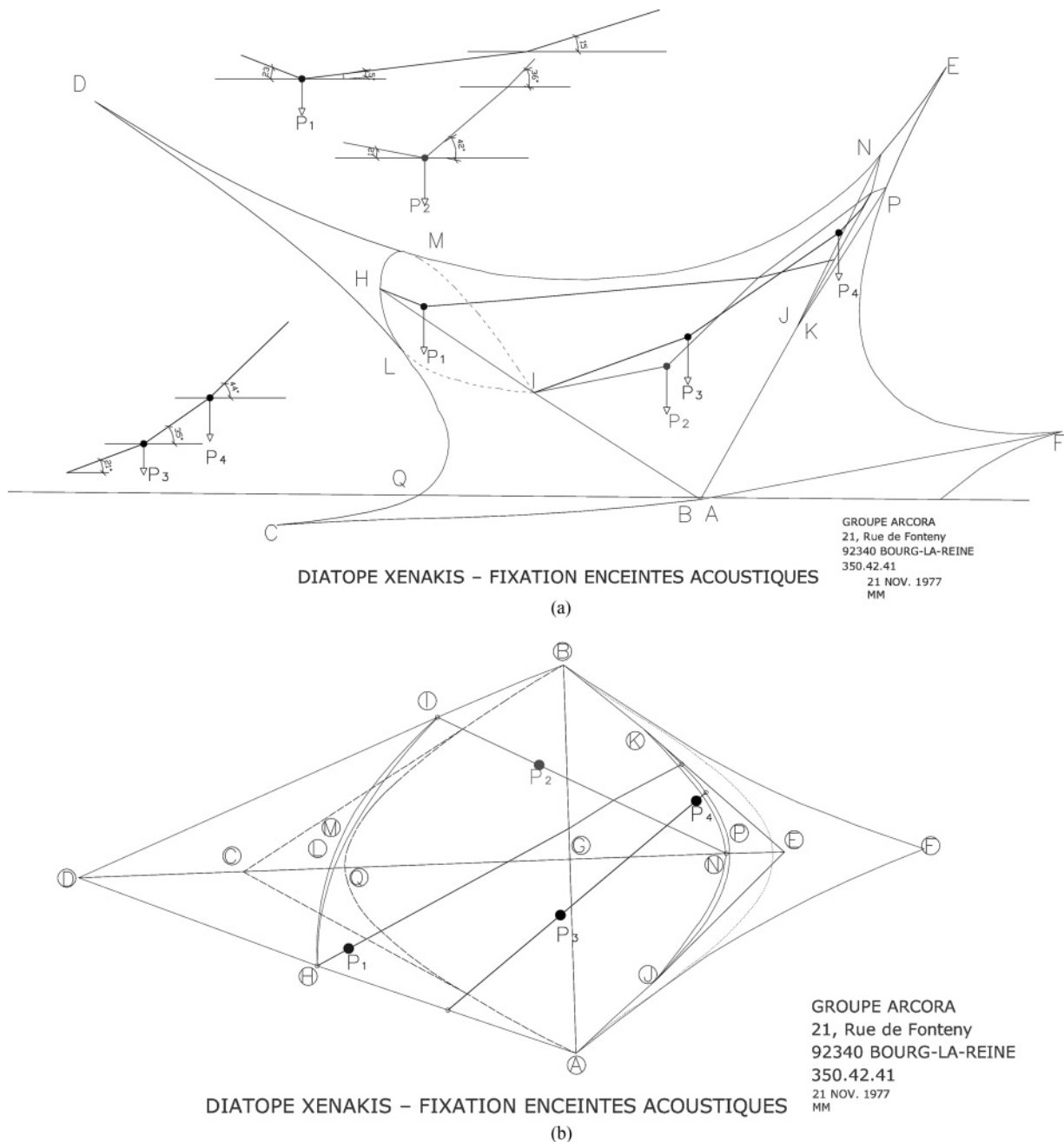
Xenakis spatialized four of the mono tapes to four different tracks (1, 3, 5, 7) by hand, using quadrophonic effect generators EMS QUEG. James Whitman spatialized two more tapes to the other four tracks (2, 4, 6, 8), using two quadrophonic joysticks, and Volker Müller spatialized the last material tape to all eight tracks, using a normal fader box. This created the illusion of continuous rotating movements possible for all the spatialized materials, even when they could not be projected onto each track. This final spatialization had to be recorded on an eight-track tape without interruption (Friedl 2015, p. 114).

Is there a reason for such a grouping of monophonic tapes into different tracks (for instance, to produce a specific spatial phenomenon) instead of a simple division into odd and even tracks? Not having access to the material of each tape, it is difficult to reach a conclusion. Volker Müller’s recollection of the Bochum performance, however, gives us a hint as to how this manually controlled spatialization was actually attained: Several people, positioned on different levels of the building (owing to lack of space), operated the seven tape machines while using an intercommunication system to synchronize their actions (Friedl 2015, p. 115). This means that in the Bochum version the spatialization already consisted of producing rotating movements of sound diffused from loudspeakers and tape machines placed at different levels in space. As I will show shortly, this was also the main principle behind the spatialization of the *Diatope* version of *La Légende d’Eer*.

Figure 4. Cross-section of the Diatropé's space with loudspeaker positions viewed from the side (a) and from above (b). The four suspended loudspeakers shown in

these plans are labeled P1 (corresponding to loudspeaker 3 in the sketch by Xenakis in Figure 5), P2 (loudspeaker 4), P3 (loudspeaker 1), and P4 (loudspeaker 2).

Original plans by Groupe Arcora, redrafted by the author. (Source: Archives du Centre Pompidou, Box 92037/744.)



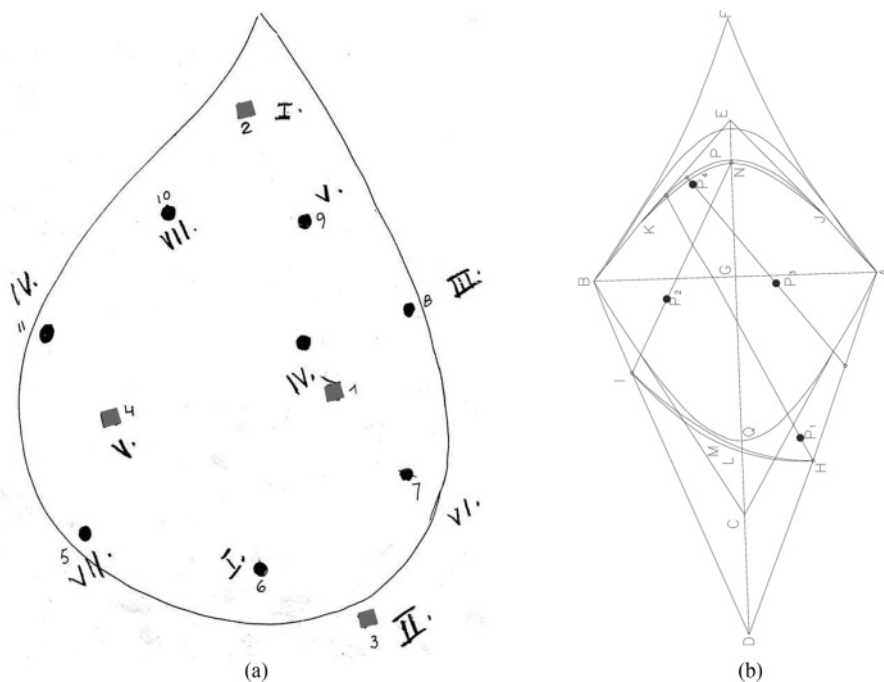
The sketches and plans in the Xenakis archives detail this meticulous elaboration of the sound movements of the seven tracks over the eleven loudspeakers inside the *Diatropé's* space. Not

knowing whether these same movements were produced during the final performance does not minimize the value of this preparatory work for the reconstruction of the spatialization of *La*

Figure 5. Sketch by Xenakis as published by Solomos (2006, p. 167) concerning the spatialization of *La Légende d'Eer* with eleven loudspeakers, labeled with

Arabic numbers, and seven tracks, indicated by Roman numerals (a). The positions of upper-level loudspeakers as given in a reproduction of Archora's plan (b). Color-coded

versions available at http://www.mitpressjournals.org/doi/suppl/10.1162/COMJ_a.00437.



Légende d'Eer inside *Diatope* that I am attempting here.

I first studied Xenakis's plan, shown in Figure 6, describing the sound movements for the first 4'50" of the seven tracks over the eleven loudspeakers (almost one ninth of the piece's total duration of 45 minutes), where Arabic numerals are used for the loudspeakers and Roman numerals for the tracks. As shown in Figure 7, track I starts at loudspeaker 5 at full volume and at the 40" mark passes to loudspeaker 1. It then passes successively to speakers 2, 3, 4, 5, and so on until 2'25", when it passes to the loudspeaker 6 and stays there until 4'15", to then pass on to loudspeakers 5, 1, 2, 3, 4, and 5. It then remains at loudspeaker 5 until 4'50". Does this mean that the sound repeats the same movements every 4'50"? It is difficult to say for sure without access to the eighth track, which controlled the whole performance but is now inaccessible. In this same document, Xenakis distinguishes the two distinct types of sound spatialization by using different graphic representations. A red horizontal line represents the continuous reproduction, for example, of track 1 by loudspeaker 5 or 6 (static

stereophony); whereas red points, when joined by diagonal lines, symbolize the loudspeakers used for the sound movement (kinematic stereophony).

If we now transpose the sound movements of all seven tracks from this document into the *Diatope's* space (the curve labeled QBPAQ in Figure 8a), we observe that, during the first seconds of the piece, tracks I, II, IV, and V are playing on the upper loudspeakers (1–4) and then move down to the floor-based loudspeakers (5–11), forming circles. On the other hand, tracks III, VI, and VII move over the floor-based loudspeakers, forming circles. These tracks do not use the upper loudspeakers, except the fourth, which is the lowest of the suspended speakers according to the plans drafted by Archora, as mentioned earlier. One can imagine how a spectator might have felt, listening to sounds moving in circles or traveling throughout the space of the *Diatope*, while thousands of small lights were twinkling and two powerful lasers were cutting through the darkness: a human, helpless and amazed by this genesis of the cosmos.

At the upper side of the document in Figure 6, under the time axis (measured in seconds), we find

Figure 6. Spatialization of the seven tracks over the eleven loudspeakers by Xenakis. A color version is available at <http://www.mitpressjournals.org>

/doi/suppl/10.1162/COMJ_a_00437. (Reprinted with kind permission of the Collection famille Xenakis from X[A] 11-7, p. 29. All rights reserved.)

Figure 7. Spatialization of the first track over the eleven loudspeakers by Xenakis, corresponding to that shown in the Figure 6. Plan transcribed by the

author. A color-coded version is available at <http://www.mitpressjournals.org> /doi/suppl/10.1162/COMJ_a_00437.

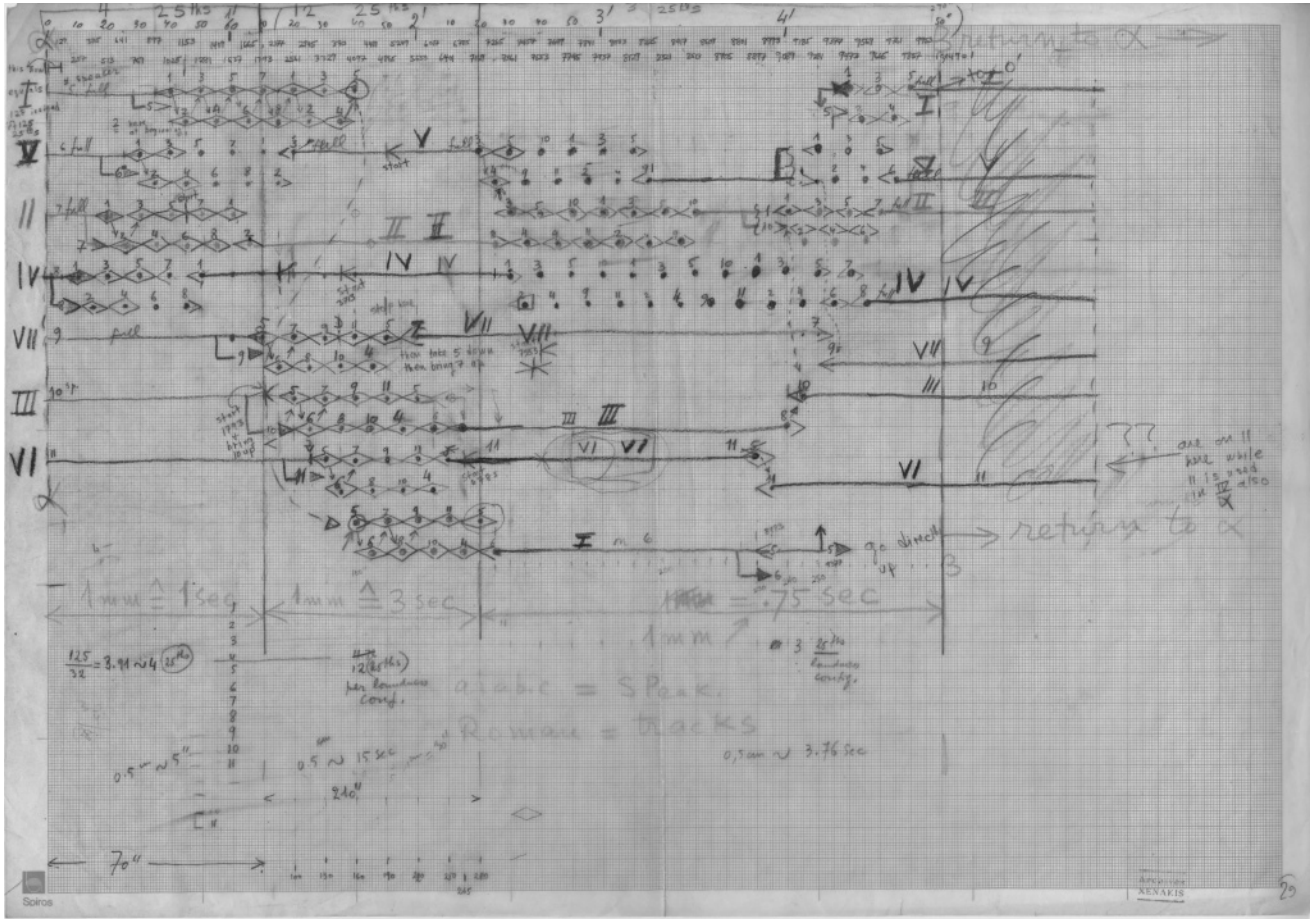


Figure 6

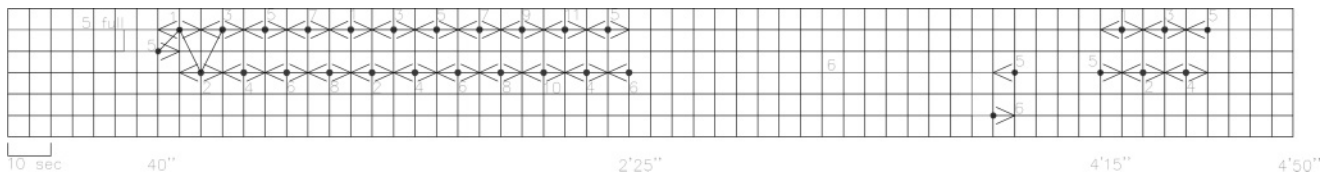


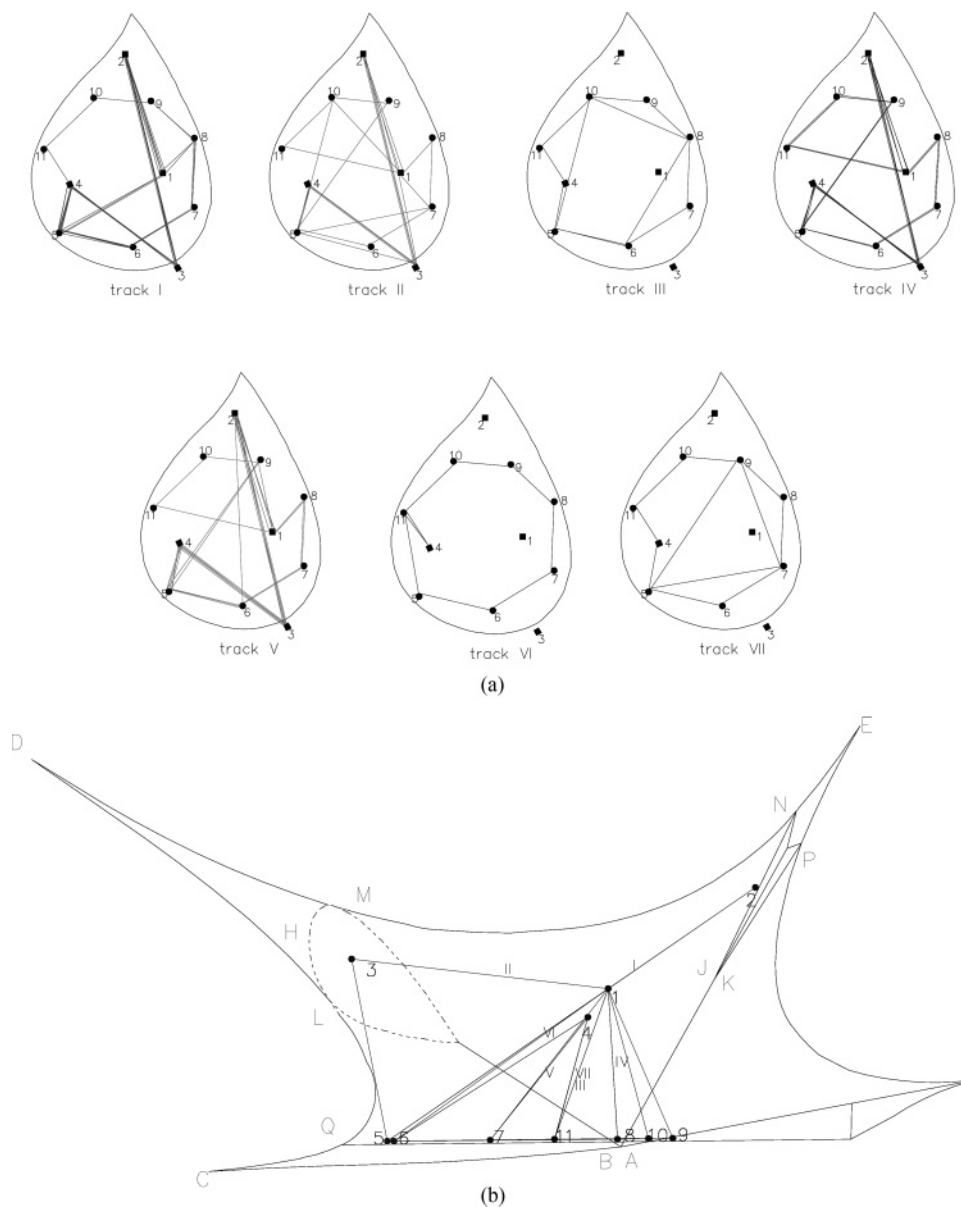
Figure 7

the relative block of information (1/25 sec) needed for automation of the performance. For the first 70 sec, 1 mm of graph paper corresponds to 1 sec, such that every 5 mm we find 128 blocks (5 sec should actually be 125 blocks). From 70" to 140", 1 mm corresponds to 3 sec, such that every 5 mm we find

384 blocks (3 × 128). Finally, from 140" until 290", 1 mm corresponds to 0.75 sec, such that every 5 mm we find 96 blocks (0.75 × 128). Could this possibly mean that the density of the events taking place was changing over time? Some of these numbers are used by Xenakis to indicate the sound's position

Figure 8. Transcription of the first 4'50" for the seven tracks over the eleven loudspeakers as shown in Figure 6, viewed from above (a) and from the side (b). Drawing by the

author. A color-coded version is available at http://www.mitpressjournals.org/doi/suppl/10.1162/COMJ_a.00437.



in space, its loudness, or even the light event to be executed by the computer program at that point in time. Otherwise, what else can the note "starts 1793 + bring 10 up" in track III mean, other than an instruction to start executing the information stored inside the 1,793rd 1/25-sec block (concerning loudness or other elements of the performance, such

as light configuration) and to go from loudspeaker 10 to loudspeaker 5 (referring to sound movement)? It can be supposed from the presence of these numbers that this version of the spatialization is almost final, because the computer program was set up in the last four months before the Parisian premiere.

Table 1. Sound Score

108	0.0	2748	II 4	14	TRACK1	2	>0	2<	-5.12	1	2	30	2	>2	1<			
						2	>1	2<	2	2	3	2	3	4	2	4	5	
						2	5	6	2	6	7	2	7	8	2	8	1	
						2	1	2	2	2	3	2	3	4	2	4	5	
						2	5	6	2	6	7	2	7	8	2	8	9	
						2	9	10	2	10	11	2	11	4	2	4	5	
						2	5	6	1	6	85	2	6	5	1	5	20	
						2	5	1	2	1	2	2	2	3	2	3	4	
						2	4	5	1	5	45	2	5	1				
108	45	2703	II4	8	TRACK2	2	>0	7<	-5.12	2	7	8	2	8	1			
						2	1	2	1	2	80	2	2	3	2	3	4	
						2	4	5	2	5	9	2	9	10	2	10	11	
						2	11	1	2	1	2	2	2	3	2	3	4	
						2	4	5	2	5	9	2	9	10	1	10	25	
						2	10	1	2	1	2	2	2	3	2	3	4	
						2	4	5	2	5	6	2	6	7	1	7	35	
						2	7	1	2	1	2	2	2	3	2	3	4	
						2	4	5	2	5	6	2	6	7				
51	70	2678	II4	8	TRACK3	2	>0	<10	-5.12	2	>10	<5	2	5	6			
						2	6	7	2	7	8	2	8	9	2	9	10	
						2	10	11	2	11	4	2	4	5	2	5	6	
						2	6	8	1	8	110	2	8	10	1	10	120	

“Sound score” with movements of the seven tracks numerically codified, probably written by Cornelia Colyer (Archives CEMAMu, dossier 123). The meaning of the numbers and columns is discussed in the main text of this article. Original handwritten table transcribed by the author.

can be found at the archives of CEMAMu, in a document named “sound score” (Archives CEMAMu, dossier 123). This document could be the “program-score” mentioned by Xenakis. The author of this program is probably Colyer, despite the fact that her name is not mentioned anywhere in the document, based on a comparison of the graphic character of this document with texts found at the archives Xenakis and signed by Colyer. The author of this program distinguished two states of sound distribution. State 1 was described as:

Given track to given speaker during given # of seconds at full alternation (ex. 1–5–10 that means the first track at the 5th loudspeaker for 10 seconds).

This could be what Xenakis called static stereophony in his article “Note sur un ‘geste Electronique’” (Xenakis 1958). On the other hand, state 2 was described by Colyer as:

Given track moving from speaker A to speaker B. We add a fourth parameter when we want to change # sec for a to b. This new speed stays in effect until next change (ex. 2-5-6-2, that means the second track moves from speaker No. 5 to speaker No. 6 in 2 seconds).

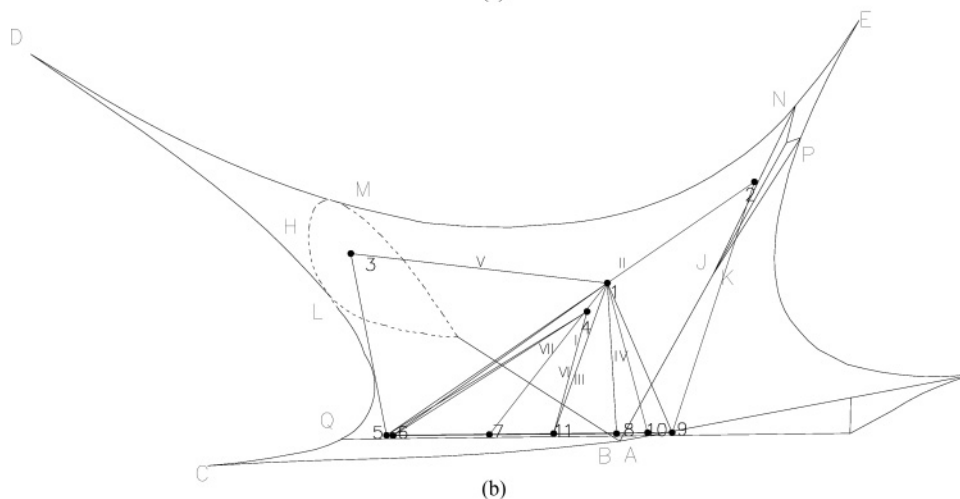
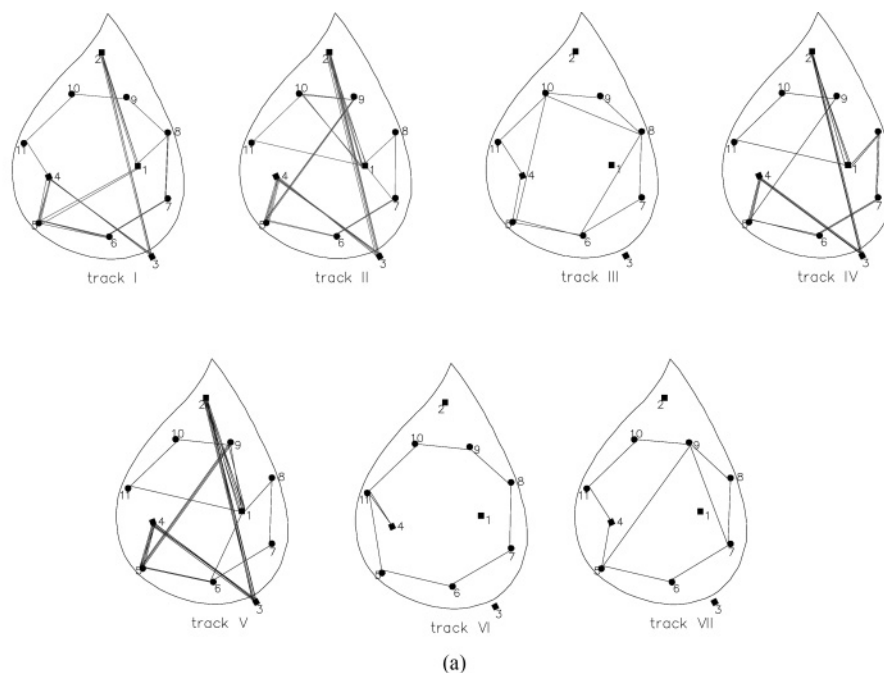
This could be what Xenakis called kinematic stereophony in that same article.

Next to these instructions, we find a table with the movements of the seven tracks encoded numerically, reproduced in Table 1. For example,

Figure 10. Transcription of the numerical “sound score” (Table 1) for the seven tracks over the eleven loudspeakers into Diatope’s space. Drawings

by the author. Color-coded versions are available at http://www.mitpressjournals.org/doi/suppl/10.1162/COMJ_a.00437 and at

http://www.mitpressjournals.org/doi/suppl/10.1162/COMJ_a.00437.



reading Table 1 horizontally, track I starts at state 2, meaning the sound moves from 0 (probably silence?) to speaker 2 in 5.12 sec. Then it passes to state 1, as the sound stays at speaker 2 for 30 sec and then moves on to speaker 1 in 5.12 seconds. Here we do not have a new fourth parameter, so we reuse the previous value for the parameter, following the programmer’s notes that “this speed stays in

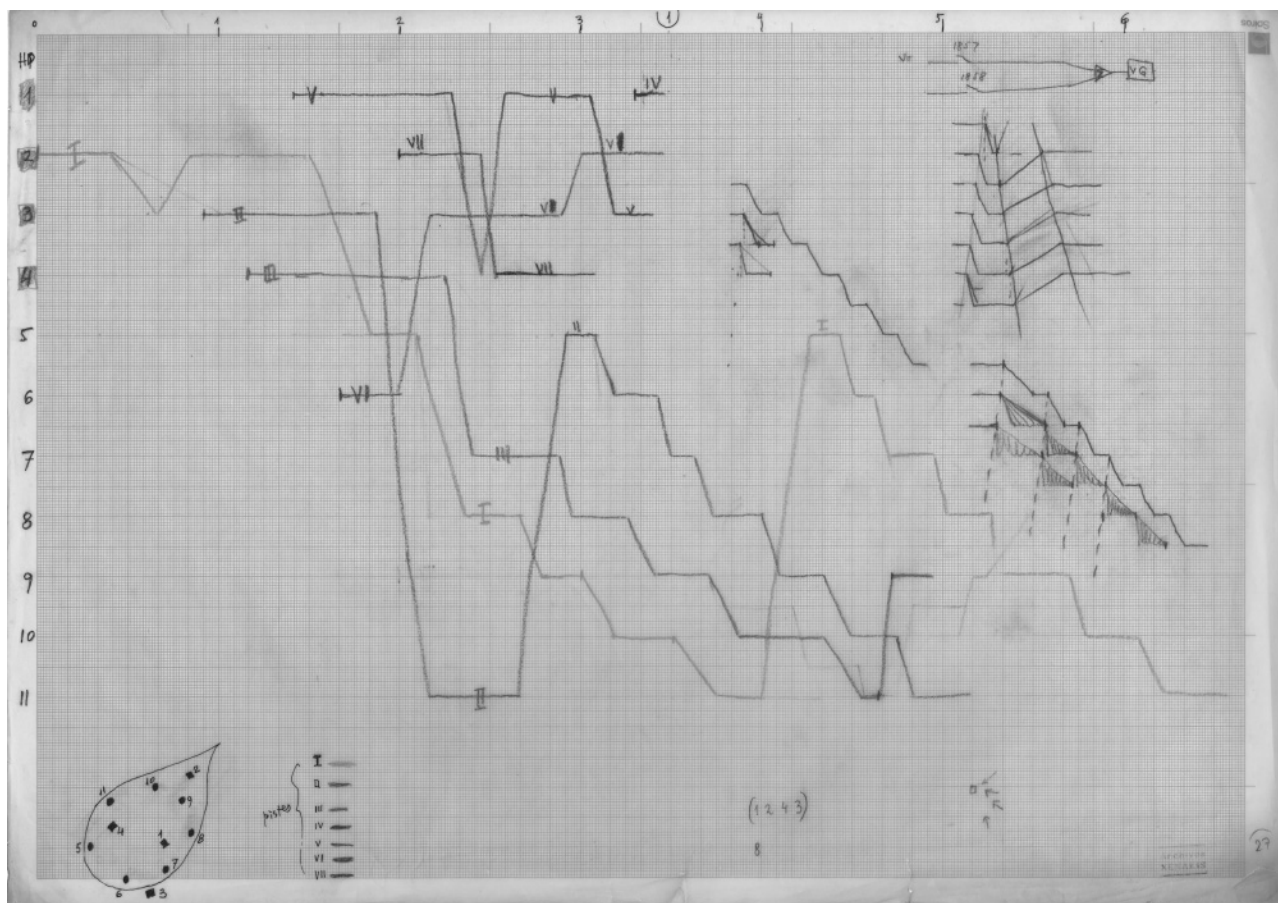
effect until the next change is mentioned.” All the commands of this table can be read in the same way.

If we now transcribe the sound movements of the seven tracks from the above sound score of Table 1 into *Diatope*’s space, we obtain Figure 10. Here, tracks I, II, IV, and V are at the beginning, following the trajectory 1–2–3–4 many times. This means they are moving over the upper loudspeakers and then

Figure 11. The evolution of the seven tracks over the eleven loudspeakers for the first 6 min, represented here on a two-axis system (loudspeakers versus

time). A color-coded version is available at <http://www.mitpressjournals.org/doi/suppl/10.1162/COMJ.a.00437>. (Reprinted with

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more or less forming circles over the floor-based loudspeakers. At the same time, tracks III, VI, and VII form circles on the floor-based loudspeakers without using the suspended loudspeakers (with the exception of speaker 4). Xenakis's notes describing the first minutes of the piece also indicate these movements: "On the upper four and then circle" or "galactic dust . . . from the upper loudspeakers."

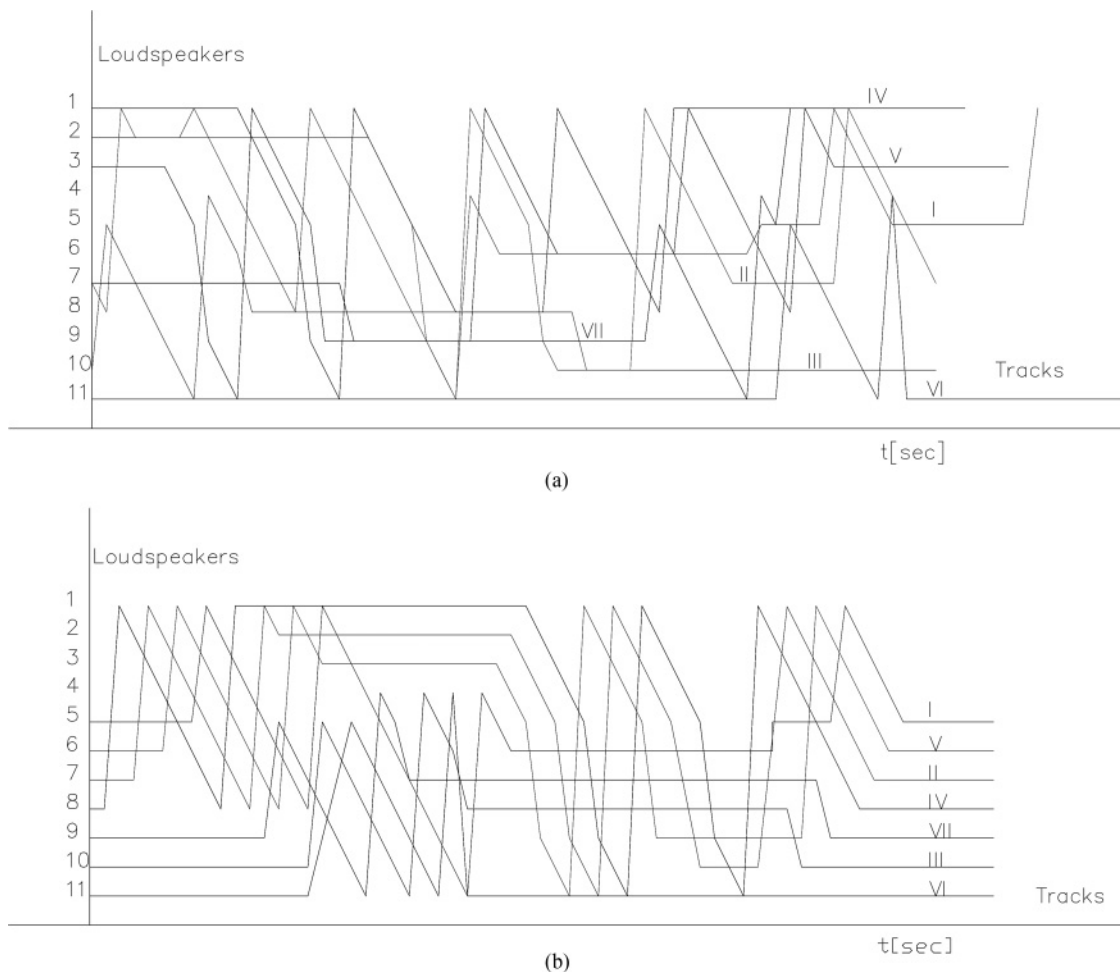
The numerical sound score of Table 1 may well be the transcription of the sound's distribution plan (cf. Figure 6) made by Xenakis for the first 4'50", since their resulting sound movements are quite similar (see Figures 8 and 10). In addition, their sound speed is almost the same (movement between two loudspeakers in 5 seconds for Xenakis's plan and in 5.12 seconds for the sound score of Table 1). Nevertheless, we cannot say if the sound movements

of the numerical sound score were kept unchanged, as in the same folder at CEMAMu's archives we also find "sound tests" using slightly different rates for the sound speed and the duration of sound movements. This does not prevent us, though, from assuming that the movements described here could be very close to the ones conceived and followed during the whole or a part of the performance. In any case, there is sufficient evidence that Xenakis organized the sound movements of *La Légende d'Eer* inside the *Diatope's* space with great precision.

In concluding this section, it is interesting to see how the alternation of the loudspeakers for the above spatialization was conceived. A schema found in the archived materials serves here as a guide (cf. Figure 11). It is an A3-format page in size and represents the evolution of the

Figure 12. Graphic representations of the numerical sound score for the seven tracks over the eleven loudspeakers (a) and sound movements for the first 4'50" (b), both in two-axis systems

(loudspeakers versus time). Plans drawn by the author. A color-coded version is available at http://www.mitpressjournals.org/doi/suppl/10.1162/COMJ.a_00437.



seven tracks over the eleven loudspeakers for the first 6 minutes of the piece in a two-dimensional system (loudspeakers versus time). Likewise, we can geometrically represent the numerical sound score of Table 1 or the plan of 4'50" from Figure 6 in a similar two-axis system (see Figure 12). In all these schemata, the lines parallel to the time axis show state 1 of the sound (that is, its static distribution) while the lines forming an angle with this axis show state 2 of the sound (that is, its kinematic distribution).

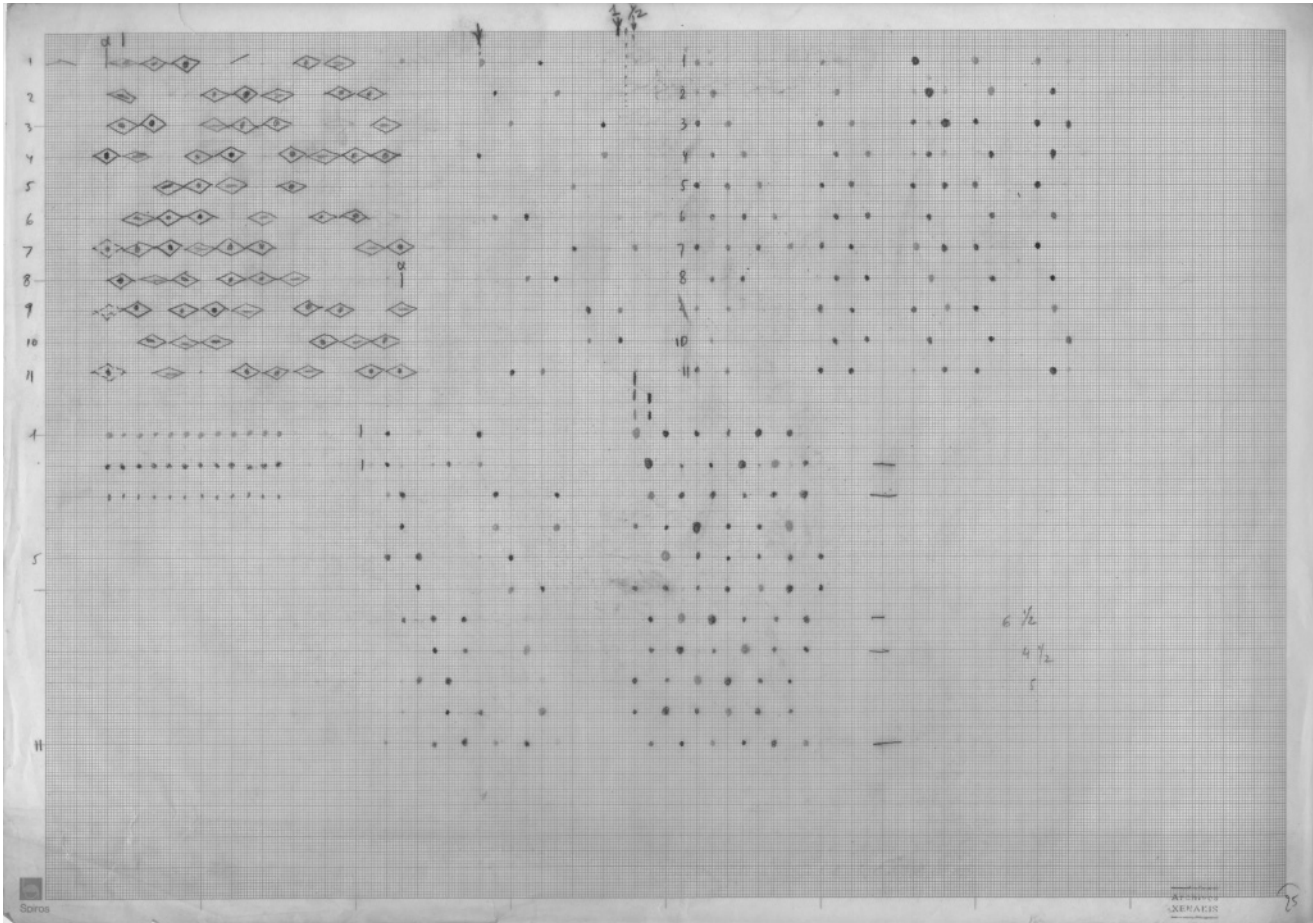
Moving backwards, similar schemata could be derived from various sketches of configurations of colored points made by the architect-composer on graph paper also found in the Xenakis Archives

(X[A] 11-7, pp. 12, 25, and 26). As shown in Figure 13, seven series of points (in the original with distinct colors, probably representing the seven tracks) are organized diagonally in eleven lines (representing the eleven loudspeakers) on graph paper. (Each box of the graph paper represents a time unit, perhaps 5 seconds.) If, as in Figure 14, we join points of the same color by a line, we represent the sound movements of the seven tracks over the eleven loudspeakers over time, exactly as in the diagrams drawn with two axes in Figure 12. This simple graphic method, used to choose and connect loudspeakers and tracks, although different, may not be all that far from the sophisticated method of sieves used in Xenakis's instrumental music from 1977 to

Figure 13. Seven series of points (colored in the original and probably representing the seven tracks) organized diagonally in eleven lines

(representing the eleven loudspeakers) on graph paper. A color-coded version is available at <http://www.mitpressjournals.org>

[/doi/suppl/10.1162/COMJ_a.00437](https://doi.org/10.1162/COMJ_a.00437). (Reprinted with kind permission of the Collection famille Xenakis from X[A] 11-7, p. 25. All rights reserved.)



1993. In this period, Xenakis used sieves to choose the values of certain sound parameters, such as pitch and note duration (cf. Gibson 2011, pp. 81–114).

It is interesting to add that Xenakis had been literally “drawing” sound movements ever the since “Notes pour un ‘geste électronique’” and *Concret PH*, which was diffused inside Philips Pavilion. While working on the spatialization with the Philips engineers, Xenakis conceived the sound as moving very quickly across a series of loudspeakers (points), placed along the lines of the hyperbolic paraboloids of the pavilion. Next to a sketch of the pavilion found in his diary (see Figure 15), Xenakis notes *des éclairs de sons = droites d’un coup* (“flashes of sound = lines all at once”). Here the lines of the hyperbolic paraboloids of the pavilion were colored

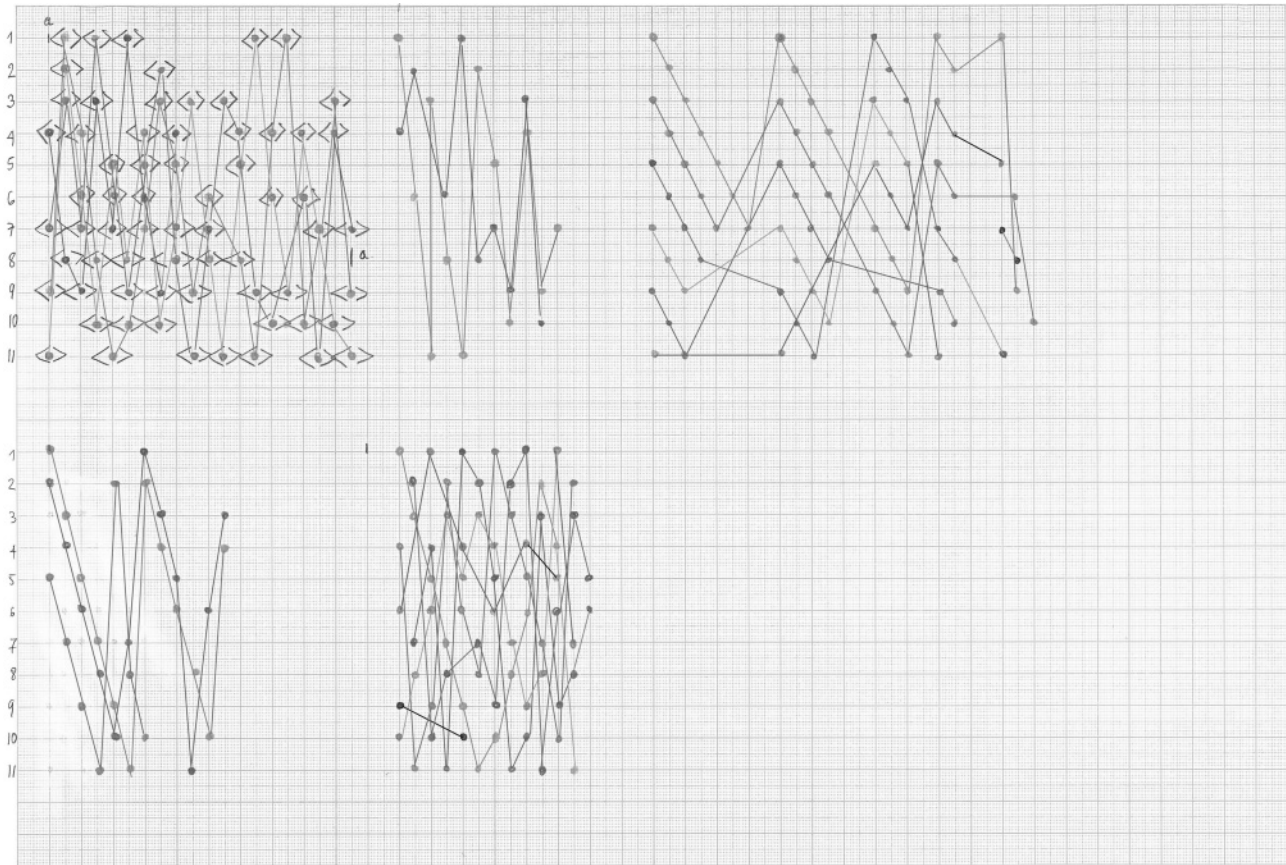
differently to point out each of the loudspeaker groups used to create the impression of “sonic” lines. This sonic geometry, which is the basis of the spatialization of the *Concret PH* (or *Interlude sonore*, as it originally entitled in 1958), has been meticulously studied by Xenakis in three A3-format pages. This documentation, called *Partition stéréophonique* (Collection famille Xenakis), had been thought to be lost for over 50 years (cf. Tazelaar 2013, pp. 153–157; Kiourtsoglou 2016, pp. 220–225).

The Light Show of *Diatope*

For the light show, which was part of the performance that Xenakis imagined for *Diatope*, four

Figure 14. The same point configurations as in Figure 13, joined by lines. Plan drawn by the author. A color-coded version is

available at http://www.mitpressjournals.org/doi/suppl/10.1162/COMJ_a_00437.



lasers were used (one red and three green) and 1,680 flashing electronic lights were distributed around a network of cables, affixed 50 cm below the metallic structure and following its parabolic form. Six glass columns, called a “well of light,” were placed inside the audience space, bearing some of the 400 reflecting mirrors (needed for the lasers’ trajectories). These mirrors were positioned in the form of a helix, and the rest were placed together with the lasers outside the security barrier. A false floor was created with glass blocks, lighting up the space and leaving about 60 cm below for cables. The electronic control panel was situated inside a truck near the tent, where a technician verified the flow of the performance.

Xenakis composed the light show as a musical score, describing what each bulb and laser had to do every 1/25 sec. Using lasers, he created configurations of continuous shapes with names

like lotus, anemones, spiders, wheels, dropper, omega, and so on, and sequences of flashing lights created glimmering “galaxies,” a “fluid star,” and “spirals” (see Figures 16 and 17). To study and calculate the duration of these light events, he used mathematical functions, “going from imaginary number (complex) to probability distributions” (Xenakis 1978, p. 12). Here too, Xenakis literally drew the laser trajectories and the configurations of the flashing lights. He used points (flashing lights) and lines (lasers) for the light show as he had done for the spatialization of the music, with points standing for loudspeakers and lines representing movement of sound.

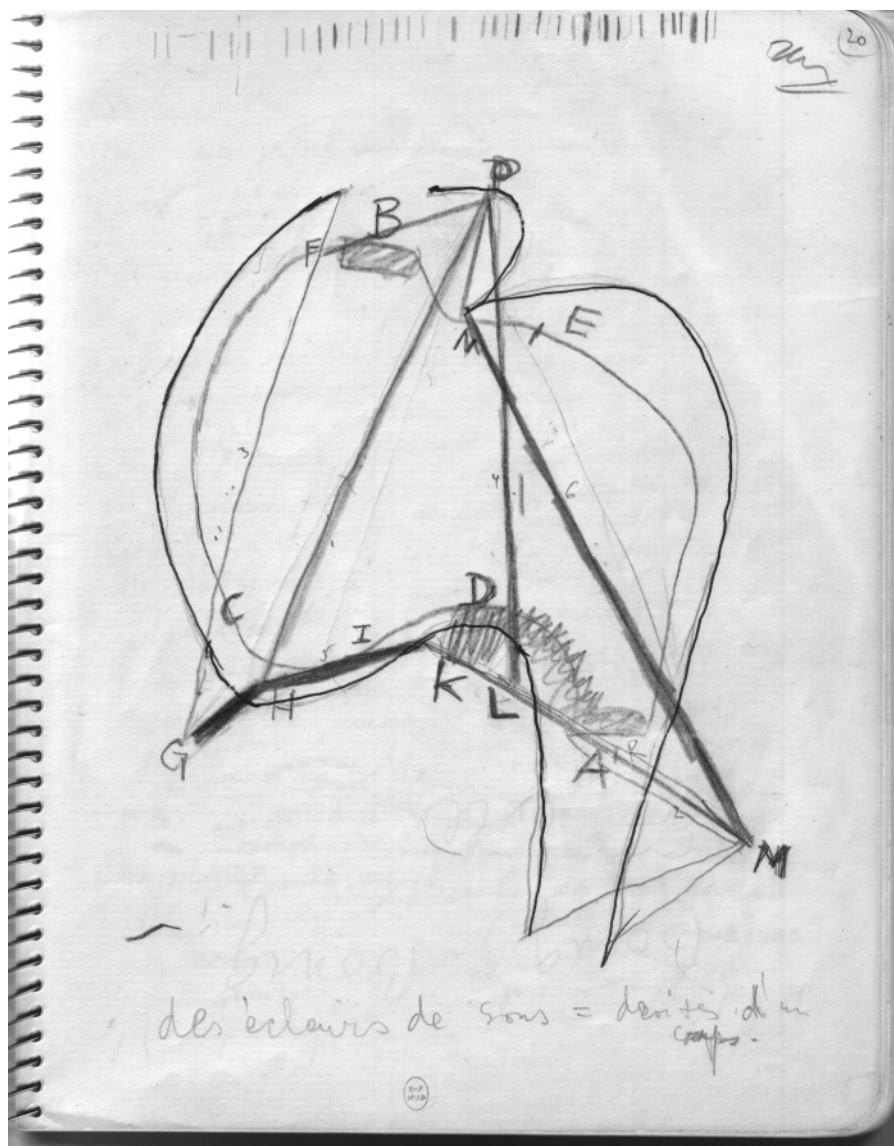
Nevertheless, as Dominique Druhen wrote,

Music and light are independent in this performance. The way light is used and the routes

Figure 15. A sketch taken from one of Xenakis's diaries. The handwriting at the bottom of the page reads *des éclairs de sons = droits d'un coup* ("flashes of sound = lines all at

once"), The groups of loudspeakers on the hyperbolic paraboloids of the Philips Pavilion form "sonic" lines. A color-coded version is available at <http://www>

[.mitpressjournals.org/doi/suppl/10.1162/COMJ_a.00437](http://www.mitpressjournals.org/doi/suppl/10.1162/COMJ_a.00437). (Reprinted with kind permission of the Collection famille Xenakis from notebook No. 20, p. 20. All rights reserved.)



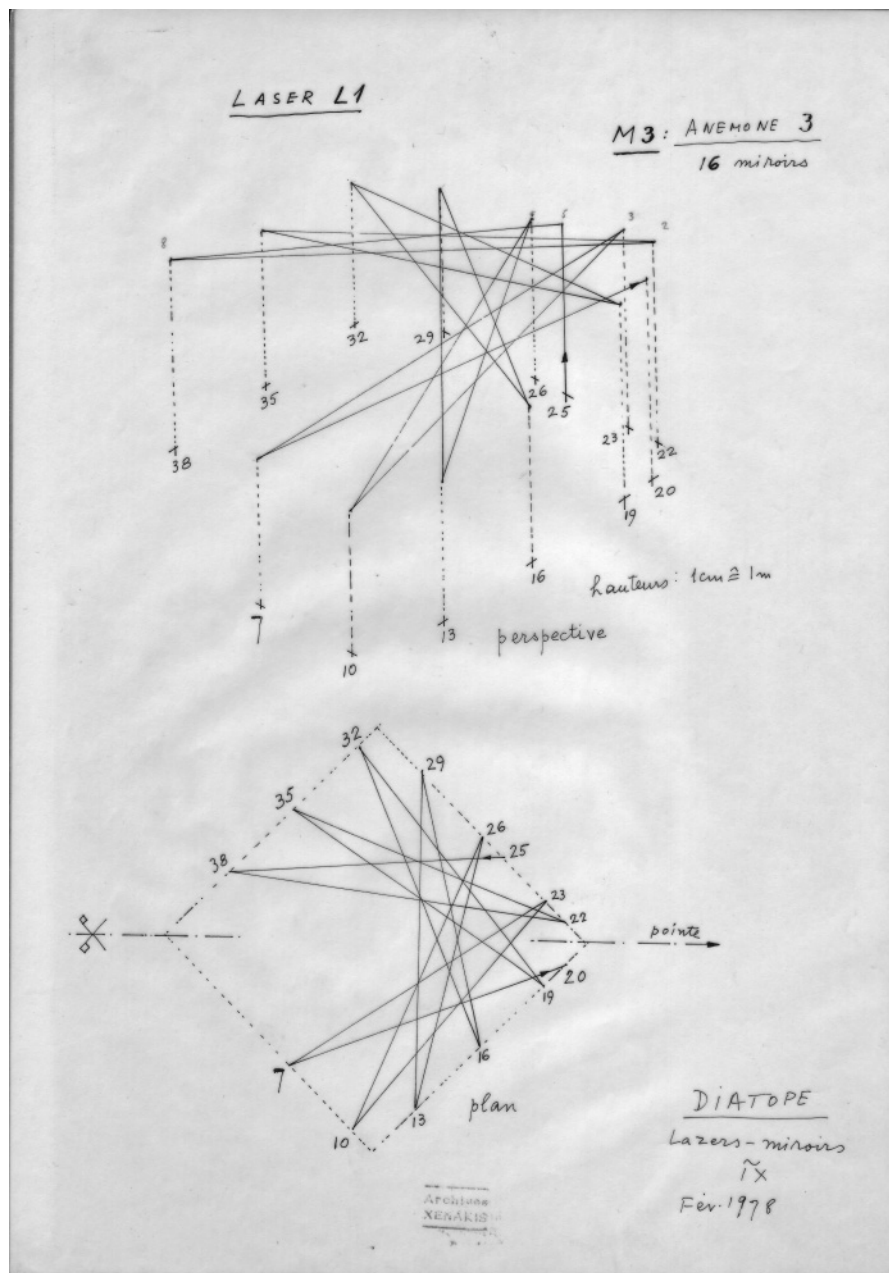
created by the [apparent] motion of light are programmed and automated, but the confluences that are produced with music—which is also fixed in its production—are fortuitous and different at every presentation (Druhen 1995).

This is consistent with Xenakis's artistic attitude: It was not his habit to "translate" directly from one form of art into another, but rather to

provoke similar or complementary sensations using different media. The distinct levels of *Diatope* (music, architecture, and light show) were neither interdependent elements of the work nor merely disparate artistic projects merged together. Xenakis presented a four-dimensional theater based on analogies between diverse aspects of space-time reality. To achieve this, he used geometry (points and lines) as a conceptual tool, based on the premise that this

Figure 16. Laser configuration called “anemone” represented by lines, to be produced by reflecting the laser beam

with mirrors. (Reprinted with kind permission of the Collection famille Xenakis from X[A] 11-6. All rights reserved.)



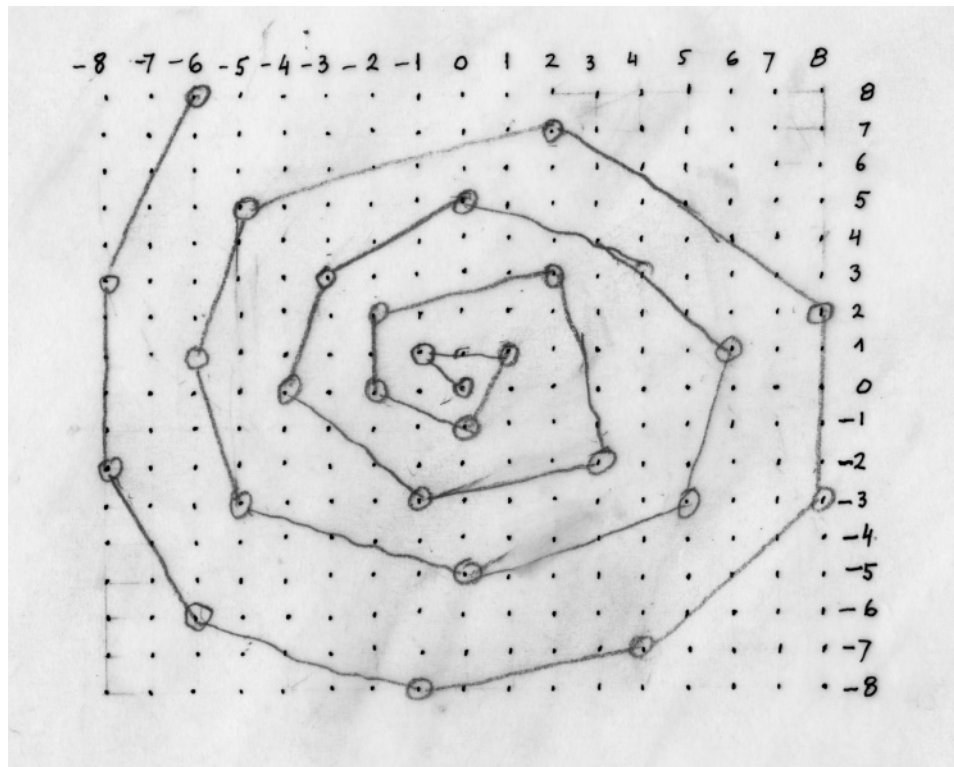
kind of representation could be abstract enough to refer both to architectural forms and to the distance covered by light and sound.

It is interesting to point out that, twenty years earlier, Xenakis had disagreed with Le Corbusier's

use of images for a visual component for *Le Poème électronique* in the Philips Pavilion; the new art he was searching for was abstract and nonfigurative (Delalande, 1997, pp. 113–114). Xenakis would have to wait until the mid 1970s and his *Polytope de*

Figure 17. Flashing light configuration using points. Produced by turning on the bulbs successively or all together. (Reprinted

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Cluny and *Diatope* to realize this dream. For him, *Diatope* is “neither a ballet nor an opera” (Xenakis 1985, p. 182) but abstract theatre (in the broadest sense of the term), in the same way that the natural phenomena of storms and thunder are. Regarding *Diatope* as such, we can understand that the preexisting texts accompanying the performance (Plato’s *Republic*; Blaise Pascal’s *Pensées*; the *Hermitic Corpus*, attributed to Hermes Trismegistus; *Siebenkäs*, by Jean Paul; and Robert Kirshner’s article in *Scientific American* “Supernovae in Other Galaxies”) were not “translated” by Xenakis into light images or musical themes. Instead, they were presented to the public like the *Diatope*’s “arguments,” as they describe in another fashion some of the questions or sensations that music and light were evoking. Richard Barrett puts it well when he writes that the texts

provide a selection of possible points of departure from which to enter the music, but also might draw the listener outwards from

the music to some fascinating manifestation of human thought. While Xenakis himself is not normally at his most eloquent when giving verbal expression to his ideas (nor, I am sure, would be claim to be), he does not appropriate these texts to speak for him: They speak for themselves, but in doing so illuminate the music—not what it consists of or how it came about, but why (Barrett 2002, p. 79).

Continuity and Evolution of Xenakis’s Creative Instinct

In *Diatope*, Xenakis literally “drew” the spatialization of the music and the form of the light events. Points and lines represent, respectively, static or moving sounds and discontinuous or continuous light configurations. From working on graph paper and thinking of sound in terms of points and lines, Xenakis conceived a space. That geometrically

defined sound-space was also one that could be transcribed by numbers; the light and sound configurations were, it is worth remembering, converted into a digital automation program, in which every command was represented by a sequence of binary code. As early as 1958, according to Xenakis, the electronic, digital infrastructure was the defining characteristic of the artist of a new era: "a new conceptual conscience, the abstraction, and a technical infrastructure—the electronic—are changing the human civilization" (Xenakis 1971, p. 150).

In conclusion, it can be assumed that the particular architectural form of the *Diatope* space determined the music of *La Légende d'Eer* in a way that Xenakis had long sought:

But I say also that the effect of the architectural forms has an almost tactile influence on the quality of music or of the spectacle within which they are presented. And this, beyond any considerations of the acoustics or of the optimal proportions of the spectacle or the sonic experience (Xenakis 1978, p. 9).

In 1978, with *Diatope*, the composition *La Légende d'Eer*, and his text "Geste de lumière et de son," Xenakis was still working in an area he had begun twenty years earlier, in 1958, with the Philips Pavilion, *Concret PH*, and the text "Notes pour 'un geste électronique.'" The close relationship between space and sound would also be a crucial question in his later project for the Cité de la Musique in Paris in 1984. Xenakis's imagination never ceased finding new ways to work on ideas that had preoccupied him since the very beginning.

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