INTERSECTION OF ARCHITECTURE AND MUSIC AS *GESAMTKUNSTWERK* IN IANNIS XENAKIS'S SELECTED WORKS

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ABSTRACT

INTERSECTION OF MUSIC AND ARCHITECTURE
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This thesis focuses on the two selected works of the architect/engineer/composer Iannis Xenakis (1922-2001); Philips Pavilion (1956-58) and *Le Diatope* (1978). It places these works at the intersection of architecture and music by showing how they combine spatial, musical and visual performances. Accordingly, it discusses them as exceptional twentieth-century examples of *Gesamtkunstwerk*; "total work of art."

Key words: Architecture and Music, Iannis Xenakis, *Gesamtkunstwerk*, Philips Pavilion, Le Diatope.

ÖZ

MİMARLIK VE MÜZİĞİN VE KESİŞİMİNDE
GESAMTKUNSTWERK OLARAK
İANNIS XENAKİS'İN SEÇİLMİŞ ÇALIŞMALARI

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Bu tez, mimar/mühendis/besteci Iannis Xenakis'in (1922-2001) iki seçilmiş yapıtı, Philips Pavyonu (1956-58) ve *Le Diatop* projeleri (1978) üzerine odaklanır. Mekan, müzik ve görselliğin bu yapıtlarda nasıl bir araya geldiğini göstererek onları mimarlık ve müziğin kesişimine yerleştirir. Bu doğrultuda, onları *Gesamtkunstwerk*; "bütünsel sanat yapıtı" kavramının iki kuraldışı yirminci yüzyıl örneği olarak tartışır.

Anahtar Kelimeler: Müzik ve Mimarlık, Iannis Xenakis, *Gesamtkunstwerk*, Philips Pavilion, Le Diatope

to my brother Cem

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INTRODUCTION

1.1 IANNIS XENAKIS: BIOGRAPHICAL NOTES

Iannis Xenakis, who was an architect, civil engineer, composer and music theorist, was born in Braïla, Rumania in 1922. His farther Clearchos Xenakis and his mother Fotini Pavlou were members of the Greek diaspora. In 1932, Xenakis was sent to a boarding school for which he left Rumania and went to Greece. He began to study ancient Greek philosophy, drama, and also piano and music theory.[1] After spending his early education years enthusiastically to learn about miscellaneous fields, he started to compose musical pieces in 1938. As he recalled:

> One day, I heard *Beethoven's Fifth Symphony* and that hit me like an apocalypse. From then on, little by little I became involved in music. But never imagining I would practice music, neither play nor compose, for my decision to write music came only much later, when I was 17 or 18.[2]

After graduating from the boarding school on the Aegean island of Spetsai, Xenakis planned to study architecture and engineering and moved to Athens to get prepared for the entrance exams for the Institute. In the meantime, he took lessons in harmony and counterpoint with Aristotelis Koundouroff (1896–1969). In 1940, Xenakis succeeded to pass the exams and enrolled the Athens Polytechnic Institute. Due to the war, however, it took seven years to receive his engineering diploma. During the German occupation, he joined the resistance first in the Greek nationalist and later in the communist organizations and he was often confined in prison. He also fought against the British forces and on January 1, 1945, while involving in a street fight against the British tanks, he was wounded when a shell hit his face. He was first considered dead and left there, and then, his father found

[1] It seems that he owed his deep interest in philosophy to "a wonderful teacher" (Xenakis, *Music and Architecture* (Pendragon Press, 2008): xvi).

[2] Iannis Xenakis, *Music and Architecture* (Pendragon Press, 2008), xvi.

him and took him to a hospital. After several operations, he survived but he lost his left eye and serious permanent wounds remained on his face.

After releasing from the hospital, Xenakis went back to the Polytechnic Institute and in 1947, he defended his final thesis on reinforced concrete and received his degree in engineering. During those years, however, he never gave up on his political activities, and he was imprisoned several times. Finally, upon the new government's search for the former resistance members, he had to escape from Greece. So, by means of a falsified passport, which his father managed, he left his country to go to the United States, where one of his brothers was studying philosophy, but, then, decided to stay in Paris for a brief period of time. He arrived in Paris on November 11, 1947 and although his intention was "to study astrophysics, math, archaeology and music" in the United States, he spent most of his engineering, design, architecture and music career in Paris and he did not have a chance to go back to his country for a long time.[3] He was sentenced to death for political terrorism in 1948 by the Greek military tribunal and his father and brother were also put into prison. Xenakis recalled those tumultuous years of his life in these words:

> For years I was tormented by guilt at having left the country for which I'd fought. I left my friends—some were in prison, others were dead, some managed to escape. I felt I was in debt to them and that I had to repay that debt. And I felt I had a mission. I had to do something important to regain the right to live. It wasn't just a question of music—it was something much more significant.[4]

Quite remarkably, he also added: "Even before the end of the war, I decided to compose music, despite the distress I was feeling. Only music enabled me some respite."[5]

[3] Xenakis, *Music and Architecture*, xvii.

[4] Bálint A. Varga, *Conversations with Iannis Xenakis* (London: Faber and Faber, 1996): 47

[5] Xenakis, *Music and Architecture*, xvi

1.1.1 Iannis Xenakis as an Architect

As an illegal immigrant, Xenakis had to find a job. Since he had an engineering diploma, he started looking for a job as an engineer and found one in the office of an architect, whose name he never heard of.[6] (Figures 1.1.1.1a-e) It was Le Corbusier's office, ATBAT (*Atelier des Batisseurs*, or Builder's Studio): "I was recommended to some communist engineer, but since they didn't offer me any work – I don't know why – I finally accepted a job in Le Corbusier's Studio."[7] It was his first and only job and it allowed him to continue his study of music in his remaining time.[8] At first, Xenakis started to work by calculating the resistance of certain building materials, and as he wrote humorously: "Once in a while, when I didn't like a project, I would respond, 'No, it won't hold up. You should construct in this way instead.' And they listened to me."[9] One day, he told Le Corbusier that he would like to practice architecture and to design projects as well. Upon Le Corbusier's approval, Xenakis started working as an architect and a designer and he was involved in most of the projects in Le Corbusier's Studio.

[6] Xenakis, *Music and Architecture*, 4.

[7] Xenakis, *Music and Architecture*, xvii.

[8] Xenakis, *Music and Architecture*, xvii.

[9] Xenakis, *Music and Architecture*, xvii.

Figures 1.1.1.1a-b Iannis Xenakis with Le Corbusier
Figures 1.1.1.1c-e Iannis Xenakis
Source: Xenakis, *Music and Architecture*, 9; www.iannis-xenakis.org

A Dominican convent/monastery of La Tourette was the first project on which Xenakis worked as a "project architect", directly under Le Corbusier's supervision. In the La Tourette project, he designed the panes of glass, located on the three exterior façades, the "Undulating Glass Panes" or as Le Corbusier preferred to call "Musical Glass Panes."[10] (Figures 1.1.1.2 a-b) In fact, the last 5 pages of the Le Corbuier's *Modulor II* volume ends with Xenakis's work for the development of the Undulating Glass Panes. As Sharon Kanach remarks, "[The designing process of these panes] combines the pure mathematics of the *Modulor*, with Xenakis' personal and musical interpretation, applying the result as an engineer and architect."[11]

Xenakis also designed "cannons of light" and "machine guns of light" for La Tourette, and he positioned them to catch the sunlight during the summer and winter solstice which revealed his interest in astronomy as well.[12] (Figures 1.1.1.3a-b)

[10] Xenakis, *Music and Architecture*, 41.

[11] Sharon Kanach, "Undulating Glass Panes" in Xenakis, *Music and Architecture*, 41.

[12] Xenakis, *Music and Architecture*, 49.

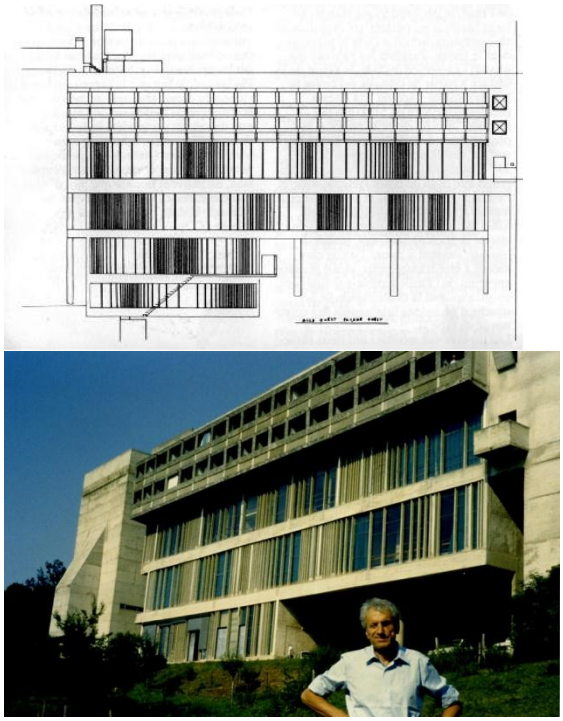

Figure 1.1.1.2a Xenakis's design for La Tourette's undulating glass panes.
Source: Xenakis, *Music and Architecture*, 42.
Figure 1.1.1.2.b Xenakis in front of the La Tourette
Source: http://www.iannis-xenakis.org/fxe/archi/real.html (accessed 09.12.2011)

Figure 1.1.1.3a Light "machine guns" of the La Tourette designed by Iannis Xenakis (Photo was taken by Tom Ledger.)
Source: http://www.flickr.com/photos/ledgr/2951557120/ (accessed 06.09.2012)
Figure 1.1.1.3b Light cannons of the La Tourette (Photo was taken byAddison Godel)
Source: http://www.flickr.com/photos/doctorcasino/2746554069/ (accessed 06.09.2012)

During Le Corbusier years, Xenakis was generally involved in the structural calculations of the projects. Starting from the housing project of *Cité radieuse* in 1949, Xenakis gradually participated in Le Corbusier's projects more actively. Firstly, he calculated the use of reinforced concrete for *Cité radieuse*. In 1951, he

was assigned for the housing project of *Rezé-les-Nantes*. He worked not only on the calculation of the reinforced concrete, but also on the development of a new design method for pre-stressed concrete components and their super-positions.[13] In the same year, his participation in the Chandigarh project as a technical advisor for the reinforced concrete structure started. As part of the same project, he designed, in 1953, the Secretariat and the Assembly Buildings' interior of the lower chamber, upper part of the plug, and the façade.[14]

During his collaboration with Le Corbusier, Xenakis proved himself that he could manage all complex calculations and solve any kind of technical problems. Furthermore, Le Corbusier realized Xenakis's other vocations and potentials as well. He was known not only as knowledgeable in mathematics and enthusiastic in geometry, but also as a talented composer, and most importantly, as a creative designer/architect in the studio.

After working 12 years in Le Corbusier's studio, Xenakis was assigned to design the Philips Pavilion project for the World's Fair in Brussels in 1958. However, the project resulted in an authorship problem between Le Corbusier and Xenakis. On this problem Xenakis wrote, "When [Le Corbusier] saw that my work was being recognized by other people as well, I think he became jealous. Then he suddenly claimed to have done everything himself."[15] In a letter, written to Hermann Scherchen[16] on June 25, 1957, he explained his frustration clearly:

> I have been in Le Corbusier for ten years and like me, there are two or three colleagues, and in his last volume of complete works there is not a single mention of our names; it is Le Corbusier who designs and we do not exist. He works only half an hour plans… and all the responsibility of the work falls on our shoulders, both design and sometimes execution, he only signs … Here is the reality of Le Corbusier and Philips … I am not in vain, … but it is much deeper thing. I have confidence in justice in all its forms.

[13] Xenakis, *Music and Architecture*, 5.

[14] Xenakis, *Music and Architecture*, 298-299.

[15] Xenakis, *Music and Architecture*, 101.

[16] Hermann Scherchen (1891-1966) was a German conductor.

> When I was young, for it I battled, blow for blow, not hesitating to risk everything. When I do architecture, I give myself profoundly to it and also in music. If at the end of twenty years I find that this too is an illusion, I shall cross the road to the other side.[17]

So, realizing that Le Corbusier did not respect any of his works, Xenakis felt betrayed and left the studio in 1959.

After leaving Le Corbusier's studio, Xenakis continued to work "as an independent architect"[18] between 1961 and 1996. An important example from his post-Le Corbusier period is the project of the New National Music Conservatory (NNMC) designed for the *Cité de la Musique* competition in Paris (1984). [19] (Figures 1.1.1.4a-b)

He worked on this rich and experimental project with Jean-Lois Véret,[20] and as he explained, it was "the result of our desire to propose an architectural solution as original as possible."[21] Accordingly, it was based on a criticism of the architecture of the 1980s which was "subjected to historical mishap." For him, "after modernism such and atmosphere of laziness and narcissism [was] drowning the arts in general, be it in music, theatre, literature, painting, and naturally, architecture."[22]

[17] Xenakis, *Music and Architecture*, 104.

[18] Xenakis, *Music and Architecture*, 160.

[19] Upon the failure of the project at the competition, Xenakis criticized the jury severely: "The decision was taken somebody close to Mitterand who has no taste in architecture. I was told that Boulez was also against my project." Xenakis, *Music and Architecture*, 179. Here, Xenakis refers to Pierre Boulez (b. 1925), a composer of contemporary music, with whom he was not on good terms.

[20] Jean-Lois Véret (1927-2011) worked with Xenakis in Le Corbusier's studio. He was the founder of l'Atelier d'Architecture de Montrouge (1958-81).

[21] Xenakis, "*Cité de la Musique*, Paris: Project 1984" in Xenakis, *Music and Architecture*, 181.

[22] Xenakis, "*Cité de la Musique*, Paris: Project 1984", 181. For more information about the project, see 178-190.

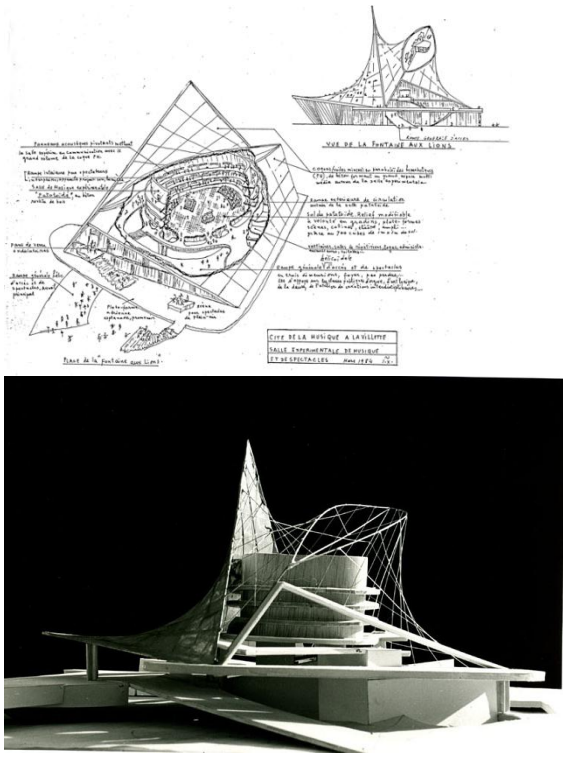

Figure 1.1.1.4a General plan for the *Cité de la Musique* Auditorium
Figures1.1.1.4b Scale model of the *Cité de la Musique* project
Source: www.iannis-xenakis.org

For the NNCM, Xenakis designed practice and theory classrooms, electronic music studios, audiovisual research centers, media library, communal spaces (cafeteria, gymnasium, student center, offices, etc.) as well as an experimental auditorium. As he explained, this auditorium created "an extraordinary multifunctional space for spectacles and encounters. Like a cellular membrane, it link[ed] the inside with outside, thanks to its transparency."[23] While working on the hyperboloid paraboloid structures, Xenakis developed the form of "patatoid" to avoid acoustic shadows and to create a rich reverberation. Accordingly, the auditorium, at its base, was in the form of a patatoid. It was curved all around and its degree was changeable. For him, it was an ideal place to listen to music, or in other words, a musical "jewel-box of sounds"[24]:

[23] Xenakis, "*Cité de la Musique*, Paris: Project 1984", 183.

[24] In his article "Places and Sources of Auditions and Spectacles" (1980) Xenakis used this term. He said: "the architecture in question must be conceived like a luminous musical-jewel box, like a

> In order to draw this characteristic into the third dimension, an 11° torsion is applied to the patatoid at the base … This offers both a remarkable combination of wavelengths without preferential effects and the effect of an architectural movement. It is important not to forget that in a "jewel box of sounds," the interior architecture may either caress or aggress the sounds within.[25]

Interpreted as "the fruit of Xenakis' years of personal reflection,"[26] the project for the *Cité de la Musique* was marked by a period in his life during which he became a well-known composer as well. It is perhaps for this reason that the project was also interpreted as a musical instrument in itself.[27]

1.1.2 Iannis Xenakis as a Composer

While working in Le Corbusier's studio, Xenakis studied composition with various conductors. After leaving the studio, he concentrated more on music and composition. Around 1952, Xenakis audited Olivier Massiaen's[28] classes in Paris Conservatoire where he met Karlheinz Stockhausen.[29] During those years, Xenakis was also in communication with Hermann Scherchen who encouraged Xenakis to perform his musical works and to do research in *Geavesano Blätter*. About this period of his life he said:

> When I decided to do only music, I was very distress because architecture was very important to me. I did it because I had to make a choice. Either go into research or become a businessman…but I didn't want to be someone's slave; I wanted to do research. [30]

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great masterpiece of instrumental building." Remarkably, in the same article, he refers to acoustic space as visual jewel box. Xenakis, *Music and Architecture*, 154.

[25] Xenakis, *Music and Architecture*, 185.

[26] Xenakis, *Music and Architecture*, 161.

[27] Kanach in Xenakis, *Music and Architecture*, 161.

[28] Olivier Massiaen (1909-1992) was a French composer.

[29] Karlheinz Stockhausen (1928-2007), who was a German composer, started to work on Schoenberg's 12-tone music in 1951 and developed concepts of spatial constructs for his compositions. Remarkably, a composition of him was performed in the German pavilion for Expo '70 in Osaka in which the audience was suspended in the equatorial plane of the sphere. (Mikesch W. Muecke and Miriam S. Zach, eds. *Resonance: Essays on the Essays on the Intersection of Music and Architecture*. Ames, (USA: Culicidae Architectural Press, 2007): 260)

[30] Xenakis, *Arts/Sciences: Alloys*, 57-58.

Among the institutions where he did research, taught and/or gave lectures were the Berkshire Music Center and Indiana University, both in the USA; "Centre National de la Recherche Scientifique" (the National Center for Scientific Research) and Sorbonne, both in Paris; the Institute Torcuati di Tella in Buenos Aires; and Gresham College in London. His works on music were performed at numerous festivals worldwide as well.

In the history of twentieth-century music, Xenakis held a distinguished place.

During the twentieth century, the western-music theory was redefined. The composers developed the 12-tone composition, atonalism, serialism, indeterminism and minimalism. These theories changed the composition methods substantially. Tonality, rhythm, form, harmony and other parameters of music, such as timbre, duration, and dynamics were redefined. The composers also searched for new tools to create new sounds, and accordingly, they used electronic devices in new musical sources.

Developed by Arnold Schoenberg (1874 –1951), who was an Austrian-born composer and a leader of the second Viennese School, the 12-tone technique was one of the major developments in the twentieth century music. The 12-tone method of composition replaced the old basis of tonality. The method suggested that all 12 notes of the chromatic scale were related only to one another and they were of equal importance. It was a definition of Serialism, meaning that the composers serialized all kinds of musical elements and used the series of values to have control in composition. Accordingly, they did not compose music in the traditional notation and created music through mathematical methods.[31]

Iannis Xenakis was among those composers who experimented with Serialism. However, it seems that his position in this group made him an outsider, holding a critical distance. As he explained:

[31] Bandur, Markus. Aesthetics of total serialism: contemporary research from music toarchitecture (Boston: Birkähuser, 2001)

> If the serialists use probability theory, then they have approached the position that I took against serial music twenty years ago. If the serialists expand by using the other domains especially stochastic domains, that it, use [sic] probability or dice throwing or things like that, then they are not in the orthodox realm of serial music.[32]

So, the important point in Xenakis's music was that he rejected not only traditional methods but also this avant-garde trend by building his own princible of "stochastic music" which he based on geometry and mathematics.[33] Furthermore, Xenakis used computer technology in composing his stochastic music which corresponded to almost a revolution in twentieth-century music.

So, Xenakis's deep interest in some branches of mathematics, such as probability theory, group theory, game theory, set theory, stochastic method, and geometry, and sieve theory[34] as well his background in Greek philosophy and music theory[35], revealed themselves in his compositions and designs. He used probability theory, aleatory distribution of points on a plane in *Diamorphoses* (1957-58), Maxwell-Boltmann law in *Pithoprakta* (1955-56), minimal constraints in *Achoripsis* (1956-57), Gaussian distribution in *ST/1O*, *Atrés* (1956-62), Markovian chains in *Analogiques* (1958-59), game theory in *Duel* (1959) and *Stratégie* (1962), group

[32] Michael Zaplitny and Iannis Xenakis. "Conversations with Iannis Xenakis." *Perspectives of New Music*, 14/1 (1975):95.

[33] See also Iannis Xenakis, *Formalized Music: Thought and Mathematics in Composition* (Stuyvesant,NY: Pendragon Press, 1991):1-43 where he discusses the relations between geometry/ mathematics and music.

[34] Sieve theory was developed by Xenakis. It was not only lends itself to total order, but is completely mechanizable, enabling widespread exploration in the future with the aid of computers and modern technology. (For more information about set thory and sieve theory on Xenakis' works see Michael Zaplitny and Iannis Xenakis. "Conversations with Iannis Xenakis." *Perspectives of New Music*, 14/1 (1975): 88,91)

[35] For Xenakis, European music was historically parallel to the successive attempts to explain the world by reason. (Iannis Xenakis, *Formalized Music: Thought and Mathematics in Composition* (Stuyvesant, NY: Pendragon Press, 1991): 1.
Similar to the relationship between the music of antiquity and the philosophy of Plato and Pythagoras, first developments in philosophy and then in the sciences, led to changes in musical composition

theory in *Nomos alpha* (1965-66), and set theory and Boolean algebra in *Hermna* (1961) and *Eonta* (1963-64).[36]

Xenakis believed the necessity of a new type of musician. He defined his ideal musician as an "artist-conceptor of new abstract and free forms, tending toward complexities, and then toward generalizations on several levels of sound organization."[37] For him, "the 'artist-conceptor' [would] have to knowledgeable and inventive in such varied domains as mathematics, logic, physics, chemistry, biology, genetics, paleontology (for the evolution of forms), the human sciences and history; in short of universality, but one based upon, guided by and oriented toward forms and architectures."[38]

1.1.3. Iannis Xenakis as an Architect and a Composer

Xenakis's architectural designs and musical compositions developed together by affecting each other during his career. When we look at Xenakis's approach toward this connection between music and architecture, we can see that mathematics, and more specifically, proportional relations play an inseparable role. Regarding these relations, Xenakis said:

> I think it is possible to feel mathematics. Let's take a very simple example, the problem of proportion. When you have two intervals of time, a long and a short one, you may proportion them so that the long one may be double that of the short one. The proportion is something that you can feel. You have to feel proportions in music, in architecture, in art wherever you use them or manipulate them. You cannot imagine them. And the same is true for larger, more complex theories. Of course, there are things that you don't care to feel. For instance, the solution of the second degree equation.[39]

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[36] http://mitpress2.mit.edu/e-journals/Computer-Music-Journal/Documents/Contents/html/mc-24-2.html

[37] Xenakis, *Arts/Sciences: Alloys*, 3.

[38] Xenakis, *Arts/Sciences: Alloys*, 3.

[39] Michael Zaplitny and Iannis Xenakis. "Conversations with Iannis Xenakis." *Perspectives of New Music*, 14/1 (1975):91.

It was especially during the design processes of La Tourette and Philips Pavilion/*Poème Électronique* that Xenakis found a close connection between music and architecture. He realized that problems in architecture were the same as in music.[40] The experiences he gained in these projects played a major role in his music, in his important early compositions, such as *Metastaseis* (1953-1954). It was the first major orchestral work that he composed when he worked on La Tourette. Two years later, Xenakis applied the use of string glissandi in *Metastaseis* in the design of the Philips Pavilion. These glissandi shaped the ruled surface of hyperbolic paraboloid shells of the Pavilion.[41]

After leaving Le Corbusier's studio, while his career in music was reaching a climax, Xenakis also worked as an independent architect. He authored a number of articles and essays on music and architecture as well.

Xenakis always worked enthusiastically on new projects and created several spatial compositions of light and sound which he collectively called 'Polytopes.' This term was derived from the ancient Greek words 'poly' (many) and 'topos' (place). Thus, the title designated spaces of light and color in one site. On the basis of his experience of Polytope spectacles, Xenakis deduced that "the future of music lies in the modern technology."[42] In an article that he wrote in 1980, he also asserted that "[this progress] will influence the evolution of both how we create and how we listen to music."[43]

While contemplating to find some principles about composition for more than twenty years, he was struggling with the "question: what architectural form is to be given to musical or visual performances."[44] Since he believed that architectural form would influence the quality of spectacle performed in it. However, as he

[40] Xenakis, *Music and Architecture*, 7.

[41] Marc Treib, *Space Calculated in Seconds : The Philips Pavilion, le Corbusier, Edgard Varèse* (Princeton, NJ: Princeton University Press, 1996):15.

[42] Xenakis, *Music and Architecture*, xx.

[43] Xenakis, *Music and Architecture*, xx.

[44] Xenakis, "The *Diatope*: a gesture of sound and light at the Pompidou Center and *La Légende d'Eer* (First Version, Paris, 1978) in "Xenakis, *Music and Architecture*, 261.

remarked, "Architectural forms and their types are elements that, in general, are neglected or regarded with contempt. That is why we get halls that are cubical or rectangular polygons."[45]

While developing new architectural forms, Xenakis experimented with new modes in music too. As a composer and inventor,[46] he aimed to achieve a total synthesis of arts, or in other words, *Gesamtkunstwerk* by combining architecture, music, texts and lights in projects, as in the cases of Philips Pavilion and *Le Diatope*.

1.2 *GESAMTKUNSTWERK*: HISTORY OF THE CONCEPT

The philosopher Karl Friedrich Eusebius Trahndorff (1782-1863) first used the term *Gesamtkunstwerk* in 1827 in his book, entitled *Ästhetik oder Lehre von Weltanschauung und Kunst*. As Trandorff explained:

> The art of world sound [*Wortklang*], music, facial expression, and the art of dance, contain within themselves the potential to join together into one presentation. But this potential is founded on a striving that pervades the entire artistic sphere; a striving towards a total work of art [*zu einem Gesamtkunstwerke*] on the part of all arts; a striving that is germane to the whole artistic sphere, in so far as we recognize the unity of its inner life. This possibility will therefore comprise not only the aforementioned arts, but all of them.[47]

Two decades later, the concept became linked with the aesthetic ideals of a composer, Richard Wagner (1813-1883), though he was not the only one who theorized it. In his remarkable essays of 1849-57, "The Art-Work of the Future" and "Art and Revolution", Wagner manifested his aesthetic ideals concerning opera and drama.

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[45] Xenakis, "The *Diatope*: a gesture of sound and light at the Pompidou Center and *La Légende d'Eer* (First Version, Paris, 1978) in "Xenakis, *Music and Architecture*, 262.

[46] It would not be wrong to call him an inventor. He designed a musical composition tool called UPIC (Unité Polyagogique Informatique du CEMAMu). It was developed at the CEMAMu (Centre d'Etudes de Mathématique et Automatique Musicales / Center for Studies in Mathematics and Automated Music in Paris. A sort of musical drawing board which, teach acoustics, engage in musical pedagogy at any rage.

[47] Quoted in Juliet Koss, *Modernism after Wagner* (Minneapolis: University of Minnesota Press, 2010), 13.

"The Art-Work of the Future" was a manifesto where he introduced the term *Gesamtkunstwerk*. He presented *Gesamtkunstwerk* as consisting of dance, tone and poetry which were three fundamental arts. Wagner called these three fundamental arts "primeval sisters", "chain of sisters", "trinity of sisters", "sister-arts" or "close-locked sisters". As he explained further:

> The arts of Dance, of Tone, and Poetry … whom we see at once entwine their measures wherever the conditions necessary for artistic manifestment have arisen. By their nature they are inseparable without disbanding the stately minuet of Art. [T]hey are so wondrous closely interlaced with one another, of fairest love and inclination, so mutually bound up in each other's life, of body and of spirit: that each of the three partners, unlinked from the united chain and bereft thus of her own life and motion, can only carry on an artificially inbreathed and borrowed life.[48]

So, among the other opera composers of the time, Wagner had a different position due to his notion of the total work of art.

As Beat Wyss and Denise Bratton describe, "Wagner's masterpiece of the future consisted of the rebirth of Attic tragedy as *Gesamtkunstwerk*, in which music, dance, poetry, theatre, and the plastic arts would be unified under the roof of architecture."[49] They also remark that "*Gesamtkunstwerk* would be revolutionary because it would redeem man from the compulsory bond of instrumental reason and return him to his highest destiny, the sphere of artistic self-awareness."[50]

Wagner combined many different art forms as similar to the ancient Greek theatre where poetry, music, and dance were combined to construct a poetic performance. As Juliet Koss remarks, "Wagner adopted from his philosophical sources, the cultural model of Ancient Greece."[51]

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[48] Richard Wagner. "The Art-Work of the Future." Translated by William Ashton Ellis. From:http://users.skynet.be/johndeere/wlpdf/wlpr0062.pdf. (accessed December 4, 2012)

[49] Beat Wyss and Danise Bratton, "Ragnarök of Illusion: Richard Wagner's 'Mystical Abyss' at Bayreuth" Translated by Denise Bratton. *October* 54 (Autumn 1990): 60.

[50] Wyss and Bratton, "Ragnarök of Illusion", 60.

[51] Koss, *Modernism After Wagner*, 14.

Remarkably, nearly 30 years after he published his essays, Wagner constructed his ideal opera house, Bayreuth Festspielhaus, for his four opera cycles, "the Ring of the Nibelung. "[52]

As the closest artwork that he came to realize his ideals, the building was first opened for the premiere of the complete opera. "As the conductor Daniel Barenboim has noted, Bayreuth began, under Wagner, as a great experimental theater. The whole world attended the world premiere of *The Ring* in 1876."[53] This series of cycles, as Wagner argued, "would demand a new theatre, built on radically different aesthetic principles from those that governed the opera houses of the day, a theater intended solely for the realization and permanent exhibition of the artwork of the future."[54]

As Matthew W. Smith explains, "the importance of the Festspielhause is … about the design and function of the theatre itself, which demanded of its audience a radical reconception of performance, of spectatorship, and of relations between nature and the machine.[55]

The Festival Theatre was built under Wagner's supervision in Bayreuth in 1876. He specifically designed the building to create an exclusive and bizarre experience for the audience. He adopted the form of an amphitheatre from the Greek theatre of Epidauros. (Figures 1.2.1a-b) His aim was also to make all spectators equal, as in the case of the Greek theatre. As Koss points out, "Wagner argued that the tragic drama of ancient Greece represented the highest cultural ideal and was

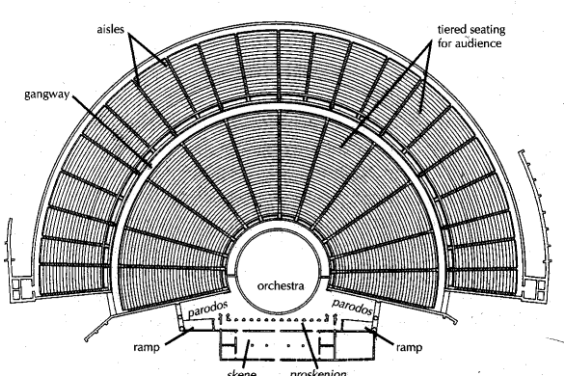
[52] Wagner's complete four-opera cycle (1876) is also known as *Der Ring des Nibelungen* (Ring of the Nibelung). It consists of *Das Rheingold* (The Rhine Gold), *Die Walküre* (The Valkyrie) *Siegfried*, *Götterdämmerung* (Twilight of the Gods). Michael Forsyth, *Buildings for Music: The Architect, The Musician, and The Listener from The Seventeenth Century to The Present Day* (Cambridge, Mass.: MIT Press, 1985), 165.

[53] "Quoted in Koss, *Modernism After Wanger*, 325.

[54] Matthew Wilson Smith, *The Total Work of Art: From Bayreuth to Cyberspace* (New York: Routledge, 2007): 22.

[55] Smith, The Total Work of Art, 21.

facilitated by the spaces of the Greek amphitheatre, where people convened to share the experience of spectatorship."[56]



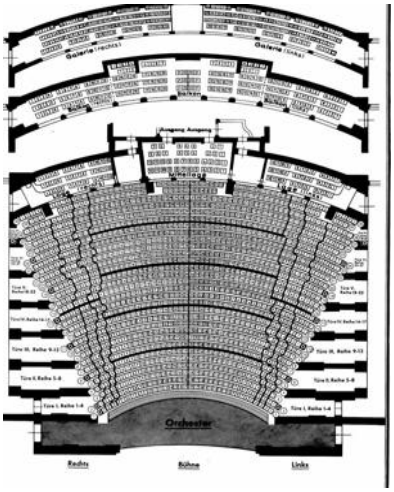


Figure 1.2.1a Plan of the theatre at Epidauros
Source: http://jotaarkka.pp.fi/Working/o-teksti.html (accessed 10.02.2012)
Figure 1.2.1b Plan of the Bayreuth Festspielhaus
Source:http://opera2011.bgsu.wikispaces.net/Wagner+and+the+Aesthetics+of+the+Theater (accessed 09.02.2012)

One of the significant innovations of the Bayreuth Festspielhaus was its unusual orchestra pit because the orchestra was completely hidden. (Figure 1.2.2) So, the audience could only concentrate on the drama performance. This feature also created ideal acoustics for Wagner's operas.

[56] Koss, *Modernism after Wagner*, 26

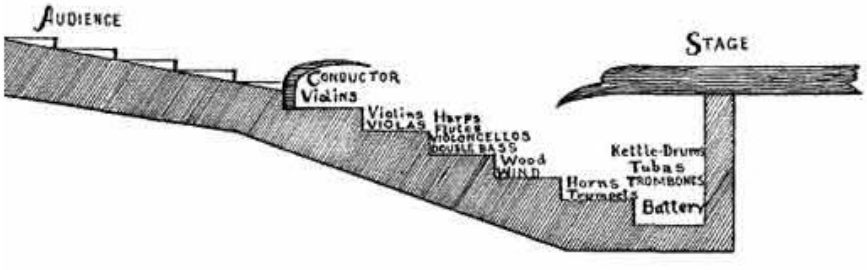


Figure 1.2.2 Sections of instruments on different vertical levels.
Source: http://www.favorite-classical-composers.com/bayreuth-festspielhaus.html (accessed 09.02.2012)

As Koss indicates, "the presence and experience of an audience helped create the work of art."[57] In other words, in Wagnerian stage, spectators played crucial roles. Regarding this issue, Wagner elucidated:

> The spectator transplants himself upon the stage, by means of all his visual and aural faculties; while the performer becomes an artist only by complete absorption into the public. Everything, that breathes and moves upon the stage, thus breathes and moves alone from eloquent desire to impart, to be seen and heard within those walls which, however circumscribed their space, seem to the actor from his scenic standpoint to embrace the whole of humankind; whereas the public, that representative of daily life, forgets the confines of the auditorium, and lives and breathes now only in the artwork which seems to it as Life itself, and on the stage which seems the wide expanse of the whole World. [58]

So, the result is the Wagnerian *Gesamtkunstwerk* which "describes both the work created by the interrelation of the arts and … its effect on an audience."[59]

In Wagnerian *Gesamtkunstwerk* "each art requires and is inseparable from, the other."[60] In uniting arts, Wagner argued that "the *Gesamtkunstwerk* would allow

[57] Koss, *Modernism after Wagner*, xv.

[58] Richard Wagner, "The Art-Work of the Future." Translated by William Ashton Ellis. From:http://users.skynet.be/johndeere/wlpdf/wlpr0062.pdf.

[59] Koss, *Modernism after Wagner*, xiii.

[60] Ronald Taylor and Richard Wagner, *His Life Art and Thought*. (London: Paul Elek Limited, 1979): 50.

each to achieve its full potential, to grow stronger in the struggle to define itself against the others."[61] As he also explained:

> [Each art form] attain the capacity to be and do the very thing which, of their own and inmost essences, they long to do and be. Each, where her own capacity ends, can be absorbed in the other, … proving her own purity, freedom, and independence as that which she is.[62]

1.2.1 *Gesamtkunstwerk* After Wagner

Wagner clearly described the idea of *Gesamtkunstwerk* in his writings. In this regard, it would be more appropriate to express the term as 'unity'. Wagner's total work of art consisted of poetry, music and dance in which "each art form discovered its own identity." [63] In this sense, none of the arts lost its identity while joining in the larger unit. However, following Wagner's death, the concept of total work of art entered the aesthetic discussion as a romantic utopia, denoting the interplay of architecture, music and dance.[64] Artists and art historians would use the notion of *Gesamtkunstwerk* as a point of departure for addressing a range of subjects, epochs and methodological approaches as well. Any kind of art form or design could be linked to Wagner's conception of *Gesamtkunstwerk* as long as it synthesized dance, music, sculpture, poetry, theatre, etc. Koss asserts that "the concept is often mistaken for a hazy mixture of art forms that intoxicates those who gather in its presence."[65] So, the idea of *Gesamtkunstwerk* was transformed after Wagner by signifying a synthesis of various techniques, media, and academic disciplines. *Gesamtkunstwerk* also appeared in poetic, visual, musical and dramatic arts and literature.

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[61] Koss, *Modernism after Wagner*, xv.

[62] Koss, *Modernism after Wagner*, xii.

[63] Koss, Modernism After Wagner, 16.

[64] See Koss, *Modernism after Wagner*, 249.

[65] Koss, *Modernism After Wagner*, xii.

Remarkably, the term was used in architectural theory and history as well with the beginning of the 20th century. It was used especially for Baroque and Art Nouveau architecture. Furthermore, *Gesamtkunstwerk* appeared in the Bauhaus period as well. As Smith explains, Walter Gropius (1883-1969), founder of the Bauhaus school, "exhorted fellow artists to create … *Gesamtkunstwerk*" in his 1919 manifesto."[66] According to Gropius, "the Bauhaus would be a place where the organic and the mechanical could be rejoined, or, more precisely, where mechanics could be made organic and rendered crystalline *Gesamtkunstwerk*."[67] Moreover, his concept of total theater expressed a search for a total work of art of architecture and art, actor and spectator. So, the Bauhaus theater was like *Gesamtkunstwerk* which combined music, stage direction, dance, theatre and film, in general.[68]

In this regard, it should be noted that Xenakis's Philips Pavilion and Polytope projects, as will be discussed in this study, were exceptional examples of *Gesamtkunstwerk* in the latter part of the twentieth-century.

1.3 IANNIS XENAKIS AND *GESAMTKUNSTWERK*: AIM, SCOPE AND STRUCTURE OF THE STUDY

This study examines Iannis Xenakis by focusing on his two selected works, Philips Pavilion (1956-58) and *Le Diatope* (1978), partially or completely designed by him, through the lenses of the Wagnerian concept of *Gesamtkunstwerk* and especially of his ideals of building Bayreuth. While doing this, it refers to a group of primary literature, consisting mainly of some texts on architecture and music written by Xenakis; and of secondary literature on Xenakis, in particular, and on history and theory of architecture and music, in general, including the concept of *Gesamtkunstwerk* as well.

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[66] Matthew Wilson Smith, *The total work of art : from Bayreuth to cyberspace* (New York: Routledge, 2007): 48.

[67] Smith, *The Total Work of Art*, 50.

[68] Koss, *Modernism After Wagner*, 241.

Iannis Xenakis's writings have been collected and presented by different editors.[69] His first published book was *Musiques formelles* (1963). *Formalized Music: Thought and Mathematics in Music* (1971) is an extensive collection of texts on the applications of his twenty years efforts of stochastic processes. There are several important articles in this book, including "The Origins of Stochastic Music" which explains how and why stochastic music developed and "Concerning Time, Space and Music"[70] which deals with the profound necessity of musical composition to be philosophically, technically and aesthetically original.

Music and Architecture (2008) (*Musique, Architecture* (1971)) is the most comprehensive book about Xenakis's architectural projects, texts, compositional activities and realizations. One part of the book is devoted to his writings on architecture. Among them, "Beautiful and Ugly" presents Xenakis's philosophy of art and architecture in general. "Notes towards an Electronic Gesture," written during the period of Philips Pavilion, reveals information on Xenakis's path which would lead him to the projects of Polytopes and to his manifesto for New Media Art.[71] Another important article is "Architecture and Listening to Music" which is about Xenakis's search for a new type of concert hall for the performance needs. In *Arts/Sciences: Alloys* (1979), his doctorate thesis defense, Xenakis describes his musical and theoretical writings and the role of mathematics in both his musical and architectural works. He also discusses his use of computers as a graphic tool in his compositions.

Among the secondary sources, *Conversations with Xenakis* (1996) by Balint Andre Varga is about Xenakis's life and music. "Towards a Space-Time Art: Iannis Xenakis's Polytopes" (2001) by Sven Sterken discusses Xenakis's multimedia installations called Polytopes. Another article, "The Architectures of Iannis Xenakis" (2003) by Elizabeth Sikiaridi focuses on Xenakis's researches on hyperbolic paraboloids in creating complex architectural forms. *Xenakis and His*

[69] Xenakis never actually wrote a book. For a full list of Xenakis's writings see the bibliography.

[70] Co-authered by Roberta Brown.

[71] Xenakis, *Music and Architecture*, 127.

Life in Music (2004) by James Harley who studied with Xenakis, analyzed his music. Furthermore, *Resonance: Essays on the Intersection of Music and Architecture* (2007) by Mikesch W. Muecke and Miriam S. Zach deals with various aspects of Xenakis's works from the viewpoint of the relation between music and architecture.

Obviously, in addition to the ones mentioned here, there is significant literature on Xenakis especially on his musical and architectural (especially on Philips Pavilion and Polytopes) works and his mathematical studies. Rather surprisingly, however, there is not any comprehensive study, which examines Xenakis and his works in relation to *Gesamtkunstwerk*, though he does not refer to the concept explicitly.

So, this study aims to contribute to the related literature by focusing on this neglected topic. It is composed of four chapters. Chapter 1, as the introduction of this study, draws a general biographical sketch of Xenakis, in relation to his architectural and musical career. Then, it juxtaposes this sketch with an outline of the concept of *Gesamtkunstwerk* to be able to see his works from the perspective of this concept.

Chapter 2 deals exclusively with the Philips Pavilion and *Poème électronique* by revolving around Xenakis's role in these architectural and musical works. Rather than replacing Le Corbusier with another canonical figure, it throws light to his role within a special team, including workers, designers, engineers, and managers, that constructed the Pavilion and produced the artworks.

Chapter 3 focuses on Xenakis's Polytopes and *Le Diatope* by exploring the architectural, musical, visual and textural components of the spectacle.

Finally, Chapter 4, as the conclusion of this study, seeks to show how Xenakis's works can be interpreted in relation to the concept of *Gesamtkunstwerk*, as the nineteenth century composer Richard Wagner defined it.

CHAPTER 2

PHILIPS PAVILION

The Philips Pavilion was built for the EXPO ′58 in Brussels. Philips, an electronics company based in the Netherlands, commissioned it.

The World Fair of Brussels was the first Expo after the World War II, called for world peace, and economic and social progress. Philips survived the war years, though its establishments were damaged seriously by bombardment. After the war, it started to recover and developed new technologies in fluorescent lighting, loudspeakers, X-ray systems and telephones.[72] Accordingly, in the Expo, the company wanted to show how it survived the war and how it experimented with the headmost technology in the World. As Oscar Lopez explains, "[t]he Philips Electronics Company decided to step away from displaying commercial goods and instead create a unique experience for the thousands of people that would be attending the Expo."[73] So, the company used most of the capabilities of its technical supplies and forced itself to invent new technological devices for the Pavilion as a spatial-color-light-music spectacle, named *Poème électronique*. (Figure 2.1)

[72] Marc Treib, *Space Calculated in Seconds: The Philips Pavilion, le Corbusier, Edgard Varèse* (Princeton, NJ: Princeton University Press, 1996): 10.

[73] Oscar Lopez, "AD Classics: Expo '58 + Philips Pavilion / Le Corbusier and Iannis Xenakis" http:// www.archdaily.com/157658. (accessed December 4, 2011)

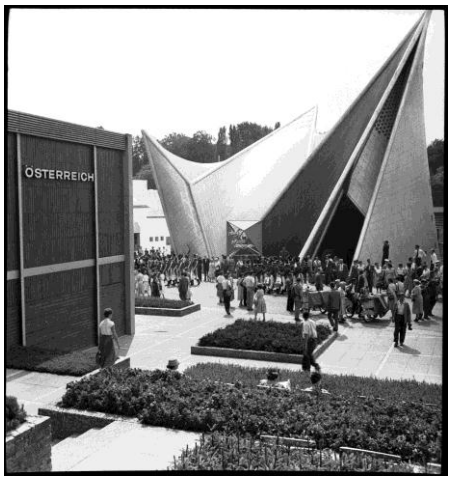


Figure 2.1Entrance of the Philips Pavilion
Source: http://www.edu.vrmmp.it (accessed 09.03.2012)

The Philips Pavilion and *Poème électronique* were produced with the help of a special team. Le Corbusier was the head of the project and wrote the visual scenario of the spectacle; Iannis Xenakis designed the form of the building in relation to the needs of the spectacle, composed a two-minute work, named *Concrete PH*, supervised the building's construction and the light and sound installations, and designed two abstract sculptures as well; Edgard Varèse composed the music of *Poème électronique*; Hoyte Cornelis Duyster worked as a structural engineer; Louis Kalff, an architect and engineer, was the art director of Philips and the project liaison; Willem Tak, Cornelius Gisgsbert and Jan Vreedenburg were acoustic specialists of the team; Adolf Bouma and Frans K. Ligtenberg worked as acoustical advisors; and S. L. de Bruin, an engineer, automated the production. Furthermore, since the construction of the Pavilion was a crucial technical issue, the workers, who were selected carefully, were very important members of the team. Therefore, even though Le Corbusier was the head of the think-tank, the project of Philips Pavilion and *Poème électronique* was created as a collaborative project. (Figure 2.2)

Figure 2.2 L. Kalff, Le Corbusier and Varèse in front of the Philips Pavilion.
Source: Treib, *Space Calculated in Seconds*, 215.

The story of the project started on January 16, 1956 when Le Corbusier received a letter from Philips, or more specifically from Kalff, saying that "we would be very pleased to discuss with you a project which we are planning to build at the next world's fair in Brussels."[74] Le Corbusier accepted the offer not immediately, but after a period of correspondences until July 1956. As quoted by Xenakis in his article, "The Philips Pavilion at the Dawn of a New Architecture" (1958), it was very clear from the very beginning of these correspondences what Kalff demanded from Le Corbusier:

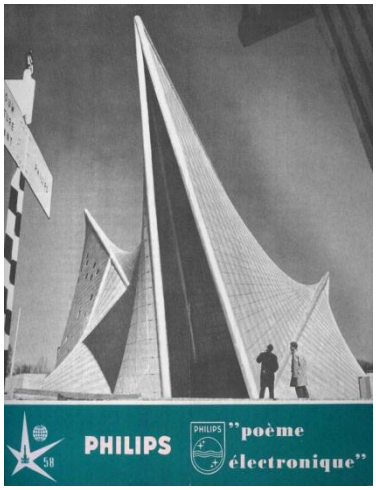
> I would like you to design the Philips Pavilion without having to display any of our products. A demonstration of most venturesome effects of sound and light, where technical progress could lead us in the future.[75]

[74] Xenakis, "Le Corbusier's Electronic Poem of the Philips Pavilion" (Brussels World's Fair, 1958) in Xenakis, *Music and Architecture*, 105.

[75] Xenakis, "The Philips Pavilion at the Dawn of a New Architecture" in Xenakis, *Music and Architecture*, 111.

In his reply, Le Corbusier explained:

> I shall not create a pavilion, but a *Poème électronique* – a 'bottle', whose contents are a concoction of the following poetic ingredients"; light, color, images, rhythm, sound and architecture. These 6 components embody the *Poème électronique* throughout 480 seconds.[76] (Figures 2.3a-b)



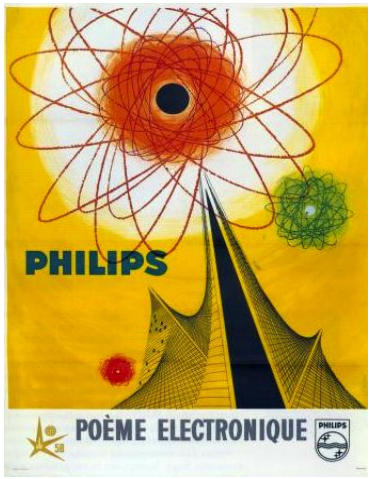


Figure 2.3a-b Posters of the Philips Pavilion
Source: http://www.edu.vrmmp.it/vep/immagini/images (accessed 09.04.2012)

This close communication continued during the construction process as well, which started in October 1956 and ended in March 1958, as we can understand from a note by Kalff:

> [F]undamental thought behind the presentation [i.e. *Poème électronique*] … will also be shared by the composer who creates the libretto [which] must be developed not by the musician alone, but equally by light and color specialists, who must be artists as well.[77]

[76] Xenakis, "Le Corbusier's Electronic Poem of the Philips Pavilion" (Brussels World's Fair, 1958) in Xenakis, *Music and Architecture*, 105.

[77] Quoted in Treib, *Space Calculated in Seconds*, 21.

2.1 DESIGN

Attributing a fundamental role to mathematics in the design of the Philips Pavilion, Le Corbusier asked Xenakis "to draw up [his] ideas and try to translate them using mathematics"[78] in the project and "to study on the architectural and the technical design of the Pavillion."[79]

Xenakis, then, started working on the design of the Pavilion, which presented a big opportunity to show his artistic and technical credentials. About the significance of the building for his career, Xenakis said:

> That was the first time I'd done something completely by myself – something entirely different, with new surface solutions. I had proved for myself that I was able to create something in the field of architecture that hadn't existed before.[80]

At first, Le Corbusier conceived the plan of the Pavilion as a 'bottle,' "containing the nectar of the spectacle in light and sound."[81] (Figures 2.1.1.a-b) But Xenakis could produce only some unsuccessful designs on the 'bottle' idea. To avoid acoustical and some other technical problems, the team abandoned that idea and decided to work on an alternative one, the 'stomach.' It was an idea representing the effect of the *Poème électronique* on spectators in the sense that the Pavilion would be a place where visitors were "ingested, violently churned and decomposed by the digestive enzyme of the *Poème* fairground."[82]

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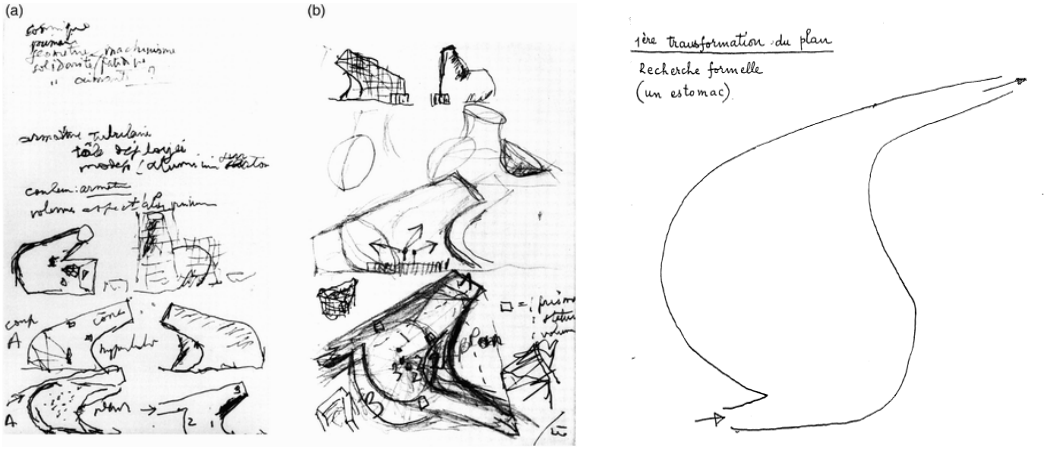
[78] Kanach, "The Philips Pavilion 1956-58" in Xenakis, *Music and Architecture*, 99.

[79] Xenakis, "Le Corbusier's Electronic Poem of the Philips Pavilion" (Brussels World's Fair, 1958) in Xenakis, *Music and Architecture*, 105.

[80] Kanach, "The Philips Pavilion 1956-58", 99.

[81] Xenakis, "The Philips Pavilion at the Dawn of a New Architecture" in Xenakis, *Music and Architecture*, 112.

[82] Joseph Clarke, "Iannis Xenakis and the Philips Pavilion" *The Journal of Architecture*, vol 17/2 2012 (213-229): 217. http://www.tandfonline.com/doi/pdf/10.1080/13602365.2012.678641. (accessed December 12, 2012)



Figures 2.1.1 Le Corbusier's bottle design sketches for the Philips Pavilion
Source: Xenakis, *Music and Architecture*, 114.
Figure 2.1.2 The stomach shaped plan of the Pavilion
Source: http://www.edu.vrmmp.it/vep/sketches.html (accessed 09.04.2012)

For Xenakis, it was an equally difficult challenge "to envelop the stomach form of the plan with a series of shell segments that would become structural and aesthetically unified."[83] After a design period of trial and error, he developed the final plan scheme, as required by the *Poème électronique* in which visitors would enter through a curved corridor, reach a central chamber for the eight-minute spectacle, and then exit. (Figure 2.1.2) For the volumetric definition of this plan, he used hyperbolic paraboloid surfaces, the inner area of which was approximately 500 m^2 to place 600 to 700 persons in the building.[84] (Figure 2.1.3) So, for Xenakis, the Pavilion represented "the dawn of a new architecture," meaning a "truly three-dimensional" [85] or "volumetric" architecture.[86]

[83] Treib, *Space Calculated in Seconds,* 36.

[84] In reality, the Pavilion contained 500 people at a time.

[85] Xenakis, "The Philips Pavilion at the Dawn of a New Architecture" in Xenakis, *Music and Architecture*, 111.

[86] Xenakis, "The Philips Pavilion at the Dawn of a New Architecture" in Xenakis, *Music and Architecture*, 118.

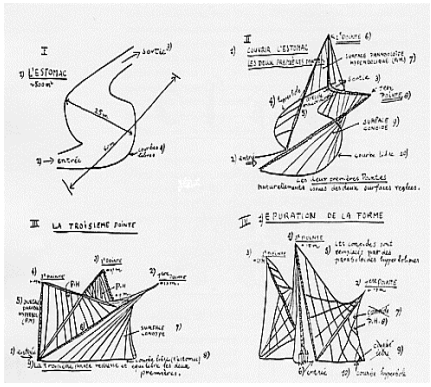
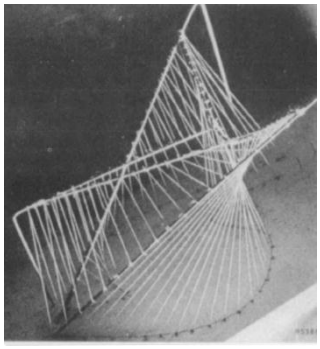


Figure 2.1.3 Xenakis's drawing of Le Corbusier's stomach plan.
Source: Treib, *Space Calculated in Seconds,* 26.

The design process of the Pavilion corresponded to three models. Regarding the first stage, and accordingly, the first model, Xenakis explained: "To make the scale model, I had to use wire to indicate the ruled surfaces and piano strings to represent the intersections of the ruled surfaces."[87] (Figure 2.1.4) Then, in the second model, he converted some surfaces into the hyperbolic paraboloids. (Figure 2.1.5)



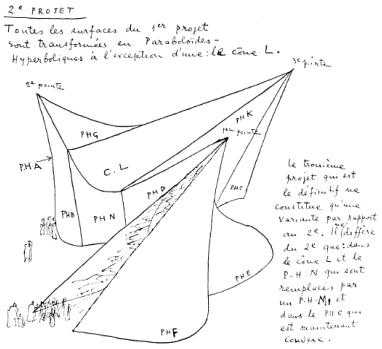


Figure 2.1.4 First scale model
Source: Xenakis, *Music and Architecture,* 95.
Figure 2.1.5 Xenakis' drawing of the Second design
Source: Treib, *Space Calculated in Seconds,* 38.

As for the final modifications of the Pavilion, Xenakis together with the engineers and artists of the team "developed a three-pronged tent, constructed with thin-

[87] Xenakis, "The Philips Pavilion at the Dawn of a New Architecture" in Xenakis, *Music and Architecture*, 114.

shelled concrete panels."[88] He "closed two triangular openings by new hyperbolic paraboloids adapted to the existing ones."[89] So, in the final model, he converted all conoids into the hyperbolic paraboloids. (Figure 2.1.6)

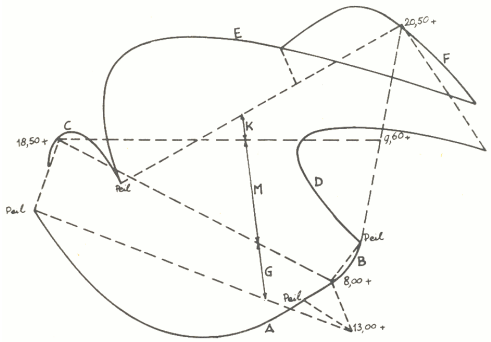


Figure 2.1.6 Geometric definition of the final design
Source: Philips Technical Review, 6.

2.1.1 *Metastaseis*

Metastaseis was Xenakis's first major orchestral work, composed in 1953-54 for sixty-one instruments. (Figure 2.1.1.1)

As its name, *Metastaseis*, meaning transformation, implied, the composition indicated his movement from Serialism towards stochastic music. Xenakis criticized serialists for using fortuitous sound in music and said: "we all have fortuitous sounds in our daily lives. They are completely banal and boring. I'm not interested in reproducing banalities."[90] Interestingly enough, this transformation caused almost a scandal when it was first performed in 1955.

It was during the period when Xenakis composed *Metastaseis* he worked on the *Modulor* as well and as he explained, "In my composition *Metastaseis* ... the role of architecture is direct and fundamental by virtue of the *Modulor*." Apart from the

[88] Lopez, "Philips Pavilion / Le Corbusier and Iannis Xenakis"

[89] Xenakis, "The Philips Pavilion at the Dawn of a New Architecture" in Xenakis, *Music and Architecture*, 118.

[90] Khai-Wei Choong, *Iannis Xenakis and Elliott Carter: A Detailed Examination and Comparative Study of Their Early Output and Creativity* (Brisbane: Griffith University, 1996): 32.

Modulor, the close relationship between music and architecture in his works found its echo in the Philips Pavilion as well. As he pointed out:

> In the Philips Pavilion I realized the basic idea of *Metastaseis*: as in the music, here too I was interested in the question of whether it is possible to get from one point to another without breaking the continuity. In *Metastaseis* this problem led to glissandos, while in the Pavilion it resulted in the hyperbolic parabola shapes. [91]

This means that Xenakis applied the use of string glissandi in *Metastaseis* to the design of the Philips Pavilion. Instead of using musical notation, Xenakis drew a graph to coordinate different instruments written for Metastasis. The horizontal axis represented time, the vertical axis represented pitch, and the straight lines represented the rising or falling sounds of each instrument.[92] (Figure 2.1.1.2a) As Sikiaridi describes, "Xenakis introduced hyperbolic paraboloid structures in … *Metastaseis*: graphs of straight lines mapping the rising or falling sounds of each instrument, the glissandi, generating curved, ruled, surfaces of sound."[93] (Figure 2.1.1.2a-b) Accordingly, the string glissandi of *Metastaseis* looked like the ruled surfaces of hyperbolic paraboloid shells of the Pavilion.

[91] Kanach, "The Philips Pavilion 1956-58" in Xenakis, *Music and Architecture*, 99.

[92] Robin Evans, *The Projective Cast: Architecture and its Three Geometries* (Cambridge, Mass: MIT Press, 1995): 298.

[93] Sikiaridi, *The Architectures of Iannis Xenakis*, 204.

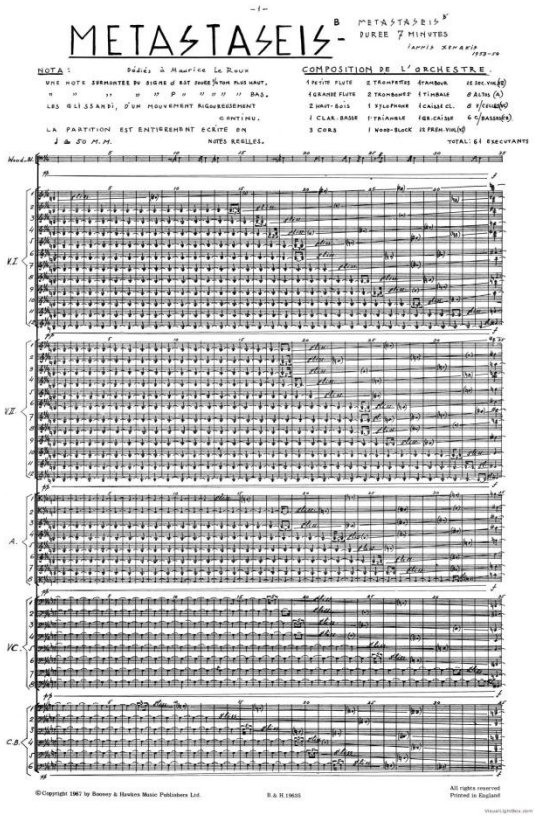
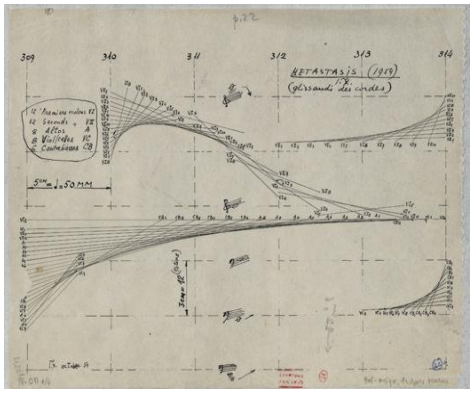


Figure 2.1.1.1 First page of *Metastaseis*
Source: Xenakis, *Music and Architecture*, 47.



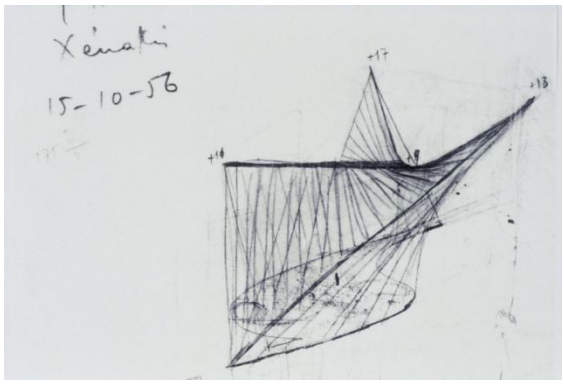
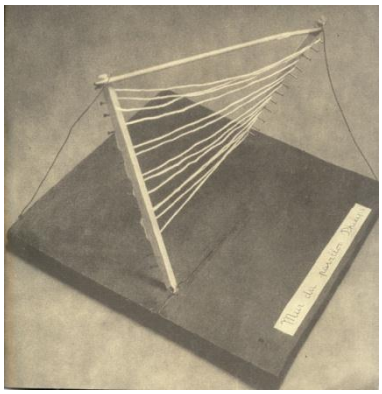


Figure 2.1.1.2a Diagram of glissandi in Metastasis
Figure 2.1.1.2b Xenakis' sketch of Philips Pavilion
Source: Xenakis, *Music and Architecture*, 47

2.1.2 Hyperbolic paraboloids

The Pavilion was a cluster of nine hyperbolic paraboloids, composed asymmetrically to create dynamically-angled contours and constructed out of pre-stressed concrete. The surface of the Pavilion's was made of 5cm thick concrete.[94] Approximately 2000 individual concrete slabs comprised them.

Solving functional equations of the Pavilion was a difficult task. During this process, Xenakis worked with Prof. Vreedenburg, Duyster, Tak and Kalff. In order to study the new form of the Pavilion, it was necessary to choose a method.[95] Accordingly, Xenakis "used metallic rectilinear rods joined by elastic strings that were attached equidistantly on each of the rods as [his] experimental tool."[96] (Figures 2.1.2.1 a-b)



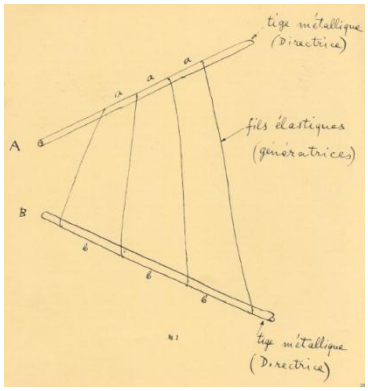


Figure 2.1.2.1a Representation of hyperbolic paraboloids
Figure 2.1.2.1b Xenakis's sketch of experimental tool for hyperbolic paraboloids
Source: http://www.archdaily.com/157658 (accessed 09.05.2012)

As Treib points out, "Hyperbolic paraboloids were structurally sophisticated because the strength of its warped surfaces derived … entirely from straight lines."[97]

[94] Xenakis, *Music and Architecture*, 106.

[95] Kanach, "The Philips Pavilion 1956-58" in Xenakis, *Music and Architecture*, 115.

[96] Kanach, "The Philips Pavilion 1956-58" in Xenakis, *Music and Architecture*, 115.

[97] Treib, *Space Calculated in Seconds*, 36.

About his method Xenakis wrote:

> The straight line permits one to imagine very complex forms with very simple controllable elements… free forms do not exist; curved surfaces are described mathematically/geometrically and their structural behavior is defined.[98]

After Xenakis and his team finished the theoretical calculation of the hyperbolic paraboloid surfaces for the upper part, they immediately tested them with scaled down model. (2.1.2.2) When the model was tested, Xenakis said that "[H]yperbolic paraboloids confirmed their astonishing properties of resistance and eloquent plasticity."[99] Then, the Pavilion was constructed by using their calculations.

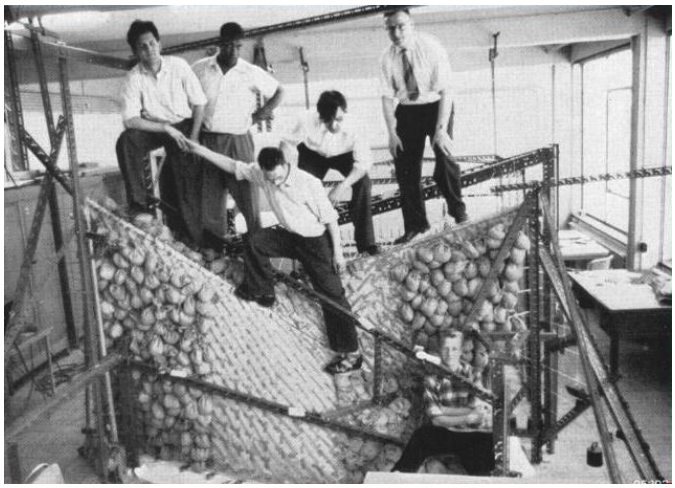


Figure 2.1.2.2 Making the plywood model
Source: Treib, *Space Calculated in Seconds*, 63. (accessed 21.04.2011)

As Xenakis also explained, the Philips Pavilion would "represent a technical novelty with regard to the synthetic application of new surfaces" which were hyperbolic paraboloid surfaces."[100]

[98] Sikiaridi, "The Architectures of Iannis Xenakis", 205.

[99] Kanach, "The Philips Pavilion 1956-58" in Xenakis, *Music and Architecture*, 118.

[100] Xenakis, "Le Corbusier's Electronic Poem of the Philips Pavilion" (Brussels World's Fair, 1958) in Xenakis, *Music and Architecture*, 106.

Before the 1930s, ruled surfaces were used in aeronautical, naval and civil engineering.[101] They had been known by geometricians and studied by a generation in statistics. Later, it started to appear in modern architecture "in the easily recognized form of hyperbolic paraboloid saddles."[102] So, before the Pavilion, "simple ruled surfaces that were created with right angles and curved planes, hyperbolic paraboloids and conoids"[103] were known for some time. These surfaces were "build out of barded reinforced concrete … but always to replace roofing or roof terraces."[104] (Figure 2.1.2.3) Moreover, before the Pavilion, ruled surfaces appeared in Le Corbusier's some works, in the pilotis and rooftop nursery of the Marseille housing project (1947-53), in the roof shell of Ronchamp, in the vaults of the High Court building at Chandigarh (1952), in the crypt and the light canons of La Tourette (1954), and in the "cooling tower" of the National Assembly building at Chandigarh (1956).[105] So, the hyperbolic paraboloids in concrete were used in the architecture of the 1950s, but the Philips Pavilion was the only building that would be composed only with these kinds of surfaces.[106]

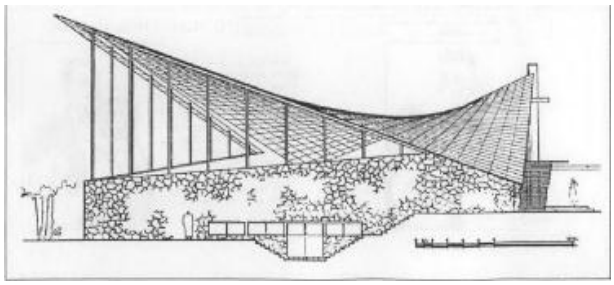


Figure 2.1.2.3 The Church Notre Dame de la Solitude Coyocan, Mexico. Designed by the Felix Candela in 1955.
Source: Philips Technical Review, 3.

[101] Robin Evans, *The projective cast: architecture and its three geometries* (Cambridge, Mass: MIT Press, 1995): 312.

[102] Evans, *The Projective Cast*, 312.

[103] Kanach, "The Philips Pavilion 1956-58" in Xenakis, *Music and Architecture,* 113.

[104] Kanach, "The Philips Pavilion 1956-58" in Xenakis, *Music and Architecture,* 113.

[105] Robin Evans, *The projective cast: architecture and its three geometries* (Cambridge, Mass: MIT Press, 1995): 301-308.

[106] Sven Sterken, "Towards a Space-Time Art: Iannis Xenakis's Polytopes." Perspectives of NewMusic, 39/2 (summer 2001): 272. http://www.jstor.org/stable/833570

However, in the Pavilion, these surfaces were "used synthetically to create a whole, without vertical walls and without a framework, which would be foreign to their nature."[107] Xenakis knew that "[this] was unique opportunity for [him] to imagine an edifice which would consist only of hyperbolic paraboloids and conoids in its structure and its form, and which would be self-supporting."[108]

2.1.3 Construction

After many calculations and designs, Strabed, the Belgian firm, started the construction in June 1957. As already pointed out, the Pavilion was a symbol of teamwork, including selected workers from several European countries.[109] The engineers and contractors, as other groups that team, never before had to deal with an experimental construction wholly based on self-supporting hyperbolic paraboloids.[110] The revolutionary volumetric architecture of the Pavilion demanded an original construction, as Xenakis explained:

> [T]he Philips Pavilion is … integral part of a new representation of plasticity … [and] has inspired the discovery of an original and general means, which includes complicated surfaces without casings.[111]

Duyster, Strabed's head engineer, worked together with Xenakis in the unusual construction process. When Xenakis finalized the design, they decided to use prestressed concrete on the exterior and the interior surface of the Pavilion. As had been confirmed by the model tests, "the extreme tensional forces exerted on certain ribs would have required extensive reinforcement and an increase in their thickness."[112]

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[107] Kanach, "The Philips Pavilion 1956-58" in Xenakis, *Music and Architecture,* 113.

[108] Kanach, "The Philips Pavilion 1956-58" in Xenakis, *Music and Architecture,* 113.

[109] Xenakis, "The Philips Pavilion at the Dawn of a New Architecture" in Xenakis, *Music and Architecture,* 118.

[110] Kanach, "The Philips Pavilion 1956-58" in Xenakis, *Music and Architecture,* 95.

[111] Kanach, "The Philips Pavilion 1956-58", 95.

[112] Treib, *Space Calculated in Seconds*, 83.

The execution of the design involved a tensile structure of steel cables strung from steel posts at the end of the tent to form the hyperbolic paraboloids. The hyperbolic paraboloid shapes of the Philips Pavilion made it impossible to build "a conventional poured concrete structure."[113] They gained strength from its double curvature and translated forces perpendicular to its curved shell into membrane forces.[114] So, Xenakis and Duyster generated a system of precast concrete panels hung in tension from wire cables.[115] Duyster had already experienced with prestressed concrete structures. In 1946, he engineered Eekloo bridge's precast elements,[116] and in 1947, he designed and built a hangar at Melsbroek Airport. The latter had one of the world's longest prestressed primary structural elements. Moreover, he also designed and engineered a service station for Volkswagen in EXPO ′58. The structure featured two umbrellas of prestressed concrete, each consisting of four hyperbolic paraboloids.[117] Then, he tried to apply these methods to the Philips Pavilion.

The structure of the Pavilion was composed of hyper shells and that shell structure was made of reinforced concrete. About 2000 individual concrete blocks formed these hyperbolic paraboloids. Within shell blocks, workers placed wooden strips that followed the regulating lines of the hyperbolic paraboloids,[118] and accordingly, the surface was divided into 100 "regulating rhomboidal units."[119] They were set one after another through portable wood scaffolding and supported by a double network of 3000 steel cables in total and in 8 millimeters diameter. (Figures 2.1.3.1a-e)

[113] Lopez, "Philips Pavilion / Le Corbusier and Iannis Xenakis" http://www.archdaily.com/157658

[114] Treib, *Space Calculated in Seconds*, 56.

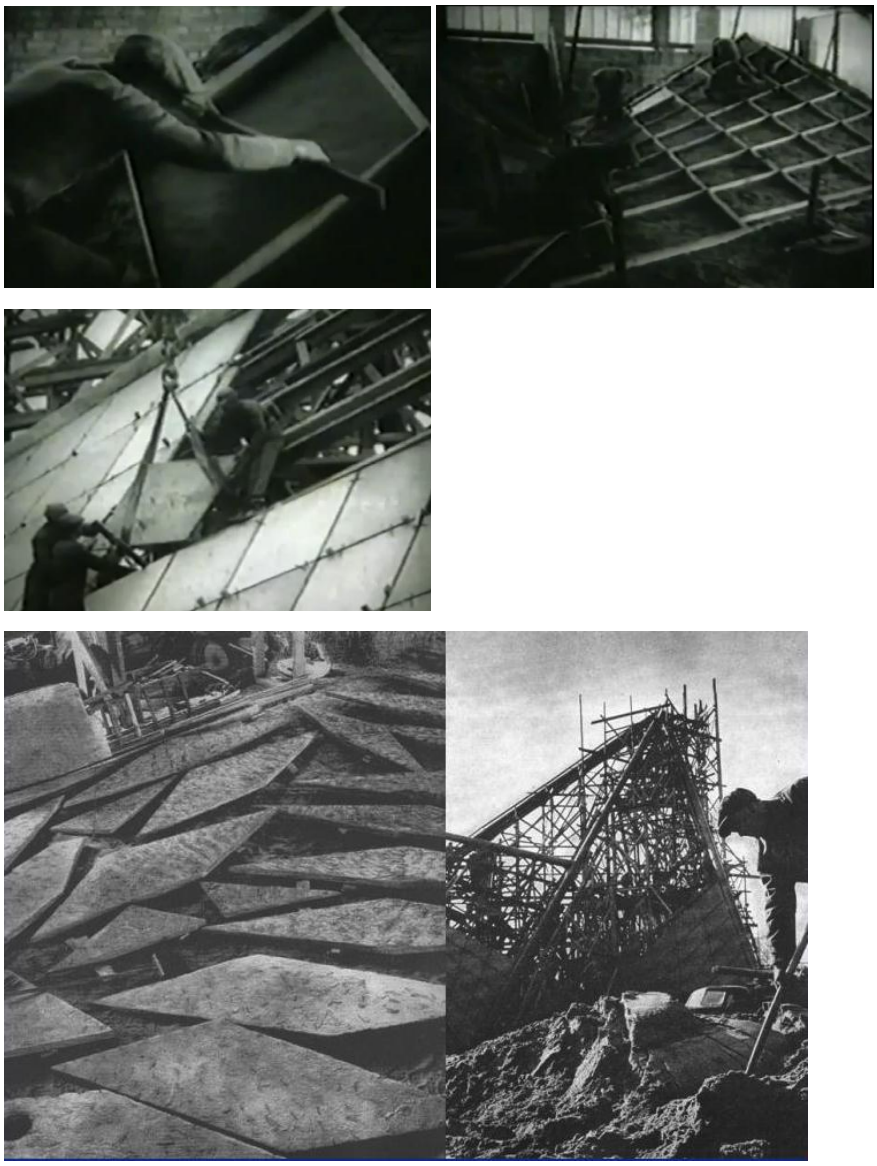
[115] Lopez, "Philips Pavilion / Le Corbusier and Iannis Xenakis" http://www.archdaily.com/157658

[116] Treib, *Space Calculated in Seconds*, 52.

[117] Treib, *Space Calculated in Seconds*, 52.

[118] Treib, *Space Calculated in Seconds*,69.

[119] Treib, *Space Calculated in Seconds*,69



Figures 2.1.3.1a-e Philips pavilion under construction.
Source: Screen shot from http://www.edu.vrmmp.it/vep/debouw.html, http://andre.meyer-vitali.com/documents/philipspavilion58/toc.htm (Accessed 09.05.2012)

The highest point of the structure was 22 meters, the length was 40 meters and the largest width was 24 meters, creating an inner surface of approximately 500 m^2 for a total volume of 7500 m^3.[120]

[120] Kanach, "The Philips Pavilion 1956-58" in Xenakis, *Music and Architecture*, 95.

The structure of the Pavilion consisted of geometrically defined shell segments to simplify construction. So, before the cylindrical ribs between the shell segments were cast in place they were prestressed. Then, when the installation of all the concrete panels ended, "the joints were grounded and the prestressing began."[121] (Figures 2.1.3.2a-c)

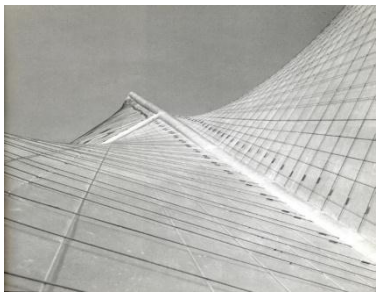
Figures 2.1.3.2 a-c Philips Pavilion under construction
Source: Screen shot from http://www.edu.vrmmp.it/vep/debouw.html

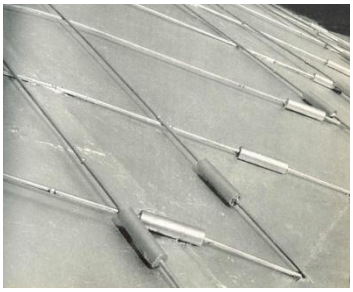
The wires were tightened one by one and each "with a maximum tensile strength of 3000 kilograms, traced the generating lines of hyperbolic parabolid and created a deformed grid with wires roughly 50 centimeters apart."[122] This prestressing system could manage to construct an unusual curvature, the hyperbolic paraboloids, and accordingly, the shape of the Pavilion. Thus, the prestressing was applied on the surface of the Pavilion "to a great variety of conditions of curvature, position, and length of prestress wires."[123] (Figures 2.1.3.3a-b)

[121] Treib, *Space Calculated in Seconds*, 73.

[122] Treib, *Space Calculated in Seconds*, 73.

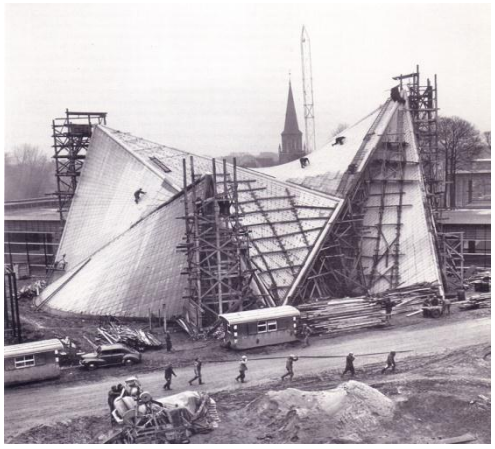
[123] Treib, *Space Calculated in Seconds*, 73.





Figures 2.1.3.3a-b Detail of prestressing wires and their tension devices
Source: Treib, *Space Calculated in Seconds*, 80

The completed concrete structure was painted by a waterproof aluminum paint to seal the concrete surfaces and to protect wires. Due to this painting, the Pavilion looked as if it was built of metal. (Figures 2.1.3.4a-b)



Figures 2.1.3.4a Final adjustments in the construction of the Philips Pavilion
Figure 2.1.3.4b Workers painting the Philips pavilion
Source: Treib, *Space Calculated in Seconds*, 83.

2.2 SOUND AND SPECTACLE

The Philips Pavilion was designed as a stage of the "central sound ingredient" of *Poème électronique*, composed by Edgard Varèse for the 8 minute spectacle. In this sense, the Pavilion and the *Poème* were indivisible. In addition to Varèse's work, Xenakis's 2 minute *Concret PH* defined the beginning and concluding parts of the spectacle.

As Tak, acoustic engineer of the Pavilion, admitted, "even the company was as yet unaware of the composer's wishes about the sound effects, they were certain about

the importance of the 'stereophony and artificial reverberation.'"[124] Philips decided that the required electro acoustical effects would be achieved by the three-track magnetic tape.[125] Numerous loudspeakers would feed each of the three recordings. As Xenakis explained, "The sound [was] acoustically conducted from one polyphonic sound source to the other by 300 loudspeakers, distributed on the inner, absorbing surfaces of the pavilion."[126] Speakers were mounted on the inner surfaces of the pavilion at the request and design of Xenakis.[127] The placement of speakers and the design of the building made spectators feel as if they were in a concrete, silver seashell. (Figure 2.2.1)

Xenakis used stereophony to create the illusion of motion of sound and artificial reverberation to create illusion of different space characteristics. Three recording tracks distributed around the Pavilion resulted in a completely new experience. To create such experience, Xenakis suggested using two kinds of speakers.[128] One of them was a high-frequency speaker, which was installed on the surface of the Pavillion according to the hyperbolic paraboloid shells. The low-frequency speakers were installed on the floor "and screened from view by concrete parapets on both sides of the space."[129] (Figure 2.2.2)

[124] Philips Review, 43

[125] Philips Review, 43.

[126] Xenakis, "Le Corbusier's Electronic Poem of the Philips Pavilion" in Xenakis, *Music and Architecture*, 107.

[127] Treib, *Space Calculated in Seconds*, 66.

[128] 20 amplifiers with an output of 120 W were used for loudspeakers.

[129] Treib, *Space Calculated in Seconds*, 205.

Figure 2.2.1 Actual distribution of speakers throughout the Pavilion
Source: Treib, *Space Calculated in Seconds*, 99.

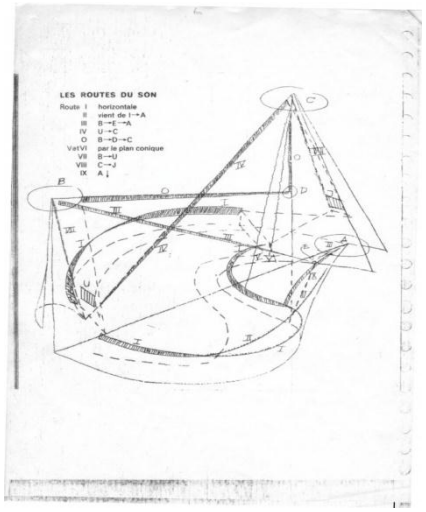
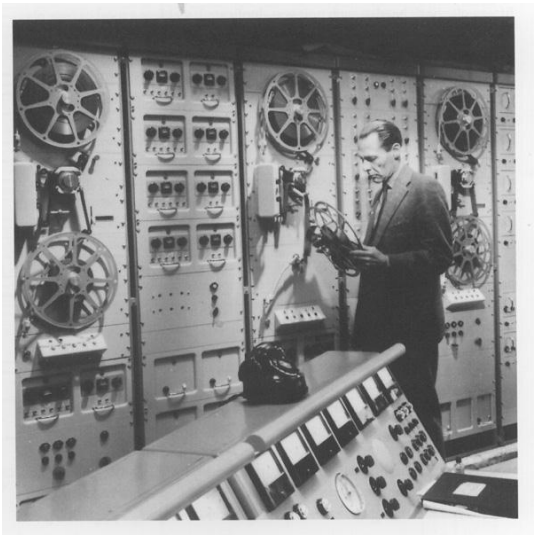


Figure 2.2.2 Xenakis's sketch of possible sound routes within the Pavilion
Source: Treib, *Space Calculated in Seconds*, 206.

These loudspeakers were developed in Philips studios in Eindhoven where Edgard Varèse produced *Poème électronique* as well. In the control room, there were four playback machines for the three-track tape and for the 15-track control tape. (Figures 2.2.3a-b) Varèse's sound was recorded on three tracks which were routed for the directions of the control tape. Original recording was made on one track. The second and the third tracks were for reverberation and stereophonic effects.

As Xenakis remarked about these automation controls, "Everything would be recorded on magnetic tape, thus leaving no room for improvisation."[130]



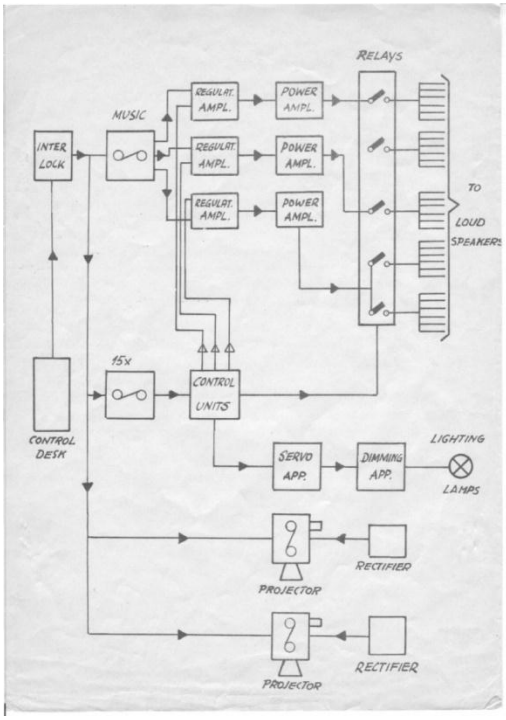


Figure 2.2.3a J. W de bruin next to the automation in the control booth, Philips studios in Eindhoven
Figure 2.2.3b Schematic representation of control tape
Source: Treib, *Space Calculated in Seconds*, 206 and *Philips Technical review*, 8.

2.2.1 *Poème électronique*

Le Corbusier offered Edgard Varèse (1883-1965), a well-known composer of the time, the project of composing *Poème électronique* in a letter, dating June 12 1957:

> It is a scenario to be created wholly from relationships; light, plasticity, design, and music. … I hope that this will please you. It will be the first truly electric work and with symphonic power.[131]

[130] Xenakis, "The Philips Pavilion at the Dawn of a New Architecture" in Xenakis, *Music and Architecture*, 112.

[131] Treib, *Space Calculated in Seconds*, 6.

Varèse was impressed by the project, and in great excitement, he accepted the offer presenting the opportunity of "[giving] birth to the most extraordinary thing possible."[132]

Actually, Philips proposed the job first to a mainstream composer, Benjamin Britten (1913-1976). Despite Philip's choice, however, Le Corbusier insisted on Varèse though he had not been in contact with the composer since 1935. Remarkably, Xenakis supported Le Corbusier's choice and wrote to Kalff many times on this issue:

> Have no fears about the music of Varèse; this is the music and the composer that you need. Your Pavilion must attract attention by its avant-garde strangeness and even cause a scandal … Truly artistic strangeness, that which you qualify as abstract, is one characteristic of a work which will survive. Long after the end of the exposition, people will talk about your Pavilion as a coup, striking the public imagination in a powerful way.[133]

Xenakis's prescient thoughts about Varèse were correct. The *Poème électronique* presented very successfully the electronic system of the Philips Pavilion.[134] Varèse worked on the composition of *Poème électronique* in the Philips studios established for him in Eindhoven, but interestingly enough, independently from Le Corbusier's scenario.[135] (Figure 2.2.1.1)

[132] Treib, *Space Calculated in Seconds*, 7.

[133] Harley, *Xenakis*, 17.

[134] Treib, *Space Calculated in Seconds*, 171.

[135] Treib, *Space Calculated in Seconds*, 6.

Figure 2.2.1.1 E. Varèse and J. W. de Bruin in Philips Eindhoven studios
Source: Treib, *Space Calculated in Seconds*, 203.

The music of 480 seconds was played with over 400 speakers, placed all around the Pavilion. Regarding this arrangement, Varèse said:

> The composer might go a step further along these lines [than positioning the loudspeakers throughout the space] by not only arranging for different parts of the overall tonal pattern of his score to reach listeners from different directions and distances … but by also giving these parts a different spatial character.[136]

So, the *Poème électronique* started with a gong. The following sounds, "[r]ising sequences, blips, tap-tap-taps, many of which were set apart in space, constituted the elements of the work."[137] On his use of human voice Varèse said: "I wanted it to express tragedy – and inquisition."[138] In addition to human voice, *Poème électronique* included bells, whistles and sirens, pipe organ notes, percussive sounds, mechanical sounds, jet engine, etc.[139]

[136] Treib, *Space Calculated in Seconds*, 183.

[137] Treib, *Space Calculated in Seconds*, 203.

[138] Treib, *Space Calculated in Seconds*, 203.

[139] See Appendix A for a detailed analysis of the *Poème électronique*.

2.2.2 Images, Color and Light

As in the case of sound affects, the visual part of the *Poème électronique* aimed to affect the audience's emotionally. The power of light and color served as an important component for the poem's atmosphere. (Figure 2.2.3.1) 15 sound and light tracks automatically continued without stopping during the program. There were four cinema size projectors, four 3KW light projectors with color wheels, two cloud effect projectors, six 600W spots, four ultraviolet projectors to excite red and blue fluorescence on the "Volumes," 50 intermittent stars in the ceiling, and 40 sets of five (white, blues, yellow, green red) fluorescent tubes hidden behind six-foot high balustrades.[140] As Xenakis emphasized, "the Philips Pavilion and Le Corbusier's *Poème électronique* are an outstanding example for the synthesis of optical, acoustical, architectural and technical interaction of human capacities."[141]

[140] Philips Technical Review, 5.

[141] Xenakis, *Music and Architecture*, 107.

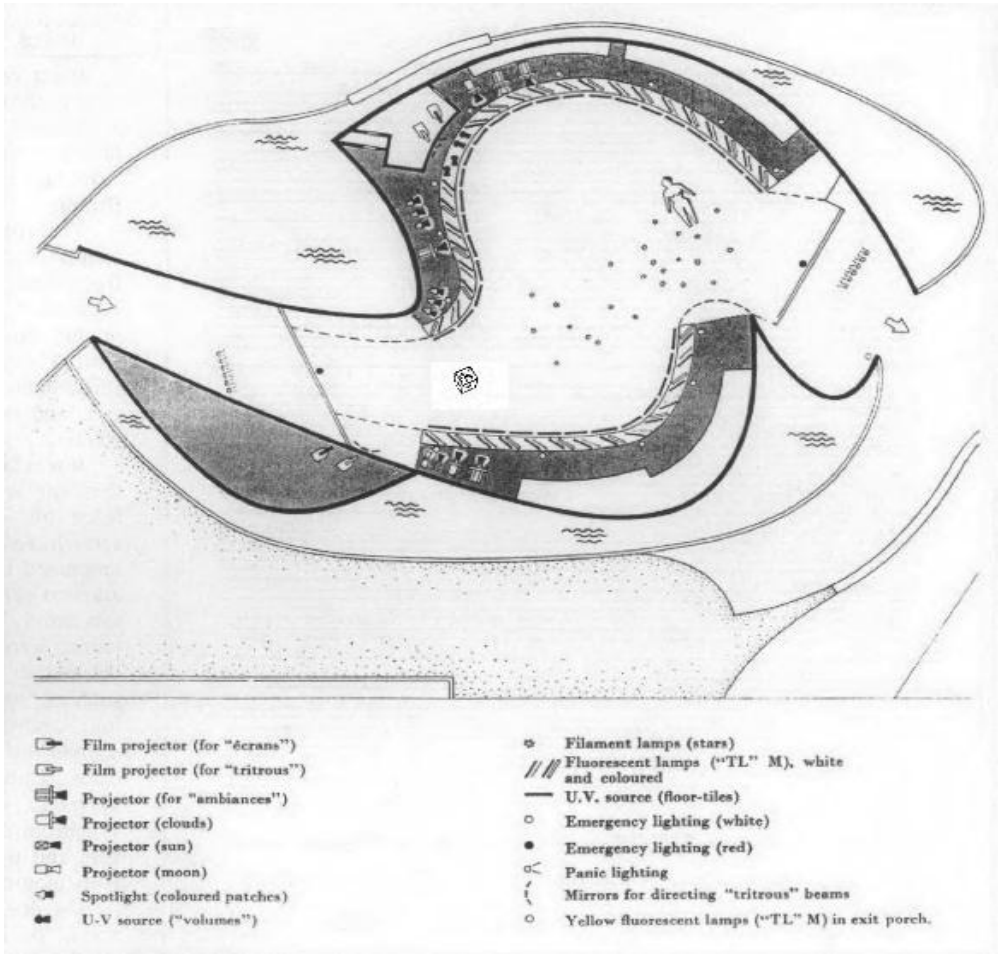


Figure 2.2.2.1 Plan of the pavilion showing the location of light and sound equipment
Source: Treib, *Space Calculated in Seconds*, 160

There were five visual components of the spectacle designed by Le Corbusier: 1) *écran* - Images and the film were projected on two large screens. On the *écran*, the audience watched Le Corbusier's scenario as a projected film. 2) *ambiance* – Variable colored lightning effects and chromatic zones were reflected on the surfaces by emphasizing the shapes of those surfaces. 3) *tri-trous*, so named for the three holes in the projection device. Three shaped hole areas placed upon the film by projectors. 4) *volumes* - Two reflective figures, a female figure and an abstract sculpture, could shine with ultraviolet light hung from the ceiling in three dimensional form. 5) other special effects – There were some other projected components and glittering bulbs like images of the sun, moon, and stars on the ceiling.

These five techniques created the amazing visual effects for Le Corbusier's visual show. The timetable of all these effects was listed and recorded on a *minutage* or 'the visual score' second by second. (Figure 2.2.2.2) In other words, the visual aspect of the poem was scheduled by the *minutage.*

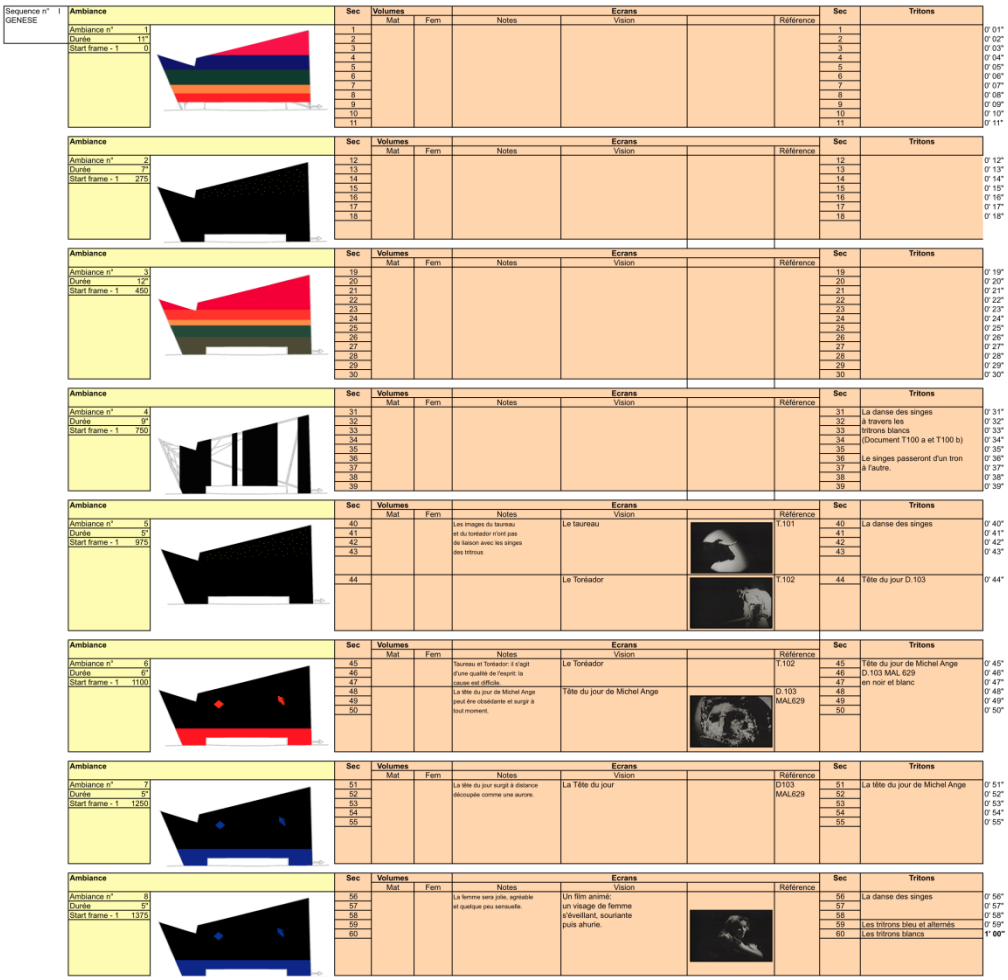
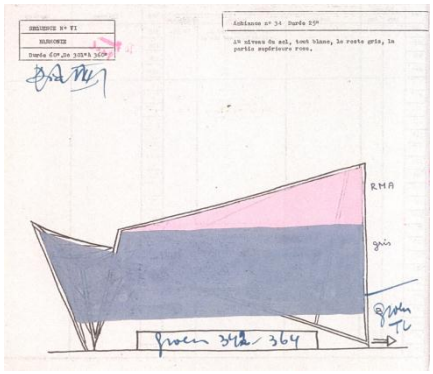


Figure 2.2.2.2 Example of *Minutage* in *Poème électronique*, Sequence I Genesis
Source: http://www.edu.vrmmp.it/vep/minutager.html (Accessed 28.06.2012)

Synchronizing Le Corbusier's scenario, sound and numerous projectors required enormous coordination. The visual score was designed by Le Corbusier and Jean Petit (b.1927) who was an author, editor, graphic designer and publisher. The m*inutage* was divided into two pages, one for the *ambiance* including time period and one for the other visual effects. (Figures 2.2.2.3a-b)

Band of colored lights and flat shapes could be projected with the help of these four visual elements' technology.



Sec.	Volumes Mat.	Volumes Fem.	Ecrans Notes	Ecrans Vision	Ecrans Référence	Sec.	Tritrous	Pareles
305			Il s'agit ici véritablement d'un ballet où doivent intervenir tous les éléments mécaniques et très rapidement à l'esporte pièce interviendront des animaux, des yeux, des visages humains.	Ballets des éléments mécaniques	T.234	305		
306						306		
307						307		
308						308		
309						309		
310				Ballets des éléments mécaniques alternés avec animaux, yeux de hibou, taureau, etc..	T.235 à T.244	310		
311						311		
312						312		
313						313		
314						314		
315				Ballets des éléments mécaniques alternés avec visages	T.235 à T.244 plus T.100 T.101 T.149 T.158	315		
316						316		
317						317		
318						318		
319						319		
320				Ballets des éléments mécaniques	T.235 à T.244 plus T.201 T.204 T.206 T.208 T.209 T.212 T.211	320		
321						321		
322						322		
323						323		
324						324		
325				Ballets des éléments mécaniques alternés avec Laurel et Hardy	T.235 à T.244 plus T.213 T.214	325		
326						326		
327						327		
328						328		
329						329		

Figure 2.2.2.3a Image of an *ambiance* in *Poème électronique*
Figure 2.2.2.3b Control score of *Poème électronique*
Source: http://www.edu.vrmmp.it/vep/minutager.html (Accessed 28.06.2012)

During the 480 seconds of music composed by Varèse, Le Corbusier's selection of projected images, paintings, photographs and montage were shown for the audience. In June 1957, Le Corbusier wrote to Philippe Agostini: "I have confirmed the plan of my Poème with a very clear visual concept. Would you be disposed to help me on this project which will not take a lot of tim, but will require a sharp mind?"[142] Agostini accepted the offer and together with Jean Petit played a significant role in the project. So, while Le Corbusier selected the images, the film montage was made by Agostini and arranged by Petit. In other words, they translated Le Corbusier's thoughts into a movie.

For the very first time, Le Corbusier had an opportunity to create freely a scene "where all the means of cinema and color projection techniques were freely at his

[142] Treib, *Space Calculated in Seconds*, 103.

disposa."[143] He selected the images and photographs from several collections of Musée de l'Homme, Musée pédagogique, the American Library, and André Malraux's[144] books on sculpture. Accordingly, montage was an essential element in the production of this spectacle.

As Xenakis defined the visualization of the *Poème électronique*:

> Panoramic screens, continuously reproducing and revolving pictures; apparatus, alternately casting lights and black colors; flashing effects, ranging from the visible to invisible areas; cinematic illuminations of vaults and curved skylines either aflame or frozen into ice; magic and tragedies by optical means; plastic ideals of life beginnings ... all these countless means and effects keep the audience wavering between uncertainty an instantaneous compression during eight minutes of uninterrupted performance, transposing them into a world where the imagination is not able to anticipate the sequence of lights and sound events.[145]

The *Poème électronique* opened with parallel texts in French, English, and Dutch drawn in white against a black ground.

> Philips have created an automatic apparatus that inaugurates a new art with unlimited possibilities, viz. a synthesis of light, color, picture, speech and music displayed in space. The "Electronic Poem," wrought by Le Corbusier, his collaborator Iannis Xenakis and the composer Edgar Varèse aims at showing how our increasingly mechanized civilization is striving towards a new harmony in the future. The scenario consists of the following sequences: genesis, spirit and matter, from darkness to dawn, man-made gods, how time molds civilization, harmony, and to all mankind.[146]

Then, its visual scenario followed seven sequences: genesis, spirit and matter, from darkness to dawn, man-made gods, how time molded civilization, harmony, to all mankind.

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[143] Xenakis, "The Philips Pavilion at the Dawn of a New Architecture" in Xenakis, *Music and Architecture*, 112.

[144] André Malraux (1901-1976) was French novelist, art theorist and Minister for Cultural Affairs.

[145] Xenakis, *Music and Architecture*, 107.

[146] http://www.edu.vrmmp.it/vep/debouw.html (accessed in 5.02.2013)

The beginning sequence was ‘Genesis’ (0″ to 60″) which lasted one minute. Most of the pictures were animated by cinematic techniques. When the images were flowing, one picture could be intertwined with another or images could be seen consecutively or side by side. ‘Genesis’ consisted of several pictures, e.g, images of colored stripes, a bull and a bull head, a matador, the head of a Greek figure, a motion picture of a woman smiling and terrifying. Then after that feeling of a terror, visitors saw the image of a skull and the second sequence began.

The Sequence II was ‘Matter and Spirit’, (61″ to 120″). Unlike ‘Genesis’, each image ran rapidly on the *écran*. That is, images changed almost every second. Among the projected images were sea shells, a skull, an African woman, a detail figure from a painting by Courbet, *Femme nue couchée* (1862), colored lights, a dinosaur and a human skeleton, animal skulls, a film of monkeys and masks.

Eyes of animals and humans and their heads described the Sequence III, ‘From Darkness to Dawn’ (121″ to 204″). An owl head, a turkey head, a woman’s face, totem, open ditch graves from concentration camps, toy soldiers, weapons, medieval religious sculptures were projected on the *écran* in this sequence.

The Sequence IV, ‘Manmade Gods’, started in second 205. This sequence was comparatively short and lasted only 35 seconds including colored lightning ambiances with the images of stone head from Easter Island, geometric cube figures, the Sphinx and hands of the Buddha.

The Sequence V, ‘How Time Molds Civilization’ (241″ to 300″) started with white light. The theme of industry and power was displayed on a green background. The sequence showed first a worker at an atomic plant and continued with the images of crowds, a telescope operator, a surgeon, workers, a horse and a cow, Charlie Chaplin, a rocket, a radar, children, clouds and mushroom clouds.

In contrast to the despairing ambiance of the Sequence V, the Sequence VI, ‘Harmony’ (301″ to 360″), was more optimistic. The last segment was ‘To All Mankind’ (361″ to 480). The list of pictures included two lovers sitting on a bench

and kissing, babies, four skyscrapers in Paris, New York, the *Modulor,* some architectural plans, Le Corbusier's works of Rezé-les Nantes and Chandigarh, a baby's hand on a dark-skinned baby's knee, open hand sculpture and a baby again.[147]

2.2.3 *Concret PH*

Together with Philips' sound engineers, Xenakis was responsible for the specialization of the sound projection. As he explained, "Le Corbusier allotted a smaller musical task to me, to compose an interlude of two minutes."[148] Accordingly, Xenakis composed a two-minute work, *Concrete PH*. It was a musical interlude "broadcast[ed] between the performances of the electronic poem."[149] Groups of approximately 500 people would enter the Philips Pavilion and hear Xenakis's transitional piece before entering a room where they could experience 480 seconds multimedia event, the Poème électronique. The two additional minutes would allow the spectators to leave the Pavilion while the next group was entering. *Concrete PH* was played at low volume at the entrance hall and the exit of the Pavilion during the visitor shift. In this sense, it was the prologue and epilogue of the Poem. The title of the musical piece, *Concret* was a reference to the construction material of the Philips Pavilion and also to the *musique concrete*; and *PH* is the French acronym of hyperbolic paraboloids and also the initial letters of Philips.

During his composition career, tape music was one of Xenakis's composition techniques. *Concret PH* was recorded with tape composition techniques. When started to work on tape composition techniques, he also began to study *musique*

[147] To see the visual material of *Poème électronique* see Appendix B.

[148] Treib, *Space Calculated in Seconds*, 105.

[149] Xenakis, *Music and Architecture*, 302.

concrète.[150] In 1954, he became a member of the of the Pierre Schaeffers's *Groupe de Recherches de Musique Concrète*.

While Varèse worked on *Poème électronique* in the Philips studio in Eindhoven, Xenakis worked in Philips offices in Paris. Actually, it was Le Corbusier who impeded Xenakis working in Eindhoven. On November 27, 1957, he wrote a letter to Xenakis which made their relation even worse:

> It is impossible for you to go Eindhoven for three weeks. Don't even think about it! We are running an architect's studio here: we are not an academy with students who spend their time however they see fit.[151]

Consequently, Xenakis worked with monophonic tape in Paris studios that were not technologically well equipped in comparison to Eindhoven. Later, this tape composition became "a miniature gem of the electroacoustic genre."[152]

2.2.4 Mathematical Objects

Apart from his duties as a designer, engineer, supervisor, and composer, Le Corbusier asked Xenakis to design a geometric sculpture, "l' objet mathématiques'."[153] Xenakis produced two of them and he placed the smaller one inside the Pavilion and the larger one near the entrance. He designed their forms as a series of outlined geometric solids by intertwining one another. "At the heart" of the one near the entrance, he also placed "a neon rendering of Le Corbusier's writing announcing the *Poème électronique.*"[154] (Figures 2.2.4.1 a-c)

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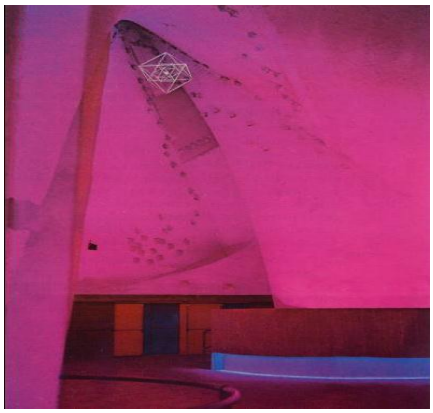
[150] *Musique concrète* is a type of electroacoustic music whose compositions are not limited to strict musical rules.

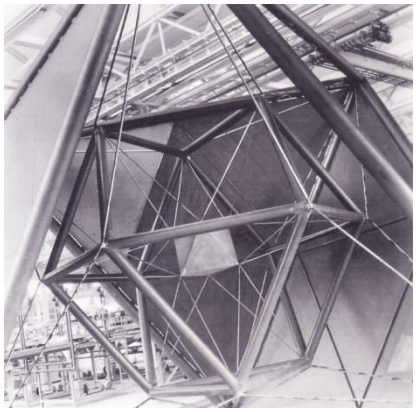
[151] Kanach, "The Philips Pavilion 1956-58" in Xenakis, *Music and architecture*, 102.

[152] Harley, *Xenakis*, 19.

[153] Xenakis, *Music and Architecture*, 100.

[154] Treib, *Space Calculated in Seconds*, 142.





Figures 2.2.4.1 a-c Mathematical objects in the Philips Pavilion
Source: Treib, *Space Calculated in Seconds*, 94-95-142.

As Xenakis explained, while working on the design of the mathematical objects, he asked himself: "What is the geometrical form which the enclosure must take in order to use the minimal about of material?"[155] So, he combined geometric and experimental methods in order to study the forms of the objects.

2.2.5 *Gesamtkunstwerk* in the Philips Pavilion

In 1958, Xenakis wrote an article, titled "Notes towards an Electronic Gesture." In the article, while describing abstract evolution in music,[156] he explored "the spatial

[155] Kanach, "The Philips Pavilion 1956-58" in Xenakis, *Music and Architecture*, 98.

[156]Both serial music and electro-acoustic techniques expanded abstract evolution in music. These developments became known as two main created music: Paris group which created music out of radiophonic sound effects of the concrete; and the electronic music studio at Cologne Radio (Westdeutsche Rundfunk) group which based music on sinusoidal sounds of electronic type by

possibilities that are permitted solely by the electro-acoustic chain as it follows: tape -- tape recorder -- loud speakers. [157] He, then, focused on the last part of the chain, loudspeakers. As he assumed, "Audible sound is directional over the entire range of its spectrum. Therefore, we can consider a loudspeaker as a punctual source within three-dimensional space, provided the room is acoustically inert."[158] "These sound poins" (speakers) define a new kind of space as geometric points in stereometrics. When we assume an acoustic straight line defined by sound points, the sound can be every point of the line.[159] Ruled or warped surfaces can be imagined in the same way in space. So, with the help of electro-acoustic techniques, the invasion of geometric space was possible as a new field in the abstraction.[160] "Total Electronic Gesture", as Xenakis named it, enabled the magnificent audiovisual spectacles in the field of abstraction. Most importantly, at the end of his article, Xenakis pointed out that the Philips Pavilion represented the first experiment and a big step towards an 'Electronic Gesture' with its artistic combination of sound, light and architecture.

In "Topoi", another article that he wrote in 1970,[161] Xenakis explained the hyperbolic paraboloids of ruled surfaces in the Philips Pavilion: "I chose this solution in order to solve problems of acoustic conditioning plus it was immediate interest in terms of the visual and the auditive spatial conditioning of the architectural form."[162] So, Xenakis wanted to create an architectural structure that

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approaching electronic music from the abstract to the concrete. Both studios used many of the same technical procedures and based on electromagnetic techniques.

[157] Xenakis, *Music and Architecture*, 133.

[158] Xenakis, *Music and Architecture*, 133.

[159] Everything that can be defined in Euclidian space can be transferred in acoustic space.

[160] As he described in the article, music began to evolve towards abstraction with the discovery of atonality. For him, this abstract evolution surpassed the 12 tone serial music which "imposed a restriction, a linear constraint on structural constructions" and also which did not "allow for sounds with continual variation" especially for glissandos. Since he aimed to enrich sound, he wanted go beyond these restrictions by means of Stochastic Music which would essentially incorporate the theory and calculation of probabilities, introducing an entire series of mathematical functions." (For more information on Stochastic composition, see Xenakis, *Formalized Music*.)

[161] Xenakis, "Topoi" in *Music and Architecture*, 142-148.

[162] Xenakis, "Topoi" in Xenakis, *Music and Architecture*, 144.

could "especially envisage skewed surfaces, twisted in space."[163] While discussing the Pavilion, he criticized the architects who were capable of making traditional concert halls by using "round forms that [might] be classical and powerful in terms of geometry but [who] totally miss[ed] the point in terms of architecture for conditioning a listening experience."[164] In this regard, his remarks on theater architecture indicated clearly how close Xenakis's ideas were to the Wagnerian *Gesamtkunstwerk*:

> Music theater or visual music should not be conglomerate of uninterested things. The light spectacle itself should be as strong as the music, and should be able to seen alone, without the music and stand on its own. The same is true for the music; it should be able to stand alone, without the visuals. Only in this way we can be sure to surpass ourselves, to go beyond our capabilities. … In theater you can have a marriage of colors, gestures, music and then finally a subject, meaning the drama, the poetry… This is perhaps the only example today that is truly polylogical, an artistic multiplicity, because you can watch without listening and listen without watching, and in both cases, the result is satisfying.[165]

[163] Xenakis, "Topoi" in Xenakis, *Music and Architecture*, 144.

[164] Xenakis, "Topoi" in Xenakis, *Music and Architecture*, 144.

[165] Xenakis, "Topoi" in Xenakis, *Music and Architecture*, 145.

CHAPTER 3

LE DIATOPE

3.1 THE POLYTOPES

Polytopes was a genre of light and sound installations of music, light and space, designed by Iannis Xenakis to present his performances. The word 'poly-topoi' from the Greek can be translated as many-spaces. As Sven Sterken describes, "Transposing his abstract and geometrical vocabulary … to the sphere of light and sound in the Polytopes, Xenakis realizes a global and parallel formalization in the spaces of architecture, light and sound."[166] So, it would not be wrong to say that with these structures, Xenakis created an amazing spectacle. In this sense, the crucial role played by the spectator or the audience connected them together. As Xenakis explained, the idea that lied beneath their creation was his admiration of nature:

> In the case of the polytopes I was attracted by the idea of repeating on a lower level what Nature carries out on a grand scale. The notion of Nature covers not only the earth but also the universe. When we look from space at the earth at night we see that the globes is lit by artificial light, which didn't exist a century ago. And this is only the beginning. If the kind of development we have seen recently continues, the possibilities of mankind will multiply and that novelty will also enrich art. One can realize more and more interesting and complex things – artists will process immense power.[167]

He once remarked that this "idea for creating one unified physical, visual and auditory space for performance date[d] back to two early events in his life."[168] The first one was his experience as director in high school. In his own words, "[i]t was the first time I realized the importance of visual phenomena as visual music."[169]

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[166] Sven Sterken, "Towards a Space-Time Art: Iannis Xenakis's Polytopes." Perspectives of NewMusic, 39/2 (summer 2001): 267. http://www.jstor.org/stable/833570 (accessed 12.06.2012)

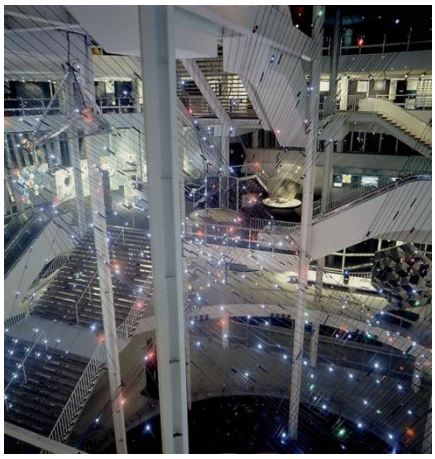
[167] Kanach, "Xenakis's Polytopes" in Xenakis, *Music and Architecture*, 199.

[168] Kanach, "Xenakis's Polytopes", 198.

[169] Kanach, "Xenakis's Polytopes", 198.

Then, he connected his second experience to his university years, when he was a leading member of the student resistance in Athens as part of the Greek revolution movement: "Whether you like it or not, simultaneous visual and auditory events … enter one's brain when experienced as fighting in the street."[170]

His first Polytope was the French pavilion at the Montréal World's Fair in 1967. All the components of architecture, music and light in the *Polytòpe de Montréal* were conceived by Xenakis. It was his first immersive environment. The lights and sound filled the pavilion hourly for six minutes. During the performance, spectators moved freely around the pavilion and could have different positions and perspectives from different floors. The company Orthotron developed 800 white light flashes and 400 colored light flashes. (Figures 3.1.1a-b) The light-sensory panel managed the light composition.



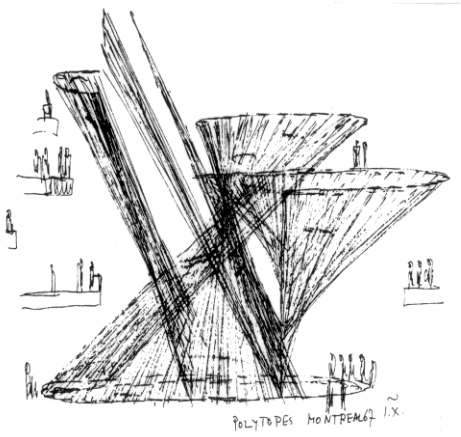


Figure 3.1.1a *Polytope de Montreal* in the French Pavilion at the Universal Exhibition of 1967.
Source: http://www.iannis-xenakis.org/fxe/archi/real.html (accessed 09.05.2012)
Figure 3.1.1b *Polytope de Montreal*: Sketch of lighting cables over five floors of the French Pavilion
Source: Hersey, *Xenakis in music*, 51

The structure of the *Polytòpe de Montreal* was composed of steel cables. As Xenakis explained, "You may have an entirely closed space into different registers

[170] Kanach, "Xenakis's Polytopes", 198.

from the inside. But you can also organize the space from the outside, treating it like a container or receptacle; then it can be precisely defined."[171]

The second Polytope was presented at Persepolis in an open space, in the ruins of Persepolis. His work of light, sound and movement was performed only once as the opening of the Arts and Music Festival of Shiraz in 1971. During the performance, two compositions created by Xenakis were used. The performance was opened with the *Diamorphoses* of 7 minutes. It was a two-track tape electro-acoustic work composed in 1957. The *Persépolis* of 56 minutes was an eight-track tape electro acoustic work composed in 1971. The components of both music and light were conceived by Xenakis. (Figure 3.1.2)

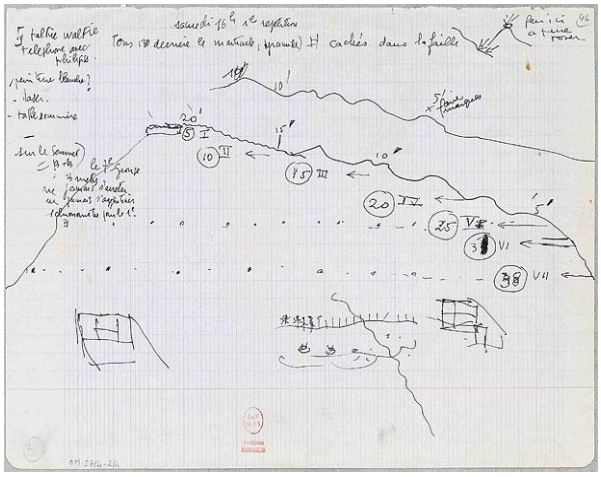


Figure 3.1.2 Xenakis' diagram for the original presentation of *Polytòpe de Persepolis*
Source: http://www.moca.org/audio/blog/?p=1024 (accessed 09.04.2012)

Approximately 150 children carried two laser beams, torches, army searchlights and bonfires. There was no seat for the audience, they walked around the ruins during the open air spectacle. (Figure 3.1.3) The listeners spread among the musicians and the conductor was in the middle of them. The light and the sound

[171] Xenakis, "Topoi" in Xenakis, *Music and Architecture*, 142.

sources were immobile as the vast audience. So, there was a spatio-temporal relationship between the audience and the sources.[172]

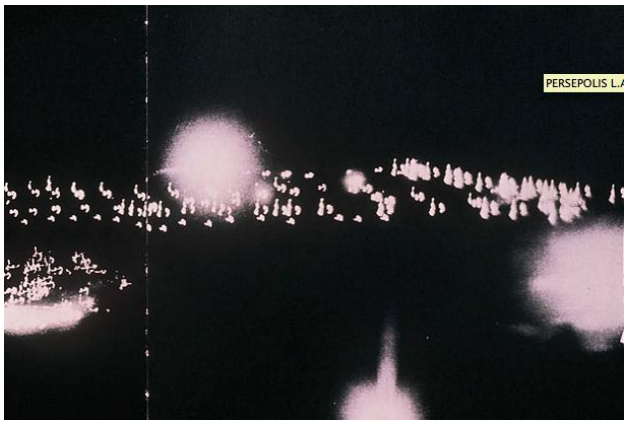


Figure 3.1.3 *Polytope de Persepolis* spectacle
Source: Xenakis, *Music and Architecture*, 222.

The third Polytope, the *Polytòpe de Cluny*, was installed as a 24 minute show in the Roman Baths of the Cluny Museum in Paris and was presented between November 1972 and January 1974. Music, architecture, lights and informatics were all conceived by Xenakis and produced by computer. Xenakis used spectators as a component "by submerging them within the composed performance of architecture, creating an inescapable interactivity."[173] By doing so, he "went one step beyond any previous total performance," as Kanach remarks.[174] (Figures 3.1.4a-b)

[172] Xenakis, "Places and Sources of Auditions and Spectacles" in Xenakis, *Music and Architecture*, 152.

[173] Kanach, "Xenakis' Polytopes" in Xenakis, *Music and Architecture*, 200.

[174] Kanach, "Xenakis' Polytopes" in Xenakis, *Music and Architecture*, 200.

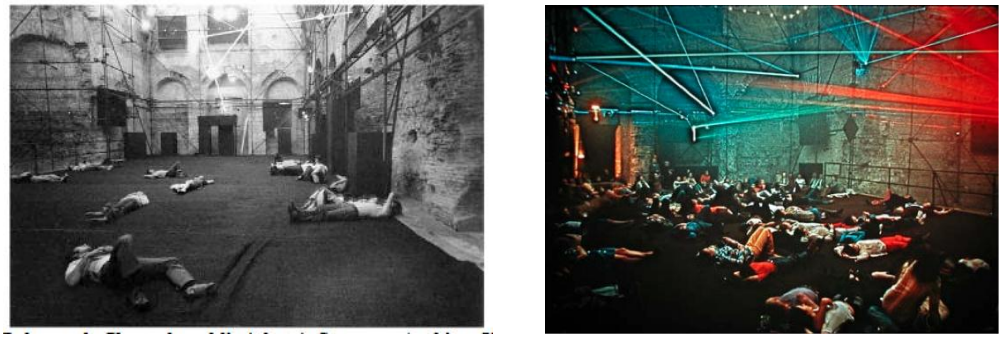


Figure 3.1.4a-b Spectators in *Polytòpe de Cluny*
Source: Solomos, "La Diatope: *Légende d'Eer*", 31.

600 light flashes and three laser beams were reflected by means of mirrors by creating extreme forms. FORTRAN 4 was used for programming the spectacle. The show needed 23,200,000 binary commands.

The fourth example, *Polytòpe de Mycène* was located in the ruins of the ancient Greek town, Mycenae on September 2-5, 1978. After 27 years of exile, Xenakis could finally go back to Greece. A 10 minute electro-acoustic tape of *Mycène Alpha* (1978) was the first work of its kind that Xenakis composed entirely on his UPIC system and speficially for the *Polytope de Mycène*. (Figure 3.1.5) His other compositions, *Hélène* of 10 minutes (1977); *Colonne* of 14 minutes (1977), a work for men's and women's chorus and ensemble; *Oresteïa* of 46 minutes (1965-66), a piece for children's chorus, mixed chorus and ensemble; *Psappha* of 13 minutes (1975), and *Persephassa* of 23 minutes (1969), a work for percussion, were also used for the spectacle.

The light, music and texts were all conceived by Xenakis. Passages from Homer and ancient scripts in Linear B were narrated by two speakers in ancient speech. The spectators were placed around the acropolis, Agamemnon's tomb and Mount Zara. Light show and the spatio-temporal relationship between the listeners and sources were similar to the *Polytòpe de Persépolis* but more advanced. In addition, both of them were large-scale events. (Figure 3.1.6) Children and soldiers carried

torches, whereas goats and sheep had small lights, army searchlights, fireworks and projection of slides. [175]

Figure 3.1.5 Graphic score to *Mycenae-Alpha*, 5'16" - 7'16"
Source: http://www.personal.psu.edu/meb26/INART55/cemamu.html (accessed 06.06.2012)

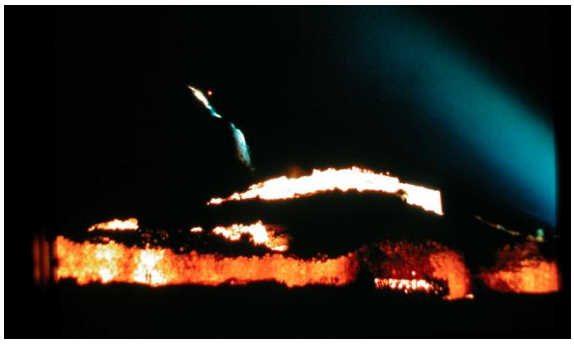


Figure 3.1.6 *Polytòpe de Mycène* spectacle
Source: http://www.iannis-xenakis.org/fxe/archi/real.html (accessed 06.06.2012)

Polytòpe de Mexique was another example of abstract light and color choreography, as well as a sound event, held in the pyramids of Teotihuacan in Mexico between 1978 and 1981. Xenakis's piece for percussion, *Persephassa*, and a broadcast of his electro-acoustic music were used for the spectacle. He was proposed by a composer, Julio Estrada, to the Mexican Government to create a show.

[175] Xenakis, *Music and Architecture*, 318.

Finally, the *Polytòpe d'Athèns* was a light and sound spectacle for the city of Athens. The event took place on June 21, 1985, the annual European Music Day. This last Polytope was "the largest and the most utopian one."[176] Xenakis considered the entire city together with its monuments, hills, and the sky as the stage of his event. He considered every living and non-living object in the city as a component of the spectacle.[177] However, the project was abandoned in 1985, mainly due to its potential risk of damaging the monuments, as archaeologists and historians worried about.

In the Polytope spectacles, in general, Xenakis's common point was the audience's experience. What he created was not simply an architectural work where the spectators could visit, walk around and then comment on it. In other words, what he created demanded active participants, not passive receivers. In this sense, his spectacles were experienced differently from ballet or opera performances, because there was neither a stage nor an auditorium in most of his Polytopes. Whether he chose the location for the spectacle or designed the structure himself, the audience could decide on the direction to perceive the show by sitting, standing up, or walking around.

In the Polytopes, Xenakis created geometrical spaces by transforming pints of light as laser beams and points of light as flashes.[178] Since a straight line and a point were two major elements of Euclidian geometry, Xenakis used laser beams as lines and flashes as points to create "surfaces, volumes, forms and moving galaxies of light" that were never created before.[179] With the help of the computer science

[176] Xenakis, *Music and Architecture*, 321.

[177] For further interest, watch "Music for one Apartment and Six Drumers" (2001,10′′) and "Sound of Noice" (2010, 102′′). The second movie shows how six percussionists used the entire city as their performance stage.

[178] Philipp Oswalt, "Iannis Xenakis' Polytopes" *Contemporary Music Review* 21 Nos 2/3 (1991):53.

[179] Oswalt, "Iannis Xenakis' Polytopes", 53.

and technology, Xenakis achieved his goal of creating a "new art of sight and sound of vision and hearing."[180]

Xenakis always went one step beyond and developed innovative technologies specifically for his projects. He never repeated himself both on a personal and technological level as a composer, designer and architect to achieve his ideals. Furthermore, he did not choose the components of his designs, such as laser beams, randomly, just for the sake of being new or just by following some inspirations. His designs were the products of a process of reflection, of asking questions and reaching answers. Especially, mathematics, music and computer science were the fields where he found his answers that he was seeking.[181] For example, he had already used the technology of laser beams in the Philips Pavilion, but to develop it further, he used laser layer and flashes in the Polytope spectacles because he "was interested in examining more abstract expressions parallel to his musical research."[182] At this point, it should be emphasized that during the same time period, Xenakis became to be known as a composer. In other words, the Polytopes developed in parallel to his musical and visual ideas and experiences of the time.

3.2 *LE DIATOPE*

Le Diatope was designed for the opening of the Centre George-Pompidou, also known as Beaubourg, in Paris. (Figure 3.2.1a-b) Commissioned by the president of the centre, it was exhibited and visited from June 28, 1978 until December 31, 1978. Then, this "movable tent"[183] as a "cultural ambassador for the new Centre Pompidou"[184] was removed and rebuilt in Bonn, on the Bahnhofplatz, in front of the railway station, as part of the Bundesgartenschau Festival, between May 2 and November 1 in 1979.

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[180] Xenakis, "The *Diatope*: Music to be seen," in Xenakis, *Music and Architecture*, 271.

[181] Xenakis, *Music and Architecture*, xix.

[182] Kanach, "Xenakis' Polytopes," in Xenakis, *Music and Architecture*, 198.

[183] Kanach, "Xenakis' *Diatope*", 247.

[184] Xenakis, *Music and Architecture*, 319.

Figure 3.2.1a-b *Le Diatope* in front of the Centre George-Pompidou.
Source: http://archipostcard.blogspot.com/2011_04_23_archive.html

Emphasizing Xenakis's progressive development in the Polytopes, in terms of achieving greater control in time, Sharon Kanach interprets the Diatope as a representation of "the *summum genus* of his previous efforts."[185]

The Diatope was a 45 minute spectacle that took place 'inside' of the pavilion designed by Xenakis. As in the case of the *Polytòpe de Montreal*, its building was designed by Xenakis. Exemplifying his multimedia art forms,[186] Xenakis composed the *La Légende d'Eer* of 45 minutes for the show; used various flashes, laser projectors, and mirrors for the visual scenario; and included several excerpts from ancient mythology to modern science.

According to Maria Anna Harley, "[t]he shift from *Polytòpe* to Diatope indicated a shift in emphasis from the coexistence of a multitude of different spaces/objects/phenomena to the homogeneous, enveloping spatiality of three media permeating each other."[187] In other words, Xenakis created the Diatope by 'uniting' architecture, music, lights and texts.[188] Actually, this kind of unity had

[185] Kanach, "Xenakis' Polytopes", 200.

[186] Makis Solomos, "Le Diatope et La légende d'Eer" (2005):1 http://www.iannis-xenakis.org/fxe/actus/Solom3.pdf. (accessed November 2, 2011)

[187] James Harley, *Xenakis : His Life in Music* (New York : Routledge, 2004): 10.

[188] Kanach, "Xenakis' Diatope," in Xenakis, *Music and Architecture*, 247.

been achieved before in the Philips Pavilion through Xenakis's overall design and Varèse's *Poème électronique*.

3.2.1 Design and Structure of *Le Diatope*

As Kanach indicates, the Philips Pavilion "certainly constituted a solid background for Xenakis later, when developing his own Polytopes."[189] Philips Pavilion's hyperbolic paraboloid surfaces proposed a new architectural form to achieve "a maximum of free volume for a minimum of enclosing surface."[190] Accordingly, the Diatope's form followed Xenakis's principle of using hyperbolic paraboloid surfaces. (Figures 3.2.1.1a-d)

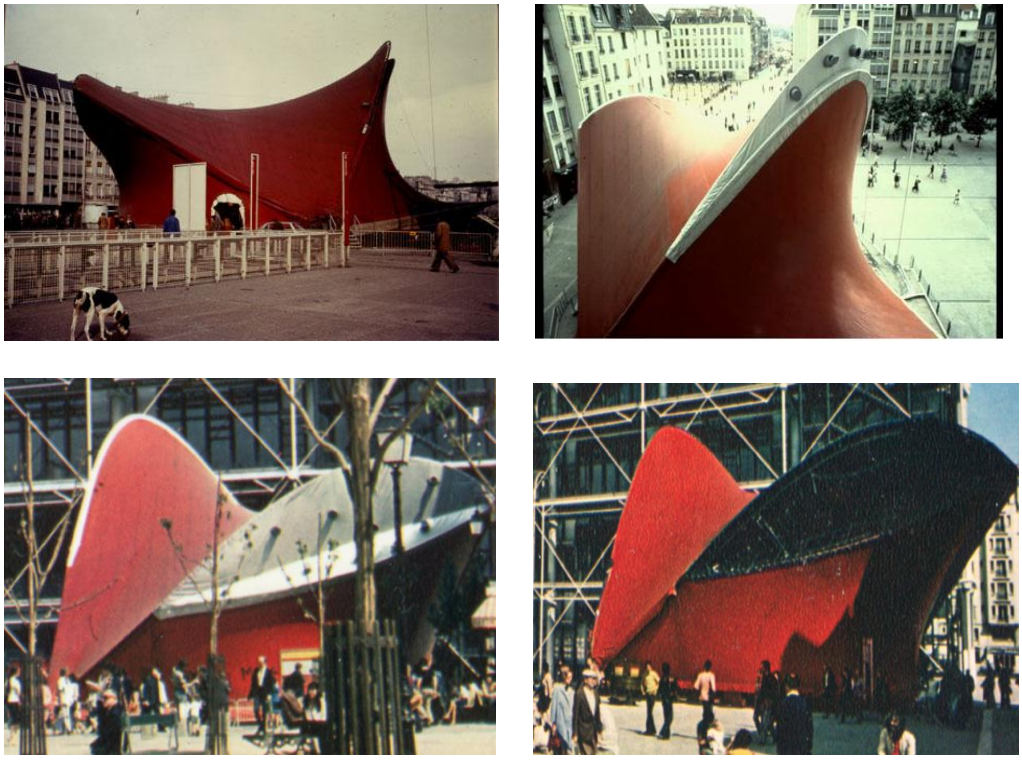


Figure 3.2.1.1a-d *Le Diatope*
Source: Xenakis, *Music and Architecture*, 247**;** Solomos, "La Diatope: *Légende d'Eer*", 21.

[189] Kanach, "The Philips Pavilion 1956-58", 100.

[190] Xenakis, "The *Diatope*: a gesture of sound and light at the Pompidou Center and *La Légende d'Eer* (1978)," in Xenakis, *Music and Architecture*, 262.

The structure of the Diatope was constructed by three hyperbolic paraboloids and "was held together by a lightweight, 50x50 cm wide meshed steel wire net."[191] Its surface was 400 square meters; its peak height was 16 meters and its total weight was 100 tons, 35 tones were for the structure itself, and the rest was for the stabilizers. (Figure 3.2.1.2a-b)

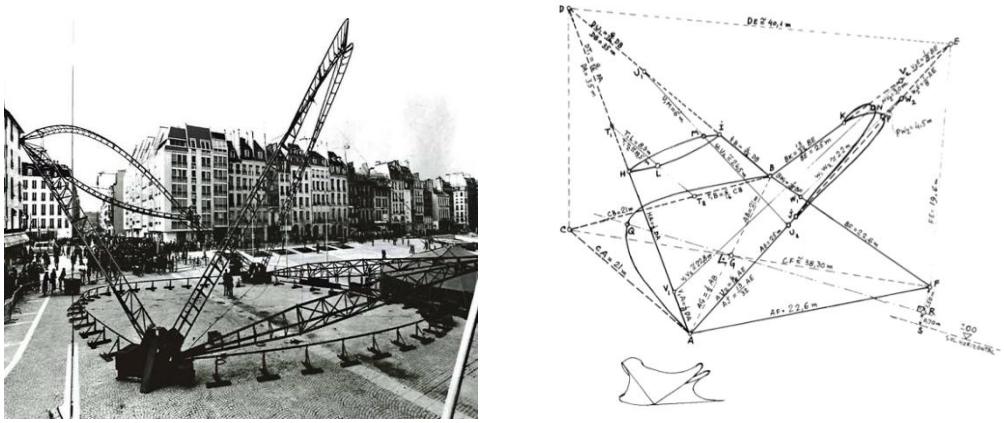


Figure 3.2.1.2a The Diatope under constructionshowing its structural system
Figure 3.2.1.2b Geometric definition of the design the Diatope
Source: Xenakis, *Music and Architecture*, 249; Solomos, "La Diatope: *Légende d'Eer*", 21.

The external shell was covered by 1000 m^2 of double-layered, semi- transparent red vinyl, which filtered light, sound, and heat. Thus, this covering did not "delimit the space, but instead modulated it."[192] Such openness of the structure revealed itself very clearly in a poster where the performance was represented as moving freely between inside and outside. (Figure 3.2.1.3)

[191] Xenakis, *Music and Architecture*, 319.

[192] Oswalt, "Iannis Xenakis' Polytopes", 37; see also 42.

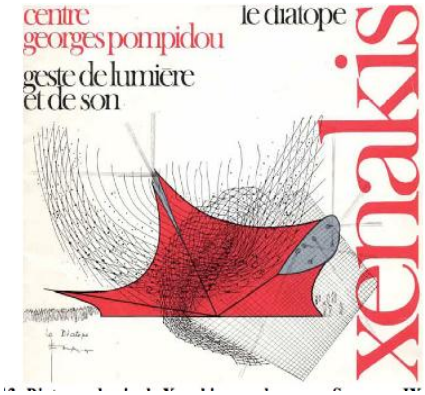


Figure 3.2.1.3 Poster of the Diatope
Source: Solomos, "La Diatope: *Légende d'Eer*"

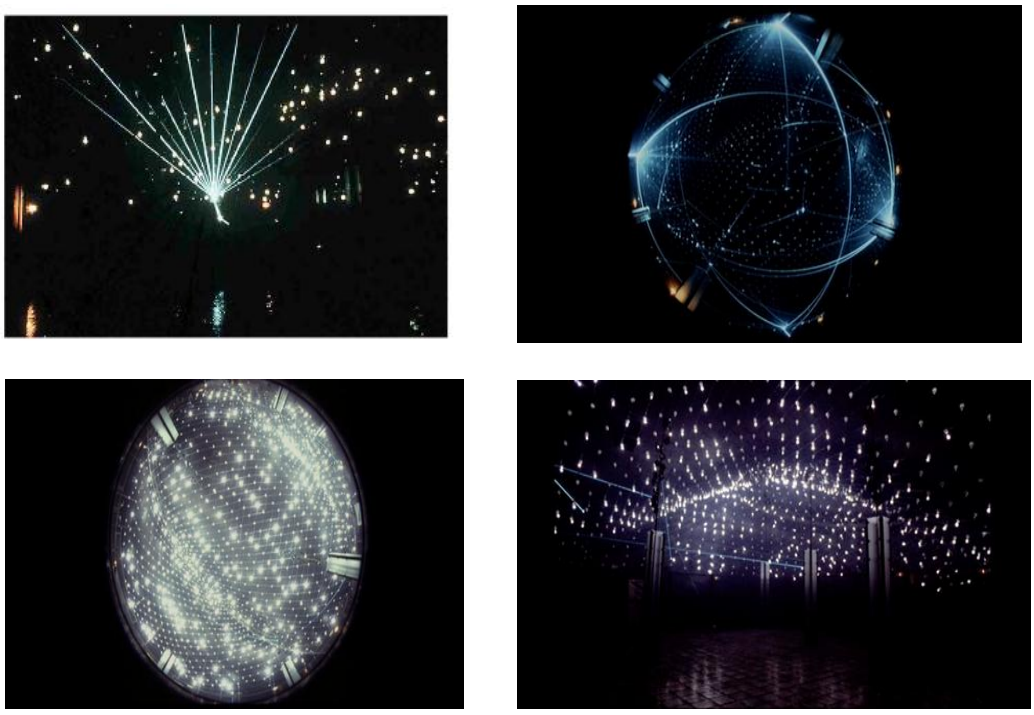
In his arcticle, "Architecture and Listening to Music" of 1983, Xenakis explained the advantages of curved surfaces for reflecting and diffusing the sound better. Accordingly, at the Diatope, he used "tent-like canvas that has no sound inertia, but which nevertheless reflected a part of the sound, and there was no untimely echo, but rather a pleasant diffusion of the sound."[193] But for him, this particular form of the Diatope presented some other advantages as well: "If you succeed in creating a space that gives the impression of flying, that's great. At Saint Sofia in Constantinople, one gets this impression."[194]

3.2.2 Spectacle

Computer generated light show of *Le Diatope* included 1680 electronic xenon flashes, four laser projectors, three green and one red, and 400 revolving mirrors and prisms. The 1680 flashes lighting every 1/25th of a second created moving galaxies while the four laser projectors, reflected by the mirrors, and their optics' special design produced previously planned effects of the show (Figures 3.2.2.1a-d)

[193] Xenakis, "Architecture and listening to music (1983)," in Xenakis, *Music and Architecture*, 156.

[194] Xenakis, "Architecture and listening to music (1983)," 158.



Figures 3.2.2.1a-d: The Diatope spectacle (Photo Bruno Rastoin)
Source: http://acousmata.com/post/536583109/the-legend-of-er (accessed 04.09.2012)

Since the floor was made of reflective glass, the visitor seemed to float halfway up in the middle of the room. (Figure 3.2.2.2) Several supported columns worked for mirrors. So, the laser beams could be reflected to create complex arrangement across the space.

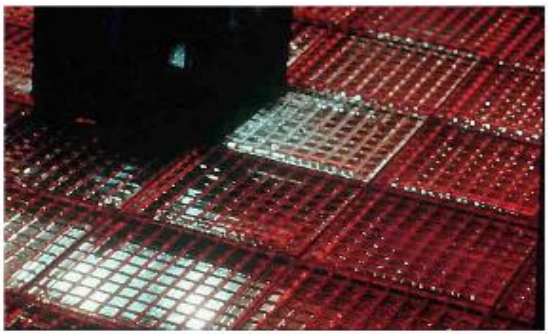


Figure 3.2.2.2 The floor of *Le Diatope*
Source: http://acousmata.com/post/536583109/the-legend-of-er (accessed 09.06.2012)

As Nouritza Matossian explains, "[l]aser beams shine and intersect in ever increasing complexes while the glass floor and columns assume a translucent green, leaving the spectators seemingly suspended in midair."[195] In other words, not only the vinyl surface but also the floor of the Diatope seemed to be disappeared. That composition was closely related to the word, 'Dia-topoi.' 'Dia' means through or across; hence, 'Dia-topois' can be translated as across the space.

In the performance, each light flash and laser composition was written on a score. The computers required 140.000.000 binary commands for the light program. (Figure 3.2.2.3)

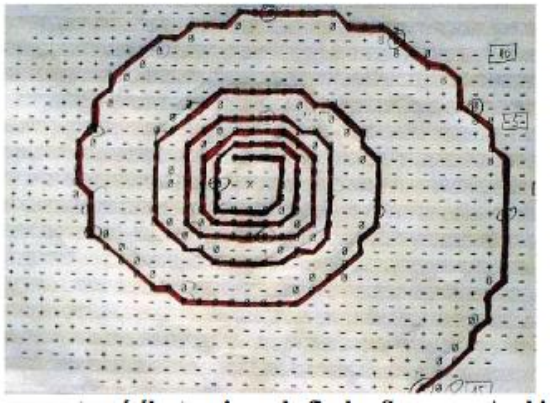


Figure 3.2.2.3 Plot of an electronic flash score for the *Diatope*
Source: Solomos, "Le Diatope: *Légende d'Eer*",23.

In the visual scenario of the spectacle, Xenakis's interest in astronomy was apparent, too. As he remarked, "I want to bring the stars down and move them around. Don't you have this kind of dream?"[196] That was why he designed a flash show, called 'Galaxies.' (Figures 3.2.2.4a-b)

[195] Nouritza Matossian,, "Xenakis's Diatope of Bonn," *Tempo*, New Series 129 (June 1979):40

[196] Harley, *Xenakis: His Life in Music*, 114.

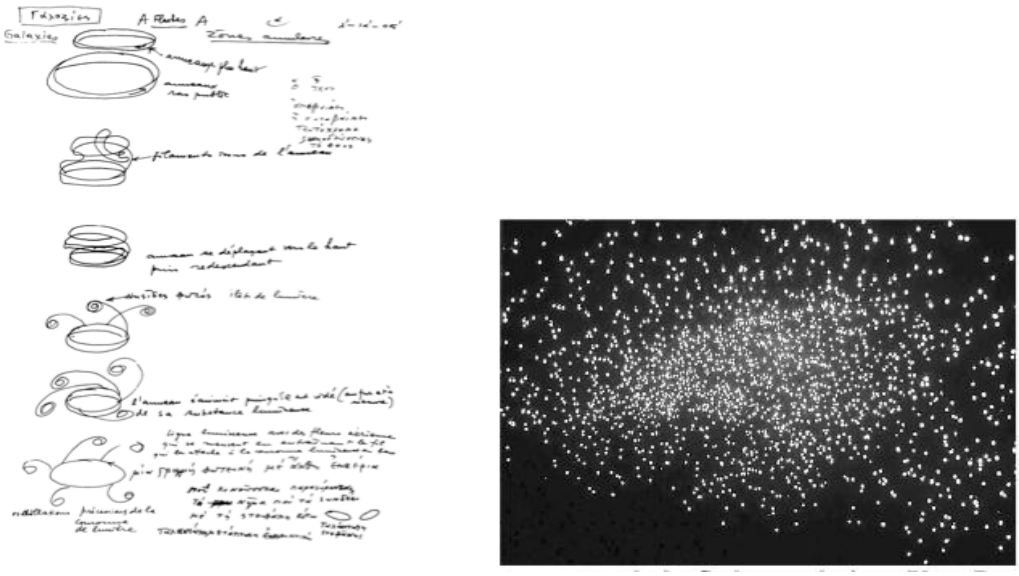


Figure 3.2.2.4a Xenakis's design of laser and mirror configurations within the Diatope
Source: Xenakis, *Music and Architecture*, 222.
Figure 3.2.2.4b Spectacle of flashes, galaxies (Photo Bruno Rastoin)
Source: Solomos, "La Diatope: *Légende d'Eer*", 23.

Xenakis's purpose was to show that by means of art, harmony of the spheres of the cosmos could be achieved.[197] He presented this complex show of light flashes and laser beams, such as spiral, galaxies or wheels, with mathematical functions and complex number transformations.

While explaining the reason for his use of lights, Xenakis referred to his observations on architecture as well:

> In modern architecture there are materials like concrete, glass, steel, in comparison with the nineteenth century which used bricks, stone, and wood. The next important innovation of modern architecture was the simplification of geometric elements like planes, straight lines, and right angles. This was the cubic kind of architecture, introduced in the beginning of the twentieth century, in order to compensate for the lack of interest in the simplicity of design. Then new proportions were introduced the game

[197] Xenakis, "The *Diatope*: a gesture of sound and light at the Pompidou Center and *La Légende d'Eer* (1978)," in Xenakis, *Music and Architecture*, 263.

> of proportions utilizing light, especially the play of light, the use of light, the type of light, and so on.[198]

3.2.3 Texts

As the thematic basis for his spatial/musical/visual spectacle of *Le Diatope*, Xenakis used excerpts selected from a diverse range of texts, including ancient mythology as well as modern science.[199]

The first excerpt was from the end of the Plato's *Republic* (4th century BC)

Book X:

> Each group would spend seven days in open country, and on the eighth, they had to break camp and head out for four days to finally reach a place where one discovers, stretching all across the sky and over the earth, a beam of light straight as a pillar, akin to a rainbow, but much more radiant and pure.[200]

It was about *La Légende d'Eer*. Eer was a warrior in the city of Pamphylia. It was believed that he was killed in a battle, but 12 days later he returned to life. He never explained how he did that, but told what he saw in the other world. The tale described the idea how moral people were rewarded and immoral people were punished after death. Xenakis explained the reason for his selection of this text because of its "ideas of morality, fate, and non-physical universe physics, death, life [given] in a closed system" as well as its "highly poetic" features and "apocalyptic visions."[201]

The second text was from Hermes Trismegistus' Poimandres, a chapter in the *Corpus Hermeticum* (2nd/3rd centuries BC). Xenakis described this text as a "revelation through tone, light and abstraction":

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[198] Michael Zaplitny and Iannis Xenakis. "Conversations with Iannis Xenakis." *Perspectives of New Music*, 14/1 (1975):90.

[199] Xenakis, *Music and Architecture*, 261. See also Appendix C.

[200] Quoted in Xenakis, *Music and Architecture*, 272-73.

[201] Solomos, "Le Diatope et La légende d'Eer", 28.

> From there emerged a crying out, indistinct, one I likened to a voice of fire, just as there emerged from the light…a holy Word blanketing all of Nature, and the purest of fire was thrust out of the humid natural world toward the sublime area above.[202]

The following extract was "The Infinite" from *Pensées* by Blaise Pascal (1669):

> For indeed, what is man within nature? A void in the face of infinity, a whole before the void, a center between nothingness and wholeness…unable to perceive the void from whence he came, nor the infinity in which he is submerged.[203]

Then, *Siebenkäs* by Jean-Paul Fredrick Richter (1796) appeared in the choral orchestral piece, *Nekuïa*, in relation to the idea that man is alone in the darkness of the Universe."[204]

> Christ went on: "I traversed the worlds, I ascended into the suns, and soared with the Milky Ways through the wastes of heaven; but there is no God. I descended to the last reaches of the shadows of Being, and I looked into the chasm and cried: 'Father, where art thou?' But I heard only the eternal storm ruled by none, and the shimmering rainbow of essence stood without sun to create it, trickling above the abyss.[205]

The common point in these four excerpts selected from these four texts was religious experience. The last extract, 'Supernovas in other galaxies' by Robert Kirschner was from an article published in *Scientific American*, in December 1976. In the article, the universe was presented "as seen by the modern science of astrophysics."[206]

> In the first stages of the explosion, the general distribution of the star's energy closely matches the distribution known for theoretical black holes at a temperature of 12,000 degrees Kelvin … At the end of this period, the

[202]Quoted in Xenakis, *Music and Architecture*, 273-74.

[203] Quoted in Xenakis, *Music and Architecture*, 274-75.

[204] Quoted in Xenakis, *Music and Architecture*, 261.

[205] Quoted in Xenakis, *Music and Architecture*, 275-76.

[206] Xenakis, "The *Diatope*: a gesture of sound and light at the Pompidou Center and *La Légende d'Eer* (1978)," in Xenakis, *Music and Architecture*, 261.

> star's photosphere, in other words, its visible surface, reaches a radius of $2x10^{18}$ centimeters, a much larger radius than that of our solar system.[207]

In the same year, in 1976, Xenakis explained in his doctoral defense:

> Actually, there is no reason why art cannot, following the example of the science, rise from the immensity of the cosmos; nor why art cannot, as a cosmic landscaper, modify the demeanor of the galaxies.[208]

So, the meaning of the light show and the music of the Diatope cannot be understood without these excerpts which reflected Xenakis's scientific rather than religious enthusiasm on cosmic space or eternity. As he pointed out:

> These texts explain better than any other speech. They form the argument of the show. I chose a sort of panorama of some of the significant epochs and particularly rich and poetic ideas. [209]

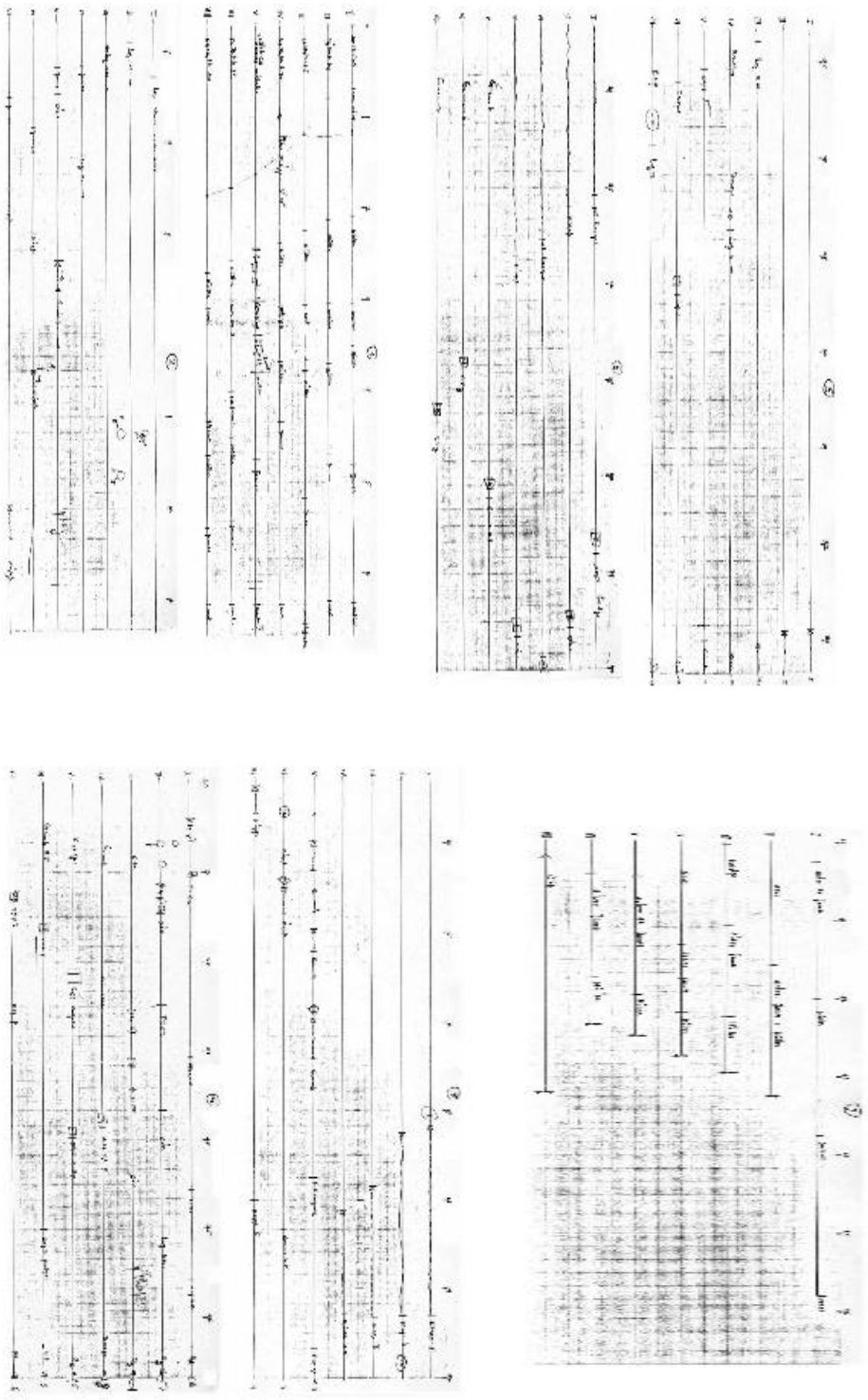
3.2.4 *La Légende d'Eer*

La Légende d'Eer was a 46 minute, 7-channel electro-acoustic composition written by Xenakis for the opening of the Centre Georges Pompidou in Paris. It was composed in the studios of the Westdeutscher Rundfunk (WDR) in Cologne and at the CEMAMu in Paris. This was Xenakis's third piece composed with the UPIC. (Figures 3.2.4.1a-d) *La Légende d'Eer*, in general, was a sound synthesis by means of computers, which still corresponded to a concept based on instrumental music, having a finite repertory of sounds. It was an example of what Xenakis called stochastic music.

[207] Quoted in Xenakis, *Music and Architecture*, 276-77.

[208] Xenakis, *Arts/Sciences: Alloys*, 3.

[209] Solomos, "Le Diatope et La légende d'Eer," 28.



Figures 3.2.4.1a-d Pages of Manuscripts of the Diatope score
Source: Xenakis, *Music and Architecture*, 351-3.

Each track of the composition distributed all over the *Diatope* with 11 loudspeakers. (Figure 3.2.4.2) The distribution was made with a special computer program.

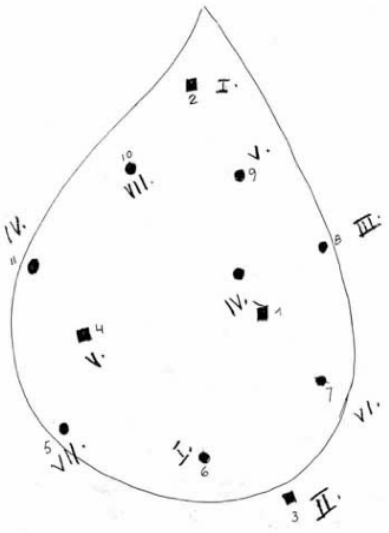


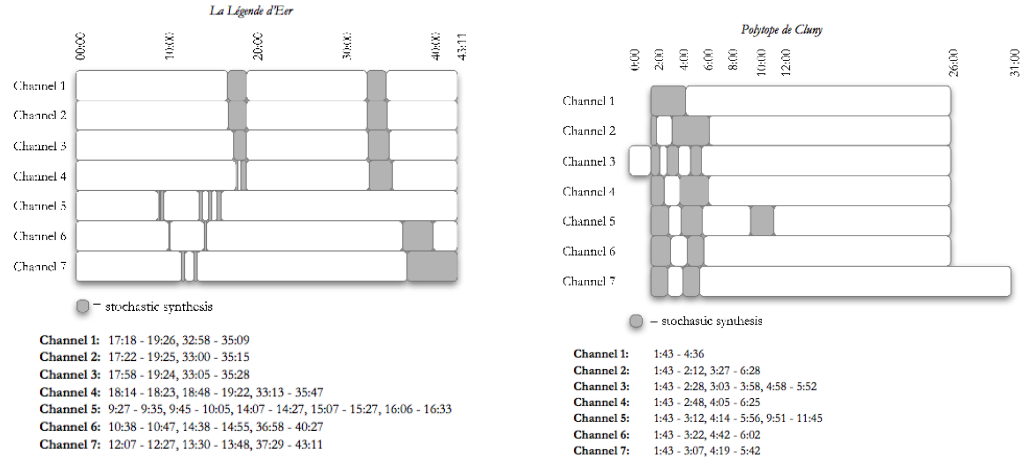
Figure 3.2.4.2 Xenakis' drawing of the distribution of speakers
Source: Solomos, "La Diatope: *Légende d'Eer*", 6.

Since his stochastic composition method required too many calculations, Xenakis had to use computers. So, the stochastic composition of *Légende d'Eer* was written on an IBM 7090 model computer at IBM France with FORTRAN programming language.

He developed this method of composition by adding his stochastic method to go beyond "its limitations" to digital sound synthesis in the *Polytope de Cluny*.[210]

The sound materials of *La Legende d' Eer'* were actually very similar to the sound materials used in *Polytope de Cluny*. (Figures 3.2.4.3a-b)

[210] Balint Andres Varga, *Conversations with Xenakis* (London: Faber and Faber, 1996): 80.



Figures 3.2.4.3a-b Graphic of the stochastic synthesis
Source: http://www.sergioluque.com/texts/Luque-Stochastic (accessed 15.08.2012)

In 1977, Xenakis introduced the UPIC system, but his stochastic synthesis research was delayed again until the late 1980s when he started using a new technique.[211] It was the UPIC/ "Unite Polyagogique Informatique du CEMAMu" system that he developed with the financial support from the French Ministry of Culture at the "Centre d'Etudes de Mathematiques et Automatiques Musicales" (CEMAMu). It was a computer drawing system, a product of acoustic and computer science. Compositions were made just by drawing with an electromagnetic pen on a special drawing board. So, the curves or waveforms of drawings were calculated by the computer and sent through a converter and then the result was heard. Xenakis described the process in these words: "A child may draw a fish, listen to it, … and learn by drawing how to think musically, compositionally without being tormented by solfege." (Figure 3.2.4.4)

[211] This technique is described in the chapter "Dynamic Stochastic Synthesis" in Xenakis, *Formalized Music*, 289-293.

Figure 3.2.4.4 Xenakis near the UPIC
Source:http://membres.multimania.fr/musicand/INSTRUMENT/DIGITAL/UPIC/UPIC.htm (Accessed 12.05.2012)

Based on stochastic synthesis, *La Légende d'Eer* was composed with three types of musical sounds: instrumental sounds, such as the sound of shooting stars and the sounds of African and Japanese instruments, including various percussions; noise, such as the sounds of bricks hit together; and electronically generated sounds, most of which was produced by Xenakis's complex theories of probability at the CEMAMu.

Xenakis's achievement did not end by inventing a composition machine and by composing a musical piece with it. The design of the building, visual spectacles and the composition were intertwined each other. In other words, he designed *Le Diatope* as a form of *La Legende d'Eer* and composed *La Legende d'Eer* as a sound of *Le Diatope*.

3.2.5 *Gesamtkunstwerk* in *Le Diatope*

As examined so far, *Le Diatope* show that his ability to design a unity of composition was an example of *Gesamtkunstwerk*. What should be pointed out here is that the components of such a unity were not randomly or accidently collected, designed or composed together to create *Gesamtkunstwerk*. If people would listen to *La Légende d'Eer* (or *Poème Électronique* or *Concret PH*) at home with their regular 2+1 computer speakers, the result definitely would not reach its

aim. Without being in the space designed by Xenakis or without seeing his visual spectacle, *Gesamtkunstwerk* would be an irrelevant concept to understand his work. So, to experience his spectacles, people had to be there.

CHAPTER 4

CONCLUSION

4.1 INTERSECTION OF ARCHITECTURE AND MUSIC IN IANNIS XENAKIS'S WORKS

The Philips Pavilion and *Le Diatope* show that Xenakis composed to exhibit and designed to create a spectacle. In this sense, by looking at these designs it is possible to hear Xenakis's music.

If we compare these two spectacles we can see many similarities. Philips Pavilion's hyperbolic paraboloid surfaces proposed a new architectural form to achieve "a maximum of free volume for a minimum of enclosing surface."[212] Therefore, Xenakis's research for such a form was an important contribution to contemporary architecture. His research was also related to his strong belief in "a new relationship between the arts and sciences, especially between the arts and mathematics; where the arts would consciously 'set' problems which mathematics would then be obliged to solve through the invention of new theories."[213] As Sharon Kanach remarks, "He has thus left open new paths of research and development for current and future architect sharing these same preoccupations."[214] Later, he developed and perfected the use of hyperbolic paraboloids and designed *Le Diatope*. Furthermore, in the Diatope, he united architecture, music, lights and texts.[215] Similarly, this kind of unity had also been achieved before, in the Philips Pavilion through Xenakis's overall design and Varèse's *Poème électronique*. However, although he used this idea in the Pavilion, he developed it in the Polytope spectacles by using laser layers and flashes as he

[212] Xenakis, *Music and Architecture*, 262.

[213] Iannis Xenakis, *Arts-science: Alloys*, 3.

[214] Xenakis, *Music and Architecture*, 163.

[215] Xenakis, *Music and Architecture*, 247.

"was interested in examining more abstract expressions parallel to his musical research."[216]

One difference between these buildings was that Xenakis applied the use of string glissandi in *Metastaseis* to the design of the Philips Pavilion. The string glissandi of Metastaseis shaped the design of the building. However, in the design of *Le Diatope*, there was no application like that. He composed *La Legende d'Eer* for the building as a component of the spectacle, like he composed *Concret PH* for the Philips Pavilion. Another difference was that in *Le Diatope*, Xenakis used texts as the basis for his spectacle of *Le Diatope*. They were excerpts that he selected from a diverse range of texts, including ancient mythology as well as modern science. Xenakis claimed that the meaning of the light show and the music of the Diatope could not be understood without these excerpts.

Regarding the question of how these spectacles were received by the audience, we can say that at the EXPO' 58, *Poème électronique* of the Philips Pavilion caused confusion. The public opinion, newspaper reports, and professional reaction varied on this "beginning of new art form."[217] As Howard Taubman wrote at the time in his *New York Times* article, "the effect it has on thousands who visit it each day ranges from bewilderment or distaste to admiration."[218] So, whether the Pavilion was celebrated by the critics or not, its palpable effect on spectators was discussed on media, especially in Belgium. An anonymous author who attended the official opening of the Pavilion noted:

> A high ranking director now had marks on his arm where his wife has pinched him hard during the presentation of the visual poem. The reporter was a bit nervous, not that many visitors might have their arms pinched, but that they would laugh at the presentation-when in fact there was nothing at which to laugh. The images of concentration camps and nuclear

[216] Xenakis, *Music and Architecture*, 198.

[217] Treib, *Space Calculated in Seconds*, 226.

[218] Quoted in Treib, *Space Calculated in Seconds*, 218.

> explosions reflected Le Corbusier's concern for humankind and were hardly humorous.[219]

While another anonymous journalist called *Poème électronique* "a modern nightmare,"[220] Jaak Vetmen interpreted it in his article in these words:

> One gets choking and gasping feeling and the eyes and ears undergo the sensation of a chaotic struggle … The intensity of this poem is baffling that the eight minutes seem to be an eternity. The premonition was created by the building itself, the shape of which in itself is like a fierce cry.[221]

Similarly, Taubman added in his *New York Times* article, titled "Fairgoers Hear Electronic Poem": "the strangest exhibit at the Brussel's World's Fair" [presented in a] building that looks like an improbable and a gigantic seashell frozen into silvered concrete."[222] About *Poème électronique* and *Concret PH* Taubman also remarked: "The sounds that accompany these images are as bizarre as the building … One hears rattles, whistles, thunders and murmurs."[223]

However, there were also the writers or journalists who celebrated the Pavilion and its spectacle. Among them, Jean Girard declared:

> The building's form was strange, bizarre, even provocative. What did it do and what did it mean? … [T]he answer would not be given until the spectacle has started. For in the Pavilion, void, naked, baffling, is a spectacle to be seen. It's there, moreover, that its greatest interest lies, its greatest originality. The spectacle is not in the least banal. It has never been seen before, hitherto unknown, sensational. What is certain is that, technically speaking, the spectacle presented at the Philips Pavilion is fantastic realization. Here, undoubtedly, technology must stand aside to art. [It is] undeniably a work of genius.[224]

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[219] Quoted in Treib, *Space Calculated in Seconds*, 217.

[220] Treib, *Space Calculated in Seconds*, 217.

[221] From a summary of the Belgian press, translated by Philips, and quoted in Treib, *Space Calculated in Seconds*, 217.

[222] Quoted in Treib, *Space Calculated in Seconds*, 218.

[223] Quoted in Treib, *Space Calculated in Seconds*, 218.

[224] Quoted in Treib, *Space Calculated in Seconds*, 217.

Similarly, in the Swedish architectural journal, *Byggmästere,* Kristian Romare wrote:

> For me this electronic poem … is a deeply fascinating realization of a dream which has tempted artists since the Bauhaus, since Kandinsky – and even Wagner: the dream of the total work of art … This is a poem without distance between the observer and the artwork. We are literally in its stomach; it is as if [the pavilion] is literally digesting us, and exposing us, against our will, to acids that etch us indelibly.[225]

Regarding the question of how the Philips Pavilion and its *Poème électronique* are interpreted in the related literature of today, we can refer to Marc Treib who points out how the building and the spectacle "titillated, tantalized, impressed, an ultimately mystified" the audience.[226] He also remarks that "They would remember the Philips Pavilion and its spectacle as a total work of art, and not the details of its architectural construction, its cinematic realization, and production of lightning effects."[227] In this sense, the building seems successful to Treib. However, he also suggests that "it just wasn't a great building" and that this may be reason for its "drift[ing] into the oblivion."[228] Similarly, Douglas Murphy remarks that "the Philips Pavilion was no masterpiece." For him, it was "in fact … a failure."[229] For Kanach, on the other hand, The Pavilion achieved "an unprecedented public success,"[230] and in comparison to the other pavilions at the EXPO '58, it was celebrated as a unique example. As she also points out, "[t]he Philips Pavilion presented a collage liturgy for 20th century humankind, depended on electricity instead of day light and on virtual perspectives in place of terrestrial views."[231] Furthermore, for Rodrigo Garcia Alvarado and Jaime Jofre Muñoz, too,

[225] Quoted in Treib, *Space Calculated in Seconds*, 223.

[226] Treib, *Space Calculated in Seconds*, 243.

[227] Treib, *Space Calculated in Seconds*, 243.

[228] Treib, *Space Calculated in Seconds*, 240.

[229] Douglas Murphy, *The Architecture of Failure* (Winchester: Zero, 2012): 134.

[230] Sharon Kanach, "The Philips Pavilion 1956-58," in Xenakis, *Music and Architecture*, 103.

[231] Kanach, "The Philips Pavilion 1956-58," 103.

the Pavilion marked an important development in twentieth-century architecture by forming one of the origins of parametric design.[232]

4.2 INTERSECTION OF ARCHITECTURE AND MUSIC AS *GESAMTKUNSTWERK* IN IANNIS XENAKIS'S WORKS

Iannis Xenakis was a follower of Wagner in the sense that he was deeply interested in the Greek theatre and its basic characteristic of "total experience." As Evaggelia Vagopoulou explains, "At the time Xenakis was finishing *Oresteia,* he published the essay 'Antiquity and Contemporary Music' in 1966, where he discusses succinctly his thoughts regarding the reconstruction of ancient sounds and also *Oresteia''s* music." As she further explains, Xenakis "starts off with a definition of Greek theatre as 'total experience' which is not confined to the senses of ear or vision, but also takes place in the sphere of thought."[233]

In the light of what is discussed above, it would be possible to argue that what the visitors experienced in Xenakis's Philips Pavilion and *Le Diatope* was *Gesamtkunstwerk* in the sense of the intersection of architecture and music as an audio-visual performance. In this regard, it would be also possible to connect Wagner's remark to Xenakis's works: "In helping to create the *Gesamtkunstwerk,* individual artists would see their work improved; painters, for example, would achieve a higher standard by contributing a stage production."[234] Although Xenakis's spectacles were not shown on stage, he built his spaces as his 'stage'. Moreover, he resolved his musical or architectural problems accordingly, as in the case of *Le Diatope,* where he aimed to "invent an architectural form that would eliminate the inconveniences of collective listening."[235]

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[232] Rodrigo G. Alvarado and Jaime J. Muñoz, "The Control Of Shape: Origins Of Parametric Design In Architecture In Xenakis, Gehry And Grimshaw," Journal of the Faculty of Architecture 29, no:1 (2012): 107-118.

[233] Evaggelia Vagopoulou, "The Universality of Xenakis' Oresteia", 2. http://www.iannis-xenakis.org/Articles/Vaggopoulou.pdf / (Accessed 23.12.2011)

[234] Koss, *Modernism after Wagner*, 19.

[235] Xenakis, Music and Architecture, xx.

As Juliet Koss remarks, in ancient Greece "Wagner believed, the spectators' experience was participatory rather than diversionary; the individual happily took part in the formation of the work of art by witnessing and encouraging its emergence into the public realm."[236] So, "[t]he emphasis on the central role of the spectatorship in producing the final work of art ensured that, fundamentally, performance would be valued above all other kinds of artistic production."[237] In this sense, the Philips Pavilion and *Le Diatope* manifested the same idea about the importance of spectators. In the projects, Xenakis attributed utmost importance to the placement of spectators "for helping to create *Gesamtkunstwerk*."[238] As Koss also points out, "[t]he ideal construction of the stage and the auditorium would allow architecture to remain silently present during the performance, fostering the most direct communication between the *Gesamtkunstwerk* and its audience."[239]

As for his ideal audience, or in Koss's terms, his utopian audience (*Volk*),[240] Wagner elucidated:

> In the arrangement of the space for the spectators, the need for optic and acoustic understanding of the artwork will give the necessary law, which can only be observed by a union of beauty and fitness in the proportions; for the demand of the collective ("gemeinsam") audience is the demand for the artwork, to whose comprehension it must be distinctly led by everything that meets the eye. Thus the spectator transplants himself upon the stage, by means of all his visual and aural faculties; while the performer becomes an artist only by complete absorption into the public.[241]

In addition to Koss, there are some other names who mention briefly Xenakis's works in relation to *Gesamtkunstwerk.*

In one of his reviews of the mini festival, "Concert Series with Computer Music" organized in Zurich in 1988, David C. Johnson explains:

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[236] Koss, *Modernism after Wagner*, 15.

[237] Koss, *Modernism after Wagner*, 18.

[238] Koss, *Modernism after Wagner*, 19.

[239] Koss, Modernism After Wagner, 25.

[240] "For more detail about *Volk* see; Wagner, "The Art-Work of the Future"

[241] Wagner, "The Art-Work of the Future"

> Iannis Xenakis struggles with extremes. Extreme sensitivity, extreme wildness, extreme calculatedness are his elements of seeming conflict. Xenakis does not harmonize or unify them, but rather seeks a system large enough and flexible enough to house them all.[242]

He, then, refers to the Philips Pavilion as "title of the *Gesamtkunstwerk*."[243]

Similarly, in her book review, Charlotte Skene-Catling mentions Philips Pavillion in relation to *Gesamtkunstwerk* as well: "It was to be true *Gesamtkunstwerk*, involving a composer, Edgard Varèse, a cinematographer, Philippe Agostini, and Le Corbusier and his assistant Iannis Xenakis."[244]

Moreover, in their article on *Poème électronique*, Vit Zouhar, Rainer Lorenz, Thomas Musil, Johannes Zmölnig, and Robert Höldrich remark that "[f]rom 1956 until 1958, the star architect Le Corbusier, composers Iannis Xenakis and Edgard Varèse and film director Philippe Agostini co-authored a *Gesamtkunstwerk* commissioned by Philips for the World Fair EXPO 1958 in Brussels."[245]

Another scholar, Sven Sterken, who has several articles on Xenakis, also elucidates:

> In the Polytopes, Xenakis has transposed his temporal thinking into three-dimensional space; these art works can thus be considered as the return to architecture of a composer who … has always remained an architect and an engineer. Through the masterly use of the latest technological tools in the Polytopes, architecture becomes an art of time and music an art of space. In this way, these specialized light and sound scenographies take part in the tradition that links Wagner's conception of the total art work with contemporary notions of cyber space, in the sense that they both deal with the creation of an immersive and artificial environment.[246]

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[242] David C. Johnson. "Concert Series with Computer Music, Zurich, Switzerland, 9-12 December 1988." *Computer Music Journal,* 13/4 (Winter, 1989): 84.

[243] Johnson. "Concert Series with Computer Music", 85.

[244] Charlotte, Skene-Catling, (Review) "Space Calculated In Seconds, The Philips Pavilion, Le Corbusier, Edgard Varèse." *The Burlington Magazine* 140/1147 (1998): 699.

[245] Vit Zouhar, et. al. "Hearing Varèse's *Poème électronique* Inside a Virtual Philips Pavilion.", 1.

[246] Sven Sterken, "Towards a Space-Time Art: Iannis Xenakis' Polytopes" *Perspectives of New Music* 39/2 (Summer, 2001): 263.

Although Xenakis described his ideals as almost the same as Wagner defined *Gesamtkunstwerk*, he never used this politically loaded term in his writings. It was such a term, since Wagner was linked to Fascist ideology. According to Theodor W. Adorno (1903-1969), the German sociologist, philosopher and musicologist, "Wagner, as human being, crystallized to an amazing extent the Fascist character long before Fascism was ever dreamed of."[247] In his *In Search of Wagner* (1952), Adorno presented Wagner as "a narcissist who personified the authoritarian principle, as the focal point of the music and performance, [and who] led members of the orchestra in Bayreuth through his music dramas like a musical dictator."[248] Considering the fact that during the Second World War Xenakis joined the Greek resistance against the Nazi occupation when he was 18, Hitler's enthusiasm for Wagner possibly repulse Xenakis to use the term *Gesamtkunstwerk*. Despite all that, how he anesthetized the war in his writings as a young man who deeply suffered from it is quite interesting:

> I discovered things about sound that I was not taught, that no one had told me. People shouting in waves, it's a very special experience. I was there in December 1944 when the Communist resistance was suppressed by the British troops. I was fighting against the British as I fought against the Germans. What was interesting were the bullets in the night, whistling, and explosions here and there, and also the searchlights trying to spot the planes - that was with the Germans. It was a large-scale spectacle that was very interesting.

Before concluding this study, it should be emphasized to avoid misunderstandings that Xenakis did not entail one to one correspondences between music and architecture. This means that he did not convert or synthesize music into architecture or architecture into music. He unified them in a Wagnerian piece of art. He also never claimed that he invented 'the machine' of translation between them. He argued clearly that "Music is not a language." By adding that "any musical piece is akin to a boulder with complex forms, with striations and

[247] Adorno, "Wagner, Nietzsche, and Hitler", quoted in Koss, *Modernism after Wagner*, 258.

[248] Adorno, *In Search for Wagner*, 9.

engraved designs atop and within, which men can decipher in a thousand different ways without ever finding the right answer or the best one."[249]

The *Gesamtkunstwerk* would encourage a more direct artistic communication between the creative artist, the work of art and the audience: the three elements that would be combined during the process of aesthetic engagement to achieve the grand unifying experience which, as Wagner believed, all artistic creation ultimately aimed to reach.[250] In this regard, without experiencing the space designed by Xenakis as an audio-visual art work, it would be impossible to understand his work simply by referring to the concept of *Gesamtkunstwerk*. In other words, to perceive his *Gesamtkunstwerk*, one has to be "there."

Another important issue that should be pointed out here is that in contrast to a commonly used definition, *Gesamtkunstwerk* does not mean the synthesis of arts, as Wagner explicitly described the term in his writings. In this regard, it would be more appropriate to express it as 'unity'. Wagner's total work of art consisted of poetry, music and dance in which "each art form discovered its own identity." [251] In this sense, none of the arts lost its identity while joining in the larger unit. This was exactly the case in Xenakis's works in which architecture, music, mathematics, geometry, philosophy, astronomy were united in one without losing their identities. What should also be emphasized here is that the components of such a unity were not randomly or accidently collected, designed or composed together by Xenakis to create *Gesamtkunstwerk*. This is perhaps the most crucial point to understand Wagner's *Gesamtkunstwerk*, and Xenakis's aim in his works.

This study has discussed so far the intersection of music and architecture in Iannis Xenakis's works by focusing on Philips Pavilion (1956-58) and *Le Diatope* (1978). As a conclusion of this discussion, it argues that these two selected works were directly related to the concept of *Gesamtkunstwerk*. So, this is the basic argument of this study which contributes modestly to the existing related literature.

[249] Xenakis' Introductory notes for Diatope performance, 1978.

[250] Koss, *Modernism after Wagner*, 13.

[251] Koss, Modernism After Wagner, 16.

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APPENDIX A: ANALYSIS OF THE EDGARD VARÈSE'S *POÈME ÉLECTRONIQUE*

Source:http://www.ipsden.u-net.com/course/EM3.html (accessed 16.08.2012)

00.00-00.06 Bell struck , rep x 2 deep full empty space. long resonance

00.07-00.16 Repeat of above, more resonance

00.17 Woodblock tapping background Foreground door opening/ siren climbing and falling more related block sounds moving siren up to

00.28 repeated 'dadadadadada' Contrasts with hollow tapping

00.29 Entry high pitch, then breath

00.33-00.36 Siren sustained. Repeat moving up pitch

00.40 Rhythmic section high and low, playing, mocking

00.46 New block sound. Richer texture percussion, scraping, mouse mimic

00.57-1.10 Single siren rising, moving up, repeated x3 with silence in between and more reverb harmonic

01.11-01.20 Low melodious tone foreground,small scrape industrial noise, building, elevator rising to meet mimic mouse as above.

01.32 Machine noise

01.36 Tennis between sounds as they pan between speakers

01.46 seagull, build to silence.

02.01 transmutes to flutter

02.02 New Block Percussion and bell siren Siren wail background -move- elevator moves up, percussion

02.37-02.42 Repeat of opening bell and resonance. Sustained siren joined tonally for harmonic ‘melody’ by other electronic tones. regular pulse, then rhythmn bridge. 03.16-03.25 Long sustained tone

03.26 build percussion

03.41 Voice appears. Startling effect- eerie. Voice traveling/ distorted transmutes from male to female. Interspersed tension provided by rhythm. Starts sparse until moves

04.17 Chorus attack / birds, jungle

04.18 foreground vocal traveling background percussion

04.33 more attack on voice

04.47 industrial sounds- more spacey

05.03 more distortion and movement down

05.16 growling voice/ noise background

05.33-46 SILENCE

05.47 new section. Long foreground reverb

06.00 build of percussion texture becoming more dense with sirens, electronic ‘melodic’tones interjected.

06.25 long sustained tone

06.27 more ‘play’

06.35 jet take off, industrial, travel motiv, repeat

06.48 distant voice -female fades in , moves up

07.01 Entry of chorus male voices - resolution

07.07 Dischordant noise, rhythms . Organ joins in builds. elements come together 07.25 clock like tic fades out

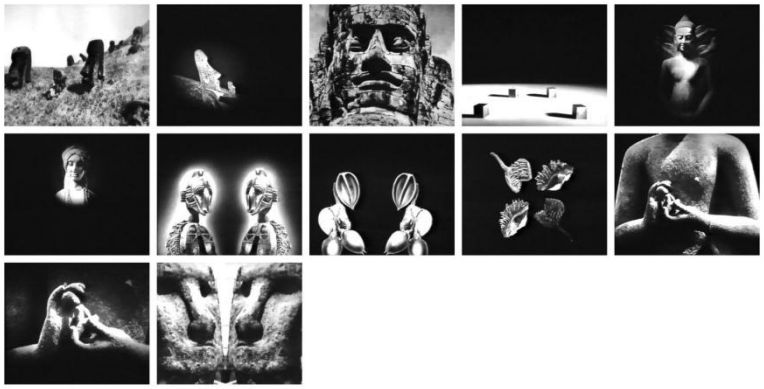
07.26 Return of organ/ siren textures from earlier

07.39 Noise travelling up and speeding up. Transmutes bird like Siren travels down and across, joins up to become shrill. Texture dense and busy. Collects sounds together then fades out quite quickly.

08.00 Silence. Resolution END

APPENDIX B: VISUAL MATERIAL OF *POÈME ÉLECTRONIQUE*

Sequence III in Poème électronique From Darkness to Dawn)
Source: http://erilkent.blogspot.com/2007_10_01_archive.html



Sequence IV in Poème électronique (Man Made Gods)
Source: http://erilkent.blogspot.com/2007_10_01_archive.html

Sequence V in Poème électronique (How Time Moulds Civilization)
Source: http://erilkent.blogspot.com/2007_10_01_archive.html

Sequence VI in Poème électronique (Harmony)
Source: http://erilkent.blogspot.com/2007_10_01_archive.html

Sequence VII in Poème électronique (To All Mankind)
Source: http://erilkent.blogspot.com/2007_10_01_archive.html

APPENDIX C: TEXTS ACCOMPANYING THE *DIATOPE*

The English translations of the five excepts were chosen by Xenakis.

Text 1: Plato – *The Republic*

The Book X, end: THE LEGEND OF ER[252]

Socrates

… Well, I said, I will tell you a tale; not one of the tales which Odysseus tells to the hero Alcinous, yet this too is a tale of a hero, Er the son of Armenius, a Pamphylian by birth. He was slain in battle, and ten days afterwards, when the bodies of the dead were taken up already in a state of corruption, his body was found unaffected by decay, and carried away home to be buried. And on the twelfth day, as he was lying on the funeral pile, he returned to life and told them what he had seen in the other world … Then he beheld and saw on one side the souls departing at either opening of heaven and earth when sentence had been given on them; and at the two other openings other souls, some ascending out of the earth dusty and worn with travel, some descending out of heaven clean and bright. And arriving ever and anon they seemed to have come from a long journey, and they went forth with gladness into the meadow, where they encamped as at a festival … If, for example, there were any who had been the cause of many deaths, or had betrayed or enslaved cities or armies, or been guilty of any other evil behaviour, for each and all of their offences they received punishment ten times over, and the rewards of beneficence and justice and holiness were in the same proportion … He mentioned that he was present when one of the spirits asked another, "Where is Ardiaeus the Great?" (Now this Ardiaeus lived a thousand years before the time of Er: he had been the tyrant of some city of Pamphylia, and

[252] Xenakis, *Music and Architecture*, 272-273.

had murdered his aged father and his elder brother, and was said to have committed many other abominable crimes.) The answer of the other spirit was: "He comes not hither and will never come. And this," said he, "was one of the dreadful sights which we ourselves witnessed. We were at the mouth of the cavern, and, having completed all our experiences, were about to reascend, when of a sudden Ardiaeus appeared and several others, most of whom were tyrants; and there were also besides the tyrants private individuals who had been great criminals: they were just, as they fancied, about to return into the upper world, but the mouth, instead of admitting them, gave a roar, whenever any of these incurable sinners or some one who had not been sufficiently punished tried to ascend; and then wild men of fiery aspect, who were standing by and heard the sound, seized and carried them off; and Ardiaeus and others they bound head and foot and hand, and threw them down and flayed them with scourges, and dragged them along the road at the side, carding them on thorns like wool, and declaring to the passers-by what were their crimes, and that they were being taken away to be cast into hell." … Now when the spirits which were in the meadow had tarried seven days, on the eighth they were obliged to proceed on their journey, and, on the fourth day after, he said that they came to a place where they could see from above a line of light, straight as a column, extending right through the whole heaven and through the earth, in colour resembling the rainbow, only brighter and purer; another day's journey brought them to the place, and there, in the midst of the light, they saw the ends of the chains of heaven let down from above: for this light is the belt of heaven, and holds together the circle of the universe, like the under-girders of a trireme. From these ends is extended the spindle of Necessity, on which all the revolutions turn. The shaft and hook of this spindle are made of steel, and the whorl is made partly of steel and also partly of other materials … The spindle turns on the knees of Necessity; and on the upper surface of each circle is a siren, who goes round with them, hymning a single tone or note. The eight together form one harmony; and round about, at equal intervals, there is another band, three in number, each sitting upon her throne: these are the Fates, daughters of Necessity, who are clothed in white robes and have chaplets upon their heads, Lachesis and Clotho and Atropos, who accompany with their voices the harmony of the sirens --

Lachesis singing of the past, Clotho of the present, Atropos of the future; Clotho from time to time assisting with a touch of her right hand the revolution of the outer circle of the whorl or spindle, and Atropos with her left hand touching and guiding the inner ones, and Lachesis laying hold of either in turn, first with one hand and then with the other … All the souls had now chosen their lives, and they went in the order of their choice to Lachesis, who sent with them the genius whom they had severally chosen, to be the guardian of their lives and the fulfiller of the choice: this genius led the souls first to Clotho, and drew them within the revolution of the spindle impelled by her hand, thus ratifying the destiny of each; and then, when they were fastened to this, carried them to Atropos, who spun the threads and made them irreversible, whence without turning round they passed beneath the throne of Necessity; and when they had all passed, they marched on in a scorching heat to the plain of Forgetfulness, which was a barren waste destitute of trees and verdure; and then towards evening they encamped by the river of Unmindfulness, whose water no vessel can hold; of this they were all obliged to drink a certain quantity, and those who were not saved by wisdom drank more than was necessary; and each one as he drank forgot all things. Now after they had gone to rest, about the middle of the night there was a thunderstorm and earthquake, and then in an instant they were driven upwards in all manner of ways to their birth, like stars shooting. He himself was hindered from drinking the water. But in what manner or by what means he returned to the body he could not say; only, in the morning, awaking suddenly, he found himself lying on the pyre.

(translated by Benjamin Jowett; Penguin Books, Harmondsworth 1977)

Text 2: Hermes Trismegistus – *The Divine Pymander and other writings: Poemandres I*

POEMANDRES[253]

1. Though in me becoming on a time concerning the Entities, and my meditation having been exceedingly sublimed, and my bodily senses also calmed down, like as those oppressed in sleep from satiety, luxury, or fatigue of body, I supposed some one of very great magnitude, with indefinite dimension, happening to call out my name, and saying to me, "What wishest thou to hear, and to contemplate; what, having understood, to learn and to know?"
2. I say, "Thou, then, who art thou?" "I, indeed," He says, "am Poemandres, The Mind of the Supreme Power. I know what thou wishest; and I am everywhere with thee."
3. I say, "I wish to learn the Entities, and to understand the nature of them, and to know the God …"
4. Speaking this, he was changed in the form, and immediately all things were disclosed to me in a moment; and I see a spectacle indefinable, all things having become light, more pleasant and joyous, and having beheld I was gladdened; and, after a little, darkness was brought down in part having become dreadful and horrible, sinuously terminated, so that I imagined myself having seen the darkness changed into a certain mosit nature, unspeakably disturbed, and giving forth smoke as if from fire, and emitting a certain sound ineffable, mournful. Then a noise from it was inarticulately sent out, - as I supposed the voice of Light.
5. From the light a certain Holy Word descended upon Nature, and a pure Fire sprang forth from the moist nature upwards on high. It was light and sharp and drastic also, and the air being light followed The Spirit; it

[253] Xenakis, *Music and Architecture,* 273-274.

ascended up to the fire from land and water, so that it seemed to be suspended from it …

6. … "that the Light." He said, "I am Mind, thy God, Who is before moist nature, that which appeared out of darkness; but The luminous Word out of Mind, Son of God …"
9. But the Mind, The God, being masculine-feminine, originating Life and Light, begat by Word another Mind creator, Who being God of the Fire and Spirit, created some Seven Administrators, encompassing in circles the sensible world; and their administration is called Fate.
10. Immediately from the downborne elements sprung forth The Word of The God to the pure creation of all Nature, and was united to the creative Mind, for it was of the same essence, and the irrational downborne elements of Nature were left to be matter only.
11. But the creator Mind along with The Word, that encompassing the circles, and making them revolve with force, turned about its own creations and permitted them to be turned about from an indefinite beginning to an interminable end; for they begin ever where they end. But the air brought out winged animals, and the water swimming, and both earth and the water were separated from each other, just as The Mind willed, and the earth sent out from itself the four-footed animals which it had, serpents, wild and tame beasts.
12. But the Father of all things, The Mind, being Life and Light, begat (engendered) a Man like to Himself, whom He loved as His own child, for He was very beautiful, having the image of His father. For, in fact, moreover The God loved his own form, and to this delivered over all His own creations.
13. Having considered the formation of the Creator in the Father, He too willed to create, and was parted from the Father, becoming in the creative sphere. Having all the dominion, He considered the creations of the brethren who were enamored of Him; but each made Him participate of his own order, and having learnt the essence of these, and partaken of their nature, He

willed to break through the circumference of the circles, and to depress the force of Him resting on the fire.

14. And He having all dominion over the mortal living things of the world, and over the irrational, looked obliquely through the Harmony, breaking through the might of the circles, and showed to the downward bone Nature the beautiful form of The God, which (- Nature) having beheld, having in itself insatiate beautiful and all the energy of the Seven Administrators, and the form of The God, smiled for love, as it were having beheld the image of the very beautiful form of the Man in the water the form like to Him being in Himself, loved it and willed to dwell with it. But along with the will came energy and begat the irrational form.
15. But Nature having received the beloved, completely embraced it, and they mingled, for they were enamoured; and through this, beyond all living upon earth, the Man is twofold, mortal indeed because of the body, immortal because of the essential Man. For being immortal, and having the dominion of all things, he suffers mortal things subject to the fate. Being, then, above the Harmony, he became an harmonious servant …

(translated from the original Greek by John D. Chambers; Samuel Weiser, New York, 1972.)

Text 3: Blaise Pascal – *Man's Place in Nature: The two Infinitives – Man's dispropostion (84) Pascal's Pensées*

The Infinite[254]

… Let man then contemplate the whole realm of nature in her full and exalted majesty, and turn his eyes from the low objects which hem him round; let him observe that brilliant light set like an eternal lamp to illumine the universe, let the earth appear to him a point in comparison with the vast circle described by the sun, and let him see with amazement that even this vast circle is itself but a fine point in regard to that described by the stars revolving in the firmament. If our view be arrested there, let imagination pass beyond, and it will sooner exhaust the power of thinking than nature that of giving scope for thought. The whole visible world is but an imperceptible speck in the ample bosom of nature. No idea approaches it. We may swell our conceptions beyond all imaginable space, yet bring forth only atoms in comparison with the reality of things. It is an infinite sphere, the centre of which is every where, the circumference no where. It is, in short, the greatest sensible mark of the almighty power of God, that imagination loses itself in that thought.

Returning to himself, let man consider his own being compared with all that is; let him regard himself as wandering in this remote province of nature; and from the little dungeon in which he finds himself lodged, I mean the universe, let him learn to set a true value on the earth, on its kingdoms, its cities, and on himself.

What is a man in the infinite?

But to show him another prodigy no less astonishing, let him examine the most delicate things he knows. Let him take a mite which in its minute body presents him with parts incomparably more minute; limbs with their joints, veins in the limbs, blood in the veins, humours in the blood, drops in the humours, vapours in the drops; let him, again dividing these last, exhaust his power of thought; let the

[254] Xenakis, *Music and Architecture*, 274-275.

last point at which he arrives be that of which we speak, and he will perhaps think that here is the extremest diminutive in nature. Then I will open before him therein a new abyss. I will paint for him not only the visible universe, but all that he can conceive of nature's immensity in the enclosure of this diminished atom. Let him therein see an infinity of universes of which each has its firmament, its planets, its earth, in the same proportion as in the visible world; in each earth animals, and at the last the mites, in which he will come upon all that was in the first, and still find in these others the same without end and without cessation; let him lose himself in wonders as astonishing in their minuteness as the others in their immensity; for who will not be amazed at seeing that our body, which before was imperceptible in the universe, itself imperceptible in the bosom of the whole, is now a colossus, a world, a whole, in regard to the nothingness to which we cannot attain.

Whoso takes this survey of himself will be terrified at the thought that he is upheld in the material being, given him by nature, between these two abysses of the infinite and nothing, he will tremble at the sight of these marvels; and I think that as his curiosity changes into wonder, he will be more disposed to contemplate them in silence than to search into them with presumption.

For after all what is man in nature? A nothing in regard to the infinite, a whole in regard to nothing, a mean between nothing and the whole; infinitely removed from understanding either extreme. The end of things and their beginnings are invincibly hidden from him in impenetrable secrecy, he is equally incapable of seeing the nothing whence he was taken, and the infinite in which he is engulfed.

(translated by Charles Kegan Paul)

Text 4: Jean-Paul Richter Volume I

Siebenkäs[255]

… At the summit of the vault rose the dial of Eternity, on which there appeared no number and which was its own hand; only a black finger was fixed on it and the dead wanted to see the Time in it. Then a tall, noble silhouette in importanl pain knelt on the altar, and all the dead cried out,

"Christ, is there no God?"

He replied, "There is none!"

The full shadow of each of the dead, and not only the breast, began to quiver and, one after another, was broken up by this quivering.

Christ continued, "I have traveled through the worlds, I have leapt towards the suns, through the Milky Ways I have crossed the deserted spaces of the sky, but there is no God. I have gone as far down as the existence, and I have cried, 'Father, where are You?', and I heard but the eternal tempest that nobody governs and the shining rainbow, made out of beings, rose above the abyss and poured out drop by drop. And when I raised my eyes to the infinite heaven, searching for a regard from God, the universe contemplated me from its empty, bottomless orbit; and the Eternity, lying on the chaos, was gnawing and rechewing it. Howl endlessly, you dissonances, and break up the shadows, because He does not exist."

The colorless shadows dispersed as white mist shaped by the cold breaks up; and all became desert. Then to the terror of the heart, the dead children who had awakened in the cemetery moved forward into the temple, and they threw themselves at the feet of the tall silhouette saying, "Jesus, have we no father?" And he replied, with tears streaming down, "We are all orphans, you and I, we have no father."

[255] Xenakis, Music and Architecture, 275-276.

Then the dissonances grinded with even more violence—the shaking walls of the temple split apart—and the temple and the children were swallowed up—and the whole earth and the sky were swallowed up after them—and all the edifice of the universe stitched by a thousand suns, the same as a mine buried in eternal night, with suns like miners' lams and Milky Ways like veins of silver …

And when, during my fall, my gaze fell again on the shining edifice of the universe, I saw the rising rings of the gigantic serpent of the Eternity which lay around the worlds—and the rings rushed down and it squeezed the universe in a double grip—and it coiled up in a thousand ways around the Nature-and it crushed the worlds, one against the others—and it ground the infinite temple into a cemetery church—and all was shriveled up in the gloom and anguish-and an endless hammering of bells began to strike the final hour of time and shattered the edifice of the universe … when I awakened …

Text 5: Robert P. Kirshner - "Supernovas in Other Galaxies" *Scientific American*, December 1976.

Supernova[256]

… A representative Type II supernova for which there are good data is SN 1970g, which was seen to explode in the galaxy M101 late in 1970. Spectrophotometric scans of the, object's spectrum show that it evolved over a period of months. In the early phases of the outburst the overall distribution of the star's energy closely matched the smooth distribution of energy characteristic of a theoretical black body at a temperature of 12,000 degrees Kelvin … For SN 1970g the radius was 3 X 10^{14} centimeters, a radius as large as that of the orbit of the planet Uranus.

Once radius of the supernova is known its absolute luminosity can also be determined. For SN 1970g the luminosity was 10^{42} ergs per second, a billion times the luminosity of the sun. Even more interesting data from spectrophotometry and from standard broad-band photometry enable one to plot the supernova's change in radius with respect to time. For some 30 days after the star's initial explosion the radius of the surface from which the visible light is emitted expands at a nearly constant velocity of 5.000 kilometers per second. At the end of that time the star's photosphere, or visible surface, has attained a radius of some 2 X 10^{15} centimeters, a radius much larger than that of the solar system. As the photosphere expands, its temperature decreases to about 6.000 degrees K. After reaching its maximum extent the photosphere, which up to then is opaque, is so thin that it begins to become transparent. Thus, the apparent radius of the star begins to shrink, giving rise to the rapid decline in the light curve of a Type II supernova.

… The model supernovas have two very important characteristics of observed supernovas. First, calculations show that extended red supergiants are already so large that they do not cool significantly as they expand to become roughly they size of the large system. Second, the interior of an extended red supergiant is a large region of nearly constant density; therefore an explosion in the center of the

[256] Xenakis, Music and Architecture, 276-277.

star transmits its energy to the surface efficiently. Hence the model predicts that the energy released in the centre of the star can appear as the heat and motion actually observed at the surface of a supernova.

The model further predicts that the supernova sould have a temperature of about 10,000 degrees K. at the surface and should expand at a velocity of about 5.000 kilometers per second shortly after it attains its maximum brightness. The fact that the calculations based on models of stars that seem likely to explode agree so well with the observation of stars that actually explode is encouraging. Conversely, the fact that the agreement comes from considerations having to do with the structure of the star's interior and not from calculations of the details of the explosion means that spectrophotometric data from a supernova during the first month of the outburst can yield little direct information on the sourve of the energy released in the saatr's core…

APPENDIX D: TEZ FOTOKOPİSİ İZİN FORMU

TEZ FOTOKOPİ İZİN FORMU

ENSTİTÜ

Fen Bilimleri Enstitüsü ☐

Sosyal Bilimler Enstitüsü ☐

Uygulamalı Matematik Enstitüsü ☐

Enformatik Enstitüsü ☐

Deniz Bilimleri Enstitüsü ☐

YAZARIN

Soyadı :
Adı :
Bölümü :

TEZİN ADI (İngilizce) :

TEZİN TÜRÜ : Yüksek Lisans ☐ Doktora ☐

1. Tezimin tamamı dünya çapında erişime açılsın ve kaynak gösterilmek şartıyla tezimin bir kısmı veya tamamının fotokopisi alınsın. ☐
2. Tezimin tamamı yalnızca Orta Doğu Teknik Üniversitesi kullancılarının erişimine açılsın. (Bu seçenekle tezinizin fotokopisi ya da elektronik kopyası Kütüphane aracılığı ile ODTÜ dışına dağıtılmayacaktır.) ☐
3. Tezim bir (1) yıl süreyle erişime kapalı olsun. (Bu seçenekle tezinizin fotokopisi ya da elektronik kopyası Kütüphane aracılığı ile ODTÜ dışına dağıtılmayacaktır.) ☐

Yazarın imzası ..... Tarih .....