How Do You Draw A Sound?

Carey Lovelace

Time itself is the blackboard on which are inscribed phenomena and their outside-time relations within the universe in which we live.

—IANNIS XENAKIS[1]

In a yellowing photo, Iannis Xenakis, age eleven, stands next to his uncle and two younger brothers in a busy port—probably in Romania, where he was born and where his father managed a British-based import-export firm [PL. 9]. His mother had died six years earlier; she had been deeply interested in music. His own passions were many—including archeology, literature, astronomy. Shortly after the photograph was taken, he was sent back to Greece for private schooling. In 1940 young Iannis began engineering studies at the Athens Polytechnic—just as Mussolini's Italians were invading. The "little stranger" ("Xenakis") became a leader in the student resistance movement. Then came the German Nazis, and in 1944, the British. Fighting the invaders, Xenakis nearly died, wounded by shrapnel that destroyed his left eye and part of his cheek, leaving him severely disfigured.

During this time, he was often in prison. Nonetheless, living a semi-clandestine existence, he managed to earn a civil engineering degree—and to study music, a passion he came to relatively late, "never imagining," he later said, that he himself might become a composer.[2] In 1947, to escape internment in a prison camp, he fled to Paris on a forged passport. He was condemned to death in absentia.

1 Iannis Xenakis, from a presentation on ideas of time given at the symposium, "Recovering Time," organized by l'Université de Bruxelles, 1988.

2 Iannis Xenakis, "Preface," in *Music and Architecture*, comp., trans., and ed. Sharon Kanach (Hillsdale: Pendragon Press, 2008), xvi.

PL. 9
Iannis Xenakis (far right) with his two brothers and uncle Sophocles, 1933

He was recommended for a position in the atelier of French-Swiss architect Le Corbusier. He was shy by nature as well as due to his facial disfigurement; he was also penniless and isolated. After work, he studied counterpoint and harmony and wrote long into the nights. He had determined he would be a composer. And he had met Françoise Gargouil. They married in 1953; she would become a successful journalist and novelist. In 1956 their daughter, Mâkhi, was born.

He sought out leading figures in Paris's thriving music scene, such as the teacher Nadia Boulanger and prominent composers Darius Milhaud and Arthur Honegger. But each, in his or her own way, rebuffed his efforts, his post-Bartokian compositions inspired by Greek folk tunes. In 1951, fatefully, he approached Olivier Messiaen. "You are almost thirty," the influential composer counseled. "You have the fortune of being Greek, an architect, and of having studied special mathematics. Take advantage of those things. Do them in your music."[3] Messiaen would remain a friend and mentor until his own death in 1992.

MUSIC AND ARCHITECTURE

Xenakis's first years with Le Corbusier primarily involved calculating the resistance of building materials. (His engineering thesis had concerned reinforced concrete.) Gradually, though, he won the respect of studio members and, in 1954, was appointed "project architect" for the soon-to-be-legendary convent of Sainte-Marie-de-la-Tourette near Lyon, whose exterior Le Corbusier conceived as a simple rectangle. Xenakis was assigned the interior spaces and designed the cloisters, study hall, library, and chapel—the latter in the shape of a grand piano. The sacristy included "machine guns" of colored light—oblong windows the interiors of whose cylindrical shafts were painted in primary hues, giving the cast light a glow.[4] Xenakis would enter architectural history, though, for what Le Corbusier dubbed his "musical screens of glass."[5]

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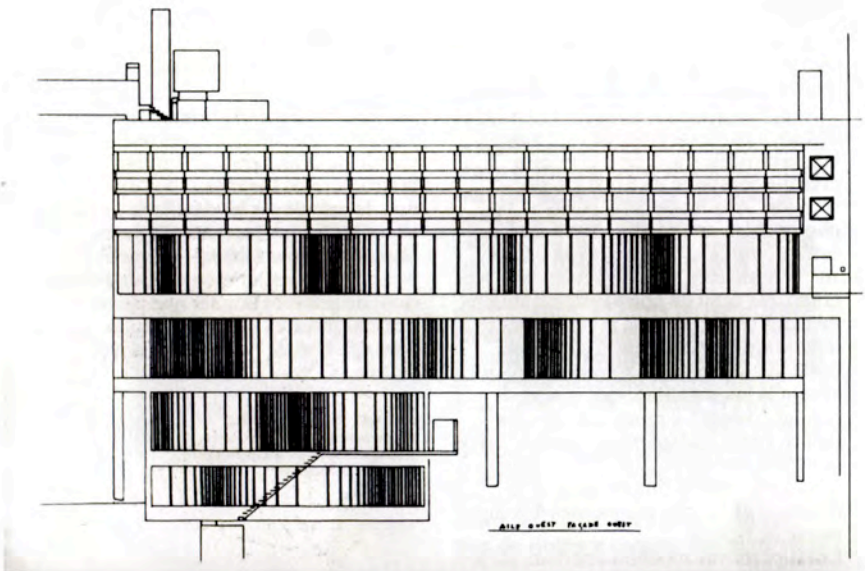
3 Olivier Messiaen quoted in Nouritza Matossian, *Xenakis* (Nicosia, Cyprus: Moufflon Publications, 2005), 59.

4 For a description of these and other Le Corbusier-related projects in which Xenakis participated see *Music and Architecture*.

5 Quoted in Matossian, *Xenakis*, 78.

PL. 10
Atrium of Convent of La Tourette showing undulating glass panes, 2004



PL. 11
Convent of La Tourette (elevation), c. 1959

PL. 12
Convent of La Tourette (west and south façades), photograph c. 2004

Earlier, the modernist innovator, who was just then absorbed in actualizing his ideas about urbanization in such landmark projects as Chandigarh, India, and Marseille's Radiant City, had traveled the world studying architecture, notably that of ancient Greece. He had formulated something called "the Modulor," a complex scale of proportion combining human measurements with the Golden Mean and the Fibonacci series. (It is composed by adding the sum of two numbers to the previous in a series: 1, [1+1=]2, [2+1=]3, [3+2=]5, etc. It is the relational structure of natural phenomena including the nautilus shell and tree rings.)

Designing a double frieze of windows for the Dominican convent's west façade [PLS. 11, 12], Xenakis turned to the Modulor. He plotted out varying widths, the intervals creating shifting rhythms, a kind of vertical polyphony. Lending dynamism to the straightforward concrete-slab rectangle, the celebrated "undulating glass panes" were essentially a "musical solution."[6]

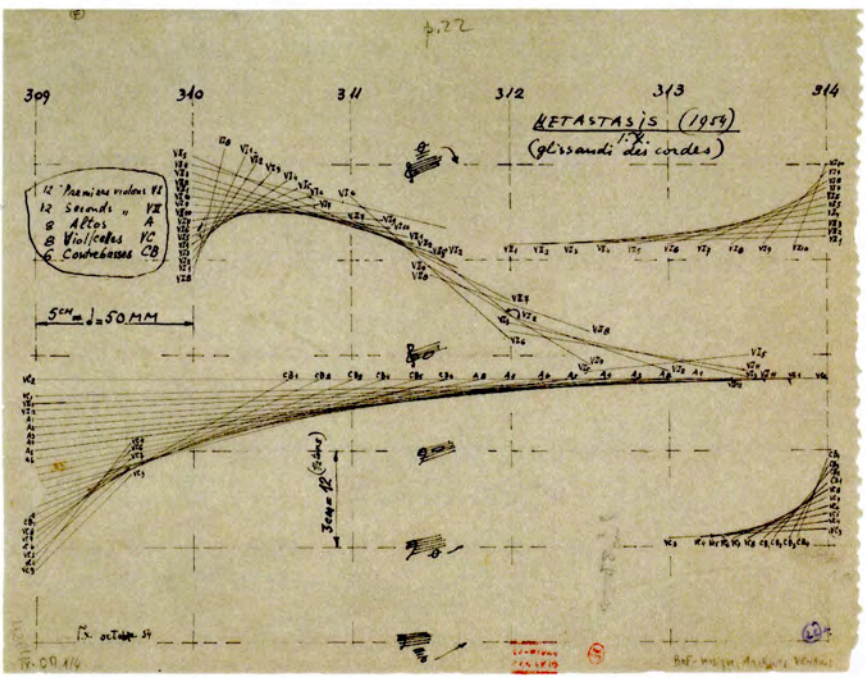
Having entered Le Corbusier's studio with little knowledge of modernism, Xenakis found himself stimulated by his employer's constant questioning, his ingenious design use of simple geometries, his "spiritual force."[7] And, inspired no doubt also by Messiaen's counsel, the young composer began applying graphic solutions to music.

In the conceptualization of his breakthrough orchestral work, *Metastaseis* (1953–54), Xenakis once stated, "the role of architecture is direct and fundamental."[8] Composing on architects' graph paper, he began by sketching arcing shapes—ruled parabolas [PLS. 13, 14]. In this pleasingly mind-bending form, lines at right angles drawn at regular intervals produce a graceful curve at their points of intersection. In his composition, he assigned each of forty-six ruled lines to a separate string instrument—violin, viola, and so on. These were translated in sound as sustained tones or glissandi. Previously,

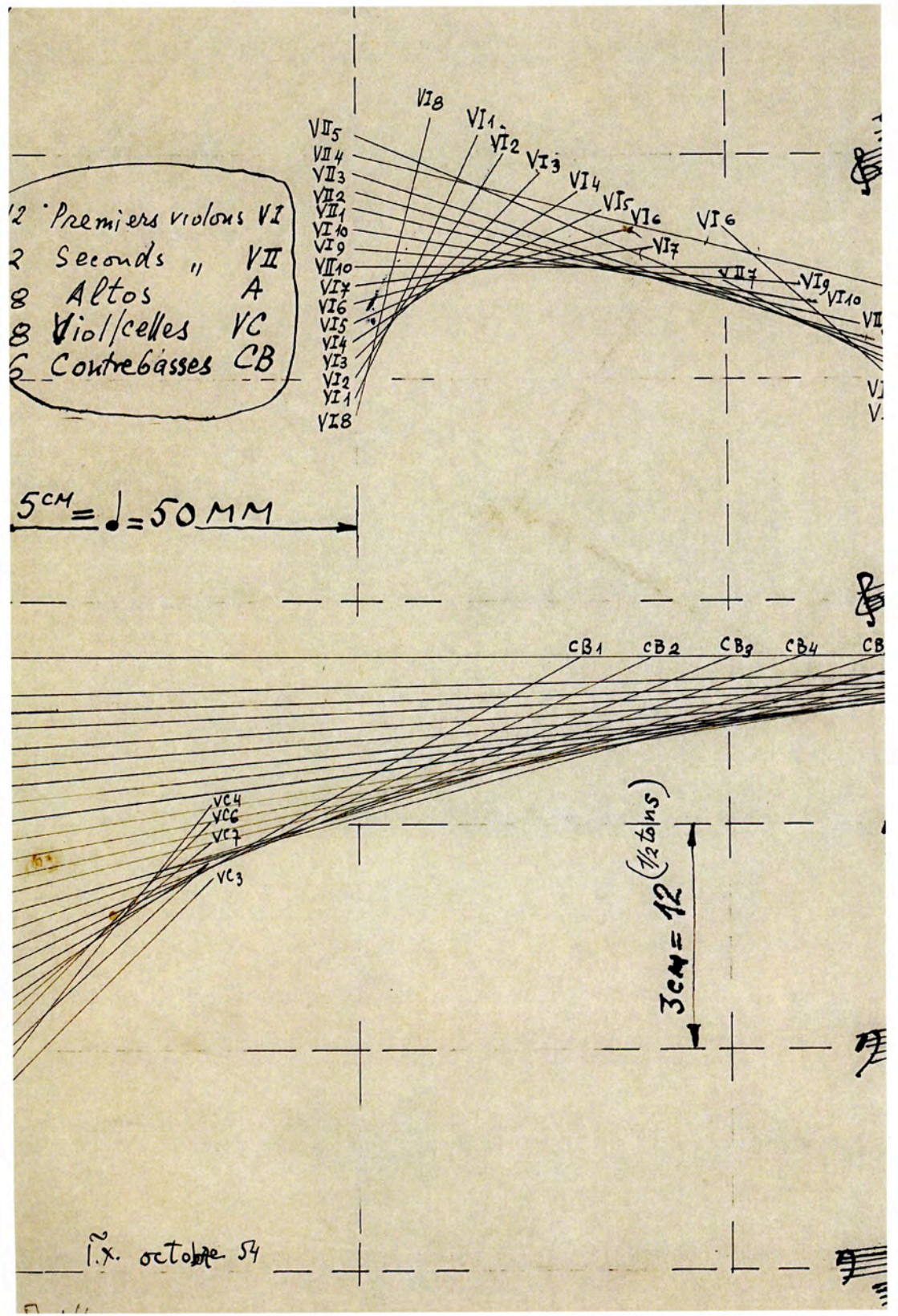
6 Matossian, *Xenakis*, 79. Despite the fact that Xenakis's contributions, including the design of the interior chapel, sleeping areas, and the interior fenestration, are essential to the building's reputation, he is often left unmentioned in historical accounts.

7 Mario Bois, *Iannis Xenakis: The Man and His Music* (London: Boosey and Hawkes, 1967), 5.

8 Quoted in James Harley, *Xenakis: His Life in Music* (New York: Routledge, 2004), 10.



PL. 13
Study for *Metastaseis*, 1954


12 Premiers violons VI
12 Seconds " VII
8 Altos A
8 Viol/celles VC
6 Contrebasses CB
VI8
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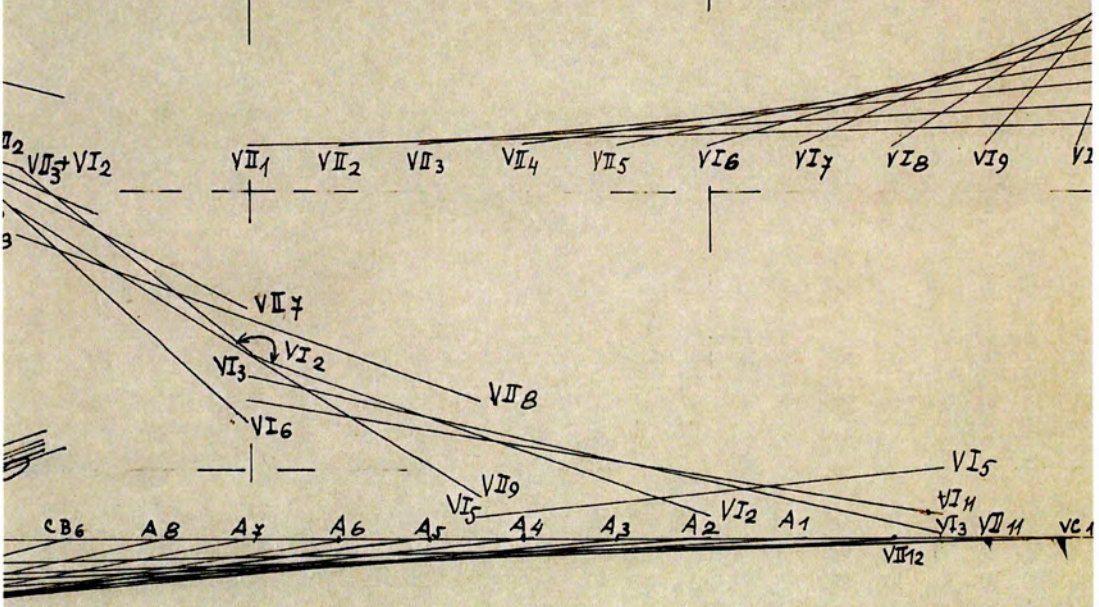
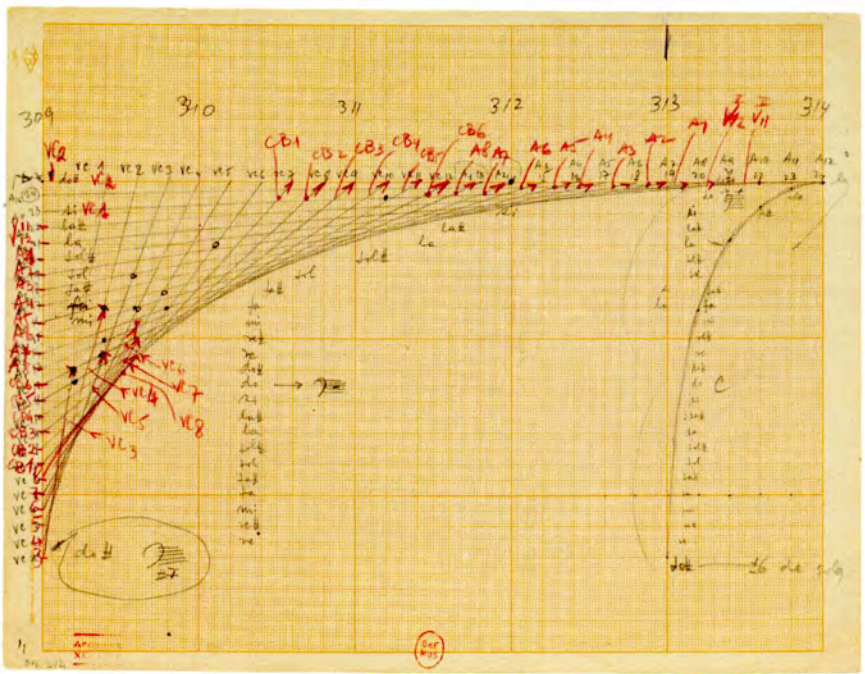
METASTASIS (1954)

(glissandi des cordes)



ARCHIVES



PL. 14
Study for *Metastaseis*, c. 1953

for example in a Paganini violin solo, this "slide" up in pitch had served as a coloristic flourish—never as a unit in itself. In *Metastaseis*, every detail was carefully plotted out. To determine proportions between and within sections, Xenakis turned, again, to Le Corbusier's Modulor.

At the time, Western music was undergoing a transformation parallel to revolutions in visual art. Just as, for example, Russian Suprematists at the beginning of the twentieth century banished representation in favor of pure geometries, so progressive composers aspired to evolve past classical music's harmonic framework with its stress on a tonal base and on dominant/subdominant "resting places." Notably, twelve-tone "serial" composition was based on the idea of a "series" or "cell" of twelve tones each of equal weight, submitted to permutations.

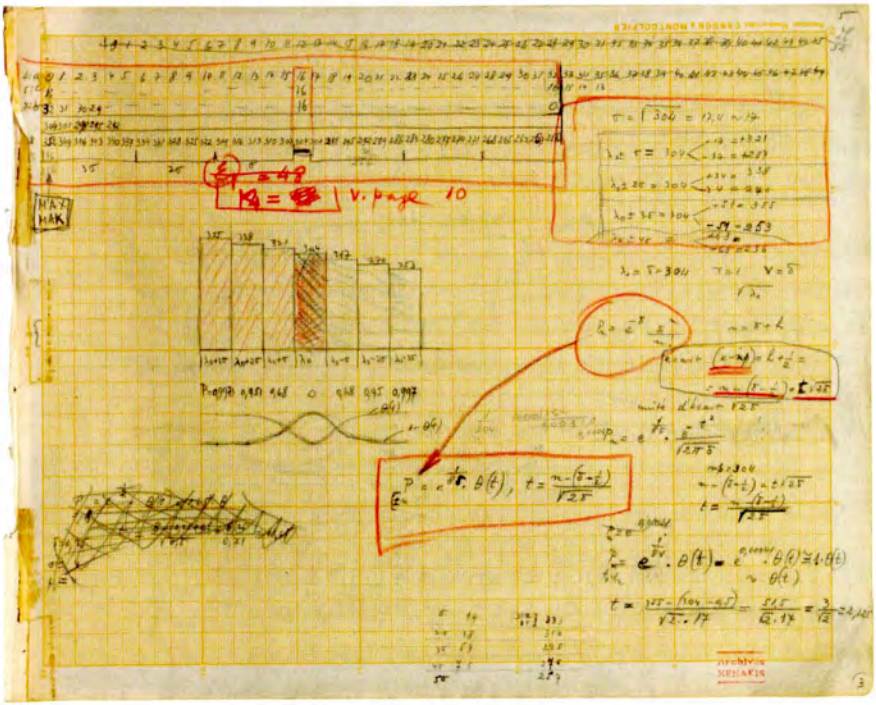
Metastaseis translates as "beyond + stasis." In Xenakis's view, Western music—limited to the tones of the chromatic scale as opposed to an infinite range of frequencies—was static, as was serial music. Although the listener is meant to follow the serial "cell" undergoing permutations, as if it were a melody transforming through a symphony, in complex works, all that is perceptible is a general sonic wash. Xenakis, instead, sought to formulate such musical textures directly. His haunting seven-minute string orchestra work[9] initiated the concept of sound "masses" and generated an unearthly music. The opening consists of long, interlaced string glissandi, "sonic spaces of continuous evolution," as Xenakis himself put it.[10] Its premiere at Donaueschingen, Germany, in 1955 caused a sensation. He was banned, he recalled, from the halls of serial music for years. "Nothing like it had been heard before."[11]

His next work, *Pithoprakta* (1955–56), considered by many his first mature orchestral piece, takes the notion of "mass sound" a step further. It again foregrounds string instruments (while also including two trombones, a xylophone, and a woodblock). While the opening and

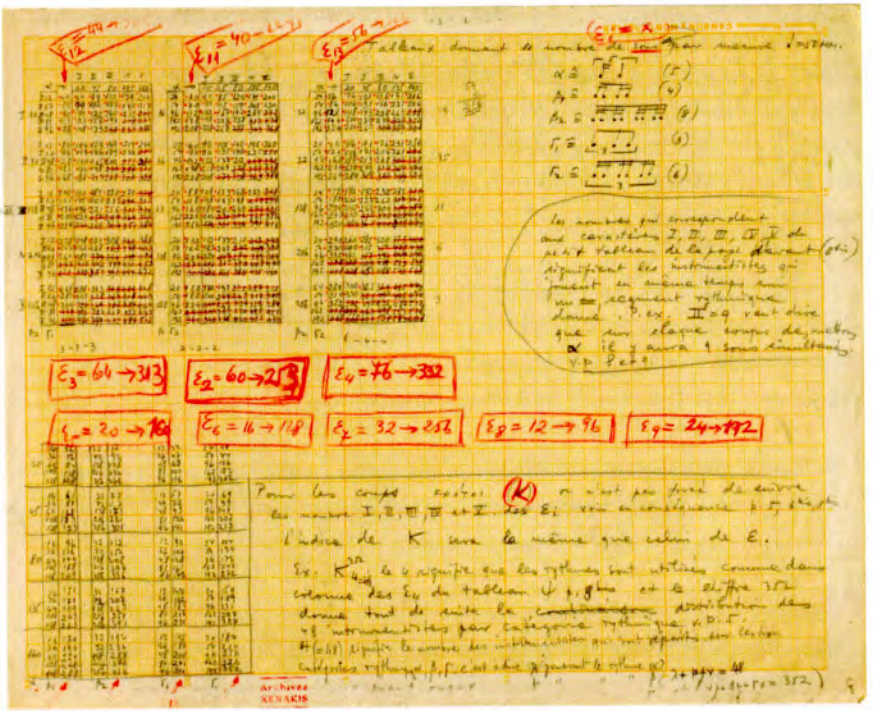
9 Emerging from a single sustained tone into a forty-six-note cluster, the piece is played *a divisi*—that is, each instrument is assigned a separate line. The ensemble also includes seven brass, six winds, and two percussion.

10 Iannis Xenakis, *Formalized Music* (Hillsdale: Pendragon Press, 1992), 10.

11 Harley, *Xenakis: His Life in Music*, 10.



PL. 15
Study for *Pithoprakta*, 1956



PL. 16
Study for *Pithoprakta*, c. 1955

concluding sections of *Metastaseis* are linear (based on glissandi) and use geometry as a formative module, *Pithoprakta* ("action through probability") is based on "clouds of points"—in this case, created by quasi-percussive modes of attack such as *pizzati* (plucked strings), *col legno* (striking the string with the wood of the bow), *arco au talon* (at the base of the bow). Over the course of the work, "points"—distributed according to probability calculations—move at various directions and speeds. Xenakis implemented varying formulas for different sections—Poisson's Law of Rare Events, Bernoulli's Law of Large Numbers, and the Maxwell-Boltzmann Kinetic Theory of Gasses. (The latter projects the movement of gas molecules, that is, particles, which can be seen as equivalents to *Pithoprakta*'s "sound points.") He dubbed this approach "stochastic music"—compositions that are generated by probability-based formulas dealing with large numbers of events.

This seemingly hyper-cerebral approach was, for Xenakis, in fact deeply grounded in nature—which he loved—as well as in human experience. Famously, he invoked an agonizing personal memory, the chaos at a political rally broken up by gunfire:

> The human river shouts a chant in uniform rhythm...[After a] whistle of bullets...The crowd is then rapidly dispersed, and after sonic and visual hell follows a detonating calm, full of despair, dust, death.[12]

The dozens of remarkable, often large-scale studies he created feature colored points or tangles of tangents along a left-to-right axis [PLS. 15, 16]. (Interestingly, these preparatory documents bring to mind drawings by the artist Hannah Darboven, for example, or even obsessive samples of Outsider Art.) As with *Metastaseis*, and nearly all subsequent compositions, Xenakis would translate such visual plottings into musical notation. At its Munich premiere, *Pithoprakta*, too, caused outrage—even the performers were hostile to the work's novel approach. It was conducted by Hermann Scherchen. In 1955, the unknown composer had approached the eminent conductor with the then-unperformed and massive score of *Metastaseis* under his arm. Scherchen had championed Arnold Schoenberg and the Viennese

12 Xenakis, *Formalized Music*, 9.

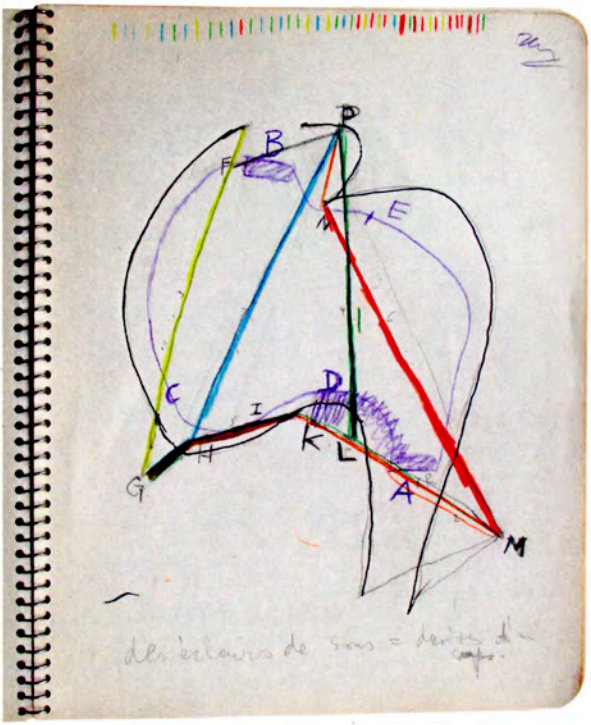
School (who, ironically, had invented the very serial music that Xenakis was about to challenge). He grasped that earlier score's value immediately. While he didn't conduct its first performance, he premiered *Pithoprakta* and became an important champion.

Meanwhile, Xenakis was gaining responsibility under Le Corbusier. When the busy atelier was approached by the Dutch Philips Corporation to produce a pavilion for the 1958 Brussels World's Fair highlighting the firm's contribution to modern technology, Le Corbusier proposed a structure housing an eight-minute *Poème électronique*, a futuristic, "immersive" display of projected visuals and spatialized music. Le Corbusier would create the images. For the audio component, he secured renegade composer Edgard Varèse, who was just then helping pioneer *musique concrète*, a still somewhat primitive collage technique involving "found" sounds recorded from everyday life, usually subjected to audio manipulations.

However, distracted by other projects, Le Corbusier turned over the pavilion itself to his protégé, leaving him with a scant sketch of a "free-form hollow structure."[13] Xenakis realized that, acoustically, the proposed globular shape would heighten reverberations and create "dead spots." He began considering a more asymmetrical framework—notably, one based on "saddle-shaped" hyperbolic paraboloids [PL. 57]. These forms have since become modish in such iconic complexes as the Sydney Opera House, completed in 1973. At the time, Xenakis knew that although such shapes had been used for roofs and terraces, they had never structured a freestanding building. Experimenting with the paraboloid curves that he had traced out for *Metastaseis*, Xenakis saw that the straight, ruled lines which graphed the curves could be translated into supporting wire cables. Working with scale models of piano wire, planks, and string, he eventually composed a non-uniform, decentralized structure of conoids sweeping into three futuristic-looking tent-like peaks. Le Corbusier had originally suggested a sprayed-on concrete shell. Instead, Xenakis proposed two-inch-thick panels of pre-stressed concrete, slightly curved to form the sweeping arcs, which would be

13 A.S. Barthel-Calvet, "Iannis Xenakis Biography," Les Amis de Xenakis, http://www.iannis-xenakis.org/xen/bio/bio.html.

PL. 17
Philips Pavilion, c. 1958



PL. 18
Study for Philips Pavilion (interior sound diagram), c. 1957

PL. 19
Le Corbusier, Louis Kalff, and Iannis Xenakis with scale model of the Philips Pavilion, c. 1957

cast on-site in open sand beds. Fortunately Le Corbusier was enthusiastic about Xenakis's radical alteration of his initial concept.[14]

When Le Corbusier arrived to sign the plans and lay the foundation stone in May, 1957, he neglected to mention the project's sole author. In what became known as the "Xenakis incident," the young composer/engineer registered a heated protest. A bitter struggle ensued; even Varèse took sides (Xenakis's). One day in 1959, the composer and two other employees arrived at the atelier to find the locks changed. They had been fired. Nonetheless, Le Corbusier, who had never before acknowledged collaborators, eventually agreed that Xenakis should share credit.

Open from May 1958 until the World's Fair's conclusion in January, 1959, the Philips Pavilion was a triumph. It was the world's first self-supporting hyperbolic paraboloid building and revolutionized volumetric architecture. Xenakis, who coordinated the interior sound and light technology [PL. 18], was also able to create his first musique concrète tape piece. *Concret PH* (high-pitched sounds derived from charcoal burning) played as the audience entered and exited.

SUBSEQUENT COMPOSITIONS

Through the early 1960s, Xenakis continued to develop new mathematical approaches. Frequently, these were mapped out in essays. In "Probability Theory and Modern Composition," one of several that appeared in the music journal *Gravesaner Blätter* (which his mentor, Scherchen, published), the renegade theoretician outlined *Pithoprakta*'s statistical method of generating orchestral textures. In "À la Récherche d'une musique stochastique," taking his analysis even further, he broke the compositional process down into steps, from conception, to definition of material, to realization. He suggested that such stages might eventually be automated on computer.[15]

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14 For a chronological account of the extent of Xenakis's musical innovations during this period, see Harley's book-long analysis, as well as Matossian's biography, cited above.

15 Xenakis, *Formalized Music*, 22. These stages of stochastic composition, or composition according to probability theories, are: 1. Initial conception; 2. Definition of sonic entities; 3. Definition of the transformations; 4. Microcomposition; 5. Sequential programming; 6. Implementation of calculations; 7. Final symbolic result; 8. Sonic realization.

(Often employing the somewhat impenetrable syntax of algebraic discourse, these essays form the basis of the 1963 *Musique Formelles*, whose explanations of algorithmic compositional method were to have international impact.[16])

In *Achorripsis* ("jets of sound") of 1956–57, he gave this abstracted system musical form. Probability theory (specifically, Poisson's Law of Rare Events) was applied not only to the distribution of notes, but to other features—for example, to the construction of melodic figures. Each of seven rows in a double-entry vector matrix is assigned to a different instrument group or mode of attack (e.g., a string *pizzicato*); columns represent fifteen-second time "slices." In working sketches, Xenakis often used color to indicate additional dimensions. In one beautiful checkerboard version of the grid, reds, blacks, whites, greens, and blues indicate the respective number of "events" within each matrix square [PL. 20].

The systemized procedure used in *Achorripsis* was indeed eventually able to be realized on computer, finding form in works such as *ST/48* (small orchestra), *ST/4* (string quartet), and *Morsima-Amorsima* (mixed quartet). Xenakis implemented other mathematical paradigms—set theory for the virtuoso solo piano work *Herma*, game theory for *Stratégie*, group theory for *Nomos Alpha* (1966). (All but *Nomos Alpha* were completed in 1962.) He generated numerous compositional strategies, many more than could possibly be detailed here.[17] Many works are technically difficult and include "impossible" elements. For example, the piano work *Evryali* (1973) features a high C-sharp off the keyboard. (Performers consider these a kind of Zen koan.)

Xenakis once remarked that he did not compose at the piano, that instead his tools were mathematics and computer science.[18] He also

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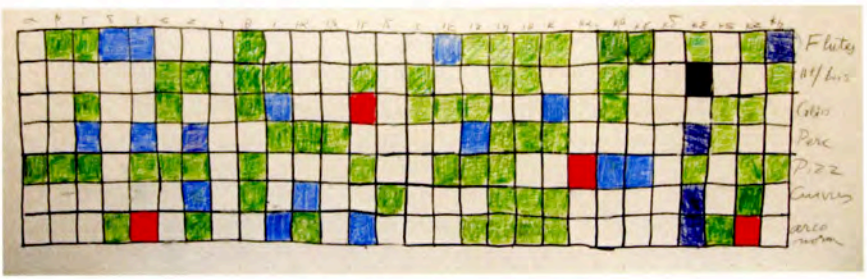
16 The first English edition of Xenakis's *Formalized Music* was published by Indiana University Press in 1971.

17 These include his concept of "screens" and his "sieve theory." For this and more on his electronic music studio, CEMAMu (the Centre d'Etudes de Mathématique et Automatique Musicales), the reader is referred to Harley's monographic book of insightful musical analysis, Matossian's biography, as well as Kanach's editorial commentaries within Xenakis's *Music and Architecture*.

18 Xenakis, *Music and Architecture*, xix.

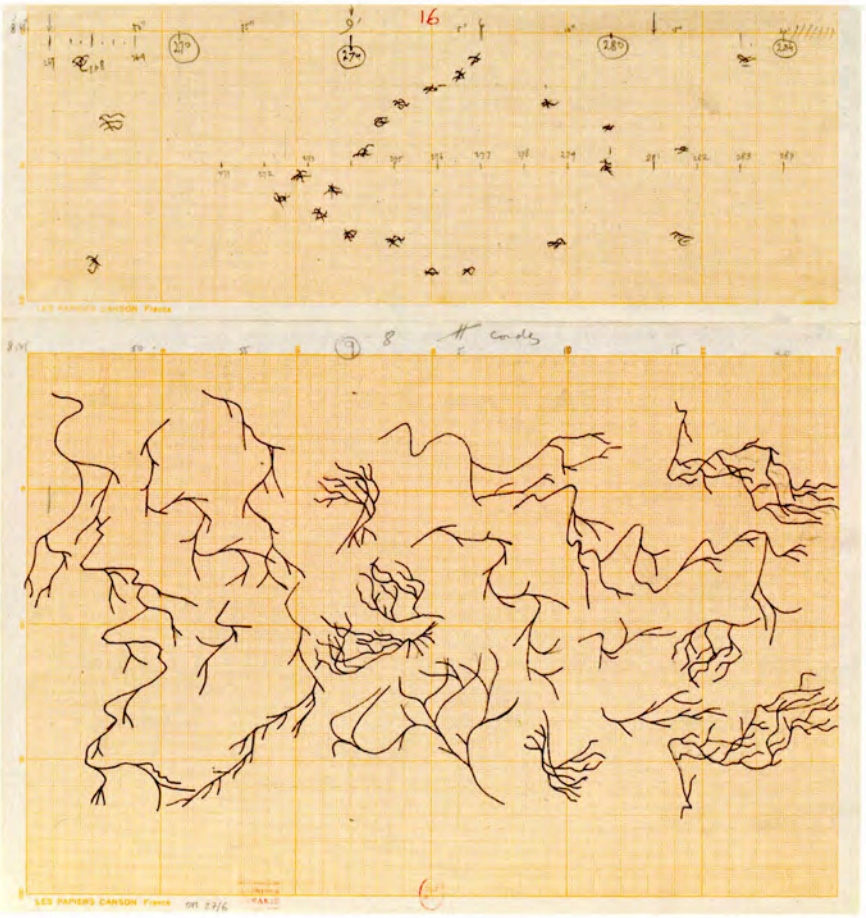


PL. 20
Vector matrix for *Achorripsis*, c. 1964

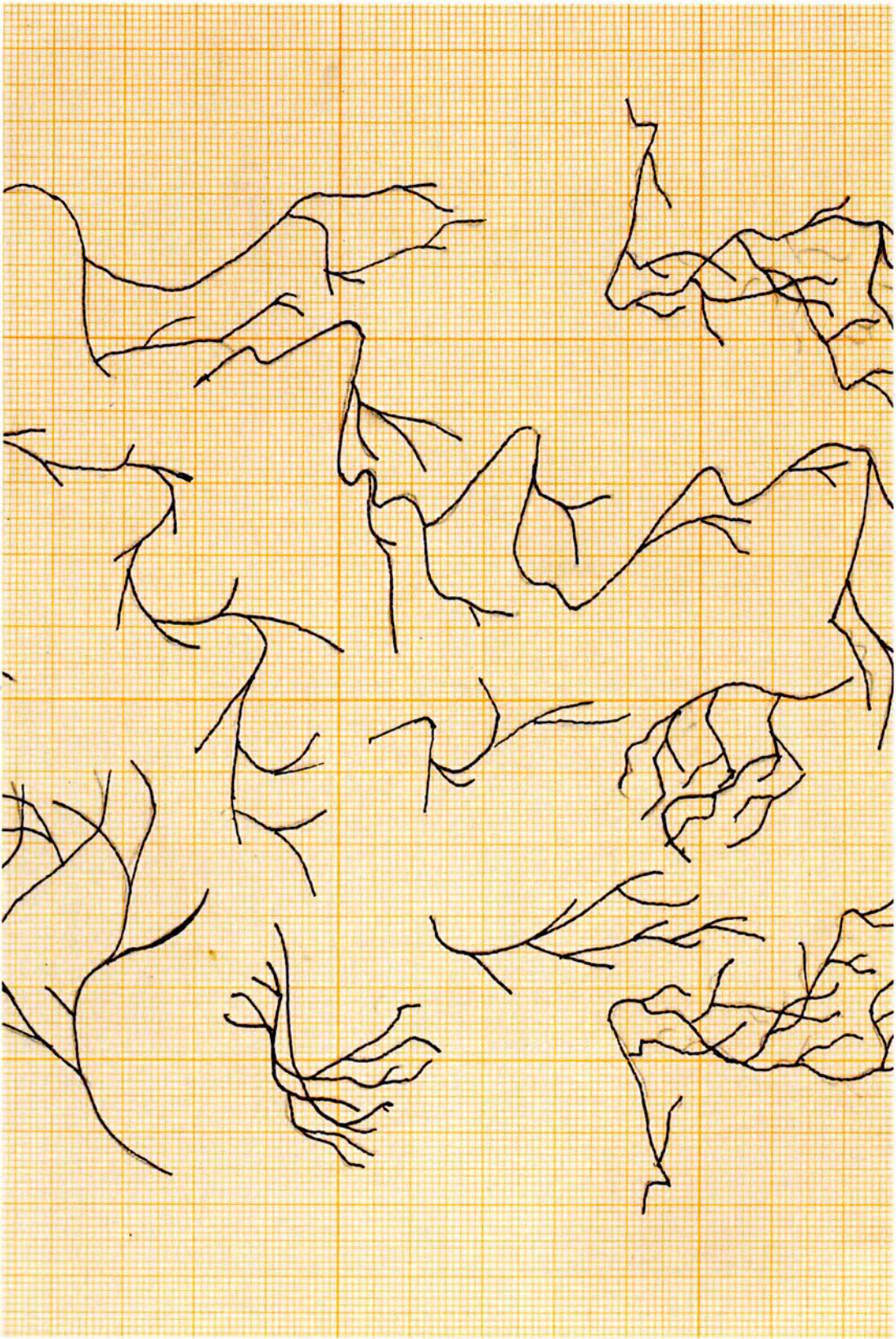
once pointed out that musicians, long before Descartes and the grid, had invented analytic geometry, via musical notation—which is space shared by two elements, pitch and time, unrelated to one another. Xenakis, as it were, occupied a conceptual plane bringing together mathematics, in its two-dimensional visualization, with organized sound. Starting in the late 1960s, he began experimenting with compositions generated by Markov chains, whose probability calculations he used to formulate branching shapes he dubbed "arborescences" or "bushes." These were used in compositions including *Cendrées* (1973), *Noomena* (1974), and *Mikka* (1971). Specifically, he implemented something called the "random walk," a trajectory generated by a series of "steps" (x+1 or x-1) of indeterminate course; the direction and size of each step, determined by probability, is unknown and can be reversible. Thus, "line" (as opposed to *Pithoprakta*'s "clouds" of points) is implied.

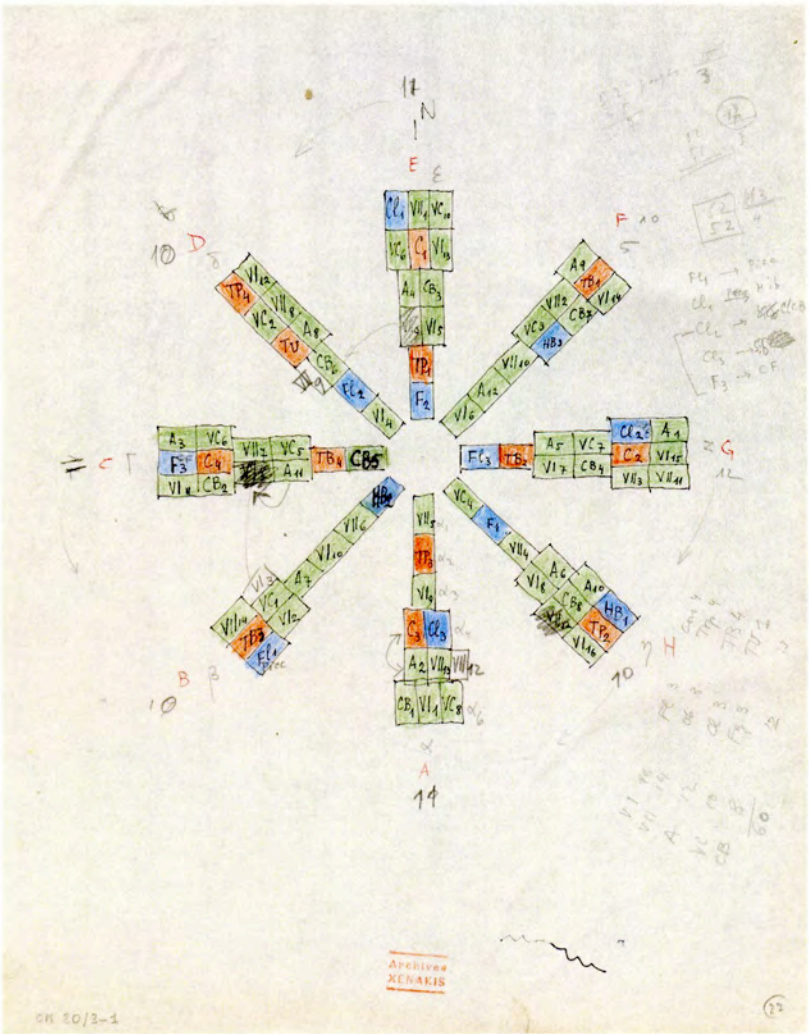
His most graphic preparatory drawings, however, served as groundwork for the seventeen-and-a-half-minute piano concerto, *Erikhthon* (1974) [PLS. 21, 50]. Here, spidery shapes were inscribed along two "tracks"—an upper, narrower strip of graph paper for the piano line, and a lower, larger one for the orchestra. The "dendrite," or branching projection, is transposed—rotated, flipped, turned upside-down—through the course of the piece. In notation, these shapes were translated into chromatic cluster-type runs on the piano and into sweeping orchestral glissandi. One can follow the manner in which shapes are musicalized by listening to the chromatic lines while viewing the preparatory drawings.

But Xenakis was not interested only in sound mapped in a graphic domain. His fascination with sonic dimensionality dated back to the "immersive environment" of 425 loudspeakers he coordinated for the Philips Pavilion. In his 1962 electronic piece *Bohor* (whose earsplitting volume sparked a scandalized reception at its premiere), he programmed dynamic shifts of sound between loudspeakers. At another moment, he mused about the habit of restricting audiences to a frontal position in relation to the musicians. In *Terretektorh* (1965–66), he designated that listeners be seated among the eighty-eight performers, who were arranged in a circular formation around the conductor (their placement in part determined by probability

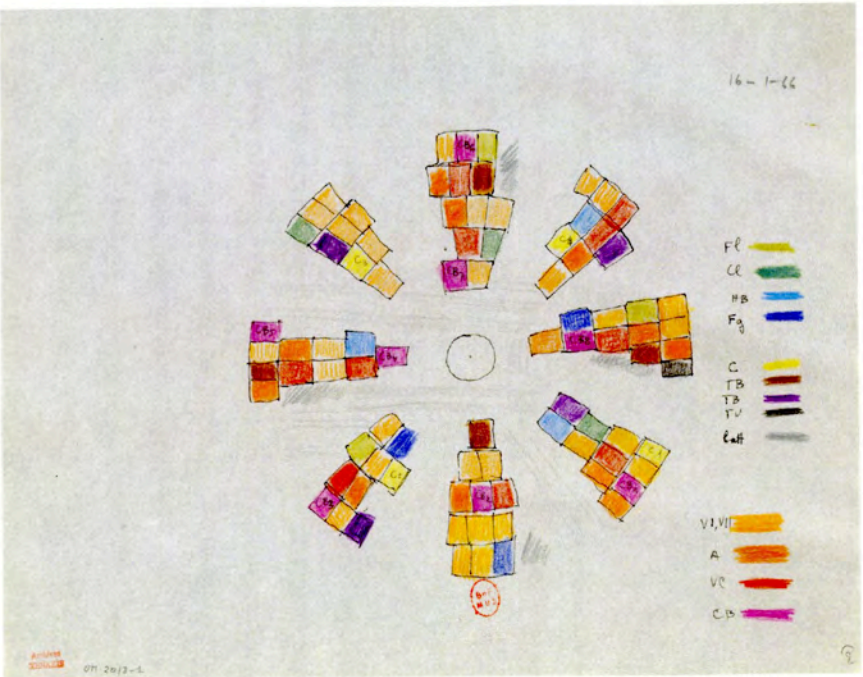


PL. 21
Study for *Erikhthon*, c. 1973

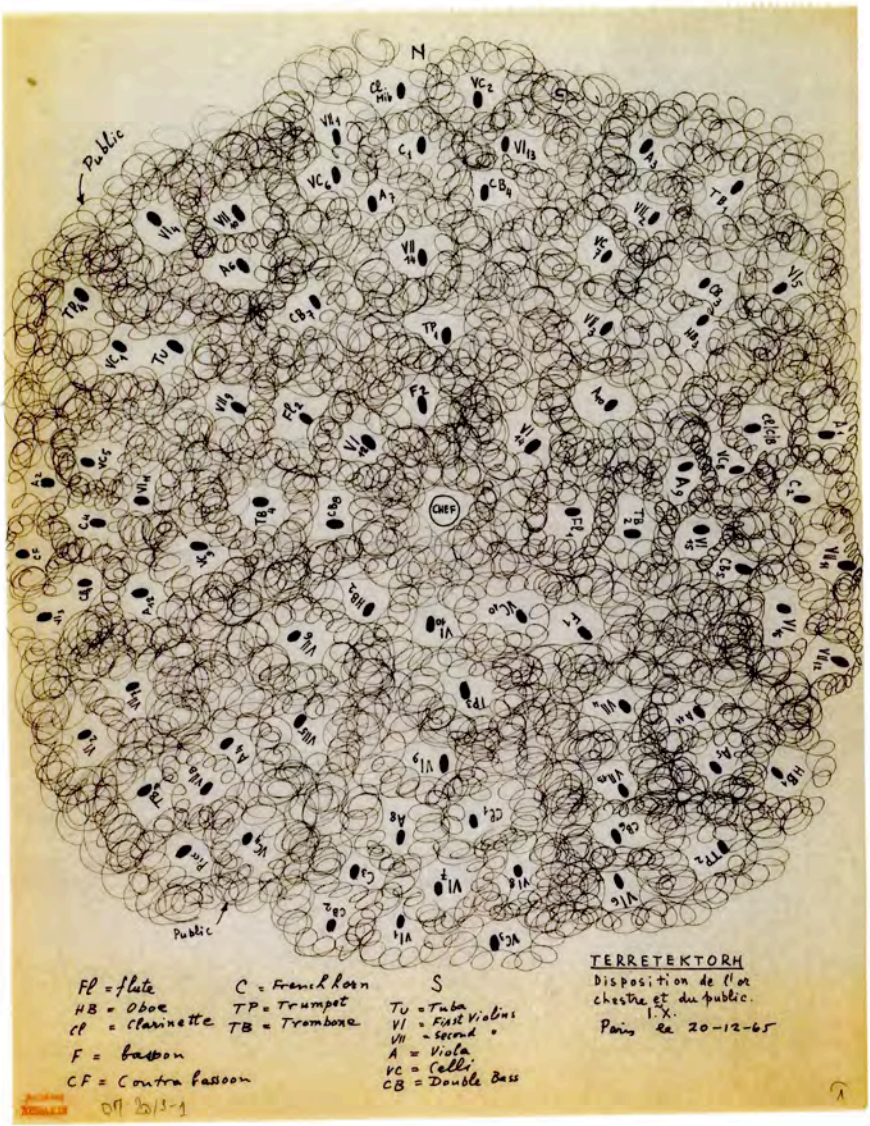




PL. 22
Study for *Terretektorh* (distribution of musicians), c. December 1964–January 1965



PL. 23
Study for *Terretektorh* (distribution of musicians), c. December 1964–January 1965



PL. 24
Study for *Terretektorh* (distribution of musicians), December 20, 1965

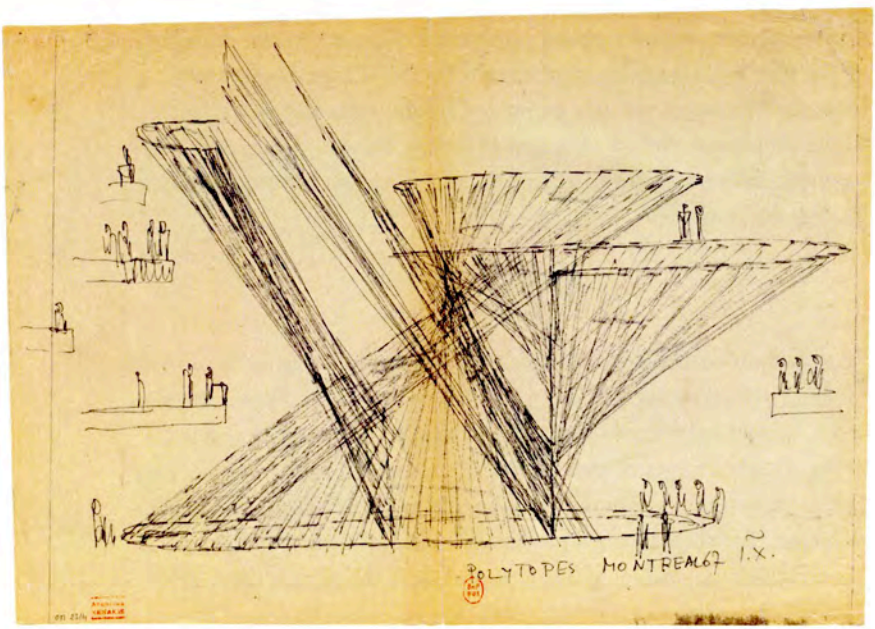
calculations) [PLS. 22, 23]. At the premiere, auditors were given camp chairs and encouraged to move about and to change sites of listening. In an engaging, somewhat obsessive-compulsive 1965 pen-and-ink rendering, this kinetic activity is indicated via meticulous swirls through which one can, with concentration, follow potential audience trajectories through the stationary instrumentalists [PL. 24].

Terretektorh, according to biographer Matossian, was inspired in part by one of the composer's many intense experiences with nature and its sounds. Xenakis spent summers in Corsica in the company of his wife and daughter, surrounded by the sea, gazing at stars, immersed in forest sounds, or rattled by the intensity of a tempest.[19] It was an almost violent primordial feeling he was after, sound shifting from instrument to instrument, as if between loudspeakers—a line traced in space.

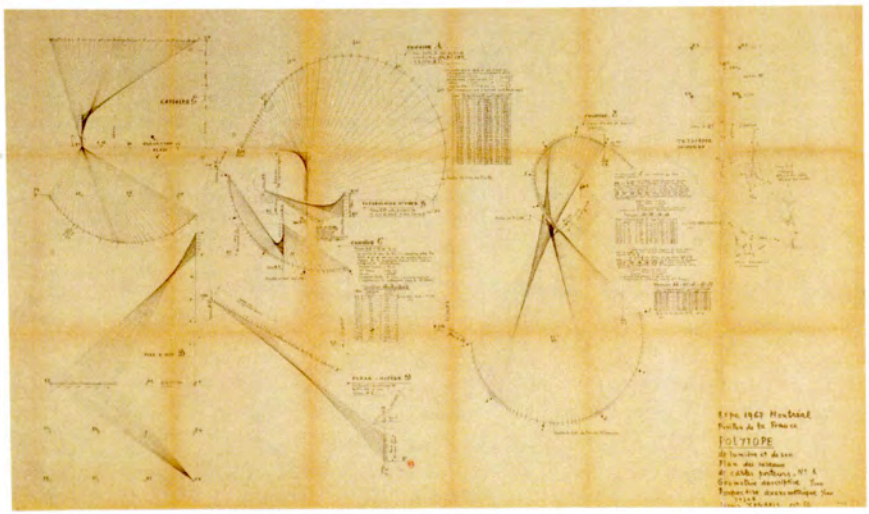
POLYTOPES

Xenakis was invited to create a multimedia work for the interior of the French Pavilion at the 1967 Montreal Expo. With the *Poème électronique*, he had been frustrated by Le Corbusier's outmoded approach to the visuals: images of movie-style dinosaurs, Charlie Chaplin, and fighter planes were projected on the walls to outline modern culture's evolution. For the Montreal project, Xenakis fashioned a sophisticated, Naum Gabo–like arrangement of steel cables that threaded through the interior of the Jean Faugeron-designed building, forming a virtual architecture of intersecting dynamic shafts of conoids and hyperboloids [PLS. 25, 26]. During the six-minute performance, some 1,200 white and colored flashing lights lying along the cables were programmed to create dazzling patterns that changed every twenty-fifth of a second. Simultaneously, a symphony recorded by four separate "orchestras" of identical instrumentation was transmitted via four sets of loudspeakers, one in each quadrant of the hall. The product was dramatically strident sustained tones, unbroken glissandi, and percussive accents reminiscent of Noh music. The public was free to experience the spectacle from many levels on the six-storey-high building's suspended platforms, linked by stairways [PL. 28].

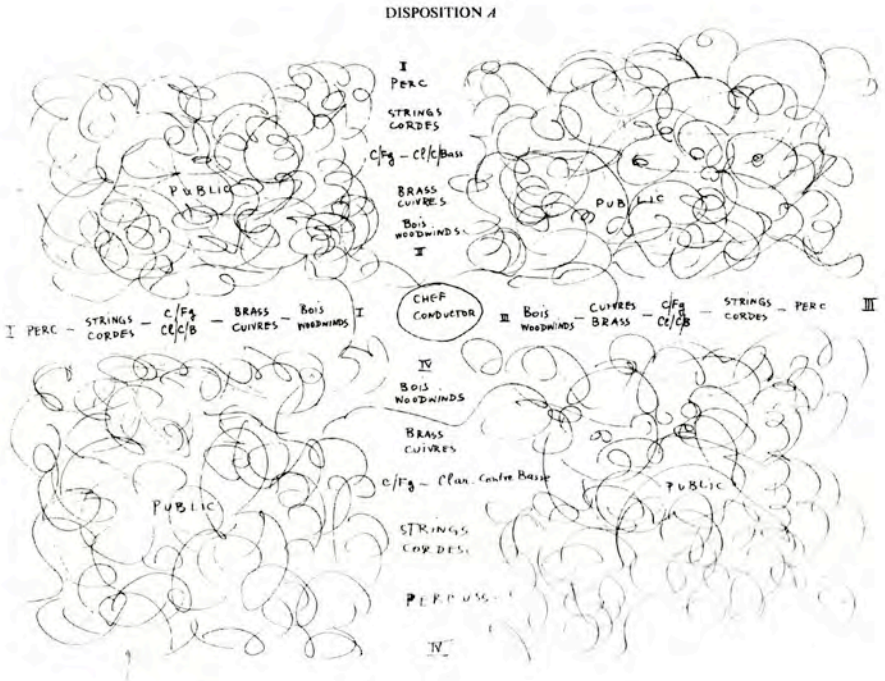
19 Matossian, *Xenakis*, 230.



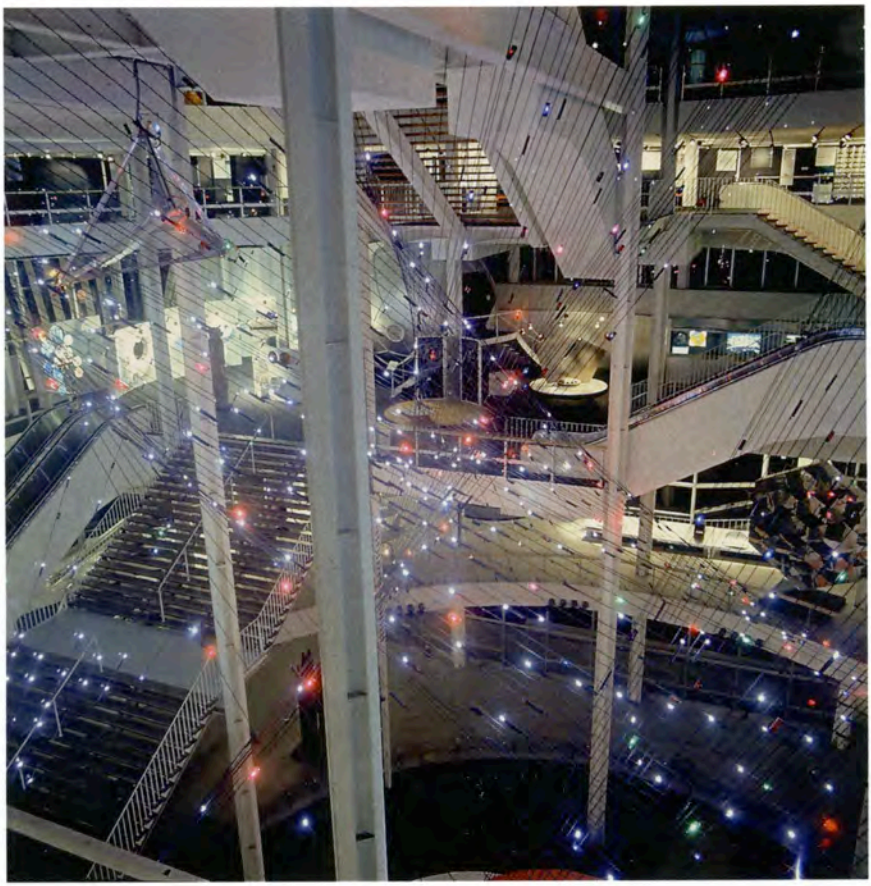
PL. 25
Study for *Polytope de Montréal*, c. 1967



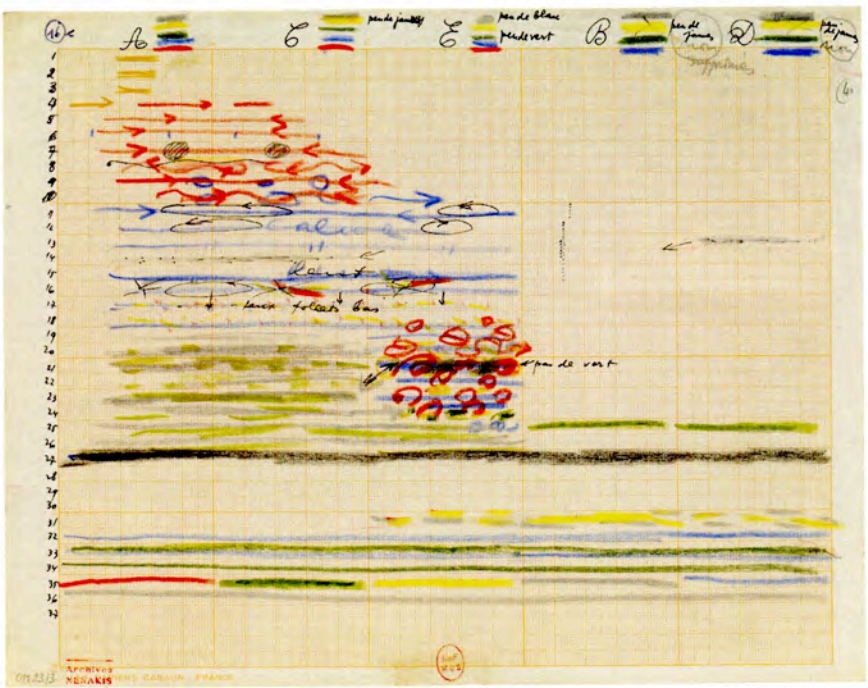
PL. 26
Polytope de Montréal (plans, elevations, axonometrics), 1966



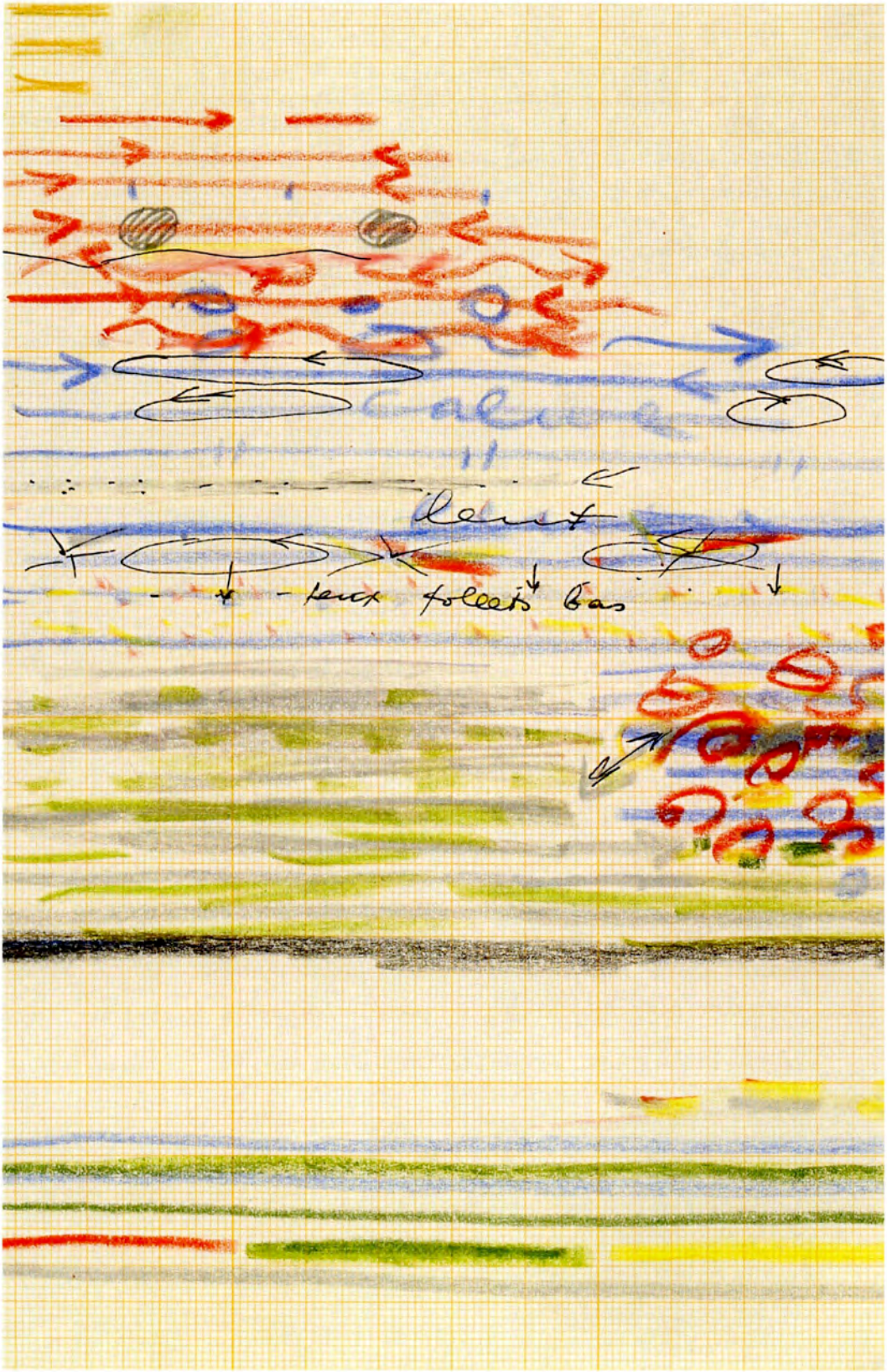
PL. 27
Study for *Polytope de Montréal* (distribution of musicians), 1967



PL. 28
Polytope de Montréal, 1967



PL. 29
Study for *Polytope de Montréal* (light score), c. 1966

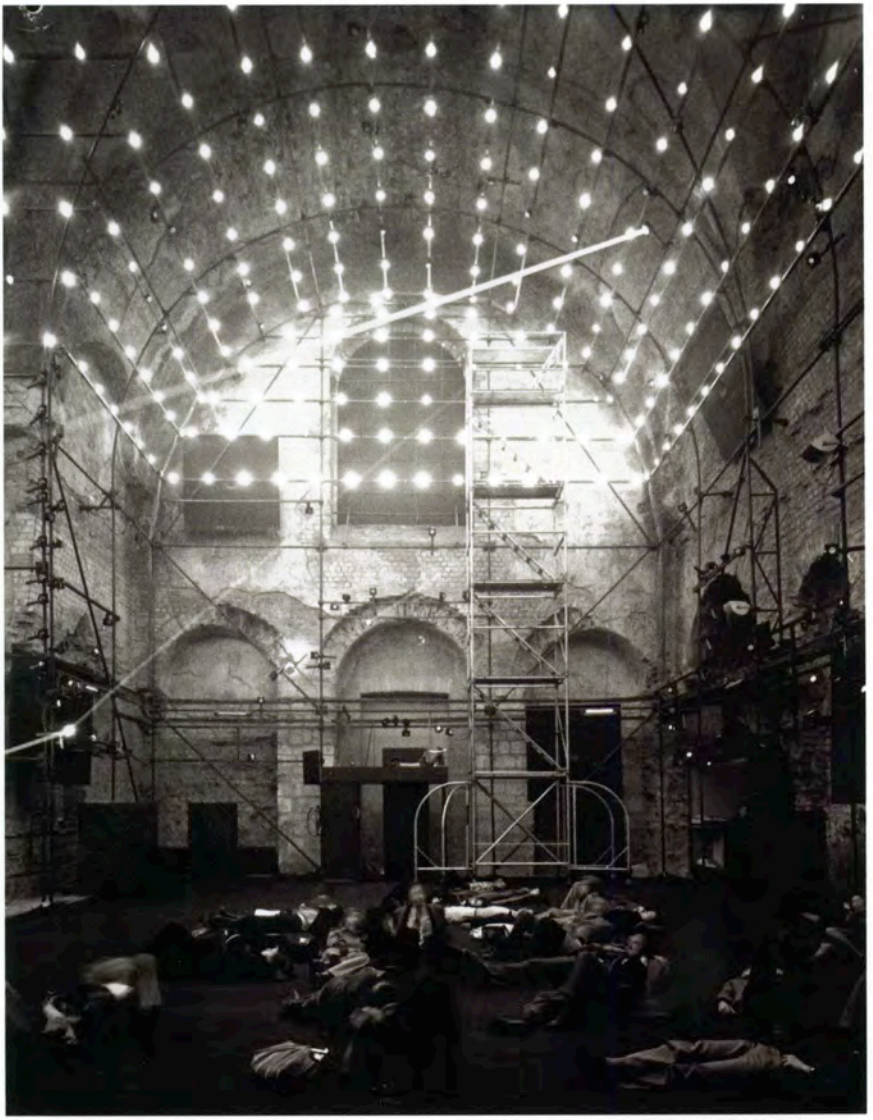


He called this a "polytope" ("many"+ "sites"), and it was the first of many. Just as he had initially used graphic geometries to visualize sound in a new way, he now reversed the equation and used music's formal strategies to craft shifting optical architectures. In a pre-digital age, automated light changes had to be laboriously hand-executed in advance via a primitive film-perforation system. By 1972, when he created the twenty-four-minute *Polytope de Cluny* (set in the ancient Roman thermal baths in Paris), computer technology had evolved to where digital instructions could be transmitted via tape and he could make use of a more advanced light source, lasers.

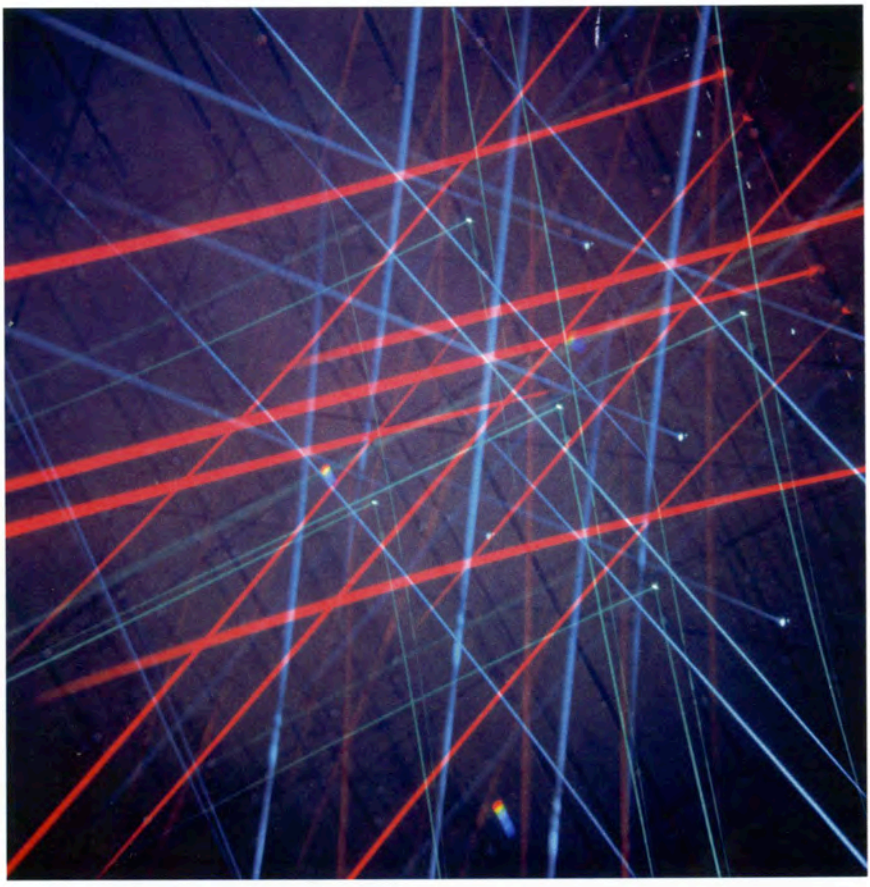
Within a T-shaped, barrel-vaulted structure, an interior scaffolding was erected, holding 600 lights that could be individually triggered, along with 400 small mirrors adjustable to reflect laser beams of red, yellow, and blue. These appeared to sit solidly in space, like holograms—virtually "drawing in air" [PL. 31]. During its two-month run in late 1972, 500 spectators per performance were ushered in four times daily; many lay or sat on the stone floor, entranced [PL. 30]. The site-specific installation was reprised the following year.

For his 1971 polytope set in the ruins of Persepolis, Iran, Xenakis brought together artistic impulses somewhat at variance with his profile as a cerebral technocrat. He had begun to plumb the wellspring of ancient Greece, as with his 1966 setting of Aeschylus's *Oresteïa*, its transformational finale scored for children's choir. That, along with a theatrical dimension, fused together in a multimedia work staged in the dark of night, the audience seated in the Temple of Darius [PL. 32]. Its finale involved 150 torch-bearing children climbing a hill toward a summit, descending in configurations spelling out, in Persian, "We bear the light of the earth." It premiered what some consider Xenakis's most powerful electro-acoustic piece, the eight-track, fifty-six minute *Persepolis*.

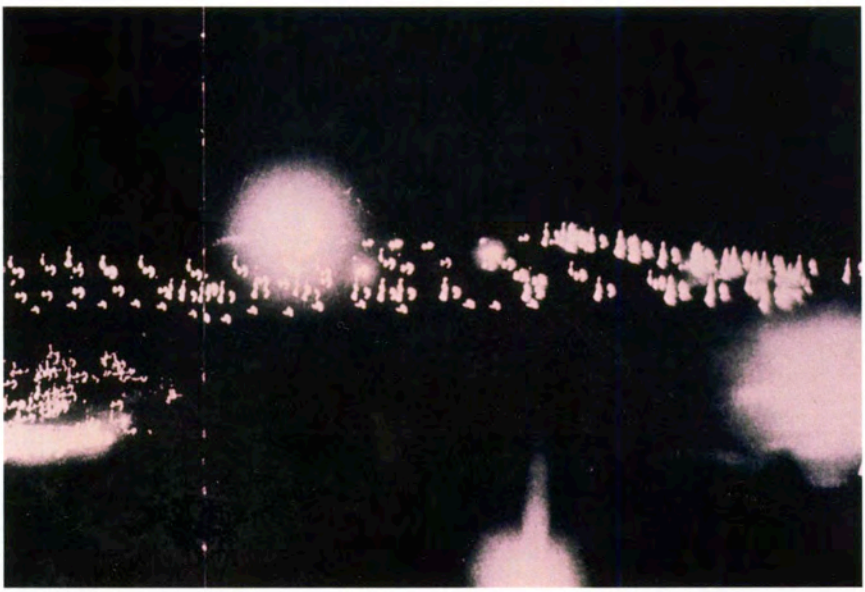
Still another outdoor spectacle, the artist's largest, set in ancient Mycenae in the Peloponnese, was a kind of homecoming. By the 1970s, Xenakis, the one-time embattled outsider, living in exile in Paris, had become a kind of cult hero. However, in his native Greece he remained under a death sentence, unable even to visit. With the 1974 Cyprus War, the right-wing nationalist government of the "generals," who



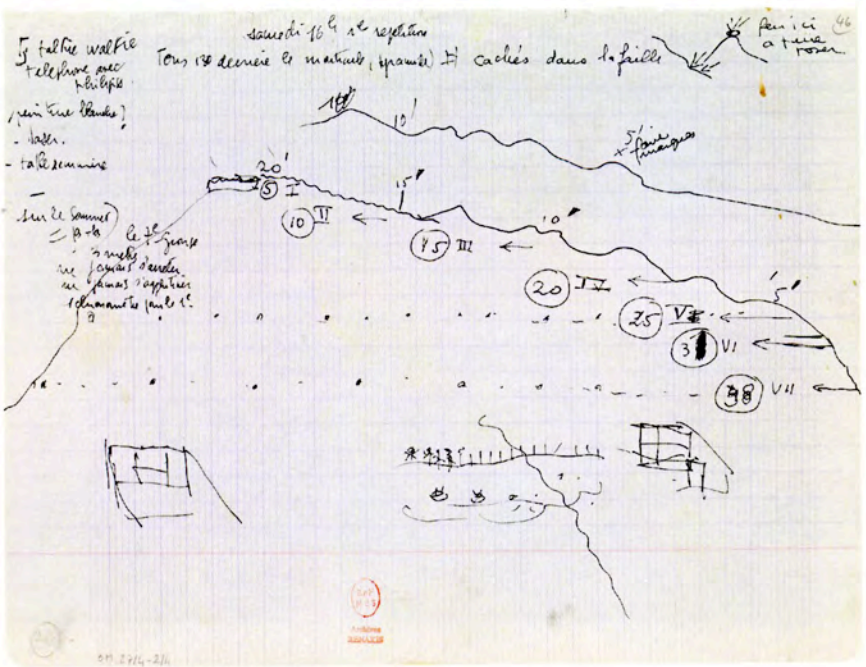
PL. 30
Polytope de Cluny, 1972–73



PL. 31
Polytope de Cluny (laser light show), 1972–73



PL. 32
Polytope de Persepolis, 1971



PL. 33
Study for *Polytope de Persepolis* (site plan of performance), c. 1971

had been in control for the previous decade, collapsed. His return to Athens was steeped in emotion. As his friend Maurice Fleuret wrote in the *Nouvel Observateur*, Xenakis was surprised to find that many knew his name and became tearful upon seeing him, crossing the street to shake his hand. Movingly, "an elderly lady traced her path through the crowds, touching ever so gently Xenakis's tragic scar, as though she were caressing an icon."[20]

The *Polytope de Mycènes* (1978) was staged at the foot of Mt. Elias on four successive evenings [PLS. 34–37]. Like *Persepolis*, it had a mythic component, but it was even more elaborate, involving searchlights and torch-bearing children; herds of belled, light-bedecked goats suddenly let loose; projections on the walls of the ruined citadel; readings from Homer, and performances of several Xenakis works drawn from ancient Greek texts, intoned in archaic dialects. At the dramatic conclusion came a fireworks display, a gush of flame along the citadel, and the children's-chorus finale from his *Oresteïa*.

A centerpiece was the ten-minute *Mycènes Alpha*, Xenakis's first full-scale composition using the UPIC, a digitized "musical drawing board" with stylus that he invented [PL. 64]. It is able to translate drawn shapes directly into electronically generated sound. According to Harley, "the rich, harsh sonorities of Xenakis's piece matched the savage magic of the landscape."[21]

During the 1970s, Xenakis's vision for his polytopes grew increasingly global. He imagined intercontinental sound-and-light events communicating via radio beams reflected from satellites.[22] In 1974, the French government commissioned him to create an on-site spectacle to coincide with the opening of the Centre Pompidou in Paris. His more sweeping technological conceptions were scaled down into a *Diatope*, an architectural framework (portable) some fifty-feet high, composed of steel cables covered by red vinyl, and shaped into three of his signature hyperbolic paraboloids [PL. 38]. The interior had a glass-tile floor

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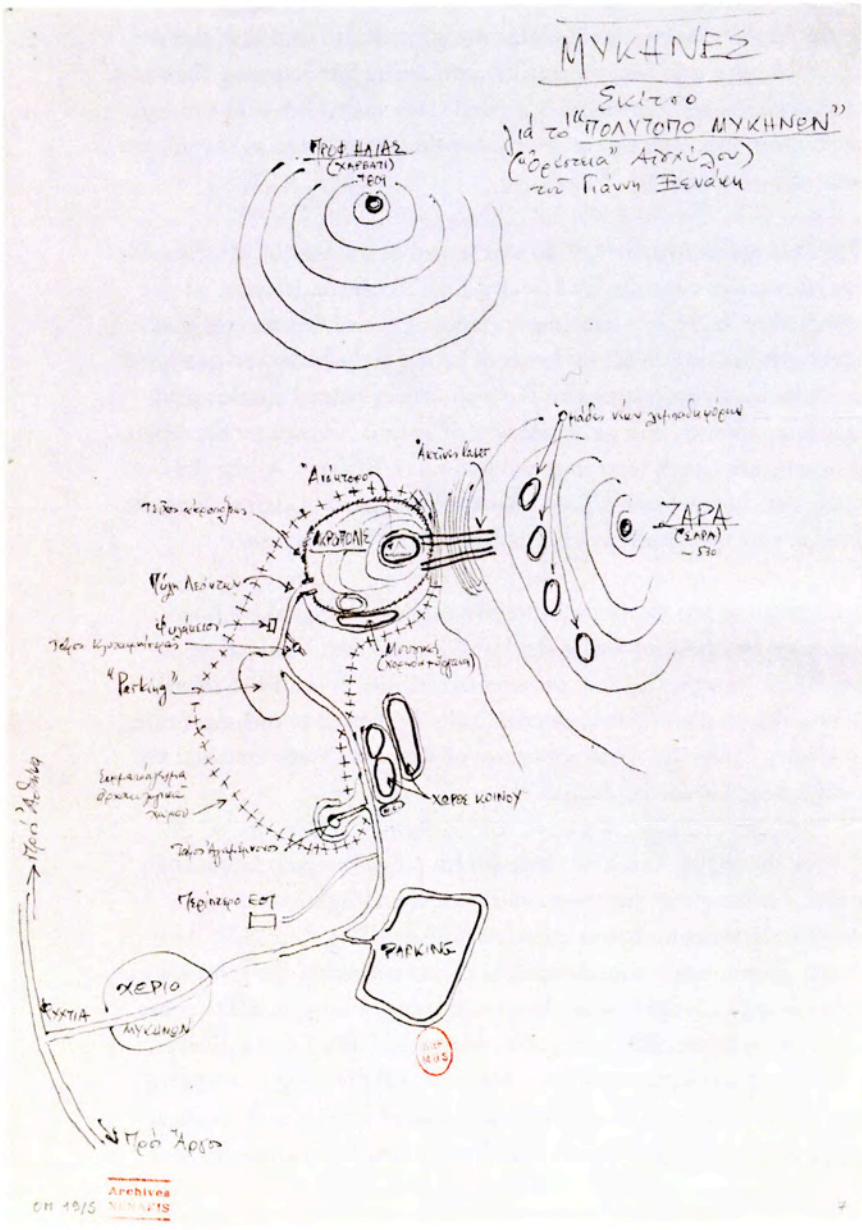
20 Maurice Fleuret, "Le Métèque du Monde Entière," *Nouvel Observateur*, no. 524 (November 25, 1974).

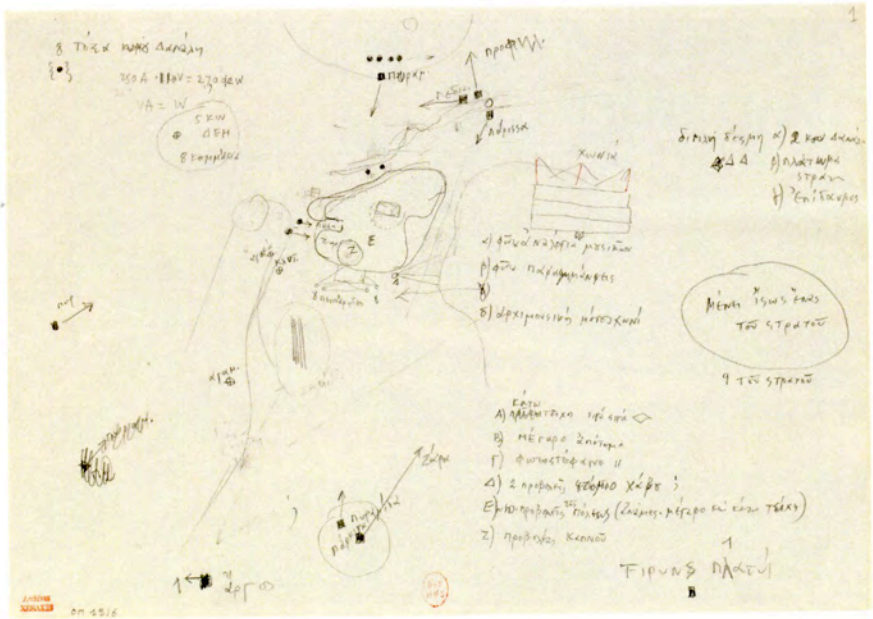
21 Harley, *Xenakis: His Life in Music*, 117.

22 Kanach, "Xenakis' Diatope," in Xenakis, *Music and Architecture*, 247 n.4.

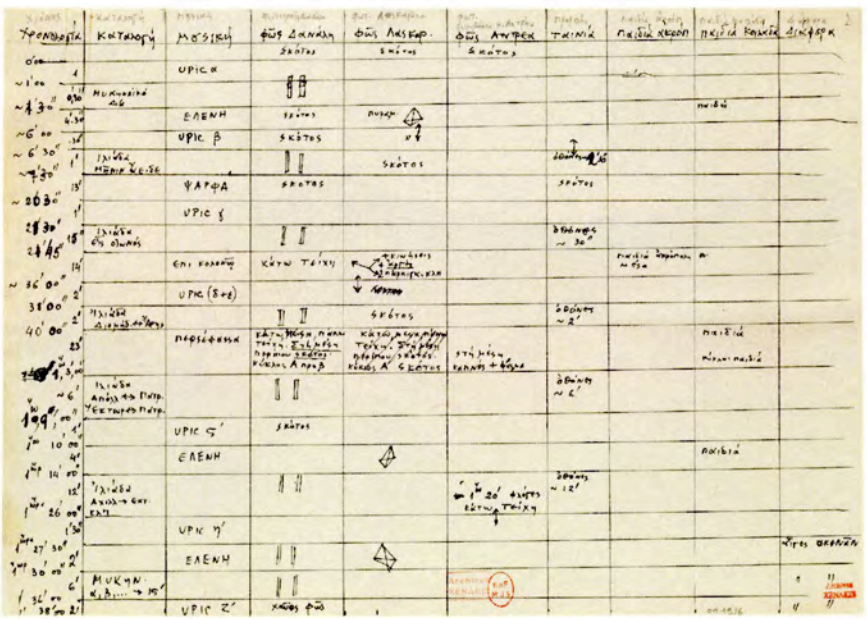


PL. 34
Study for *Polytope de Mycènes* (site plan of performance), c. 1978

PL. 35
Polytope de Mycènes, 1978



PL. 36
Study for *Polytope de Mycènes*, c. 1978



PL. 37
Study for *Polytope de Mycènes* (performance matrix), c. 1978

PL. 38
Diatope, 1978

lit from below. Employing four laser projectors, 400 pivoting mirrors and prisms, and 1,680 flash-style bulbs, he created "galactic movement rendered accessible"[23] [PL. 39]. By the time of the polytope's July 1978 premiere, computer technology had evolved to the point where the 140 million commands necessary could be completely digitized. The seven-track tape work, the forty-seven-minute *La Légende d'Eer*, begins with extremely high-pitched sounds the composer termed "sonic shooting stars," gradually descending in register. (The title is taken from a tale at the end of Plato's *Republic*, describing the soldier Er's return from the underworld; it treats themes of death and rebirth.)

OTHER ARCHITECTURAL PROJECTS

In 1964, while a Fellow of the Ford Foundation in Berlin, Xenakis accepted an invitation to contribute to Françoise Choay's book *L'Urbanisme: Utopies et Réalité*. When he had first flown over Manhattan's skyscrapers, their scale had both repelled and attracted him. With this impression in mind, he conceived his Cosmic City—slender, three-mile-high arching towers piercing through the clouds, accommodating five million inhabitants each. They would replace civilization's tendency to expand outward with an upward thrust, "putting the populations in contact with the vast space of the sky and stars."[24] Reminiscent of, but in many ways opposing, Le Corbusier's right-angled, automobile-based urban planning initiatives, the towers, curving inward in the form of revolving hyperboloids, would be ecologically sensitive. For example, their outer shells would be translucent to allow natural light to enter. The towers could be stationed in any area on earth, "a biological collective garment."[25] Xenakis not only sketched the overall concept, he planned actual structural design details, such as the buildings' double walls on a metal framework.

In the early 1960s, Xenakis had begun speculating about a "new kind of architecture," more flexible and dynamic, for "all types of present-day music."[26] Invited in 1983 to sit on a jury charged with

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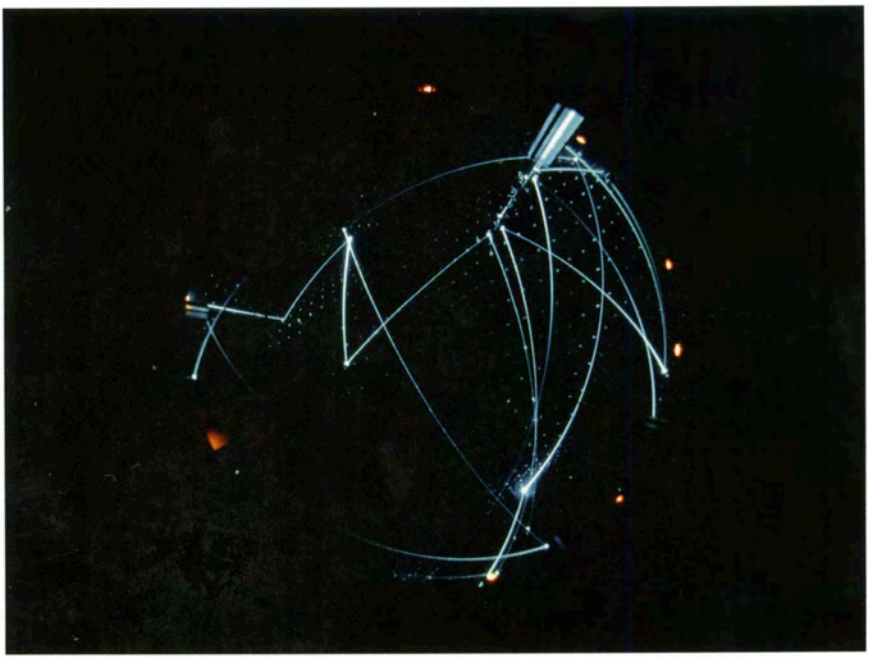
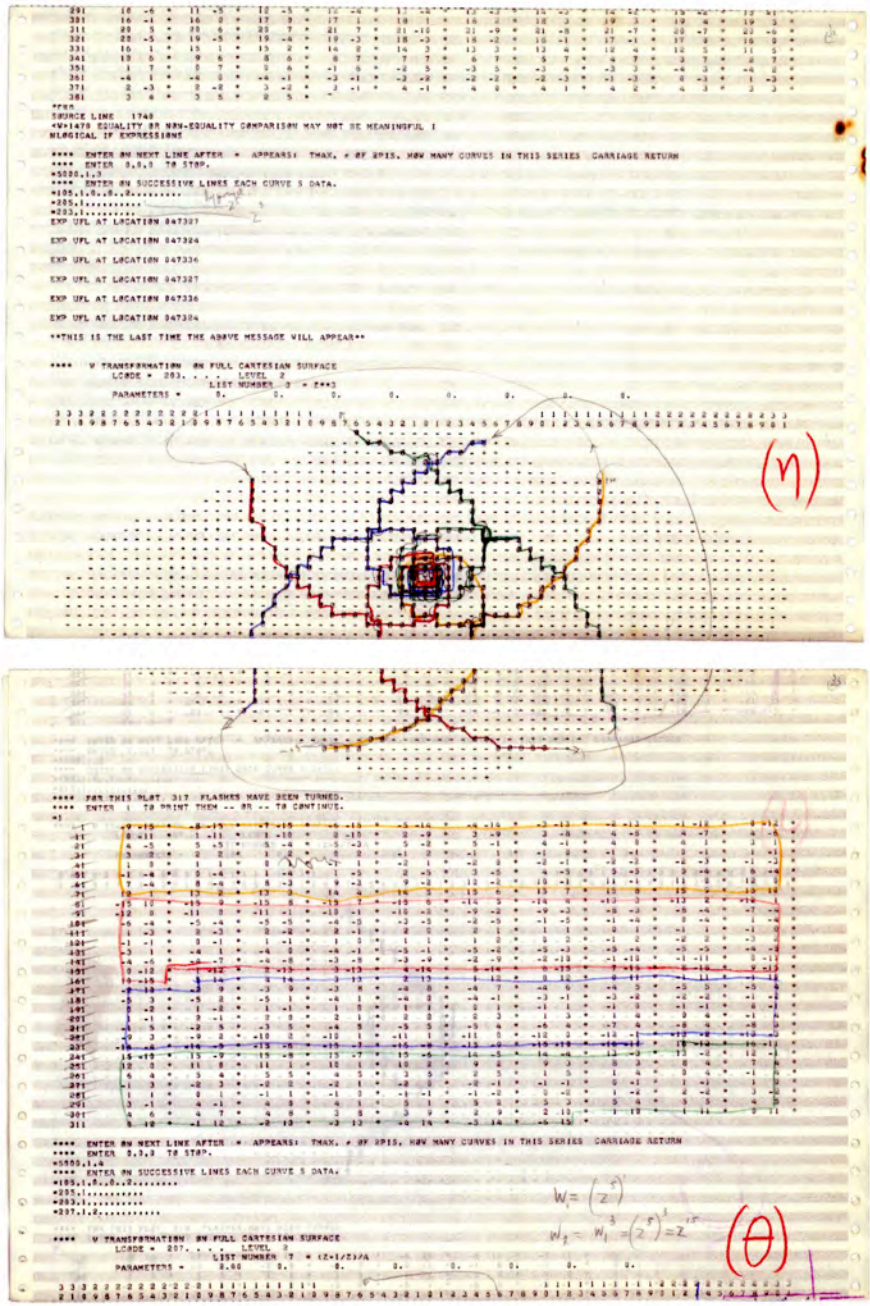
23 Xenakis, *Music and Architecture*, xix.
24 Ibid., 139.
25 Ibid.
26 Xenakis, *Formalized Music*, 236.



PL. 39
Diatope (laser lights), c. 1978



PL. 40
Diatope (light score), 1978

selecting a design for a New National Music Conservatory in the Parc de la Villette in Paris, he chose to submit a plan himself, teaming up with Jean-Louis Véret, a credentialed architect, his colleague from Le Corbusier days. His 1,200-person-capacity "experimental auditorium," a "jewel box of sound," brought together insights developed throughout his career. A quasi-ovoid, asymmetrical "potato-shaped" floor plan would maximize resonance; an eleven-degree torsion would ensure visual interest; the floor would be composed of one-meter-square cube surfaces overall that could be raised or lowered pneumatically up to twenty feet in height, permitting a limitless range of staging configurations; a sound booth would be moveable on tracks overhead [PLS. 44–47]. In the end, though, his Cité de la Musique, whose external concrete shell would have been topped by Xenakis's signature vaulting hyperbolic paraboloids, was not accepted.

Through the 1980s and 1990s, Xenakis continued to craft musical works, each of which continued to map out new territory with exhilarating rigor. Singular, in many ways, he is also without equal. One of his most brilliant insights was that it is by going to the very physical foundations of artistic phenomena—and their basis in physics—that one can find viable ways to move forward. His sketches, drawings, and musical scores, although never intended as "art," occupy a unique place in the history of drawing. Featuring vibrant forms projecting into space within drawing's two dimensions, they are the way he imaged *sound*.