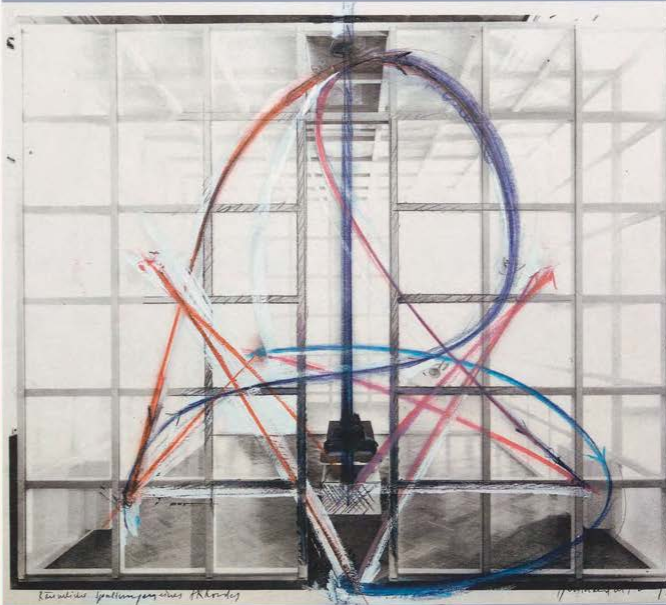


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Sound, Music and Architecture

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BREPOLS

ARCHITECTURE WITHOUT WALLS: BERNHARD LEITNER'S *SOUNDCUBE*

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INTRODUCTION

IN 1968, AFTER GRADUATING from Vienna Technical University, the young architect Bernhard Leitner (b.1938) installed himself in New York and took up a job at the city planning services. In his free time, he started to experiment with sound, examining its capacity to produce spatial effects. To this end, he envisioned a three-dimensional matrix with speakers at regular intervals, with a view to verifying the capacity of sound to suggest enclosure, movement, depth and perspective. Considered by Leitner as a «laboratory of dimensional neutrality», this *Soundcube* was meant to test the feasibility of spatial perception based on sound; if it was indeed possible, it would pave the way for an architecture without physical walls or visual elements. Carefully detailing his findings in elaborate drawings and photo-collages, Leitner's research was quickly picked up by the art press, and he soon became a leading figure in the emerging field of Sound Art, receiving many commissions for in situ sound installations in public spaces. Whereas Leitner's installations have been documented in numerous articles and interviews, and have been on display in exhibitions all over the world, little critical scholarship on his work exists¹. With the aim of retracing and contextualising Leitner's initial ideas within the wider field of immersive sonic practice, this chapter focuses on his experimentations with the *Soundcube*. More specifically, the paper offers a close reading of Leitner's ideas and experiments in both conceptual and technical terms, and relates them to similar endeavours undertaken at the time by music composers such as Iannis Xenakis and Karlheinz Stockhausen.

¹. Research on Leitner will undoubtedly receive a boost after the publication in 2023 of a *catalogue raisonné* of his oeuvre (KRATZER 2023). Kratzer's introductory essay provides a compelling overview of Leitner's career, situating his work within the wider artistic context of the day.

SOUND AS AN ARCHITECTURAL ELEMENT

In an interview with the German curator Eugen Blume, Leitner recalls the various elements that led up to the sound-space experiments that would preoccupy him from 1968 onwards². The basis was formed by his studies in architecture at the Technical University in Vienna in the late 1950s. A talented student, he felt trapped within the boundaries of his own discipline and soon started to venture out into the arts he considered peripheral or adjacent to architecture³. Music was one such field: attending many classical music concerts, Leitner developed an interest in the avant-garde music of Stockhausen, Nono and Kagel. Interestingly, the sonic aspect of this new musical idiom appealed to him perhaps even less than the way its complex new sonorities were written down. Indeed, as their music transgressed the limitations imposed by classical music notation, these composers resorted to graphical notation to guide the performance of their work. Such scores were also of interest for an architect, especially as composers increasingly started to incorporate the spatial dimension into the performance of their music⁴. At the same time, Leitner also became interested in dance, which he understood as «the motion of bodies in, and through space». Or, as he later stated: «[...] Classical choreography [...] is like danced architecture. A temporal configuration of mobile, opening and closing spaces. [...] Gesture defines, designs space, becomes space»⁵. Precisely because of their common dependence on space, Leitner began to explore the crossovers between the fields of architecture, music and dance. As he later asserted, this interdisciplinary attitude felt natural for him: «I've always tended to get involved in different fields and tried to use the mindset and terminology of one artistic field to make assessments with which I tried to examine those in another field; a focusing of critical awareness or critical thinking through comparisons, so to speak»⁶. In Leitner's recollection, the mythical instant where all this came together occurred during a flight to New York in 1968, when he arrived at the idea of designing architectural spaces through the medium of sound⁷. It was a career-defining moment, as Leitner's central mission as an artist became the exploration of the ways in which sound and space could become entangled and which new architectural and sculptural forms of expression and experience this could lead to. The 'impetus', so to speak, was decidedly architectural, however: «The original idea was actually derived directly from architectural

². BLUME 2008, n.p.

³. LEITNER 2020, p. 39.

⁴. BLUME 2008, n.p.

⁵. LEITNER 2008, pp. 172-173.

⁶. BLUME 2008, n.p.

⁷. *Ibidem*, n.p.

sketches. I defined a line as a sequence of points and saw each point as a source of sound. I drew lines for the eye with a pencil; for the ear they were lines of sound»⁸.

During the next two years, Leitner explored the theoretical aspects and the technical constraints of this idea, with the goal of testing his hypotheses as soon as possible at full scale. The idea of an 'experimental room' already appeared in his first sketches (October 1968): a three-dimensional Cartesian grid with sound sources on the walls and the ceiling distributed at regular intervals⁹. This was easier said than done, however, and the actual realisation of such a *Soundcube* (or *Ton-Würfel* in his native German) would preoccupy him until well into the 1980s. Its basic idea was to provide an infrastructure allowing for movements of sound as a tool to create and characterise ephemeral spaces. To this effect, it was to feature 64 loudspeakers on each of its sides (384 in total) allowing programmed sounds to travel from loudspeaker to loudspeaker; this would enable testing of the perceptual effects of a wide range of patterns¹⁰. One such pattern would, for example, be based on sounds circling alternately at four different levels whereby their speed, pitch or direction was to be attuned such as to create an effect of height. Another pattern would involve a three-dimensional line of sound developing between the loudspeakers, creating an effect of space fading away. Other drawings from this early period further feature undulating sound trajectories enveloping the listener; they allude to the idea of 'spatial chords' through the simultaneous projection of sounds in a certain rhythm, or suggest a spiral sound pattern creating an illusion of depth. As Leitner put it, this grid would be a «dimensionally neutral space», so neutral that the physical, visual walls would become irrelevant to a person's perception due to an infinite number of spatial effects that would be created through sounds moving across the loudspeakers. The *Soundcube* was therefore not a device for spatialised listening, but rather an instrument for producing space through sound. Or, in the words of Leitner: «It is a laboratory for experiments and studies in environmental research, definition and character of space. At the same time it is a place for demonstrations and presentations of results to the public»¹¹ (ILL. 1).

Although the *Soundcube* was a mere theoretical proposition at that stage, it was appealing enough for the editors of the prestigious and highly influential art journal *Artforum* to give Leitner the opportunity to publish his ideas¹². With its short and dense sentences, precise

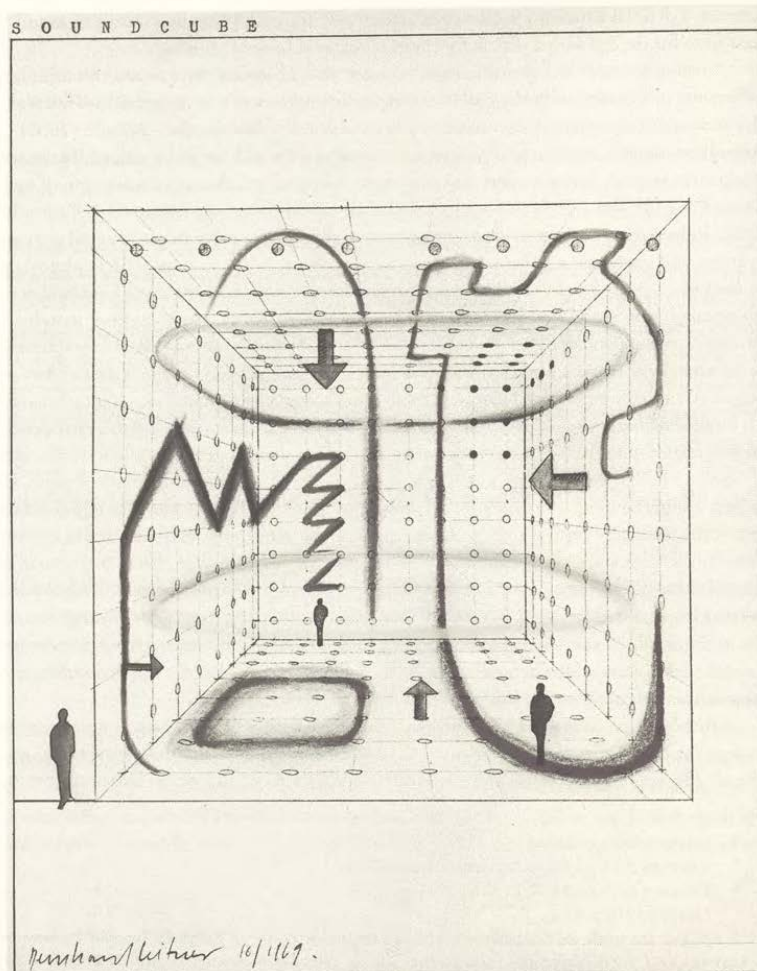
⁸. LEITNER 2008, p. 173.

⁹. KRATZER 2023, pp. 32-33; LEITNER 2015, pp. 40-41.

¹⁰. KRATZER 2023, pp. 34-37; LEITNER 2015, pp. 43-51.

¹¹. LEITNER 1970, p. 47.

¹². *Ibidem*. The article was also published (with an additional section no. 7 'Praktische Versuche') in German, see LEITNER 1971. For the anecdote: Leitner got the chance to publish in *Artforum* through his colleague Annette Michelson from New York University who had previously asked him to write about the Wittgenstein House in Vienna, then under threat. The *Artforum* article was also partially reprinted as 'Sound Creates a New Architecture' (*ARCHITECTURE PLUS* 1973).



ILL. 1: Bernhard Leitner, *Imaginary Designs for Sound Spaces*, 1969. Source: collection of the artist, used with permission. [See APPENDIX, no. 9.]

drawings and authoritative tone, the text formed a curious mix between a manifesto, an artistic programme and a research agenda. The first paragraph set the tone: «A LINE IS AN INFINITE series of points // A line of sound is produced when sound moves along a series of loudspeakers, from one loudspeaker to another // Space can be defined by lines // Lines of sound can also define space: space-through-moving-sound»¹³. This elementary proposition, which unavoidably evokes Kandinsky's statements in *Point and Line to Plane* (1926), was followed by two postulates. First, Leitner distinguished between «sound in space» and «space through sound». In the first case, a large number of loudspeakers or sound sources would be used to produce a movement of sound in space; this was indeed what various contemporary composers such as Stockhausen or Xenakis were experimenting with at the time (see further in this paper), exploring and exploiting the spatial distribution of sound as a musical parameter. This was *not* what the architect in Leitner aimed to achieve, however. In his view, space ought not to be a «passive container waiting to be filled», but could only originate from, or receive meaning through, its use: «[...] It becomes fully meaningful only when it is used in an appropriate way. [...] Space created through moving sound is the frame for different kinds of activities and functions, a spatial experience for certain uses. The building material is sound, the abstract line of sound. Space through sound. Architecture»¹⁴. The second postulate related to the distinction between vision and hearing. As Leitner stated, whereas both senses are essential to our spatial awareness, contemporary society is almost exclusively visually oriented. But this is to forget that sonic impulses can instil powerful spatial sensations as well — with the caveat that they are fundamentally different from the ones arising from visual clues as they are dependent not only on sound but also on its *movement*. As a result, sound spaces would be inherently dynamic and ephemeral, as opposed to the static and permanent aspect of visual space¹⁵.

The remainder of the article methodologically described the theoretical and practical apparatus required to develop and test these premises. To start with, Leitner outlined the various sound parameters, examining how they could be interpreted in architectural or spatial terms. «Speed», he suggested, could be linked to «how fast or how slow space is produced», while «rhythm» could be used to describe the succession of such spatial effects. Pitch, in turn, he saw as fundamental in determining the «quality» of a space, just like «timbre» would be critical in giving it a distinctive «character». Further, the intensity of a sound could be related to the notion of transparency in the visual realm if we accept that a dense, noisy volume of sound might have a similar effect as a heavy, massive wall. As to the type of sound required for these experiments, Leitner did not express a preference. While this downplaying of the aesthetic aspects of sound was in line with his approach to sound as only a tool to realise his architectural

¹³ LEITNER 1970, p. 47.

¹⁴ *Ibidem*, p. 44.

¹⁵ *Ibidem*.

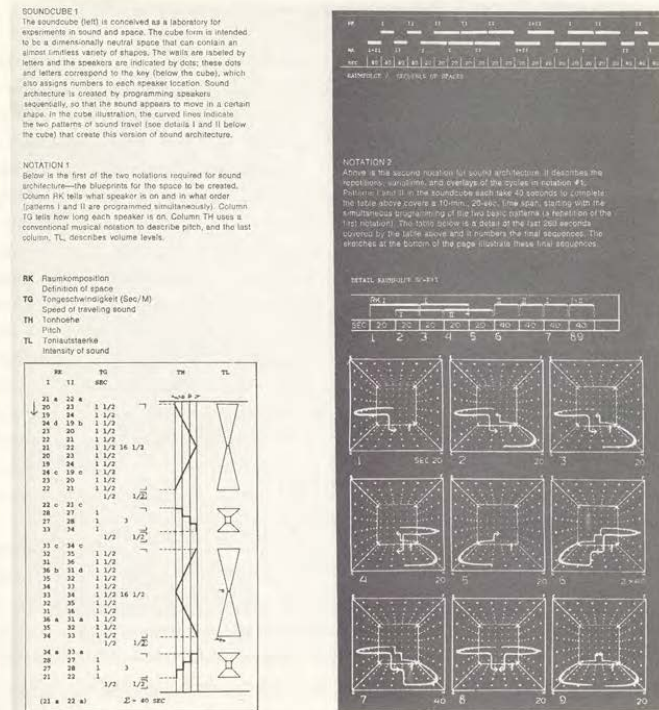
ambitions, one could even go further and state that his take on sound was purposely «anti-musical». Indeed, a crucial passage in the *Art Forum* paper was Leitner's statement that sound could, and should, also be used for other purposes than to «convey "messages" to act upon our emotions»¹⁶, for in his view, the dominant interest in the emotional impact of sound [its musical use] obscured its more rational, acoustic properties and possibilities. Hence the phenomenon that late into the twentieth century, hearing was still being treated as an isolated, anatomical question rather than as a comprehensive physico-intellectual experience, in contrast with optical perception, the epistemological capacity of which has been exhausted *ad nauseam* in modern Western society. This idea, namely the need to emancipate hearing and, by extension, the bodily awareness of sound, would become almost a mantra for Leitner: «Our ears have not been educated yet. [...] The importance of the acoustical environment is such that the ear should be able to measure it, to experience it consciously — but the ear itself is underdeveloped»¹⁷. The fact that neuro-physiological experiments conducted at that time at Vienna University revealed a correlation between specific auditory impulses and changing levels of brain activity only solidified his beliefs¹⁸. For his part, Leitner saw a vast field of potential applications, from biopsychological experiments related to the impact of acoustic changes on spatial perception, to therapeutic uses and architectural applications such as the humanising or rescaling of the many non-places of modern society, like underground corridors or airport lounges.

To conclude, the message of the *Art Forum* article was clear enough: Sound-Architecture deserved to be taken seriously and must be validated empirically. To this end, as it befits a well-prepared experiment, Leitner developed a detailed notation system with a view to steering the precise evolution of his tests and assuring their reproducibility. This notation system actually consisted of two complementary 'scores'. The first one comprised the parameters defining the various sound cycles: *which* speakers would become activated in what order (patterns of sound movement); *how long* a certain speaker would be on (speed of the travelling sound or *Tongeschwindigkeit*, in sec/m); and the pitch (*Tonhöhe*, using conventional musical notation) and intensity of the sound (*Tonlautstärke*). The other notation described the repetitions, variations and overlays of the various cycles defined in the first notation (ILL. 2). Although Leitner's ideas were still purely hypothetical at that point, their boldness and their scientific outlook clearly struck a chord. The *Art Forum* article was, for example, picked up by the influential *New York Times* art critic Clive Barnes, who not only stated that it read as much like a mathematical paper as an artistic manifesto, but also publicly endorsed Leitner's endeavour in expressing that «[...] we live in a visually dominated culture. Perhaps one day the shape of the

¹⁶. *Ibidem*, p. 45.

¹⁷. *Ibidem*.

¹⁸. See Leitner in CONRADS 1985, p. 28.



ILL. 2: The two types of notation developed by Leitner to describe Sound Spaces in the *Soundcube*. Source: *ARCHITECTURE PLUS* 1973, p. 67.

sound could rival the shape of the image»¹⁹. The artistic-scientific duality hinted at by Barnes became apparent as, shortly after, Leitner was able to present his ideas in both an abundantly illustrated article in the newly established architectural periodical *Architecture Plus* as well as at the Annual Conference of the venerable Acoustic Society of America²⁰.

¹⁹. BARNES 1971.

²⁰. *ARCHITECTURE PLUS* 1973; *ACOUSTIC SOCIETY OF AMERICA* 1974.

LISTENING AS IMMERSIVE EXPERIENCE AT EXPO 70

Apart from their genuine relevance, the recognition for Leitner's ideas also stemmed from the artistic climate at the time, where the notion of 'space' entered the fields of the visual arts, sculpture and architecture. At the same time, many artists became fascinated by the rapidly evolving technological innovations, providing them with new tools to control light, sound and movement that greatly enlarged their expressive spectrum. Many collaborations between artists and engineers arose in this climate, often backed up by large commercial enterprises. This convolution between art, technology and capital reached its culmination at the 1970 Osaka World Fair, where the exhibition pavilions shifted from a space of instruction and mass education to multisensory environments, not only enhancing mental absorption and emotional involvement, but also tending towards dematerialisation as if the physical aspect of building formed an obstacle in the realisation of a fully immersive experience²¹. The most extreme example of this was the Pepsi pavilion, conceived by the artists collective E.A.T. (Experiments in Art & Technology) as an interactive multi-sensory environment of light, sound and movement. Covered with an air pressurised reflective film that evoked weightless floating, the pavilion's dome-shaped interior was also equipped with a multitude of speakers directing sounds via various spatial trajectories, further distorting the spatial orientation of the visitor. The pavilion was also difficult to grasp from the outside due to a fog system designed by Fujiko Nakaya that veiled its appearance in an ever-changing fogbank.

Two other pavilions were of particular interest in the context of Leitner's experiments. Curated by Karlheinz Stockhausen, then an absolute celebrity in German cultural circles and beyond, the German pavilion was entirely dedicated to the country's contemporary music and sound technology scene. Hence the pavilion's principal feature, a spherical concert hall with a capacity of 550, designed almost literally according to the instructions formulated by Stockhausen more than a decade earlier in his essay 'Musik im Raum' (1959): «New kinds of concert halls have to be built suited to the requirements of spatialized music. I propose a spherical space which is equipped all around with loudspeakers. In the middle of this spherical space a sound-permeable, transparent platform will have to be suspended for the listeners. Thus, they will be able to hear music composed for such standardized spaces coming from above, from below and from all points of the compass»²². For Osaka, Stockhausen conceived *Hinab-Hinauf*, an immersive mixed-media spectacle based on the aforementioned ideas, together with the visual artist Otto Piene. Stockhausen's ambition to overcome gravity was, however, limited by its excessive cost; the projected budget was even debated in the national parliament and, in the end, *Hinab-Hinauf* was reduced to a broadcasting program alternated with daily

²¹. STERKEN 2011; STERKEN 2012.

²². STOCKHAUSEN 1971. On the German Pavilion at Osaka, see SIGEL 1999.

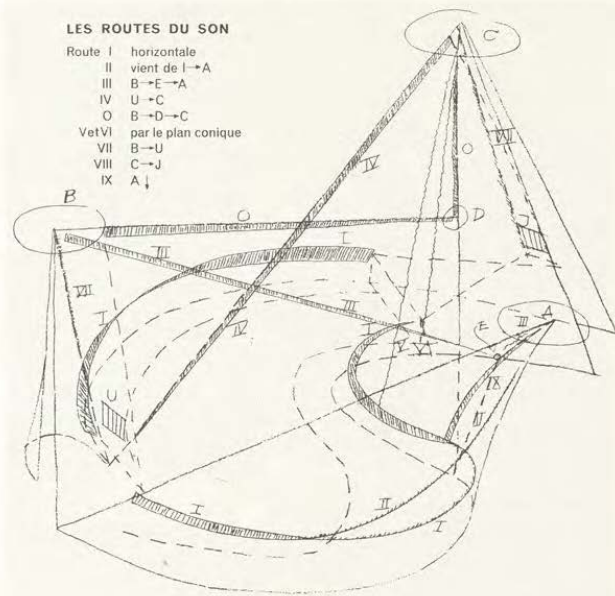


ILL. 3: Karlheinz Stockhausen at the control desk of the Auditorium in the German Pavilion at the 1970 World Fair in Osaka. Source: Stockhausen Foundation Kuerten. Used with permission. [See APPENDIX, no. 10.]

live spatialised performances of Stockhausen pieces. In the course of the 180-day exhibition, *Spiral*, for a soloist and short-wave receiver, was played no less than 1,300 times. During the performances, the sound was distributed over 650 speakers with the aid of a spherical sensor, while the darkened interior space suggested an endless cosmic space (ILL. 3).

Stockhausen was not the only composer at EXPO 70 to implement some of his earlier ideas about spatialised diffusion of music in the electronic era. Iannis Xenakis also had the chance to conduct such an experiment in the so-called 'Space Theatre', where his (purposely composed) electro-acoustic piece *Hibiki Hana Ma* was broadcast through no less than 800 loudspeakers according to all sorts of geometrical patterns²³. It was the closest Xenakis would ever get to the ideal of an *isotropie sonore* (an environment where the quality of the sound would be identical in every spot), which he had theorised in his 1958 essay 'Notes sur un geste

²³. PALAND 2015; STERKEN 2009.



ILL. 4: The 'Sound Routes' in the Philips Pavilion at the Brussels World Fair, 1958. Drawing by Xenakis. Source: Jean Petit, *Le Poème Electronique*, Paris, Editions du Minuit, 1958 (KU Leuven Special Collections). Used with permission.

Electronique', where he reflected upon his participation in Le Corbusier's Philips Pavilion at the 1958 Brussels World Fair. In this seminal text (which would form the blueprint for his later *Polytopes*, i.e., large in situ sound installations including laser beams and flashlights), Xenakis argued that the current state of electronic media allowed for a more advanced concept of the total work of art than the *Poème Electronique*, the multimedia spectacle displayed inside the Philips Pavilion. It was accompanied by a *musique concrète* piece by Edgard Varèse broadcast over about 350 loudspeakers; an 11-channel sound system enabled the music to travel along walls of the pavilion's tent-like architecture according to various 'sound routes' (ILL. 4). Created by engineers from Philips, this system was manually controlled through rotary telephone dials, which allowed switching between groups of five speakers at a time²⁴. In Xenakis's view, the

²⁴. COSTABILE 2022.

appeal of the pavilion lay, first of all, in its demonstration of how contemporary technology enabled the composer to 'conquer' the spatial dimension and enrich the classical structural components of sound (duration, timbre, dynamics and pitch) with those of location. However, in opposition with the figurative aspect of the *Poème Electronique* (both the visuals and the sounds were based on the principle of collage), he argued that a true integration of visual and aural arts had to be abstract in nature. In this manner, Xenakis argued, «music may now govern mathematical space and its abstract relations and thus become wonderfully perceptible to the ear without the use of visuals or any physical apparatus of measurement»²⁵. This is very close indeed to Leitner's proposition that the ear can provide us with spatial orientation just as much as the eye. But the similarities do not end there: as Xenakis further stated, a crucial component in realising this idea of 'audible space' would be a three-dimensional acoustic grid, allowing sounds to emanate from any point in the floor, the walls and the ceiling. In his vision, «these sound points define space in the same manner as geometric points in stereometrics. Everything that can be stated for Euclidian space could be transposed into an acoustic space»²⁶. In both Xenakis's and Leitner's view, sound was thus no longer to be solely considered as a carrier of musical expression, but also as a means to generate ephemeral architectures. Leitner's ideas therefore have clear origins, and given both his active interest in contemporary music and the notoriety of Xenakis and Stockhausen at the end of the 1960s, it is unlikely that he was not aware of their endeavours.

EMPIRICAL VERIFICATIONS

Leitner's idea «to work with the medium of sound architectonically and sculpturally, to design space»²⁷ was surely an exciting one, but very difficult to realise with the technology of the day, and especially for someone without access to the financial and technological means of established composers such as Xenakis or Stockhausen. Taking into consideration that the *Soundcube* was to include 384 individually controllable loudspeakers, and that (commercially) accessible technology at that time was limited to four-track tape recorders, it seemed like an unattainable dream. Recorders with more tracks did of course exist, however these machines were expensive and large to transport²⁸. Leitner did not let this discourage him, however, and rented a large loft in New York where he started testing his ideas on a 1:1 scale with a view to identifying the objective and predictable aspects of sound architecture, and to answering the

²⁵. XENAKIS 2008, p. 134.

²⁶. *Ibidem*, p. 133.

²⁷. BLUME 2008, n.p.

²⁸. COSTABILE 2022.



ILL. 5: Bernhard Leitner, 'Sound Gate' investigations, 1971. Source: collection of the artist, used with permission.

question: «How would one hear what I sketched, what I formulated for myself in writing?»²⁹. To this effect, Leitner did not content himself with simple haphazard attempts, but instead carefully planned the steps required to experimentally verify his hypothesis, taking care to annotate and document them in order to assure their verifiability and reproducibility.

Initially, Leitner's equipment was rudimentary enough, consisting of wooden beams approx. 5m long upon which loudspeakers were attached at regular intervals. By placing them in various configurations, a wide variety of situations could be tested. An early example was the 'Sound Gate', a structure composed of three such beams with two additional ones on the ground extending the gate perpendicularly in both directions (ILL. 5). By moving electronically produced fast beats and voice recordings along the 19 loudspeakers, the idea was to «acoustically

²⁹ BLUME 2008, n.p.

redesign» the gate by, for example, articulating its height through decreasing the intensity of the sound towards the upper beam, or undoing its static aspect by accompanying the passage through the gate with increased volume of the sound. The 'Sound Gate' thus illustrated how superimposing a sound-dynamic secondary space over a static primary one was able to modify, enrich and intensify it.

Gradually, the constellations became larger and more complex. One installation from 1972, for example, featured a 5m high grid on the wall with 48 loudspeakers distributed over 8 beams, designed to experiment with vertical movements of sound (by means of fast electronic beats in the medium frequency range), whereby the upward movement was emphasised by a decrescendo, and the falling one by a crescendo³⁰. It was followed by a series of «Sound Fields», investigating the movement of sound across a horizontal surface through monotone percussive and bowed (cello) sounds which enacted, for example: a narrow circle enclosing a person; linear sound lines down an individual module (beam); a curved sound line across several modules; and accentuating points in the field. Further experiments included: a «Sound Swing», e.g. two pairs of beams in a V-shape meant to create a «valley-like path»; «Vertically Bouncing Space», e.g. four pairs of vertical beams on each of the four sides of a space, creating a pulsating movement in space and thereby the illusion of an ascending or descending vertical movement, like in an elevator; and «Leading Path», investigating how sound movement along two beams parallel to a given path reinforced its directionality if parallel to the path³¹. The findings of these early experiments found their synthesis in the «Sound Tube», where Leitner exhausted the sonic-spatial grammar developed previously: eight horizontal beams featuring five loudspeakers each formed a tubular space of 3.25m high and 7m wide, a configuration which allowed experimentation with four varying sonic-spatial patterns: «swinging», e.g. sound moving back and forth in pendular motion perpendicular to the axis of the tube; «circling», e.g. single sound movement creating an effect of enclosure, as if one were in a tube; «arching», e.g. sound moving back and forth above the person's head; and «leading», e.g. sound moving along the axis, reinforcing the axial directionality of the tube³² (ILL. 6).

The increased complexity of the «Sound Tube» illustrated how Leitner's conceptual ideas developed in accordance with the technological means he had at his disposal. At first, he used a crank wheel: a manually controlled electromechanical circuit relay with 20 contacts (thus allowing for max. 20 loudspeakers) realised together with an electrical engineer. This primitive device enabled the control of two parameters: the direction of the sound movement (in two opposing directions) as well as its speed (through the velocity of cranking). Each jack

³⁰ KRATZER 2023, pp. 78-79.

³¹ 'Sound Swing', in: *ibidem*, pp. 86-87; 'Vertically Bouncing Space', in: *ibidem*, pp. 90-91; 'Leading Path', in: *ibidem*, pp. 96-97.

³² *Ibidem*, pp. 98-101.

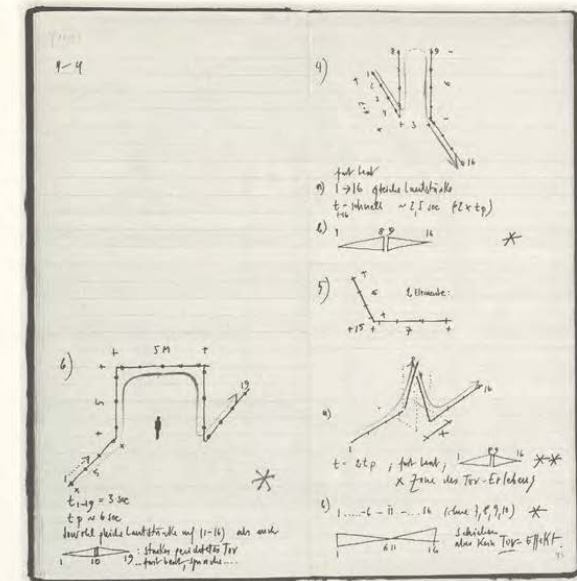


ILL. 6: Bernhard Leitner, 'Sound Tube', 1973. Source: collection of the artist, used with permission.

was controlled by a potentiometer that was used to set a dynamic value between «piano» and «forte» for each loudspeaker³³. Primitive as this may seem, the basic idea behind this device was the same as, for example, the then cutting-edge *Tonmühle* used by Stockhausen for the spatialisation of his music at Osaka: it, too, used a kind of rotational resistance patched to a circle of loudspeakers. By manually turning the crank of the mill, the sound source could be shifted in a circular motion through the 50 loudspeakers surrounding the audience³⁴. To overcome its intuitive and laborious aspect, Leitner soon replaced it with a control box based on a variable-frequency ring counter, which enabled him to program 24 loudspeakers and activate the sound movement with a simple start-stop button. The principal difference was that two lines of sound could now be activated simultaneously, enabling the study of staggered sound movements in space, in addition to endless repetition without assistance. Furthermore, the device also allowed for more precise adjustment of the parameters, making the experiments more easily replicable and precisely measurable. The conceptual «leap» leading to the aforementioned Sound Tube only became possible in 1973, however, when Leitner acquired a Remex punched card reader enabling sound movements across 40 loudspeakers. Moreover, four different dynamic values (e.g. ranging from piano to forte in four steps) could now be predetermined. A further step in

³³. *Ibidem*, pp. 440-444.

³⁴. PYSIEWICZ – WEINZIERL 2017.



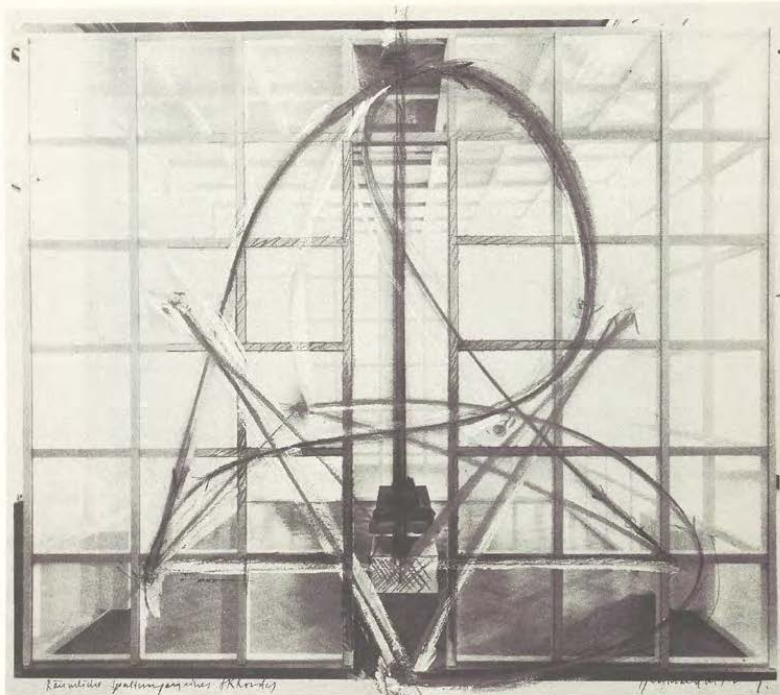
ILL. 7: Bernhard Leitner, preparatory sketches and notes for 'Sound Gate' (see ILL. 5). Source: collection of the artist, used with permission. (See APPENDIX, no. 11.)

this evolution occurred in 1980, when Leitner started using a Rockwell AIM-65 microcomputer controlling 16 amplifier cards. Using a specially developed programming language, material from three different sound sources could now be directed to 16 loudspeakers at any amplitude and in any unit of time³⁵.

The technological evolution sketched above not only increased the complexity and precision of the experiments, it also affected the way they were recorded. Initially, Leitner kept detailed notebooks (referred to as *Arbeitsbücher*) in which, much like a lab technician, he would describe: the purpose of the experiment; the type of sound material used; how the experiment went; and what findings could be drawn from it³⁶ (ILL. 7). Photographs, often taken from the same angle and without any optical or artistic «effect», played an important role here: first and foremost documenting the precise set-up, they also served as an underlayer

³⁵. KRATZER 2023, p. 443.

³⁶. LEITNER 2015.



ILL. 8: 'Räumliche Spaltungen eines Akkordes' ('Spatial Splits of a Chord'), Sound movement diagram superposed on a picture of the 1981 *Soundcube* in Vienna. Source: collection of the artist, used with permission. (See APPENDIX, no. 12.)

upon which the various sound trajectories (i.e., how the sound moved between the various loudspeakers) were drawn. The advent of the punch-tape reader changed the format and role of these documents, for the exact same sound constellations could now be repeated automatically. As a result, Leitner's visual documents became more aesthetic, graphical and evocative. Resembling wrapping artist Christo's typical working drawings in their use of worked-up black and white photographs, the documents became art pieces in their own right, put on display in various exhibitions (ILL. 8).

THE *SOUNDCUBE*

In 1977, Leitner summarised his findings in the introduction to his first monograph, entitled *Sound Space Manifesto*³⁷. After having reiterated his central tenets that space could be (re)defined by sound and that «hearing» needed to be emancipated from «audio-physical perception», he reflected on a decade of experimentation. A first, rather obvious finding was that the state and position of the human body crucially affected audio-physical perception: «A passive body position (such as lying down) makes one especially prepared to perceive spatial motions of sound, whereas walking permits and invites reactions to the sound motions, interaction with space»³⁸. A second finding was that the experience of certain sound spaces did not depend on a person's musical-acoustic perceptivity but rather derived from an immediate bio-acoustical, psycho-physiological sensation. As taste and culture were therefore not involved, the content of and reaction to certain spaces could become objectified: repeated, slow pendulum-like motions of sound along the body for example were found to be tension-relieving, while people tended to stretch their standing body when surrounded with upward moving sounds. Finally, having now exhausted all possible permutations between body, sound, movement and space, Leitner felt confident enough to define more precisely the nature of his installations as «space instruments» as an analogy for musical instruments. Indeed, as Leitner observed: «Just as a wide variety of pieces can be played with a conventional sound instrument, so a large number of temporal-spatial programs, that is a large number of different experiences, can be created with and within each sound space instrument»³⁹.

Yet, it was not before 1981 that Leitner was able to bring this idea to its logical conclusion in the first full-scale incarnation of the *Soundcube*. Realised in the context of a larger exhibition on his work at the Palais Lichtenstein in Vienna in 1981, it measured 4.2 x 4.2 x 3.6m and was executed using white painted timber with a 60cm unit of measure, over which white netting was stretched (ILL. 9). While this net visually demarcated the spatial boundaries of the *Soundcube*, it left its walls visually and acoustically transparent, its minimalist and abstract rationality contrasting neatly with the baroque aspect of the Palais's interior. Much smaller than Leitner initially envisioned, this *Soundcube* was a space for one visitor only, in reclined position. The number of loudspeakers was also reduced to eight, of which two were situated under the chair. This allowed for various types of spatial experience nonetheless, which Leitner described as «contracting», «bouncing», «arching» and so forth.

³⁷ LEITNER 1978, KRATZER 2023, pp. 23-27.

³⁸ KRATZER 2023, p. 26.

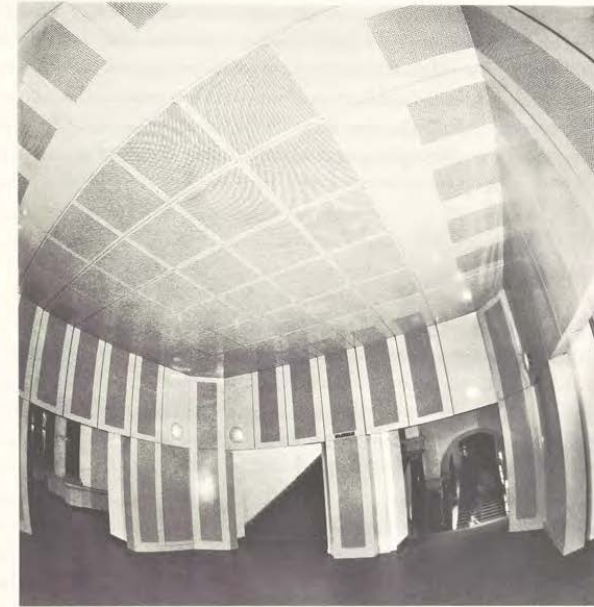
³⁹ *Ibidem*, p. 27.



ILL. 9: Bernhard Leitner, *Soundcube*, Vienna, 1981. Source: collection of the artist, used with permission.

Soon after, another opportunity arose after Leitner won a competition for an in-situ art installation organised by the Berlin Technical University⁴⁰. His original idea, namely to acoustically link the four campuses of the university through interconnected «Sound Fields», had to be abandoned, however, and was reduced to an intervention in the great hallway of the university's main building, a cube-shaped passageway connecting three different corridors (ILL. 10). Although based on the same principles as the previous iteration, their materialisation was now markedly different. To begin with, the new *Soundcube* was twice as large, measuring 7.5 x 7.5 x 4m. Second, intended as a permanent structure, it now consisted of a solid metal structure with perforated surfaces, constituting a kind of acoustically transparent skin which also contained insulating material in order to reduce the reverberation time and ambient noise. Lastly, contrary to the museum conditions in Vienna, the *Soundcube* was now installed in a

⁴⁰ LEITNER 2003.



ILL. 10: Bernhard Leitner, 'Sound Space TU Berlin', Berlin, 1984. Source: collection of the artist, used with permission.

passage space where a stream of students and employees passed through on their way to their daily activities. As its boundaries coincided with that of the physical room it was installed in, it also no longer constituted an acoustic «island» within a larger space, but instead constituted a proper space of its own, its singularity being further emphasised by dimmed lighting. The latter features, together with its generally minimalist aspect (again consciously clashing with the architectural context, this time a monumental 19th century building), ensured that one could not really miss the installation when moving around the university premises. Despite this apparent incongruity between work and site, the *Soundcube* was still very much a site-specific work in that it consciously intervened in and contrasted with its surroundings, thus provoking a defamiliarisation effect in its appropriation of the site that fed it with a new identity⁴¹. A

⁴¹ I muse here on Åsa Stjerna's comparison between Leitner's Berlin Sound Cube and Max Neuhaus's notorious sound art installation on Times Square in New York. See STJERNA 2013.

final difference from the previous iteration had to do with the number and position of the loudspeakers: the 24 full-range and 18 high-frequency ones were now entirely hidden from sight and enabled to perform eight different types of sound-spaces, some of which had poetic-evocative names such as «Kreis-Lauf-Spiel», «Atmende Diagonale», «Elastische Linien», or «Verschillungen». The Berlin *Soundcube*, which is still in place and operational today, therefore constituted the ultimate incarnation of Leitner's dream of architecture «as an instrument, a tool for sculpting immaterial time space. The sculptural, form-taking material is sound»⁴².

CONCLUSION

As this paper has shown, in the late 1960s, Leitner was not the only artist relying on the immersive capacities of sound to create spatial effects and illusory experiences. His concept of the *Soundcube* can be linked to a modernist, electroacoustic and experimental tradition linking music and architecture, including the Philips Pavilion at Expo 58 in Brussels and the German Pavilion's *Kugelauditorium* at Osaka '70. Yet, there are a number of important differences between Leitner and his contemporaries that are worth highlighting. One obvious distinction lies in the fact that Leitner always remained an architect in the sense that he was not interested in the spatialisation of sound as an expressive parameter, nor did he use sound as a vehicle of artistic expression in the sense of Bill Fontana or Max Neuhaus. His interest lay in how spatial perception could be formed and informed by sound. For this reason, he intentionally used the word *Ton*, which in German has a different connotation than *Klang*. Both translated as 'sound' in English, the latter term has more a musical meaning⁴³. Indeed, as we have seen, his sound material was intentionally very simple as not to distract the participants, and deliberately abstract so that musical preconceptions would not interfere with the spatial perception.

Another major difference resides in the fact that, whereas the immersive effect of much of Stockhausen's and Xenakis's spatialised music derives from their collective dimension (many people sharing the same experience together), Leitner's installations are in most cases created for one single person, singling out the individual visitor and clearly allocating their place, an aspect that has divided various critics. Boris Groys, for example, has noted how the solitary meditation that the installation leads one into has a theatrical aspect to it, for a person absorbed

⁴². KRATZER 2023, p. 220. The continued presence of the installation was confirmed to the author by Franziska Schilling (Architekturmuseum TU Berlin) by e-mail, 21 June 2023.

⁴³. BLUME 2008, n.p.

in contemplative listening provides a delightful image for the other exhibition visitors. For Groys, this play with movement and contemplative dwelling creates a unique choreography which inevitably fascinates the visitors, drawing them under its spell⁴⁴. Yet, this absence of personal choice, i.e., the extent to which one can determine his or her own experience, raises the question of the status of the visitor in Leitner's installations. Is he or she addressed as a person, or as a mere 'resounding body'? In this regard, it is relevant to note that the human figure is effectively ever-present in Leitner's drawings, diagrams or photocollages. Although often recognisable as himself or his female companion, this depiction seems to symbolise the 'hearing subject', at first glance. For Eugen Blume, this illustrates how, in Leitner's installations, «[...] the human being is not a functioning creature moulded by technology and alienated from himself, but a hearing creature sheathed in sound»⁴⁵. However, this same aspect can also lead one to the opposite conclusion. Indeed, as Greg Hainge has argued, while Leitner's sound spaces are necessarily mobile in and of themselves, as well as in relation to the listener's position relative to them, they are not in fact *altered* by the presence or the movement of the visitor at all. By consequence, «the architect's intention, hard-coded into the programming, produces the desired form in response to which the subject passing through these forms and their corresponding spaces has no option but to submit to the intended meaning and function of the space»⁴⁶.

This aspect leads to a third and final difference between Leitner and his contemporaries, namely the way the former constantly sought to extrapolate the act of «listening» beyond the ear, emphasising the fact that the entire body is in fact exposed to sound waves and that, as a result, we are constantly acoustically immersed⁴⁷. Vice versa, as Leitner states, sound spaces cannot exist without human presence, for it is in the visitor's perception that the sound-space work finds its completion⁴⁸. Indeed, his explorations articulate the model of the plastic, resonant body and demonstrate that one is never strictly outside of space, but truly «in»⁴⁹. In this sense, the central theme of Leitner's work is not «space» in itself, but how it relates to our bodily presence and sensory perception. Indeed, his sound spaces are there to be heard, seen and felt, requiring an involvement in the aesthetic experience which is perhaps deeper than is traditionally the case in the visual arts, music or architecture.

⁴⁴. GROYS 2008, p. 10.

⁴⁵. BLUME 2015, p. 11.

⁴⁶. HAINGE 2018, p. 102.

⁴⁷. BLUME 2008, n.p.

⁴⁸. LA MOTTE-HABER 1997, p. 18.

⁴⁹. ROBINSON 2020, p. 32.

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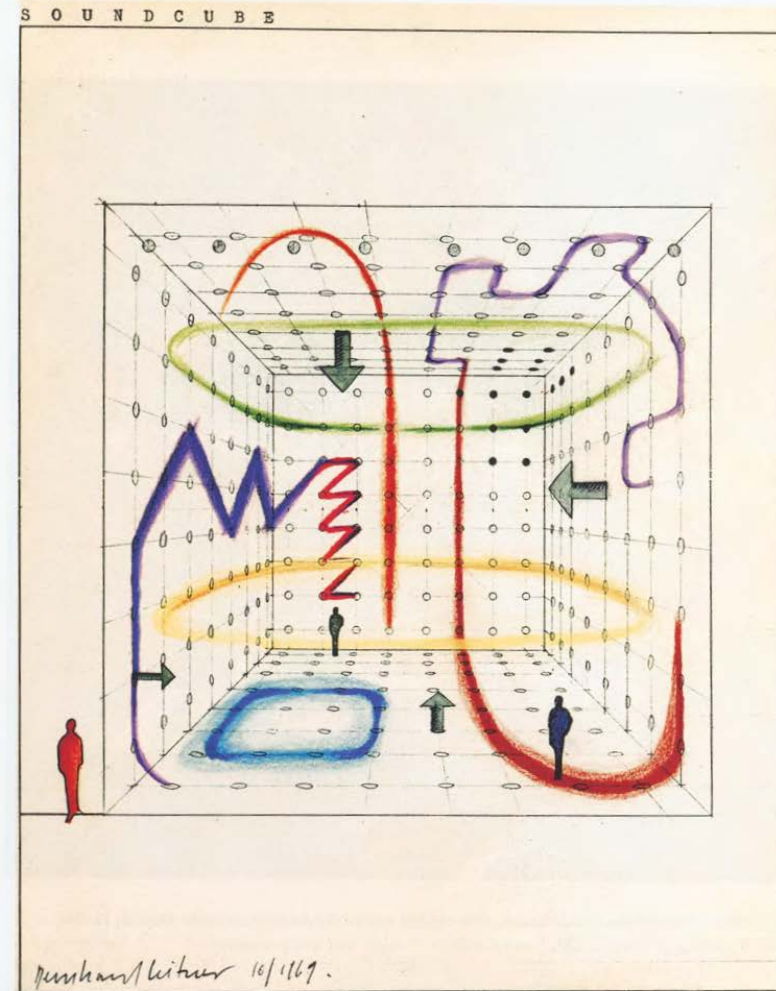
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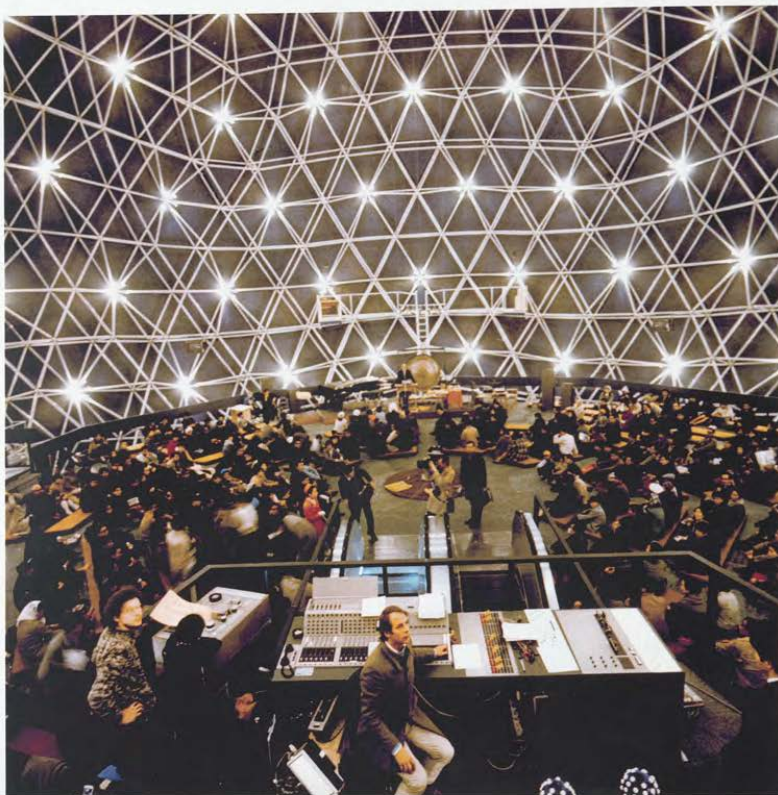
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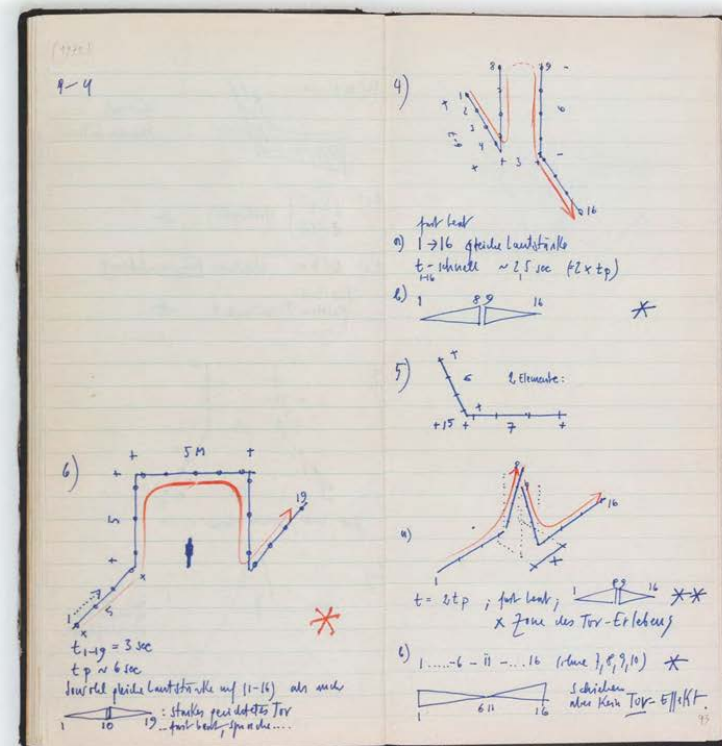
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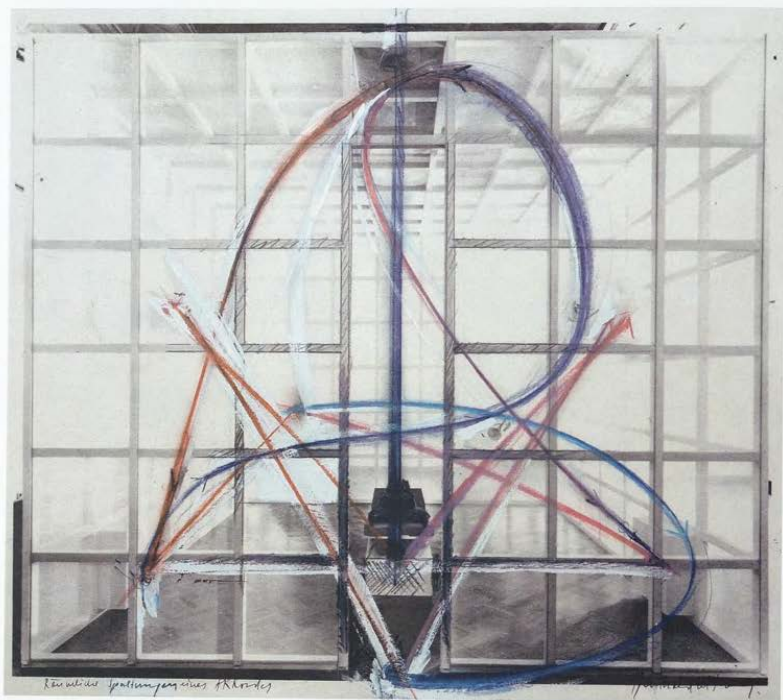
No. 9: Bernhard Leitner, *Imaginary Designs for Sound Spaces*, 1969. Collection of the artist, used with permission.



No. 10: Karl-Heinz Stockhausen at the control desk of the Auditorium in the German Pavilion at the 1970 World Fair in Osaka. Stockhausen Foundation Kuerten, used with permission.



No. 11: Bernhard Leitner, preparatory sketches and notes for 'Sound Gate'. Collection of the artist, used with permission.



No. 12: 'Räumliche Spaltungen eines Akkordes' ('Spatial Splits of a Chord'), Sound movement diagram superposed on a picture of the 1981 *Soundcube* in Vienna. Collection of the artist, used with permission.



No. 13: The church of Ronchamp, Notre-Dame du Haut (photo: Marta Lorente, 2018).

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