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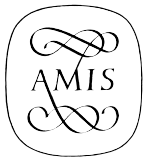

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Inside-Out: David Tudor's Composition of the Pepsi Pavilion as a Musical Instrument

You Nakai

it would be nice to turn one's thoughts inside-out, which is possible for me, because I don't compose in a straight line.
- David Tudor

In the spring of 1970, David Tudor composed a musical instrument. Approximately 120 feet in diameter, this instrument stood inside the World Expo site in Osaka, Japan. Its construction was funded by the Pepsi-Cola Corporation and carried out under the auspices of Experiments in Art and Technology (E.A.T.), an organization co-founded by Robert Rauschenberg and Bell Labs engineer Billy Klüver in 1966. The unusual matching of a multi-national soft-drink corporation and a non-profit organization aiming to facilitate experimental collaboration between engineers and artists was devised by the artist and filmmaker Robert Breer. Two years earlier, Breer had been asked to participate in the Pavilion project by his neighbor who happened to be the Vice-President of Pepsi-Cola International. Exited about the scale and potential of the project but worried about the tastes and conventions of the commercial company people, Breer contacted Klüver, who had experience in coordinating large-scale projects at the intersection of corporate business and avant-garde art. E.A.T.'s first project, *9 Evenings: Theatre and Engineering,* had paired eleven selected artists with Bell Labs engineers to produce extravagant multi-media performances.

For the Osaka project, Klüver, together with Breer, chose three other core artists. Robert Whitman, who had been creating theatrical happenings and environmental works throughout the 1960s, was put in charge of the inner space of the Pavilion. Forrest Myers, who made giant light-beam sculptures, would illuminate the exterior space. When they came to select the artist to design the sound space of the Pavilion, Klüver recalled the astonishing use of the acoustics of the 69th Regiment Armory that Tudor had made in his piece *Bandoneon ! (a combine)* during the *9 Evenings*:

In *9 Evenings* the Armory space had an echo of 6 seconds, which was a problem for some of the artists. But I remember I saw David once on the balcony, with a pick up microphone in his hand. He rotated it 180 degrees to listen to

the different reflections of sounds from each corner of the Armory. In his piece David played the bandoneon, but he also used the giant hall as an instrument and literally played the Armory.[1]

Taking the free-reed instrument lending its name to the title as the only sound source and interface, Tudor picked up its sounds through a number of contact and air microphones and used them to control the modulation process of the same sounds, as well as to activate a multiplicity of audio-visual devices, lights, and loud-speakers distributed across the entire performance space. Tudor thus appeared to be a perfect recruit for Klüver's new project that sought to convert the entire Pepsi Pavilion into a work of art.

The technical conditions of performance differed considerably between the *9 Evenings* and the Pepsi Pavilion, however. At the Armory, the instrumental configuration of Tudor's own electronics and the gigantic Theater Environmental Modular Electronic (TEEM) system, developed by Bell Labs engineers, composed a network of modular devices whose connections and spatial placement were highly flexible. This variability of system was derived from its intended use: there were two performances by different artists every night (each artist performing on two evenings), which required the network of components to be set up and torn down with considerable ease. Audience members for the most part sat on chairs and observed the spectacle from a distance, without interfering in the haywire of cables and equipment. In contrast, the Pepsi Pavilion was designed to be active for the entire six-month duration of the Osaka Expo, with an average of 350,000 expected visitors per day. The massive crowd would be free to move around inside the Pavilion during that time. These conditions demanded the sound system to be fully composed in advance and rigidly installed into the interior architecture of the free-standing dome.

Every account on the Pepsi Pavilion agrees on what Tudor intended to make: "[Tudor] conceived of the sound system as an 'instrument,' so that the sound would not be fixed in advance but would result from the visiting artists playing it."[2] This is an extraordinary claim, for the sound

1. Billy Klüver, Interview with Matt Rogalsky, Berkeley Heights, NJ, May 8, 2002. Quoted in: Matt Rogalsky, Liner Notes, *The Art of David Tudor 1963–1992,* New World Records 80737, 2013, 7 CDs.

Billy Klüver, "Transcript of Talk on David Tudor at the Getty Research Institute, 2001," Julie Martin's personal archive, Berkeley Heights, NJ.

2. Billy Klüver, Julie Martin, Barbara Rose, *The Pavilion: Experiments in Art and Technology* (New York, NY: E.P. Dutton, 1972), 15.

system of the Pavilion—comprised mainly of an eight-channel modification console, an assembly of microphones and tape machines, and a network of thirty-seven loudspeakers—was distributed across its entire architecture. But the radical implication of turning a whole pavilion into a musical instrument has passed strangely unnoticed. Instead of taking Tudor at his word, his conception has often been paraphrased to fit the norms of convention. There is a prevalent desire either to reduce the "instrument" Tudor composed strictly to the sound console, or to rephrase it as a "sound installation."[3] This psychological resistance seems to be rooted largely in a particular imagery of "musical instrument" derived from the perceived nature of acoustic instruments: namely, an instrument is: 1) an object that can be performed to generate or modify sounds, 2) smaller (or at most similar) in scale compared to the human performer. Hence, if it is not such an object, then it must be an installation. In order to fully grasp Tudor's idiosyncratic conception, however, we must ask not what a musical instrument is or has been, but what it *can* be. Analysis needs to follow the expansion of a notion, rather than aim its reduction to common usage. The impediment for regarding the entirety of the sound system Tudor composed as an instrument comes from the second part of the above-mentioned imagery—the convention of *scale.* That is to say, the anomaly of Tudor's conception demands the normalcy of physical scale pertaining to musical instruments be dispensed with. The only condition left for an instrument then, is that it be something performable—"so that the sound would not be fixed in advance but would result from [. . .] playing it."

This tethering of instrument to performance—pertinent to the virtuosic performer that Tudor was—does not dictate the former's scale. But neither does it singularly fix the latter. An instrument, in other words, always holds the potential for more than one performance. Indeed, this apparent difference between the single instrument and multiple performances became a case in point at the Pepsi Pavilion. For one thing, Tudor was not going to be the only performer to play his instrument. This required the system to be versatile enough to accommodate the diverse needs and usages of the visiting artists. Perhaps more significantly, the instrumentality of the Pavilion introduced a gap within Tudor's *own* practice. That is to say, "instrument" was not the only thing Tudor composed. The Pepsi Pavilion opened its doors on March 15, 1970, and

3. These were suggestions made by the two anonymous reviewers of the first draft of this paper.

already on April 25, E.A.T. was dismissed by Pepsi Cola International and forced to leave its premises for spending too much money. By then, Tudor had created and performed nine or ten "programs" specific to his instrument. The nature of these so-called "Pepsi Pieces" defies the commonplace formula in electronic music of equating instrument with composition: the claim that the instrument *is* the composition. Instead, the complex nature of Tudor's approach to his instrument is revealed precisely in the gap between the Pepsi Pavilion and the Pepsi Pieces—between the composition of an instrument and that of ten or so programs performed on it.

The focus on instrumentality allows for an exploration of the Pepsi Pavilion via a different route than the usual. The standard overview places its emphasis on the "immersive environment" of the Pavilion, guiding the reader through the interplay of sound, light, and visual effects.[4] However, this path is misleading on two fronts. First, it falters factually since immersion was only one of the available modes of the overall system.[5] More emphasis was placed on articulating the space through directional sounds, spot lights, or localized sound loops, which foregrounded the multiplicity of the space, than to enwrap all visitors within a singular environmental spectacle. Second, it falters methodologically since immersion is an aesthetic *effect* produced by the network of components, which in turn is not only composed and distributed, but also performed in real-time. The focus on the Pavilion's immersive nature therefore effaces the specifics of its instrumental set-up. Instead, this study probes into the nature of Tudor's composition—both the instrument and the programs—by paying attention to its material condition, multiscalar complexity, and metaphysical conception.[6] It also follows the

4. For instance, read the account on the Pepsi Pavilion in the Wikipedia entry for E.A.T. https://en.wikipedia.org/wiki/Experiments_in_Art_and_Technology.

5. As will be discussed later, the three types of speaker patterns were: "Line sound" (a rapid switching of speakers in different patterns), "Point sound" (only one activated speaker at a time), and "Immersion or environmental sound," where sounds come from all around.

6. Aside from the sound system, another important part of the Pepsi Pavilion Tudor became involved was the sound activated laser deflection system that was installed in the so-called "Clam Room," where the visitors first passed through before climbing up the stairs to get into the Mirror Dome. For this section, Tudor asked Lowell Cross and Carson Jeffries, who had been developing an audio-laser system he had closely collaborated with on a number of occasions. The deflecting mirror in the laser system was activated by the sound system, thus expanding Tudor's instrument both spatially—to the Clam Room below—as well as sensorially—allowing it to have a visual output. The scope of this single article unfortunately cannot encompass, and

chain of events within the process of composing the Pavilion, since the specifics of this history is embedded in the nature of what Tudor composed. In this way we offer a view of the Pepsi Pavilion *from inside*—both within the instrument and within the history of its production—thereby adhering to Tudor's own suggested approach that will be discussed later. Our trajectory will certainly meander, introducing several shifts in the scale of observation as it proceeds. As Tudor admitted, he did not compose in a straight line.

Premises: Rock Environment & The Problem of Input/Output

A survey of the premises shows numerous points of interest. Pepsi-Cola International's initial plan before E.A.T. became involved was a blatant public relations campaign targeted at the specific demographic of their consumer base: to organize a rock concert inside the so-called "Youth" Pavilion.[7] By the time Tudor was contacted, the rock plan was already in place, so his ideas had to develop around this given. Tudor, the prominent performer of the post-war avant-garde whose extreme virtuosity on the piano had led an array of composers (e.g., John Cage, Karlheinz Stockhausen, Christian Wolff, Sylvano Bussotti) to write music specifically for him, and whose recent endeavors in soldering circuits and patching home-made devices to create his own electronic works inspired many younger composers and signaled the start of "the development of experimental music in the United States,"[8] thus found himself in a strange position: "I tried to imagine what I would consider an interesting environment if I were a rock performer."[9] The actual plans he

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therefore do justice to, the multi-faceted significance of Tudor's collaboration with Cross, both at the Pepsi Pavilion and in general. Cross's input is of critical importance to understanding Tudor's electronic music, and deserves a close inspection of its own.

7. Lowell Cross, "Letter to Vernon J. Fowler (March 13, 1969)," Box 17 Folder 3, David Tudor Papers, Getty Research Institute.

8. Alvin Lucier, "Thoughts on Installations" (accessed October 30, 2015). http://www.kunstradio.at/ZEITGLEICH/CATALOG/ENGLISH/lucier-e.html. Similar comments about Tudor's electronics can be found elsewhere in Lucier's writing: "Then David Tudor came along. You would attend one of his concerts and notice a table filled with homemade electronic devices housed in plastic soap dishes. [. . .] David made his own orchestra out of these, each one plugged into the other in a complex web. He would buy all the components cheaply at Radio Shack, things he found and picked up. He really saved our lives. He enabled us to make our own work. A bunch of people would meet get together, make these pieces, and play them. We just sidestepped the huge classical music institutions." (Alvin Lucier, *Music 109* [Middletown, CT: Wesleyan University Press, 2012], 61).

9. Klüver, *The Pavilion*, 17.

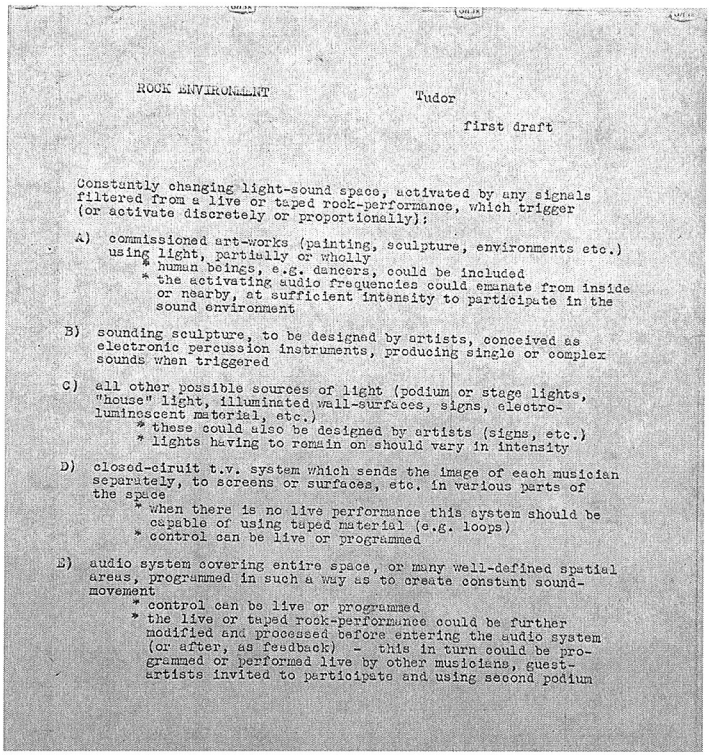
drafted, however, reveal how peculiar Tudor's image of a "rock performer" was.

One of the earliest proposals bears the appropriate title of "Rock Environment," and depicts a "constantly changing light-sound space, activated by any signals filtered from a live or taped rock-performance"[10] (fig. 1). The list of items to be activated includes sounding sculptures, various lighting, a closed-circuit TV system, and an audio system covering the entire space. The similarity to *Bandoneon !* from three years ago is immediately apparent: "Rock Environment" simply replaces the input source activating the multimedia environment from the concertina to a rock concert. Nevertheless, this seemingly subtle change turned the entire situation inside-out as far as Tudor's own relationship to the "environment" was concerned. For the premise at the Pavilion was that, thanks to Pepsi-Cola International, *Tudor had absolutely no control whatsoever over the input source.*

To what extent and how seriously Tudor imagined himself as a rock star remains an open question. But the condition of having to use a sound source he could not control determined the conception of Tudor's instrument, forcing him to narrow his focus to the only area over which he knew he had control: the modulation process of sound.[11] *Bandoneon !* had already explored the peculiar nature of sound modulation in electronic music whereby the shape of a sound in the form of signal voltage could be used to change the parameters of another. In other words, once sounds were transduced into signals, the need for manually performing the knobs or switches of an instrument became dispensable. The idea of voltage-control thus opened an entirely new approach to musical instruments. For one thing, as Don Buchla noted, performance was no longer limited by the physicality of human bodies: "as soon as I added voltage control to the elements of the synthesizer it became a different ball game because you could parametize everything. You weren't limited by how fast you could turn a knob to get between two states of a

10. David Tudor, "Rock Environment Draft," Box 19 Folder 3, David Tudor Papers, Getty Research Institute.

11. Sound "modification" and "modulation" are usually differentiated by the degree of transformation the original signal undergoes. A modifier, like a filter, only adds or subtracts some characteristics of the input signal, whereas a modulator produces a new signal from two different input signals. However, Mumma consistently called his instrument for the Pepsi Pavilion a "modifier," despite the fact that it had two modulation stages. To avoid confusion, Mumma's original term is used to address the instrument, but the difference between modification and modulation will be maintained when discussing individual functions.



ROCK ENVIRONMENT Tudor

first draft

Constantly changing light-sound space, activated by any signals filtered from a live or taped rock-performance, which trigger (or activate discretely or proportionally):

A) commissioned art-works (painting, sculpture, environments etc.) using light, partially or wholly
* human beings, e.g. dancers, could be included
* the activating audio frequencies could emanate from inside or nearby, at sufficient intensity to participate in the sound environment

B) sounding sculpture, to be designed by artists, conceived as electronic percussion instruments, producing single or complex sounds when triggered

C) all other possible sources of light (podium or stage lights, "house" light, illuminated wall-surfaces, signs, electro-luminescent material, etc.)
* these could also be designed by artists (signs, etc.)
* lights having to remain on should vary in intensity

D) closed-ciruit t.v. system which sends the image of each musician separately, to screens or surfaces, etc. in various parts of the space
* when there is no live performance this system should be capable of using taped material (e.g. loops)
* control can be live or programmed

E) audio system covering entire space, or many well-defined spatial areas, programmed in such a way as to create constant sound-movement
* control can be live or programmed
* the live or taped rock-performance could be further modified and processed before entering the audio system (or after, as feedback) - this in turn could be programmed or performed live by other musicians, guest-artists invited to participate and using second podium

FIGURE 1. Rock Environment draft (David Tudor Papers, Box 17, Folder 7) © J. Paul Getty Trust, The Getty Research Institute, Los Angeles (940039).

parameter."[12] More significant than the practical advances on how fast and precise a given instrument could be controlled, though, was the conceptual expansion of what instruments can be. If an "instrument" is anything that can be used to produce or modulate sound, voltage-control made instruments out of sound signals. The physicality traditionally attributed to instruments was now discovered within the waveforms of sounds themselves.

12. Quoted in Trevor Pinch, *Analog Days: The Invention and Impact of the Moog Synthesizer* (Boston, MA: Harvard University Press, 2002), 40.

As Ron Kuivila noted, Tudor latched onto this expanded notion of instruments that electronics offered:

> "Modulation" techniques allowed one sound to control another. The ideas underlying this "instrumentalization" of sound did not hold appeal to Cage, a composer whose goal was a completely dissociated experience of sound that would make any and all sounds fascinating. However, for Tudor, this instrumentalized sound created the possibility of a new musical instrumentality.[13]

Early on, Tudor focused on combining this instrumentalization of sound with the indefinite recycling phenomena of sound feedback, a general formula from which the nature of his specific compositions emerged: a semi-automatic performance of instruments by instruments (i.e., sounds by sounds). *Bandoneon !* was a seminal work in this regard, where the sound of the acoustic instrument was used to modulate the same sounds as well as to control other instruments, all within a constant feedback that tended "toward total oscillation."[14] In Tudor's own words, it was precisely a work that, "when activated [. . .] composes itself out of its own composite instrumental nature."[15]

At the Pavilion, however, Tudor could not resort to this formula—at least not initially. Neither modulation via the "instrumentalization of sound" nor the driving feedback could be used, unless Tudor was willing to let the rock-n-roll racket impose its mighty force on the modulation process—the only domain he had secured for himself. On the contrary, the role of the input had to be decisively minimized and preferably suppressed. This explains why all of Tudor's initial plans concentrated on the other end of the system—the output. Thus one of his ideas of "an interesting environment" for rock performers was an indeterminate sound-system created by the movement of sound across multiple loudspeakers that would distort the sound input beyond recognition:

> One thing about rock groups is that they all have the same density of sound, and I felt there ought to be some means of creating an unpredictable space relationship that would vary the source of the sound. That is, the rock group wouldn't be able at first to figure out how they are actuating such movement.[16]

13. Ron Kuivila, "Open Sources: Words, Circuits and the Notation-Realization Relation in the Music of David Tudor," *Leonardo Music Journal* Vol.14 (2004): 20.

14. David Tudor, "Pre- and Post-Operative Note," Box 19, David Tudor Papers, Getty Research Institute.

15. Pontus Hultén and Frank Königsberg eds., *9 Evenings: Theatre and Engineering* (New York, NY: The Foundation for Contemporary Performance Arts, 1966), 11.

16. Klüver, *The Pavilion*, 18. As Tudor's note from an early phase of planning suggests, this idea seems to have started as an aerial development of the mobile loud-

As preparations for the Pavilion materialized, it became obvious to everybody on the E.A.T. side that the idea of holding a rock concert was absurd. In his customary fashion, Tudor let the very nature of his instrument have the final say: "As we defined more and more details of the interior, it became its own space, with its own characteristics, and finally it became clear that rock groups were inappropriate."[17] The primordial "Rock Environment" had already left an irrevocable mark on the project, however, and Tudor now regarded input as a given. This was quite literally so: he asked geographer Peter Poole who was working with E.A.T. to collect a vast number of sound materials from bio-medical laboratories and field recordings all over the world to use as sound source for the Pepsi Pavilion. By February 1970, Poole had gathered more than 500 recordings of different sounds, out of which Tudor edited a library of forty-five-minute tapes.[18] Some of the recordings were modified electronically in the process, but the modification in most cases consisted in merely changing the speed of the tape. As Tudor recalled, "I didn't really transform it; I sort of trimmed it to a useful material for me."[19] Tudor would continue to use this library of materials as input for his sound systems throughout the rest of his career, but his concern for input that adorned the title of his seminal effort as composer in 1966 had turned into utter disregard. As he later explained in a 1986 interview with Bruce Duffie, "I find that I'm still using that [the library of source tapes], because that's *only an input.* It depends on what kind of device is meeting it at the other end."[20]

Indeed, it was his focus on the "other end" that foregrounded at the Pavilion: "I kept the sound movement because the idea was still in my head."[21] If anything, he decided to increase the speed of the movement as much as possible until it became a "dangerous matter," until new sounds would be *generated* indeterminately from the physicality of the action:

> I thought it would be intriguing to experience sound that moved very quickly. The sound moving from speaker to speaker moves so quickly that it

speakers that ran around on remote-controlled vehicles in *Bandoneon !*: "the listener would have the impression that the sound was somehow embodied in a vehicle that was flying around him at varying speeds." (Ibid., 18).

17. Ibid.

18. Ibid., 283.

19. David Tudor, "Presenting David Tudor: A Conversation with Bruce Duffie" (accessed October 30, 2015). http://www.bruceduffie.com/tudor3.html.

20. Ibid. Emphasis added.

21. Klüver, *The Pavilion*, 18.

> destroys the shape of the sound wave. There will be a point at which the speed is so great that the original sound will be destroyed. My interest is in going beyond that point and seeing what speed itself will create; to see what kinds of sound material will not require faithful reproduction or will act as a new sound generator. We've never heard that.[22]

His notes and sketches document the working out of this idea (fig. 2). The distinctiveness of this approach concerns *where* modulation takes place: neither at the level of input, nor inside the circuitry by means of electronics, but at the speakers—or more accurately, *in the space between one speaker and another.* In other words, Tudor conceived of the entire internal space of the Pavilion as a giant modulator and a potential generator of sound. Input remained "only" an input, while the "other end" became everything. *Bandoneon !* had played the Armory as an instrument, but as implied in its title, a single instrument still served as the central generator, controller, and modulator of sound, triggering the exponential accumulation of audio-visual events. In turn, it was the removal of such core instruments at the Pavilion that led Tudor to conceptualize its interior space, "with its own characteristics,"[23] as an instrument.

For instance, one of the prominent characteristics of the pavilion space was such that, "special acoustic experiences occur in the center of the dome [. . .] A person hears his voice as a loud echo no matter which way he faces when he speaks."[24] This naturally made things catastrophic for Pepsi's initial plan: "the Pavilion [. . .] was acoustically the worst design imaginable for a live rock group because they would not be able to hear themselves playing."[25] For Tudor, this was simply the very nature of his instrument with which he had to contend.

This is not to say that Tudor's instrument coincided with the architecture of the Pavilion. Tudor had no say in the architecture—in fact, none of the participating artists did. A faceted dome had already been built by the Japanese construction firm Takenaka Koumuten. If anything, the E.A.T. artists concentrated their energy on blurring the physical presence of the building that they considered ugly. This was ultimately achieved by using Fujiko Nakaya's artificial fog to obscure its exterior and setting a mirror dome held by negative pressure for the interior.[26]

22. Ibid.
23. Ibid.
24. Elsa Garmire, "An Overview," in Klüver, *The Pavilion*, 190.
25. Ibid., 6.
26. Ibid., 19.

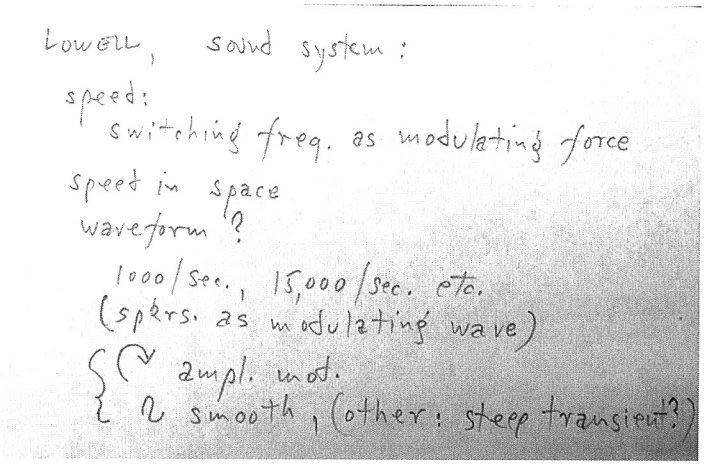


FIGURE 2. Tudor's notes on sound modulation using rapid switching of speakers (David Tudor Papers, Box 17, Folder 7) © J. Paul Getty Trust, The Getty Research Institute, Los Angeles (940039).

The aluminized mylar diaphragm of the latter also contributed to the acoustic nature of the Pavilion, by functioning as a low-pass filter for the sounds going through it. Although these physical properties certainly imparted their characteristics onto the sound system, neither the architecture nor the Mirror Dome encompassed Tudor's instrument. These were instead conceived as components connected to other components and open to mutual influence. In this way, Tudor's Pepsi Pavilion was a composite "instrumentarium"—to use Frank Hilberg's convenient term—defined by the topological network of its components, which included, but was not reduced to, the Pavilion as architecture.[27] Sounds would be generated and modified through the interactions of components pertaining to different scales, each of which influenced others and was influenced by others in return.

This is also to say that the "sound space" of the Pepsi Pavilion did not coincide with the Pavilion's interior space. If sound's physicality allowed it to be instrumentalized, then by necessary extension, the same could

27. Frank Hilberg, *David Tudors Konzept des "Elektrifizierten Klaviers" und seine Interpretation von John Cages "Variations II"* (Saarbrücken: Pfau, 1996).

be said about the space *it* composed: "You see, for me, sound space is more physical; I can almost touch it."[28] As if to prove this autonomous physicality of sound space, Klüver reminisced how Tudor at one point even brought the entire Mirror Dome into sympathetic vibration: "David often played at the sound console and soon found the resonant frequency of the mirror. One day, Sig Stenlund, the engineer from Schjeldahl, the company that had made the mirror, ran after me and demanded excitedly, 'Stop THAT MAN from shaking my mirror!' Of course, I ignored him."[29]

Inside: Sound System

Tudor's preliminary conception was in this way constrained by Pepsi-Cola International's ardent efforts to capture the hearts of the youth. Even in the absence of the rock plan, however, the physical constraints of the project, both in terms of time and money, continued to exert a significant influence on the nature of Tudor's composition. The Pavilion sound system can be seen as having three relatively distinct levels: input, processing, and output. For input, the assembled library of sound materials could be played from sixteen quarter-track monaural tape recorders, although microphones, audio generators, as well as telephones were also available. In terms of output, Tudor asked for twenty sound channels that could be moved independently in different speeds and patterns. Fred Waldhauer, who had worked with Tudor during the *9 Evenings*, served as the engineering consultant for the development of the sound system at Osaka in the early phase of the project. To devise the necessary switching system, Waldhauer contacted Larry Owens, a colleague engineer at Bell Labs who had recently assisted Steve Reich on *Phase Delay Music Gate* presented at the Whitney Museum.[30] Owens proposed and designed a digital switching system that allowed separate activation of each speaker installed behind the mirror dome in a rhombic grid pattern (fig. 3).

Two types of program cards could be used to control the switching process: (a) the "Sequence Card," which programmed the order and pattern of switching speakers, and (b) the "Clock Card," which pro-

28. Klüver, *The Pavilion*, 18.

29. Klüver, "Transcript of talk on David Tudor."

30. Norma Loewen, *Experiments in Art and Technology: A Descriptive History of the Organization*, PhD Dissertation (New York, NY: New York University, 1975), 284.

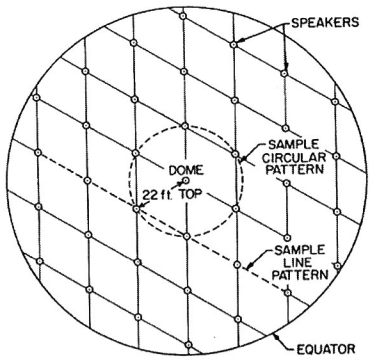


FIGURE 3. Rhombic grid pattern of loudspeakers. © Experiments in Art and Technology.

grammed the switching speed. Using this system, the number of activated speakers could be shifted freely, with a variety of switching patterns available at different speeds. There were three basic modes: "Line sound," a rapid switching of speakers in different patterns; "Point sound," with only one activated speaker at a time; and "Immersion or environmental sound," where sounds come from all around.[31]

To realize this flexible system, however, Owens cut the number of modulation channels Tudor had requested from the initial twenty to a mere eight. The number of loudspeakers was similarly reduced from the initial sixty to thirty-seven in the final plan. Tudor expressed a deep dismay at being left out of the decision process:

> If you [. . .] can't go inside the engineering problems and are never allowed to offer an alternative along the engineering road, the thing takes the engineer's shape. It was a one-way street, and my original ideas were leaving one by one. [. . .] The number of channels cost me more heartache than anything else. My conception of numbers was real. Like with a juggler, three balls are different from four balls, and the difference is so extreme it goes all the way down the line. In January 1969, I asked for twenty channels, in the system I was presented with it finally stopped being reduced at eight. Numbers were different in Larry's thinking and there was no translation possible.[32]

31. Garmire, "An Overview," 190.
32. Klüver, *The Pavilion*, 58.

For the engineer, the number of channels and loudspeakers was merely an abstract figure that could be traded off for realizability. For Tudor, they were *physically* specific, just like the sound space he could almost touch. Thus, in addition to the input, now consigned to foreign sources, Tudor was denied access to the actual design of the output end. He pressed on: "I knew if I only got a part of what I asked for I could recreate my vision of what it would sound like."[33]

In order to secure control over the modulation process, Tudor had proposed earlier to add a separate sound-modification unit between the input that had been taken up by the rock group and the output that took the engineer's shape. For the actual construction of this modifier, Tudor turned to Gordon Mumma, his peer musician at the Merce Cunningham Dance Company and an experienced builder of electronic instruments with whom he had collaborated since the early 1960s. The Pepsi Modifier created by Mumma consisted of eight channels that could take in as many as thirty-two inputs, summed in groups of four. In each channel, the signal went through frequency modulation, amplitude modulation, and a high-pass filter, any of which could be bypassed[34] (fig. 4). The choice of using only a high-pass filter was to enhance the directionality of sounds in the Pavilion, since higher frequencies are inherently more directional. Moreover, each filter had a slightly different cutoff frequency to increase the diversity of resulting sound.[35] Mumma placed an envelope follower in the side-chain that extracted the input signal's amplitude envelope to be used as control voltage for the variable circuitry determining the modulation rates in all three processing stages, thus putting the "instrumentalization of sound" back into the Pavilion. The outputs from the eight channels were then sent to an audio switch matrix, which distributed the modified sounds across the thirty-seven speakers (fig. 5).

33. Ibid.

34. The two modulation stages were each built around the same IC chip Motorola MC1545, which was a wideband amplifier originally made for video switching.

35. Mumma recalls how he "tuned" each channel carefully: "I spent a lot of time testing them out. I would put in a sine wave or a square wave or something and I'd do the same thing and if they sounded the same, I wanted to adjust it so that they were different. I was tuning the channels. Tuning them spectrally. [...] So that there was no duplication in the results." (You Nakai, "Interview with Gordon Mumma," Vancouver, BC, November 4, 2016.) Also see: Maggi Payne, "The System Is the Composition Itself," in *Music with Roots in the Aether*, ed. Robert Ashley (Cologne: MusikTexte, 2000), 118–119.

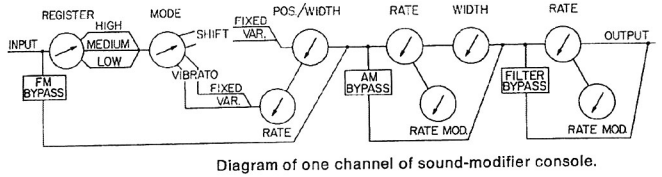


FIGURE 4. Diagram of the sound-modifier console (one channel).

Because there were twelve control knobs in each modification channel, the total number of controls on the eight-channel console added up to ninety-six. Mumma attached a specific meaning to this number. Ninety-six, he explained, was "the same order of magnitude of combinations as one has with a large organ."[36] This comparison was relevant for Tudor who, as Mumma knew well, had began his career as a virtuoso organist before switching his primary instrument to piano when he was nineteen. Mumma therefore added, "a person with practice can, in an hour or so, get a good idea of possible configurations and then be able to treat it as a performing instrument."[37]

The similarity of magnitude between the organ and the Pepsi Modifier, however, also went beyond the number of controls. As the shared byname of "console" implies, the interface of both instruments served a quasi-equivalent function of gating and modifying a constant supply of potential sound source, which is then output through the pipes or the loudspeakers, reverberating through the entire architecture that housed them. The further implications of this parallel would surface through Tudor's performance of his instrument.

Inside: Pepsi Bird Anima Pepsi

Once inside the Pavilion, Tudor made nine or ten "programs" for his instrument. Despite his and others' claim that this was the case, only four

36. Klüver, *The Pavilion*, 19.
37. Ibid.

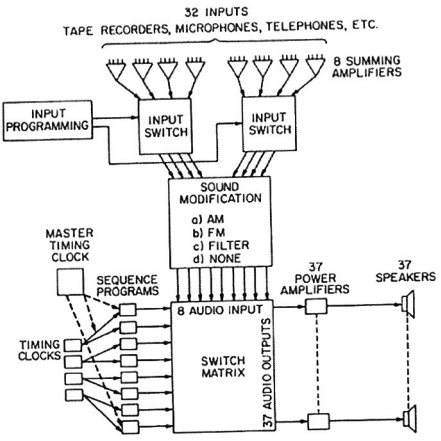


FIGURE 5. Diagram of Pepsi Pavilion sound system.

(Programs 1, 2, 3, and 6) came to be known as the "Pepsi Pieces."[38] In the sketched diagrams, each piece receives a program number:

Program 1 = *Pepsibird*	Program 2 = *Pepscillator*
Program 3 = *Anima Pepsi*	Program 6 = *Microphone*

Two additional programs contained in a diagram found among Tudor's papers fill in the gap in enumeration between *Anima Pepsi* and *Microphone*: "Program 4 = *Space*" and "Program 5 = *Animals*" (fig. 6).

Of the six programs, *Pepsibird*, *Anima Pepsi*, *Space*, and *Animals* made use of the extensive library of collected sound materials, processing selected sources through the Pepsi Modifier and distributing them across the thirty-seven loudspeakers. Two types of scores can be found for these works: (1) hand-written diagrams that list the names of source tapes, type of modulation, gain settings, speaker patterns designated with program cards ("R" for "Rotating", and "S" for "Stationary"), and switching speed

38. Lindgren noted in his general account of the Pavilion written immediately after the Expo that Tudor "created nine programs for the Pavilion." (Klüver, *The Pavilion*, 58) In a 1988 interview with Teddy Hultberg, Tudor himself claimed that he made ten programs: "I was one of the programmers from the musical side, to make material to listen to while you were examining the pavilion and I made ten different programs there." (David Tudor and Teddy Hultberg, " 'I smile when the sound is singing through the space' " (accessed October 30, 2015. davidtudor.org/Articles/hultberg.html).

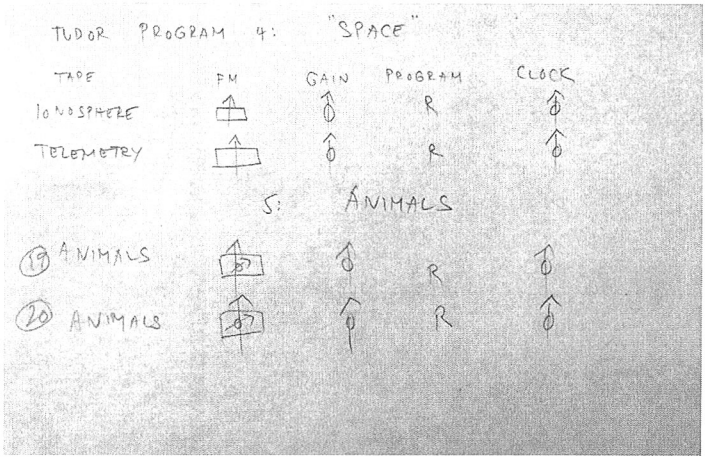


FIGURE 6. Program 4 "Space" and Program 5 "Animals" diagrams (David Tudor Papers, Box 18, Folder 1) © J. Paul Getty Trust, The Getty Research Institute, Los Angeles (940039).

controlled by clock cards; and (2) a typed description, written only for *Pepsibird* and *Anima Pepsi*, similarly listing the source tapes but with an additional text describing the method of performance. The discrepancies between the diagram and the description are considerable. Program 1 *Pepsibird* is a "live mix of ten source tapes" according to the typed description, although the diagram only lists nine sources (fig. 7) . The content of the source also differs. The description does not contain "Wasp Mod" (modulated wasp sound) and "Beetle Mod" (modulated beetle sound) from the diagram but adds three more sound materials: "Cat's Eye," "EEG" (electroencephalography—brain's spontaneous electrical activity), and "Brainwaves Regular."

Moreover, whereas the diagram indicates processing of all source tape (except for the "Nightjar" source in fast speed [7½ inches per second]), mostly through frequency modulation, the description adds an asterisk to five sources out of ten and simply notes that these "may be modified through the console channels."[39] All in all, the typed description, which re-frames the four programs as "Four Pepsi Pieces," and was therefore

39. David Tudor "*Pepsibird*, Typed Description," Box 3 Folder 10, David Tudor Papers, Getty Research Institute.

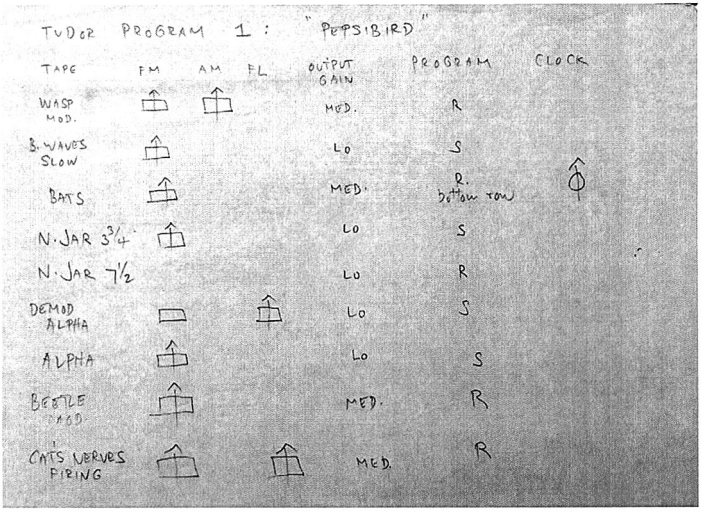


FIGURE 7. Program 1, "Pepsibird" diagram. Courtesy of the David Tudor Trust.

presumably written afterwards, gives a more articulate and focused delineation of pieces, compared to the diagram that seems more like a shorthand notation of the settings that were tried out at the Pavilion.

Despite the title of *Pepsibird*, the source tapes in neither the diagram nor typed description include any bird sounds other than the two Nightjar sounds. They instead consist mostly of recordings of neural activity—presumably linked to the theme of "flight," albeit on a micro scale: nerves firing, brainwaves, EEG, or alpha waves. The instruction on the typed description reads:

> Distribute [the ten source tapes] among the eight output channels as follows:
> Define the interior space by establishing different speaker patterns (distinguishing between rotating and stationary patterns):
>
> | | |
> |---|---|
> | small circle | spiral |
> | great circle | small triangles |
> | large rhomboid | small ovals |
> | single overhead | |
>
> Associate the sourcetapes with the speaker patterns, distinguishing between constant or intermittent sound materials.

Maintain the identity of each sound—if modified through the console, it should not occur also in unmodified form
No more than five tapes sounding simultaneously.[40]

Tudor's aim is to establish a clear relationship between the source tapes and the loudspeaker patterns. For this reason, the use of the modifier is kept minimal, even allowing for the possibility to bypass it entirely (the addendum "[five source tapes] *may* be modified through the console channels," obviously implies that they may *not* be modified at all). The clear identity of input sources, as well as their lucid differentiation attained by limiting the number of simultaneously used tapes, would have been necessary to foreground the changes occurring at the output end. Thus, the first program Tudor prepared for the Pavilion does what he had been planning all along: to move sounds across multiple loudspeakers in different patterns and speeds to define the interior space of the Pavilion.

This approach was turned inside out in the third program *Anima Pepsi.* The nine assigned source tapes consisted of animals and insect sounds, marking also a contrast with *Pepsibird* (fig. 8). The typed description adds two sources not found in the diagram: "insects" and "fly on flypaper modified." The instructions read as follows:

Employ the console modifier channels freely—modifying characteristics can be changed discretely or within the durations of the sounds.
Relation of sounds to output channels can be changed freely.
Speaker clocking rates should be varied.[41]

Contrary to the first program, the focus here is decidedly on exploring the nature of Mumma's Pepsi Modifier. This also explains why no mention is made of the speaker patterns, except that they and their speed should be changed.

Matt Rogalsky analyzed the difference between these two programs based on the nature of input source: "Whereas *Pepsibird* had to do primarily with 'interior' spaces of neural activity, *Anima Pepsi* [. . .] is a blend of field recordings of 'exterior' animal and insect sounds."[42] This spatial dichotomy of inside versus outside, however, is itself turned inside out when the nature of the modulation process is considered. Whereas the

40. Tudor, ibid.
41. David Tudor, "*Anima Pepsi,* Typed Description," Box 3 Folder 10, David Tudor Papers, Getty Research Institute.
42. Rogalsky, Liner Notes, *The Art of David Tudor 1963–1992.*

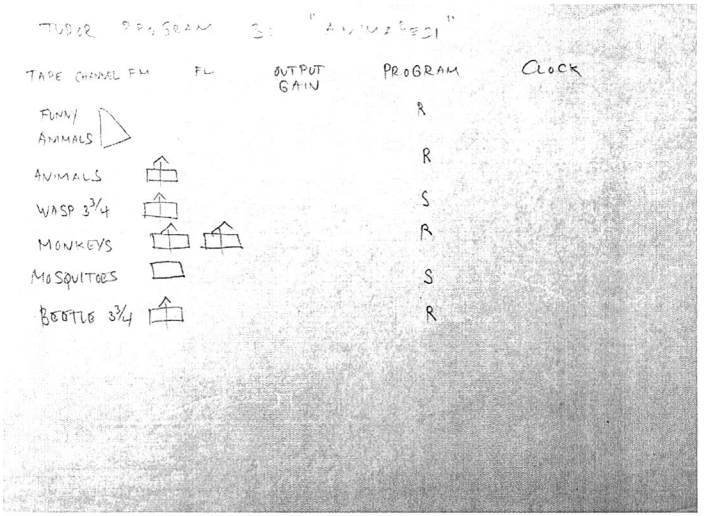


FIGURE 8. Program 3, "Anima Pepsi" diagram. Courtesy of the David Tudor Trust.

"interior" sounds of *Pepsibird* were used to define the entire space of the Pavilion *exterior* to Mumma's modifier, the "exterior" sounds of *Anima Pepsi* were directed toward exploring the *interior* operations of the same modifier and the overall sound system. This is only to note that the distinction of inside and outside is relative to the *scale* of instrument with which a program is engaged—a point that the two remaining programs brought home.

Inside: Pepscillator & Microphone

If the first program, *Pepsibird*, realized Tudor's original conception of the Pavilion as an instrument, the second program, *Pepscillator*, developed out of his initial experiments with the Pepsi Modifier: "[Mumma] made eight channels of modification. Of course one of the first things I did was to see: 'can these be used without any input?' So I chained them together in various ways and, lo and behold, there they were, oscillating."[43] What Tudor discovered was that when the output of one modifier

channel was connected to the input of another, returning to the input of the same channel after going through several others in a daisy chain, any subtle electronic noise in the circuit triggered a process of oscillation that produced a complicated and erratic rhythm.

The reason he spoke about this approach as a matter of course is because he had been doing it for some time by then. Anthony Gnazzo reminisced that as early as 1967, when Tudor was on a teaching residency at Mills College, he had used the Buchla synthesizer in exactly that way: "David's favorite patch on the Buchla which he used to demonstrate to his students, was one where he would feed the output of a device through one of the mixers back into the input, i.e. howling feedback."[44] In the same year, Tudor applied the same "no-input" technique to his own modular instruments in the realization of Toshi Ichiyanagi's *Activities for Orchestra.*

The diagram of *Pepscillator* shows how the seven modification channels—and it was seven, because the eighth channel turns out to have been never installed—were divided into three main oscillator sections, framed by the yellow square[45] (fig. 9). However, the only section that would truly oscillate is the top three channels, in which the output of channel 2 is returned to its own input through channels 5 and 7. The other sections are dedicated to output processing, where the channels are connected in chains without forming a loop. Naturally, therefore, the sensitive control points whose adjustment was critical concentrated in the first three channels. The process starts from channel 2, and oscillation is obtained by gradually opening the gain for channels 5 and 7, which then subsequently becomes processed in the lower channels.

In all the preparatory sketches, the feedback loop that became *Pepscillator* was simply designated as "Rhythms." In particular, the low frequency oscillators in the feedback path of Mumma's modulator produced shifting sub-audible tones that articulated the signals, imparting them a

43. David Tudor and John David Fullemann, " '...performing is very much like cooking: putting it all together, raising the temperature' " (accessed October 30, 2015). davidtudor.org/Articles/fullemann.html.

44. Anthony Gnazzo, "Email to John Bischoff," March 3, 2015.

45. A report from April 22, 1970—just three days before the E.A.T. was kicked out from the Pavilion—listing up the problems found in the sound system, stated: "Sound modification board for channel eight not installed" (David Tudor, Fred Waldhauer, and Julie Martin, "A Quick Review of Problems Encountered in Sound System," Box 17 Folder 7, David Tudor Papers, Getty Research Institute).

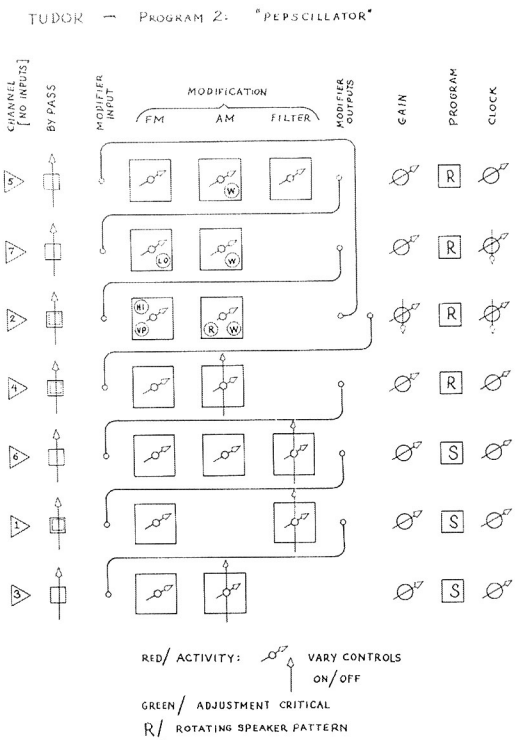


FIGURE 9. Program 2, "Pepscillator" diagram. Courtesy of the David Tudor Trust.

repetitive pattern that gradually transformed itself as it progressed. By thus arranging the feedback path itself as a modulation channel, Tudor was able to finally break away from the continuous tone that had been inherently associated with feedback. Instead, feedback now provided him with a constant supply of *non-continuous* sound—a complex oscillating rhythm that would characterize Tudor's no-input pieces of the 1970s. As he later reminisced, when he patched the *Pepscillator* together, "Rhythms began to appear and the degree of their variability was really extraordinary. When I was performing this at the pavilion, people started to dance on the floor."[46]

The last remaining program, "*Microphone,*" explored the same phenomenon of feedback oscillation, though it used the entire Pavilion, instead of limiting itself to the Modifier. The relationship between *Pepscillator* and *Microphone* is therefore analogous to that between *Anima Pepsi* and *Pepsibird.* Tudor employed two shotgun microphones, one directed at the loudspeakers and the other at some random space in the Pavilion, creating discrete bursts of feedback that were regulated by the slow rotating pattern of activated speakers (fig. 10). The input from the microphone pointed toward the loudspeakers went through amplitude modulation and the other input through frequency modulation and high-pass filter. The acoustic feedback through the two differently-directed microphones converted the entire Pavilion into a giant oscillating echo chamber, which accumulated the soundings of its own resonance characteristics while being gated intermittently by the programmed movement of activated speakers. Here again, the continuous nature of feedback was gated and converted into a rhythm—albeit a much slower one than in *Pepscillator*—through the modulating channels of the instrument itself.

With these two no-input pieces Tudor collapsed the dichotomy between *generation* and *modification* of sound that he had confronted since the start of the Pavilion project. The very difference between generating and modifying sound ceases to exist for a system that generates sound from *within* the channels of modification. *Bandoneon !* had already used feedback for producing white noise, but once it was activated it simply kept accumulating in a semi-automatic manner—composing itself out of its own composite instrumental nature. The sole control point for the single performer against this exponential growth of feedback was a "reset button" attached to the bandoneon that cut off the entire process. In

46. Tudor and Hultberg, "I smile when the sound is singing through the space."

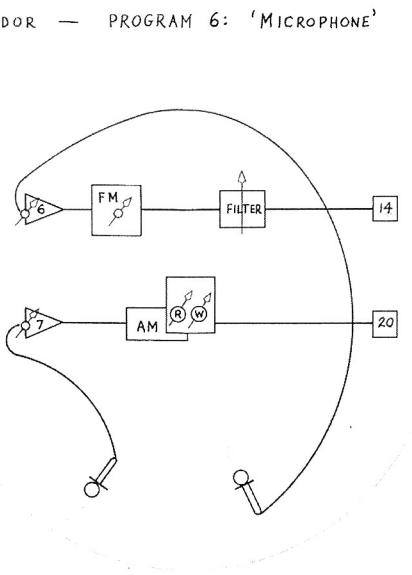


FIGURE 10. Program 6 "Microphone" diagram. Courtesy of the David Tudor Trust.

turn, at the Pepsi Pavilion, feedback became the very principle for generating sound, and Tudor could regulate its returning path by the console interface and the programming of speaker patterns. This difference is brought by the nature of the control interface: whereas the bandoneon was primarily a generator of sounds, the Pepsi Pavilion had been conceived as a modifier in its entirety, all the way up to its thirty-seven loudspeaker output. By using the output of the instrument as its sole input, both on the scale of the Pepsi modifier (*Pepscillator*) as well as the Pavilion (*Microphone*), Tudor turned the modifier into a generator, and discarded external input completely.

Inside-Out: Instrumental Synecdoche & The View(s) from Inside

In electronic music, it is customary to refer to an electronic device, or even a configuration of multiple devices, as an "instrument." Tudor's conception of the Pepsi Pavilion as an instrument reveals a more counterintuitive expansion of the same notion, however. For if the oscillating Pavilion is itself an instrument, then *the instrument is larger than the human performer.* As a matter of fact, the human performer and audience members now find themselves *inside* the instrument. The conventions of scale collapse.

Throughout his life, on the rare occasions he talked about his music, Tudor referred to the lasting influence of organ on his distinct approach. "You could say that my sound imagination was controlled by [the organ]," he explained in an interview from 1995, the year before his death. "And even to this day, you could see the traces in my own music."[47] These visible traces have been noted, most notably by Mumma, who recalled accompanying Tudor to European churches with historic organs while on tour with the Merce Cunningham Dance Company in the 1960s and 70s. Whenever possible, the former organist would play the instrument: "He thrived on the time delays between keyboard activation and resulting sounds, the motion of overlapping sounds among separate ranks of pipes and their reverberation and cross resonances in the unique acoustics of each venue, and the vast possibilities of timbre and attack."[48] As Mumma stressed, these abilities Tudor developed on the

47. David Tudor, "Interview with David Tudor by Jack Vees (July 12, 1995) [Side r]," Oral History of American Music archive, Yale University, 3.

48. Mumma, "With Tudor the Organist," *Cybersonic Arts: Adventures in New American Music* (Champaign, IL: University of Illinois Press, 2015).

organ, along with the focus on "the unique character of each instrument," were to be of profound significance for his music.[49]

Aside from nourishing his virtuosity, however, the exposure to the largest of all Western instruments whose body parts—the blower, bellows, wind chest, console, swell box, the various pipe sections—often extend across the interior space of the church architecture also seems to have sparked in Tudor an idiosyncratic view concerning the *physical scale* of musical instruments. With the king of instruments, the human performer and listener are always placed inside its composite network of components.

The extraordinary scale at which Tudor conceived musical instruments explains a peculiar method he developed for composing his works. As is obvious from the title, Tudor conceived of the no-input configuration of *Pepscillator* as an oscillator: "Seven channels of sound modification hooked up together to form a complex oscillator, without using external input material of any kind."[50] A feedback oscillator oscillates by returning the output of an amplifier to its own input through a filter. What is significant about this mechanism is that *it requires no input*: the circuit uses thermal noise, usually generated by switching the amplifier on, to get the oscillation started, which then becomes smoothed into a sine wave as the signal goes around the loop through the filter. Indeed, Mumma's modifier contained four oscillator sections, three of which were set to low-frequency, to smooth out the control signals extracted from the envelope follower before sending them to the variable circuits in each stage.[51] In this way, *Pepscillator* formed a sort of an "instrumental synecdoche," whereby the internal mechanism of an electronic device was taken out of the box and materialized on a giant scale.

This method turned the nature of a specific instrumental component inside-out and realized it as the nature of the entire instrumentarium.[52]

49. "You're in a big church and your organ is up somewhere there and the pipes aren't necessarily in the same place. So Tudor developed early the skill of being able to adjust to the time lag, the latency, if you will, between what he does and what he hears. This is *profoundly* significant in understanding the evolution and development of his electronic music way later." (You Nakai, "Interview with Gordon Mumma," November 11, 2011, San Francisco).

50. David Tudor, "*Pepscillator*, Typed Description," Box 3 Folder 10, David Tudor Papers, Getty Research Institute.

51. This was examined by the synthesizer builder and composer Michael Johnsen, who analyzed the internal circuitry of the prototype modifier Mumma made, and is now stored at the David Tudor Instrument Collection at Wesleyan University.

52. It is possible to observe in this method the influence of Anthroposophy, the occult philosophy created by Rudolf Steiner which Tudor followed throughout his

Tudor first employed this tactic in *Bandoneon !* in which he shifted his first idea of using the white noise generator as the sole sound source, to the generation of white noise using all the components involved—essentially turning the whole sound system into a giant white-noise generator. It would subsequently become his preferred compositional method. Tudor called *Pepscillator* a "complex oscillator," but in a later note for *Untitled*, another no-input piece written two years after the Pepsi Pavilion, he employed a more straightforward description: "the configuration of devices & their inter-connections, was conceived of as a 'Giant Oscillator.' "[53]

Similarly, the instrumental loudspeakers of *Rainforest*, constructed by attaching transducers to different physical materials to turn them each into an output with a unique resonant characteristic, were essentially objects turned into giant filters or equalizers. John D.S. Adams, the sound engineer of the Merce Cunningham Dance Company in the 1990s who assisted Tudor on numerous occasions, describes a similar approach in the composer's treatment of loudspeakers at a Cunningham performance: "Tudor [. . .] used his acoustic environment as a big EQ [equalizer]. By using a multiple speaker system (8+ channels) he could take advantage of the different acoustic characteristics of the theatre by localizing the sound to a certain area. [. . .] Each speaker [. . .] acts like an EQ by responding to the frequencies that it was designed to."[54]

If the instruments and their nature are enlarged, the humans are rendered small in turn. Tudor consequently appears not only as a composer, builder, or performer of his electronic music, but also a component of

---

life. Based on a dichotomy between the inner spiritual world and outer material world, Steiner sought to describe the interconnection between these two realms through the topological principle of inversion—of turning things inside-out. As with Tudor, Steiner's operation entailed a shift of scales: "Suppose that you could take the human being as you see him here and turn him inside out [. . .] taking hold of him in the inmost heart and turning him inside out like a glove, then man would not remain man as we see him here; he would enlarge into a Universe." (Rudolf Steiner, "The Cosmic Origin of the Human Form," in *Planetary Spheres and their Influence on Man's Life in Earth and in Spiritual Worlds* (London: Steiner Press, 1982), quoted from www.rsarchive.org/Lectures/Dates/19220822a01.html (accessed February 15, 2017). For an overview on Steiner's methodology of inversion and its influences, see: Markus Brüderlin, "You Must Turn Your Life Inside Out!: Rudolf Steiner and the Modern Principle of Inside Out," in *Rudolf Steiner: Alchemy of the Everyday* (Weil am Rhein: Vitra Design Museum, 2013), 120–30.

53. David Tudor, "Notes for *Untitled*," Box 19, David Tudor Papers, Getty Research Institute.

54. John D. S. Adams, "Equalization a la Tudor," davidtudor.org (accessed October 30, 2015). http://davidtudor.org/Electronics/eq.html.

his own composite instrument. The role he played in his compositions was indeed parallel to the workings of electronic components that modify and control the process of modification: sounds would enter his ears, influence the way he manipulated other components, which in turn influenced their behavior and the sounds they produced. Already in the 1950s, his exceptional capacity as a pianist and as a "genius solver" of indeterminate graphic scores had nurtured among composers the peculiar recognition that "David Tudor" was a musical instrument rather than an instrumentalist. As Cage reminisced, "he was [. . .] 'a musical instrument.' And when Bussotti wrote a piece for him, he didn't say for piano, he said for David Tudor, meaning him as an instrument."[55] When he turned to electronics and started making his own instruments, it was as if Tudor had discovered a way to externalize his role, to create surrogate systems that would behave for him as he behaved for others. This uncanny parallel between Tudor as instrument and instruments of Tudor remained at the basis of his works, influencing the way he talked about them. Thus, the description of his relationship to his instruments—that he could "only hope to *influence* the instrument"[56]—was replicated precisely in his description of the relationship *between* his components: "I found out that if the components don't match, then the one component is able to *influence* the next, so that signals are created at many points within the circuit."[57]

In 1976, Tudor wrote a manifesto-like text entitled "The View from Inside," for the program note of a concert by "Composers Inside Electronics," a group he had formed with younger musicians to perform *Rainforest* as a collaborative piece. Opposing the cybernetic control of servomechanisms—machines seen as "servants"—Tudor rooted instead for a personification of non-human components. The result was music that revealed itself from the nature of the very instruments used:

> Electronic components & circuitry, observed as individual & unique rather than as servomechanisms, more & more reveal their personalities, directly related to the particular musician involved with them. The deeper this process of observation, the more the components seem to require & suggest

55. John Cage and William Duckworth, "Anything I Say Will Be Misunderstood: An Interview with John Cage," in Richard Fleming and William Duckworth, eds. *John Cage at Seventy-five* (Lewisburg, PA: Bucknell University Press, 1989), 26–27.

56. Ray Wilding-White, "David Tudor: 10 selected realizations of graphic scores and related performances (1973)," Box 19, David Tudor Papers, Getty Research Institute.

57. David Tudor, "From Piano to Electronics," *Music and Musicians* 20 (August 1972): 26.

their own musical ideas, arriving at that point of discovery, always incredible, where music is revealed from 'inside,' rather than from 'outside.'[58]

The significance of the term "inside" shifts in relation to *what* is considered as an instrument. The composer arranging a feedback path around an amplifier may be "inside electronics," but so is the composer maneuvering a shotgun microphone in the oscillating echo chamber of *Microphone*. The methodology of instrumental synecdoche along with the notion of giant instruments relativizes and multiplies the view from inside. With this understanding, it is possible to see Tudor's compositional output with a surprising coherency. The apparent stylistic difference between works based on modulating external tape sources—continuing the exploration of *Pepsi Bird* or *Anima Pepsi*—and those which pursue the no-input generation of sound through feedback—the lineage extending from *Pepscillator* and *Microphone*—has been noted and discussed.[59] If, however, the entire space of performance is regarded as an instrument, the use of tape is obviously not inconsistent with the "no-input" approach, since that is also an event happening *inside* the instrument. The question of what constitutes an "input" is necessarily dependent on where the instrument's inside/outside are delineated, and thus always relative to the *scale* of observation. John Driscoll described a rare public talk Tudor gave in 1978, in which the composer claimed that, in using the tape materials, "I really don't care about where it starts. All I care is what I end up with."[60] The role of the tape input is therefore analogous to the random thermal noise within the oscillator circuit that activates the no-input feedback system—albeit on a much larger scale.[61]

58. David Tudor, "The View from Inside," Box 19, David Tudor Papers, Getty Research Institute.

59. See for instance: D'arcy Philip Gray, "David Tudor in the Late 1980s: Understanding a Secret Voice," *Leonardo Music Journal* Vol.14 (2004): 41–47. John Fullemann, who worked as the sound engineer for the Merce Cunningham Dance Company and assisted Tudor in many of his works throughout the 1970s, expressed a strong opinion: "I really really loved *Toneburst*, because it was so crazy, and it was so risky. And the pieces before that with the microphones and things have been leading up to this feedback and difficulties, and *Weatherings* struck me as a giant step back from that risky world—because it was sound input, processing, sound output." (You Nakai, "Interview with John David Fullemann," Skype, December 23, 2011).

60. You Nakai, "Interview with John Driscoll," Long Island City, NY, November 19, 2011.

61. This disregard for the "nature" of what is given, in contrast to the dedicated focus on what happens within the modification process extends to Tudor's general attitude towards electronics. As Mumma recalled: "I never saw him building fundamental

The analyses of individual "programs" show how Tudor's performances each focused on a different scale to explore the Pepsi Pavilion. The fissure between the composition of the instrument and that of the programs brought to the fore at the Pavilion was therefore grounded in the multi-scalar nature of his instrument. In other words, the Pepsi Pavilion was never simply "one" instrument. Each program discovered a new instrument inside (or outside) another. The apparent divide between a single instrument and multiple performances is thus turned inside out to reveal the multiplicity of the instrument itself.

Outside: After All

In October 1958, Tudor visited the Brussels Expo with John Cage and gave a piano concert inside inside the German Pavilion and French Pavilion. Although the Philips Pavilion—the famous collaborative effort between Le Corbusier, Iannis Xenakis, and Edgar Varese—stood nearby, Tudor wrote nothing about it in the postcard sent from the Expo to his then-wife M.C. Richards. The only pavilion mentioned was the Dutch one, which apparently had an artificial wave built inside. "It makes a beautiful sound," Tudor reported.[62] This peculiar disregard for other musical pavilions may be excused for the pianist in 1958, but it extended all the way to the composer of sound systems in 1970. The Osaka Expo alone included several well-known pavilions dedicated to complex spatialization of sound: The West German Pavilion, which hosted a spherical concert hall designed by Karlheinz Stockhausen, or the Iron and Steel Pavilion where composers like Iannis Xenakis and Toru Takemitsu presented tape works. The sound system of these other pavilions all seem to display strong affinities with that of the Pepsi Pavilion, from the use of multiple speakers and the movement of sound across space, to the control console allowing various forms of electronic modulation. If anything, they were more extravagant: the German Pavilion had fifty loudspeakers installed across its spherical wall; the Iron and Steel Pavilion boasted an impressive 696 speakers under the floor and 124 hanging

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equipment; which I did—I built fundamental equipment. But he was always rearranging things and for the most of the eight years that I performed with him with the Cunningham Dance Company and sometimes extra things. It was how he arranged that collection of modules, and rearranged, and rearranged, and brought in new sound sources." (Nakai, "Interview with Gordon Mumma," November 11, 2011).

62. David Tudor, "Postcard to M.C. Richards (October 23, 1958)," Box 26, Mary Caroline Richards Papers, Getty Research Institute.

from the ceiling. No document indicating the slightest interest on Tudor's part has been found.

This utter indifference to set even a remote comparison between his composition and other seemingly related endeavors that existed in his vicinity may have resulted from the complex nature of Pepsi Pavilion's instrumentality. Perhaps Tudor was more focused on exploring the multiplicity *within* his instrument rather than comparing it with a multiplicity of others. At least for him, the similarity with other pavilions may have been something that pertained to the view from "outside," so to speak. However, the view from outside is a view that we, necessarily removed both in time and space from the Pepsi Pavilion, must admit to as well. And from *this* viewpoint, it is possible to see that there is an obvious "outside" to Tudor's view from inside—and not merely a relative one pertaining to scales. For the scalar shift from one inside to another always happened *inside* the Pavilion. After all, the singularity of the Pavilion as architecture frames the plurality of the Pavilion as instrument. The view from outside, therefore, tends to equate Tudor's instrument with the Pepsi Pavilion *as an object.* The instrument always seems be singular when it is not performed. The view from inside is structurally blind to this perspective. But of course one must step out of the Pavilion at some point.

Because the Pavilion was assigned to visiting artists from the second week onward, Tudor must have made his nine or ten programs within the first week. Perhaps he could have gone on indefinitely, but on April 25, 1970, just over a month after the Pavilion opened its doors to the public, Pepsi-Cola International demanded the E.A.T. artists to leave the premises of the Pavilion immediately for spending too much money. Against Pepsi's strict orders to leave every single piece of equipment and material for which the corporation had paid, Tudor and others managed to remove all the source tapes and sneak them out across the perimeter fence. With all the tapes and artists gone, Pepsi had little choice but to blast from the thirty-seven loudspeakers of Tudor's instrument, the theme song from their offering at the 1964 New York World's Fair: *It's a Small World.*

As the lyrics to the popular song attest, scale is a matter of perspective. A given instrument always suggests smaller instrumental components inside itself as well as larger ones that can be composed outside using itself as a component. There must be a *physical* limit to this constant relativization of scales, though, if an instrument is to be actually realized—composed and performed—by a human being. How small is not difficult

to discern—if not the sounds turned into instruments, then it must have been at the level of electronic components and integrated circuits for Tudor. How large, on the other hand, is not so obvious.

Once outside of its premises, as it gradually receded away in distance, the Pepsi Pavilion may have appeared small to Tudor's eyes—after all. Soon after returning from Osaka, Tudor began searching for the location of his next project, which sought to verify "the maximum scale feedback could be implemented."[63] He would do this by extending the idea of "giant instrument" out of a man-made architecture into the expanse of natural landscape—Tudor now wished to turn a desert island into a musical instrument.[64]

63. You Nakai, "Interview with Fujiko Nakaya," January 15, 2014, Tokyo.

64. For more details about *Island Eye Island Ear*, Tudor's decade-long effort to convert an island into a musical instrument, see: You Nakai, "The Natures of Technology: David Tudor's Conception of an Island as a Musical Instrument," Proceedings of the Conference on Interdisciplinary Musicology (Berlin: Staatliches Institut für Musikforschung, 2014).