Open Sources: Words, Circuits and the Notation-Realization Relation in the Music of David Tudor

Ron Kuivila

ABSTRACT

As a pianist, David Tudor played a pivotal role in the development of the postwar musical avant-garde that has only recently received the scholarly response it warrants. The author traces the development of Tudor's approach to live electronic music from his work as a pianist and assesses the extent to which the indeterminate notations he so often realized entered into the development of his approach to electronic systems.

David Tudor's transition from performer to composer, like anything associated with Tudor, was a complex and multi-threaded process that resists a simple narrative account. It was a gradual and not entirely conscious development. *Fluorescent Sound* (1964) was identified as Tudor's first composition only in retrospect, years after its performance in Stockholm in conjunction with a performance by Robert Rauschenberg and Steve Paxton. *Bandoneon!* (1966) was presented at the 9 Evenings of Theatre and Engineering in 1966 with the following note:

> *Bandoneon!* is a combine incorporating programmed audio circuits, moving loudspeakers, TV images, and lighting instrumentally excited. . . . *Bandoneon!* uses no composing means, since when activated it composes itself out of its own composite instrumental nature [1].

The term "combine" is significant, for *Bandoneon!* is not quite a composition in the traditional sense. Tudor does not claim the role of composer; rather, he is interpreter and performer acting within an interactive situation created collaboratively. The idea that a piece can "compose itself" is best understood by considering the development of Tudor's self-conception as a pianist and his approach to the indeterminate compositions with which he was most closely associated.

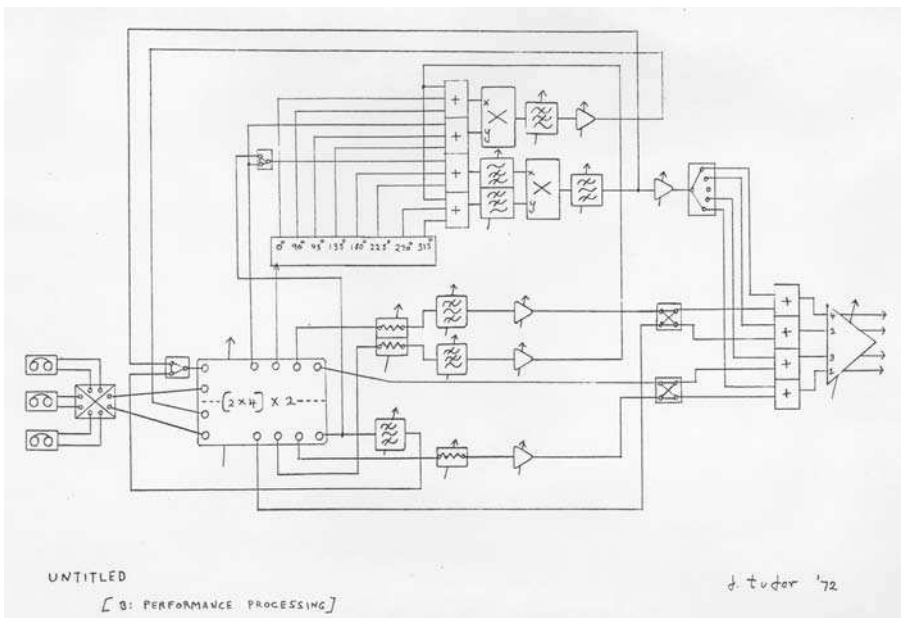
Notation/Realization

Tudor's own description of his passage "from piano to electronics" begins with the following sentence: "Ever since the early days I've always preferred to work with other people" [2].

Tudor invoked Ferruccio Busoni's adage that "Notation is an evil separating musicians from music," while at the same time insisting that fidelity to a composer's intentions was his primary obligation. This viewpoint allowed Tudor to directly affect—perhaps even alter—composers' conceptions of their own works. Speaking of Stefan Wolpe's *Battle Piece* (1943–1947; premiered by Tudor in 1950), Tudor recalled, "The details of articulation in the fourth movement, I had to do that myself. . . . I don't know how to express the quality of joy that came to me when he [Wolpe] had understood the texts as I played it in regard to that movement" [3].

This role became more radical, and more codified, in Tudor's work with John Cage. Cage often invoked Sylvano Bussotti's designation of Tudor as a "musical instrument" without revealing the playful tone of Bussotti's description of Tudor as a "minotaur of the pianistical mythology" [4]. In 1970 John Cage commented that everything he had composed after 1951 was written

Fig. 1. Performance patch diagram for *Untitled (Homage to Toshi Ichiyanagi*), 1972. (© Estate of David Tudor)



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An earlier version of this article was presented at the symposium "The Art of David Tudor: Indeterminacy and Performance in Postwar Culture," held at the Getty Research Institute, Los Angeles, California, 17–19 May 2001. Documentation of the symposium is available at: <http://www.getty.edu/research/conducting_research/digitized_collections/davidtudor/symposium.html>.

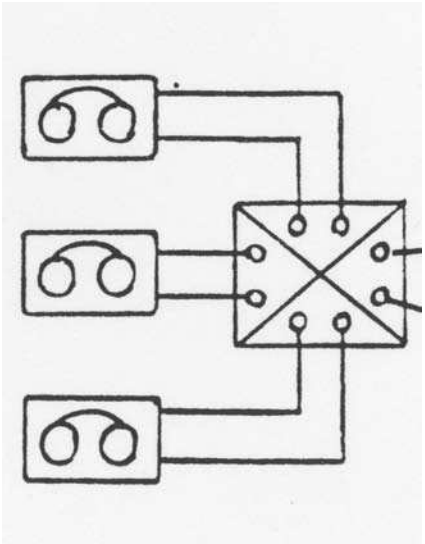

Fig. 2. Detail of performance patch diagram for *Untitled (Homage to Toshi Ichiyanagi*), 1972: tape recorders and channel selection notation. (© Estate of David Tudor)

for David Tudor, and that while composing *Song Book* (1970), he "changed the singers into David Tudor" [5].

Ananda Coomaraswamy, whose thought Cage invoked repeatedly throughout his career, distinguishes between the types and archetypes in Platonic and Indian thought as follows:

> But whereas Platonic types are types of being, external to the conditioned universe and thought of as absolutes reflected in phenomena, Indian types are those of sentient activity or functional utility conceivable only in a contingent world. Oriental types are not thought of as mechanically reflected in phenomena, but as representing to our mentality the operative principles by which we "explain" phenomena [6].

It is in this sense that Cage seems to discuss Tudor as an archetype who literally embodies music. One can appreciate both the power and the restrictiveness of such a formulation for both Cage and Tudor.

The development of this connection began with the composition of *The Music of Changes* (1951). In that piece, chance specifies every detail and the performer has no choice but to be as faithful as possible to the physical requirements dictated by the chance process. It seems entirely appropriate that the first explorations of chance-determined music would require of the composer meticulously detailed notation of chance determinations and of the performer perfect compliance with those notations. How else to discover what chance provides?

Cage came to reject this attempt to fully specify all details of the sounding music: in "Composition as Process" (1958) he described *The Music of Changes* as "an object more inhuman than human" [7]. His goal had become to compose notations that circumscribed a field of musical possibility out of which an unrepeatable stream of unique sounds and actions could emerge. Beginning with *Winter Music* (1957), the notations of his works became increasingly abstract, requiring the performer to play an increasingly direct role in determining all aspects of the specifications of the sounding music. The *Concert for Piano and Orchestra* (1957–1958) is a benchmark of this development. Its Solo for Piano is an encyclopedia of 84 different notations from which the soloist is to derive a part. Like most concerti, the Solo is intended to be a virtuosic exercise. (Cage himself told me this after a performance in which he was dissatisfied with the soloist.) Such a display of virtuosity appears to be in tension, if not in outright contradiction, with a sensibility that shuns personality and ego. This contradiction can be resolved by claiming for Tudor, the intended soloist, the status of a "musical instrument."

After the *Concert,* Cage began recasting notations from the Solo for Piano as transparent overlays that could be rearranged to generate a stream of new notations. James Pritchett refers to these notations as "musical tools," because they also functioned as decision-making devices that could be applied in new situations independent of the original piece for which they were made [8]. For example, Tudor used these materials in preparing the combination of piano and electronics he performed in parallel with Cage's reading of the 90 stories of *Indeterminacy* (1959). Two of these "tools" have relevance to Tudor's subsequent involvement with electronics: *Cartridge Music* (1960) and *Variations II* (1961). In these pieces, the composer-performer dialog between Cage and Tudor became increasingly complex, as emerged in an interview with Teddy Hultberg in 1988:

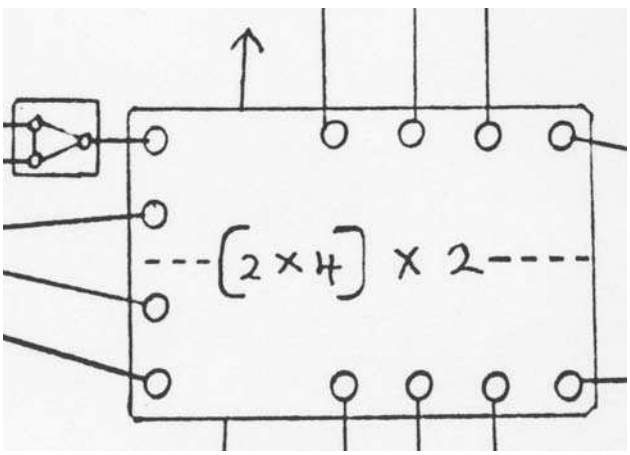

Fig. 3. Detail of performance patch diagram for *Untitled (Homage to Toshi Ichiyanagi*), 1972: signal routing. (© Estate of David Tudor)

> **TH:** When we look at some of the scores of John Cage, were you not in a sense a co-composer when you realized them? How do you draw the line between interpreter and co-composer?
>
> **DT:** Oh, I think it's a great line. I crossed over it with great difficulty because I always wanted to be a faithful interpreter and my whole early training was for absolute realization of a score, which is a very complicated proposition. For instance, nowadays, I feel that many people don't read John Cage's score in the sense that they don't realize why the instructions are difficult to understand. Now, when you look at a score that somebody presents to you and you see that you are following the instructions and the way they are laid down, you are the composer's helper. If you have to select a medium for yourself in which to realize those materials, then you have to think about how far you have to go in order to realize it. One example is John Cage's *Cartridge Music.* All the instructions were given. All you had to do was to do what it said quote unquote and bring about a performance score for yourself. However, in doing that, there are a lot of small things which cause you to actually alter the readings you got from the score. For instance, for the determination of time, John Cage had employed a clock on transparent paper which goes around from one to sixty. Well, one thing which I discovered very early on was that when you are performing, there are lots of things you have to do besides looking at a stopwatch or thinking about the time. So after a while, you think, "Oh, I was so late, what am I going to do? I'm supposed to hurry," or, "the time is so long, I have nothing to do, what shall I do?" So after looking back on it you decide, well, it's not important what minute it is, it's only important what second it is, so then you see that if you make your determination only reading the second hand and it does not say what minute it is, then all of a sudden you are giving yourself a freedom of interpretation which you didn't have before.
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> It was years later, because John and I performed this piece for many years, that I found out that he had done exactly the same thing in his own realization. And another thing which I had done was with reading a time bracket. If you take a time

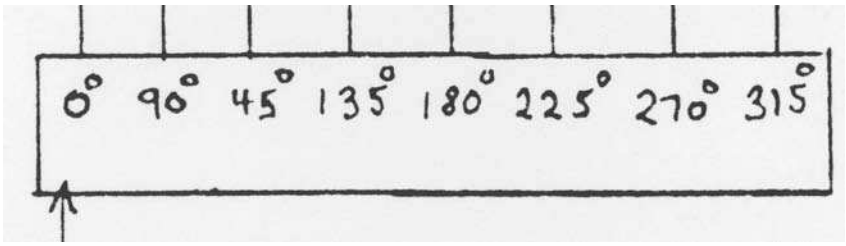

Fig. 4. Detail of performance patch diagram for *Untitled (Homage to Toshi Ichiyanagi*), 1972: phase-shift network. (© Estate of David Tudor)

> bracket, it says you start at :05 seconds and you stop at :35 seconds. It's also possible to read the bracket backwards. I mean, what difference does it make? And John was also doing that himself, but he had never told me. He had never told any of his performers that that was possible. But that's also given in the score material. If you look at it, precisely, you see that there are those possibilities [9].

Throughout the later years of the 1950s there had been a kind of dialectical collegiality between Stockhausen and Cage. Tudor was closely associated with both and, in general, played the role of musical ambassador, bringing American music to Europe and vice versa. Both groups claimed Webern as an antecedent. Cage described their difference as follows: "Stockhausen assumes a responsibility toward the problem of unification of disparate elements," while the Americans worked from the "possibility of making a music not dependent upon linear continuity." Of course the ability to perform independent of linear continuity (and so to "be free for a whole hour at a time") was understood to be an attribute of Tudor's virtuosity.

Cage commented that Tudor's "interest in puzzles invited the whole thing of indeterminacy. And so what you had to do was to make a situation that would interest him. That was the role he played" [10]. Possibly Tudor was looking for the formulation of the composer's idea most open to his own intervention. For example, Tudor says of Stockhausen's *Klavierstucke:*

> All his works of those days were composed as theoretical forms, structures dealing with numbers, and whenever it came to making a score he had to translate his original material into musical form. Many's the time I would ask him why he didn't publish the original idea instead of the realization he had made from it, but he always refused [11].

WORDS

Both Cage and Stockhausen adopted a parametric conception of sound in which musical composition came to determine vectors of attributes. It is this approach that created the performance problems Tudor describes above. In the late 1950s, Cage offered a course in experimental music at the New School for Social Research. According to Liz Kotz [12], one of the original goals of these classes was to introduce the innovations of Darmstadt to the American musical context.

The student response to Cage's course went in a direction quite different from the quantitative approach. The pieces of this younger generation avoided the technical virtuosity and procedural complexity that seems to have been so much a part of the Darmstadt–New York dialogue. Instead, they began to work directly with naturally occurring chance processes and to compose brief, elliptical texts that could be conceived as scores, instructions or poems. This tactic was adopted by others not directly involved in the classes and within a few short years became one of the central features of Fluxus.

Within the class, George Brecht began to compose pieces in which the indeterminate structure of the piece arose directly from the action rather than being predetermined. His later event scores were "private, like little enlightenments I wanted to communicate to my friend. . . . Later on, rather to my surprise, I learned that . . . others had made public realizations of pieces I had always waited to notice occurring" [13]. Yoko Ono's word pieces of the early 1960s are quite similar to Brecht's events (1959–1966), but they involved a play between public and private spaces in which reading a text effectively performs it or individuals are asked to break a taboo (the cut piece, the touch piece, etc.) in a context of mutual responsibility. In contrast, La Monte Young's text pieces were quite public in conception, with an occasional dose of inter-generational brattiness. For example, his *Piano Piece for David Tudor No. 2* recalls Tudor's performance of *4′33″* by asking him to open and shut the keyboard lid repeatedly until the action is performed in complete silence.

The first budding of these text pieces was warmly received by both Cage and Tudor. Given Cage's acknowledgment of the role Tudor played in conceptualizing the *Black Mountain Piece* (1952) it is intriguing to note that Brecht, Ono and Young all wrote pieces dedicated to Tudor and that Tudor was directly involved with presenting these pieces in Cologne and New York. In interviews of that time [14], Cage explicitly acknowledged Young as making work close in spirit to but different in kind from his own. (George Maciunis, perhaps because of his hostility to Stockhausen, met with a much more reserved reception.)

In his analysis of Tudor's realization of Cage's *Variations II*, James Pritchett explores in detail how Tudor's approach became the specification of actions and tendencies (complex versus simple) rather than the specification of sounds [15]. Thus, Tudor moved quite far from Cage's normal mode of working and rather close to the approaches of the younger generation. In an interview, Tudor partially acknowledged this:

> **DT:** Now, John Cage had a series of *Variations*. In the first *Variation*, we both followed the score and made precise determinations. We commonly decided upon the time length and everything fell within that time length and the proportion that we had read. When it comes to *Variations II,* the material given by Cage began to be much freer and so many more determinations were necessary. One thing you had to determine was what instrument you had to use and, in the case of *Variations II,* it didn't matter what instrument. That is, it didn't have to be one instrument, it could have been many instruments. This was a new piece and I wanted to make it a new experience so I wanted to experiment. I decided to do it for amplified piano. I had been assimilating experience using electronic equipment. I looked at the score and thought, "How can I realize these parameters using electronic equipment?" Now involved in my decisions was the fact that John Cage always makes his electronic notations according to numbers. For instance with the gain control, he looked at how many gradations there were on the dial. Well, gain controls can be made in different ways: you can turn the control almost all the way up and there is no change in gain or it can happen very immediately halfway through the control and there is no further effect. I had to find some relevant means of using this amplification as part of the instrument. It's not just amplifying the instrument, but the whole thing taken together is an instrument of its own.
>
> So I began to look at the parameters and I made certain decisions as to what was important and that enabled me to make a score of my own. I looked at it and I said, "well, this whole proposition is so fraught with chance happenings, that I have to be able to have a score

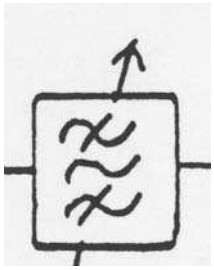

Fig. 5. Detail of performance patch diagram for *Untitled (Homage to Toshi Ichiyanagi*), 1972: band-pass filter. (© Estate of David Tudor)

> which itself incorporates all those possibilities, at the same time being faithful to the readings which I make from John Cage's material." So I made a series of nomographs. They had every notation I had made but I could see every parameter at one glance. It was like a sign to me saying that you have to realize this within a certain time bracket.
>
> Well, when you go that far, then in a sense you are co-composer. However, I still would be unable to call myself a co-composer. I call it my electronic version and I give my name as its being my version [16].

Similarly, Cage's *0′00″,* dedicated to Toshi Ichiyanagi and Yoko Ono, adopted the event score format. Henry Flynt has commented that this piece was a response to the text pieces of the younger generation [17]. However, in its call for a maximally amplified "disciplined action," it might also be understood as a theatrical generalization and simplification of Tudor's electronic realization of *Variations II.*

Circuits

Word pieces can appear on gallery walls, books or postcards [18]. In the early 1960s, they provided a means of developing an international art movement with many disparate participants on a limited budget. Technology provided a similar means of organizing collaborations with more privileged and powerful participants. Beginning with Le Corbusier's Philips Pavilion in 1958 [19], the association of artistic invention with technology became a basis for corporate, foundation and university support of artistic projects large and small. In the case of Le Corbusier, authorial identity was jealously guarded—so jealously guarded that Iannis Xenakis had to threaten to resign in order to receive any public acknowledgment of his role in the design and conception of the Philips Pavilion. In the early 1960s, a more democratic and anarchic model of collaboration evolved out of Robert Rauschenberg's encounter with engineers from Bell Laboratories: Experiments in Art and Technology (EAT) [20].

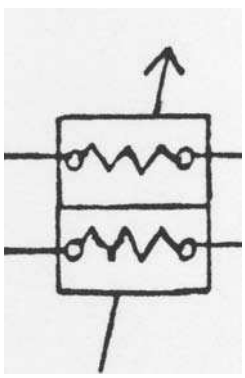

Fig. 6. Detail of performance patch diagram for *Untitled (Homage to Toshi Ichiyanagi*), 1972: gain controls. (© Estate of David Tudor)

For the 9 Evenings of Theatre and Engineering, the extent of the involvement of engineers from Bell Labs steadily increased, initially out of their own interest. As the project became more and more publicized, it became an important matter of public relations for the corporation that the events be a success. (EAT employed the same tactic, with catastrophic results, during the development of the Pepsi Pavilion for Expo 1970.) Tudor's description of the overall project suggests that he understood it to be an inherently ephemeral exploration:

> It seems most of the ideas that emerged during 9 Evenings could be realized again and again, each time with current state of the art technology no matter how far different from the means originally used. Nine Evenings bent the concepts of systems engineering, celebrating the arrival of technology rather than using it: no blame for either engineers or artists [21].

However, the actual engineering concepts at Expo 1970 had a longer lasting impact on Tudor than this might suggest. Most were based on elements of the phone system familiar to the participating engineers. In particular, tones and narrow band filters were used to create multiple channels of control. "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. *Bandoneon!* was an initial exploration of this terrain, in which the sound of the bandoneon acted as a control source that would determine the details of a multimedia environment of lighting, video projection and sound. The use of the bandoneon, extended by these sonically based systems of control, allowed the collapsing of the roles of notation and realization, making room for an entirely different kind of music-making and an entirely different kind of musician.

In the 6 years following 9 Evenings, Tudor's involvement with electronics steadily grew and his distinctive approach evolved. Tudor's own description of that approach was as follows:

> I need to observe something in a way that I don't put any prejudice. I want to see what it tells me. My experience with Alvin [Lucier] is that he approaches things more like a romantic, so that he's an appreciator of these phenomena, and he appreciates their specific beauty. Then, when he goes to compose the work, he wants to display those characteristics, which seem beautiful to him. Whereas, in my case, I want to show it as something in nature. You know, I don't want to display it, I want it to display itself, you see [22].

Given the distilled simplicity and acoustic specificity of Lucier's music and the technological complexity of Tudor's, the comparison Tudor offers is quite extraordinary. What does it mean to "show something in nature" in the entirely constructed realm of live electronics? Possibly he is referring to his tendency to work "against the grain" by directly engaging the physical principles of an electronic device rather than accepting the original intent of its design. Towards that end, Tudor tended to take any technological paradigm or device that interested him and attempt to invert its terms. *Rainforest* typifies this. Loudspeakers are prized for their ability to produce all possible sounds, while the concept of *Rainforest* is that loudspeakers should have their own voice. In Tudor's description of the idea:

> It came about because of a sudden idea which occurred to me one day: that one didn't have to think of the generation of electronic music from signal source to the reproducing output, but one, instead, might just as well start from the other end and go back and arrive at a signal source [23].

Rainforest is the best known of Tudor's pieces, in part because the germinal concept is readily understood and invites multiple realizations. One selects an object and refashions it as a loudspeaker. As one prepares sound material, discoveries are made; some sounds "work" for many objects, others do not. To realize the piece, one must collaborate with the object chosen, which constrains the choice of sounds that can be used. Within the composition, all that must be stipulated are the basic terms of this collaboration; the rest will unfold as "nature." In the initial form of the piece, the objects were small and produced small sounds that required amplification. In that form, the piece was similar to Cage's *Cartridge Music,* but with a level of indi-

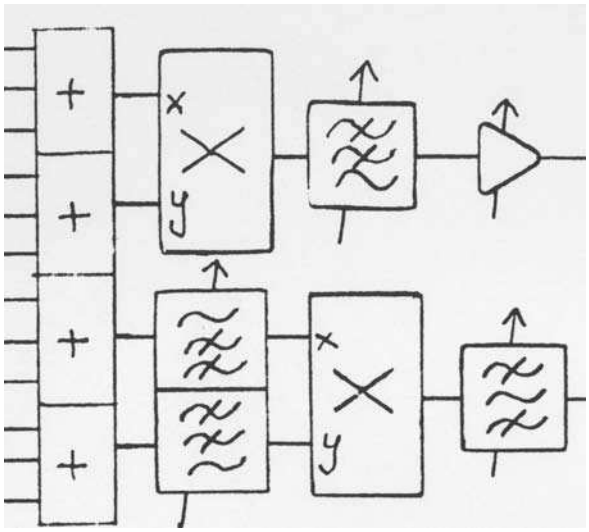

Fig. 7. Detail of performance patch diagram for *Untitled (Homage to Toshi Ichiyanagi*), 1972: modulation network. (© Estate of David Tudor)

rection. Small sounds requiring amplification were activated by other small sounds rather than by the performer's physical manipulation of an object. In *Rainforest IV,* the objects became large and the performance became part concert, part science fair and part cocktail party. Adopting the model of "fault tolerance through redundancy" (a common engineering term), Tudor trusted that the piece would emerge out of the tuned space of objects and overlapping social activity. Once again, the piece "composed itself" out of its constituent elements.

As his work continued to develop, its defining concepts lodged more and more deeply "inside electronics," becoming less and less accessible to others. Tudor built some of his own devices and used many built by others. Designers of those components, like composers of indeterminate notations, had no clue how he used what they had made. Tudor acknowledged this:

> In my electronics, I work with an instrumental principle. . . . They become my friends. They have personalities, that only I see, because of my use of them. It's an act of discovery. I try to find out what's there and not to make it do what I want but to, you know, release what's there [24].

In later years, Tudor spoke wistfully about the early, passive transistor electronic devices in which he could treat outputs as inputs and inputs as outputs and produce useful results. About commercial synthesizers, he commented,

> I hated the way those machines were so predictable and it's very difficult to make them sound, you know, different than they're supposed to. . . . So I put all my gainstages into a single oscillator and the poor thing doesn't know what it's doing [25].

Clearly, tactics such as these are difficult to discuss outside of the specific context of the devices themselves.

INSIDE *UNTITLED*

Untitled, also referred to as *Homage to Toshi Ichiyanagi,* was first performed in 1972 in a series of concerts of simultaneous presentations of both Cage's and Tudor's work as composers. This marked something of the end of an era, as Cage and Tudor would follow increasingly divergent paths afterwards. The complexity of the configuration required for *Untitled* led it to be performed as a combination of pre-recorded material and live electronics. An entirely live version, *Toneburst* (1975), was prepared for Merce Cunningham's *Sounddance.*

Untitled extends an idea first found in a piece Tudor composed for the Pepsi Pavilion, *Pepscillator,* in which electronic processors were arranged in a feedback circuit to create an autonomous electronic system with "no input." The schematic diagram notation of *Untitled* indicates the details with Tudor's characteristic combination of precision and abstraction. In general, icons refer to specific pieces of electronic hardware, but that hardware may change between performances as equipment breaks down or new components become available.

Tudor's overall performance diagram for *Untitled* is shown in Fig. 1. Figure 2 notates three tape recorders (most likely cassette decks) connected through a stereo source select switch. These twin outputs go to two separate 2-input, 4-output mixers (Fig. 3), which allow the sound material to be distributed to different points in the overall network. Those points include a phase-shift network (Fig. 4), a band-pass filter (Fig. 5), and a controllable gain stage (Fig. 6). (It is likely that the gain stages were photoelectric keys designed and constructed by Hugh LeCaine.) Outputs of the phase-shift network are directed to a set of modulators (Fig. 7). This consists of two separate multipliers (marked with a large ×), filters and gain controls. These multipliers were classic ring modulators, which redistribute audio energy to the sum and difference of each of the constituent frequencies found in those two signals. If the inputs are close in frequency, this will create a combination of very low-frequency outputs (the differ-

Fig. 8. Source images for *Toneburst: Maps and Fragments*, 96 × 96 in, electronically cut film on acrylic panels, 1995–1996. (© Sophia Ogielska and the Estate of David Tudor)

Fig. 9. Complete panel from *Toneburst: Maps and Fragments*, 96 × 96 in, electronically cut film on acrylic panels, 1995–1996. (© Sophia Ogielska and the Estate of David Tudor)

ence frequencies) and higher-frequency outputs (the sum frequencies).

In particular, one channel has as its inputs the outputs of complementary high- and low-pass filters. This configuration was called a "formant shifter," as frequencies near the cutoff frequency yield frequency differences at very low frequencies. These subaudible frequencies produce the quasi-periodic patterns of articulation characteristic of the piece. The outputs of the two ring modulators are fed back and also distributed (in phase-shifted and unshifted forms) to the other channel. Feedback tends to "lock" on a single frequency; allowing the two channels to interfere with one another creates more complex composite behaviors. It is interesting to note that a feedback path using nonlinearity to redistribute energy is the fundamental design approach of such chaotic systems as Chua's Oscillator [26].

In these ways, the feedback path becomes its own control signal, and the "instrumentalization of sound" that began with the 9 Evenings no longer requires the introduction of an external sound source rendered by a performer in a traditional manner.

Untitled was also the basis for a collaboration with the visual artist Sophia Ogielska, undertaken 20 years later. The latter project was based on the analogy Tudor saw between Ogielska's manner of working and his own. Both began with a limited range of initial material, which was subjected to a wide range of transformations in order to generate the totality of the work. In the installation, the source images for Ogielska's transparent panels are taken directly from Tudor's notations of the piece, subjected to varying transformations of position and scale and rendered in an extremely bright palette that Tudor insisted upon.

Figure 8 shows a basic set of images that Ogielska created from Tudor's notations. The five figures to the left in the top row are filtering operations with three sinusoids to indicate low, middle and high frequencies; the figures in the second row from the top are mixing (including nonlinear mixing) operations; and the figures in the bottom two rows are control points. Figure 9 shows how they were combined to form large transparent panels. It was not possible for Tudor to realize the original score of *Toneburst* for a tour of Merce Cunningham's *Sounddance* in 1995. Instead, he created three CDs of material drawn from the same techniques that were remixed, equalized and rerouted for the performances. While this version differed from the original and was understood as a "solution" rather than a new piece, the dynamic range, density and transparency of this "remixed" version was remarkably vivid on its own terms and quite close in technique to the pieces he undertook in collaboration with Ogielska.

Conclusion

Tudor's own explanation for his departure from the piano is cast in fairly critical terms:

> One of the reasons I gave up the piano was because people from all over the world would send me scores knowing I was a pianist and they didn't interest me . . . I wasn't interested in playing a game or dealing with a set of finite circumstances but rather in the fact that the world was completely open, and through a set of finite circumstances one could be led into something completely open. This was always uppermost in Cage's works, but a lot of the pieces I was getting seemed to be more attracted by the idea of structures rather than by the possibilities these open up.
>
> Christian Wolff never delineates a universe. He deals with possibilities which one could use if one wanted to. That's what is so beautiful about his pieces, because they don't express a composite view [27].

It is significant that Tudor singled out Christian Wolff as well as Cage as exceptions. At about the same time that Cage began to work with transparencies, Wolff voiced some dissatisfaction with the fixed nature of the realizations of indeterminate notations that Tudor was in the habit of preparing. Wolff developed an alternative approach, based on contingency, which attempted to make such preparations impossible. Simply put, Wolff developed notations that stipulate specific actions to be taken based on the sounding music. In *Duo for Pianists* (1957), the choice of a loud or soft sound by one pianist directly determines the possible actions of the other pianist. In such situations, it becomes increasingly difficult, or even impossible, to pre-plan the performance. The introduction of this kind of "real-time" decision-making was a fundamental expansion of the indeterminate mechanisms Cage and Tudor were evolving together. Certainly, contingency is part of how Wolff composes without, in Tudor's words, "expressing a composite view."

The conception of live electronic music as a liminal situation caught between composition and performance that is central to Tudor's work is a logical extension, perhaps even a logical conclusion, of his role as a performer of indeterminate scores. However, electronic configurations, unlike transparencies, produce their own temporal behavior. This creates a musical situation in which advance planning is only partially useful, perfect compliance is impossible, and the concepts of contingency and action are essential. In such situations, Tudor could create a particularly private music in which he continued to act as a collaborator, diplomat and wayward influence on the actions and interactions arising from the confines of his electronic and electroacoustic systems.

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Ronald Kuivila composes music and designs sound installations that revolve around the unusual homemade and home-modified electronic systems and instruments he designs. He pioneered the use of ultrasound and sound sampling in live performance. His other pieces have explored compositional algorithms, speech synthesis and high-voltage phenomena. More recently, his pieces have recalled the sound world of live electronics while exploiting the compositional possibilities of digital signal processing. Kuivila's professional relation with David Tudor dates from 1977, when Tudor invited him to provide music for three studio events by the Merce Cunningham Dance Company. In 1994, Kuivila began to provide technical advice on Tudor's Neural Synthesis *project. As Tudor's health declined, this evolved into a more far-reaching project to stabilize Tudor's earlier compositions, in collaboration with John DS Adams, John Driscoll, D'Arcy Gray, Matt Rogalsky and others.*