

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

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ABSTRACT

Throughout his career, David Tudor maintained an allegiance to the goal of a music where sounds are 'free to be themselves', distinct, unique and unfettered by formal obligation. Of course, 'sounds as themselves' is a phrase of John Cage's, and Earle Brown, Morton Feldman and Christian Wolff were equally involved in uncovering the musical possibilities it suggested. All were involved in a systematic reconsideration of all of the materials and means of musical practice. As the primary performer of this music, David Tudor's role in that reconsideration is difficult to underestimate. For example, in an interview with Daniel Charles in 1970, Cage comments:

In all my works since 1952, I have tried to achieve what would seem interesting and vibrant to David Tudor. Whatever succeeds in the works I have done has been determined in relationship to him.

For Cage, composition became the creation of notations that circumscribe a field of musical possibility out of which an unrepeatable stream of unique sounds and actions should emerge. The goal becomes to expand sonic difference to such a degree that both notation and imagination fail. Notation fails because the repetition inherent in any finite set of symbols suggests relations where there are none. Imagination fails because it is beyond the ability of any individual to comprehend the limitless difference and distinction that is, in principle, possible. This is a music that can be 'heard' only when it sounds. Interpretation by the performer is no longer the determination of the composer's note-by-note intention. Rather, it is the realization of sounding music out of the possibilities of the notation, an open source for an unending stream of musical difference.

The development of Tudor's own work as a performer, as a performer of 'self-composing' electronic configurations, and ultimately as a composer of live can be understood in relation to an evolving understanding of how the notation/realization relation can be enacted to create new musical difference. This evolution will be traced through a series of specific innovations of technique:

The gradual transition from chance determined fixed notations to flexible indeterminate notations of an increasingly abstract character in Cage's compositions of the 1950's. Christian Wolff's introduction of the concept of contingency as a means of insisting on 'real time' realization. George Brecht and LaMonte Young's use of texts as a means of identifying a situation, process, action, or task as a 'piece' without resorting to time based specification. The instrumentalization of sound as a 'control signal' in the devices developed by telephone engineers for the Nine Evenings of Theatre and Engineering and Tudor's idea that those devices consequently become the basis for a work that 'composes itself'.

The paper will conclude with a detailed analysis of the phase shift feedback networks that define the material of Tudor's *Homage to Toshi Ichihyanagi* and the performance considerations inherent in attempting a realization of it.

FULL PAPER

Introduction

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. Years after the fact, Tudor identified music he provided to accompany a performance by Robert Rauschenberg and Steve Paxton in 1964 as his first composition. The piece, retrospectively titled *Flourescent Sound*, involved amplifying the sounds of fluorescent lights starting and stopping. Its original status was not that of a

composed work but simply something done in response to Rauschenberg's request for assistance. The first work publicly presented as Tudor's or, more precisely, *not* presented as another composer's work, was *Bandoneon!*, from the *Nine Evenings of Theatre and Engineering*. The program notes for that piece state:

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.

(David Tudor Paper, Getty Research Institute.)

It is significant that Tudor describes this piece as a 'combine', Rauschenberg's term for an artwork that is neither painting nor sculpture. As a combine, *Bandoneon!* is not quite a composition in the traditional sense, and Tudor does not claim the role of composer. The electronic components, designed by Lowell Cross, Robert Kieronski, and Fred Waldhauer, create an electronic configuration that imposes a set of material constraints on a musical performance. Tudor acts as the interpreter and performer of a composition that "composes itself" out of these constituent parts. Understanding this idea where collaborative enterprise obviates the need for composition requires a review of the interplay between fidelity and freedom that Tudor characterized as central to the evolution of indeterminacy and how, in his own music, these are fused in a new concept of instrumentality.

Notation/realization

Much of this discussion will cross reference Tudor's own description of his passage "from piano to electronics", which begins with the following sentence:

Ever since the early days I've always preferred to work with other people. [Schonfeld]

The pattern that Tudor's collaborations took is discernable almost from the beginning in his work with Stefan Wolpe. Tudor's piano teacher, Irma Wolpe, found her husband's *Battle Piece* too demanding and Tudor, a teenager, stepped into the breach. His own struggle with the piece led him to study virtuosity by reading Ferruccio Busoni's writings. He recalls learning from Busoni that "notation is an evil separating musicians from music" which led him to forgo his studies with Irma Wolpe to find his own solutions to the problems of the piece. Thus, from the start he seems to have found it possible to reshape his self-conception as a musician when needed to shape and materialize a composer's conception. But such changes were a two-way street where his collaboration with the composer could alter or affect the composer's conception of the piece. Speaking about *Battle Piece*, Tudor recalls, "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." [Clarkson]

For Tudor, the most important aspect of this early period was a "change in musical perception" triggered by his performances of Pierre Boulez's *Second Piano Sonata* and John Cage's *Music of Changes*. To discover how to play these pieces, Tudor moved on from Busoni to Artaud. Artaud's concept of acting as "affective athleticism" led Tudor to the possibility of playing in a "state of non-continuity, not remembering what had passed, so that each moment is alive."

Both pieces were a radical departure, a different musical consciousness, though Cage's turned out to be more radical than Boulez's. The Boulez is where I learned I really had to change the way I thought about musical continuity, and that you don't necessarily go on in a linear progression. When I came to the Cage I had to work on the moment-to-moment differences. *Music of Changes* was a great discipline, because you can't do it unless you're ready for anything at each instant. You can't carry over any emotional impediments, though at the same time you have to be ready to accept them each instant, as they arise. Being an instrumentalist carries with it the job of making certain physical preparations for the next instant, so I had to learn to put myself in the right frame of mind. I had to learn how to be able to cancel my consciousness of any previous moment, in order to be able to produce the next one. What this did for me was to bring about freedom, the freedom to do anything, and that's how I learned to be free for a whole hour at a time. [Schonfeld]

A central characteristic of *The Music of Changes* is that chance specifies every detail. The performer has no choice but to be as faithful as possible to the dictates of the chance process. This appears to have been a more or less innate

tendency of Cage, who Virgil Thomson once characterized as a “precision worker.” It seems completely appropriate that the first explorations of chance determined music would be completely rigorous in their application of the chance mechanism and require perfect compliance with its results. How else to discover just what chance provides? The demand of fidelity to a score was also entirely congruent with Tudor’s training. The goal of perfect adherence to the score as central to his organ studies with H. William Hawke and piano studies with Irma Wolpe. *The Music of Changes* was organized by the time structures characteristic of Cage’s work in the 40’s, but with the addition of constantly shifting tempi. In Tudor’s papers, amidst an enormous collection of numerical calculations in pencil is a single page of ink on vellum. That page contains the formula required to integrate a tempo function and thus determine the precise moment in clock time when an event should occur with such shifting tempi. Tudor describes performing the timings of the piece in the following terms in terms of Wolpe’s doubts about Cage’s piece:

...there was Stefan Wolpe trying to feel it in his physical organisms, as musicians were taught to do up to that time...I was watching time rather than experiencing it. [Schonfeld]

Tudor’s feats of accuracy were not limited to the piano. Cage’s *Williams Mix* involved the completion of splices according to a two hundred page score that, like a dressmaker’s pattern, diagrammed each splice required. The work was time consuming, demanding and tedious. Christian Wolff marvels at Tudor’s execution, commenting, “His attention to the smallest detail was remarkable. When recording was done on magnetic tape and editing involved cutting and splicing everything, he might spend hours fixing the decay of a single note inside a flurry of others, a tape cut of maybe 1/16th of an inch. [Wolff]

But Tudor’s collaboration with Cage extended beyond that of a performer developing new levels of technical and mental virtuosity. In an interview with Joel Chadabe, Tudor describes Cage as imagining the piece could include any possible sound and his countering that there are physical sounds that could not be recorded. The *Black Mountain Piece* sometimes described as a ‘prototype happening’ was composed by Cage but actually conceived by Tudor and Cage together during a lunchtime conversation about Artaud. Cage takes pains to give this credit to Tudor in an interview from 1969. The dialectic between conceptual framework and physical realization seems to have been central to their collaboration from the start.

Cage came to reject the attempt to fully specify all details of the sounding music he had made in the *Music of Changes*. He began to see the demands for purely precise execution it placed upon the performer as the creation of “an object more inhuman than human.” Cage began to introduce flexibility into his notations to allow the performer to work from “his own center” in relinquishing choice to chance. It is perhaps this context which led Cage to tell the story of Feldman asleep on a car trip suddenly waking and saying, “Now that everything is so easy there is so much to do.” Composition became the creation of notations that circumscribe a field of musical possibility out of which an unrepeatable stream of unique sounds and actions should emerge and superabundance became the creative discipline appropriate to the new understanding of composition. The paradoxical goal was to create a musical situation where both notation and imagination fail. Notation fails because the repetition inherent in any finite set of symbols suggests relations where there are none. Imagination fails because it is beyond the ability of any individual to comprehend or conceive limitless difference. The music can be ‘heard’ only when it sounds. And so, Cage began a program of composing the “10,000 things.”

Beginning with *Winter Music*, Cage adopted increasingly abstract notations where the performer more and more directly determines the specification and detail of the sounding music. In an interview with John Holzapfel, Cage indicates 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.” It might be more precise to say that Tudor was looking for the simplest — and, thereby, most open - formulation of the composer’s idea. For example, he says about Stockhausen’s early *Klavierstücke*:

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. [Schonfeld]

The Concert for Piano and Orchestra represents a crucial point of closure in Cage’s initial work in this direction. While the orchestral parts are notated relatively strictly and simply (pitches are specified, notes are of three sizes

indicating changes in dynamics and/or duration) the Solo for Piano is an encyclopedia of 84 different notations. Like most concerti, the *Concert* is a showpiece for a solo virtuoso. This appears to be in tension with a sensibility that shuns personality and ego, if not outright contradiction. In interviews, Cage often invoked the designation of David Tudor as a ‘minotaur of the pianistical mythology’ quite literally, without the facetious undertone that was the Bussotti’s intent. Coomaraswamy, whose thought Cage invoked repeatedly throughout his career, distinguishes between the types and archetypes in Platonic thought and in 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.

In this sense, Tudor can be imagined as an ‘archetype’ of music for Cage who literally embodies music. One can appreciate both the power and restrictiveness of this understanding.

After completing the *Concert for Piano and Orchestra*, Cage began to explore even greater flexibility by remaking notations from the *Solo for Piano* as reconfigurable transparencies. James Pritchett refers to these transparencies as “tools”, because they really function as decision-making devices that can be applied in new situations independent of the original piece. Tudor used these materials in preparing the part that paralleled Cage’s reading of the 90 stories of Indeterminacy. The two works of this genre that have the greatest relevance to Tudor’s subsequent involvement with electronics are *Cartridge Music* and *Variations II*. His approach to both can be considered prototypes for the live electronic music he subsequently developed. Tudor discussed both of these pieces and his understanding of the composer/performer distinction during an interview with Teddy Hultberg in 1988.

Hultberg: 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?

Tudor: 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 composers’ 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.

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 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. [Hultberg]

Words

Throughout the later 50's there had been a kind of dialectical collegiality Stockhausen and Cage. Tudor was closely associated with both and played a critical role as a kind of musical ambassador bringing the 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 work from the "possibility of making a music not dependent upon linear continuity." Of course this is Tudor's conception of the performance problem posed by Boulez's and Cage's piano works. It is unclear whether this release from linear continuity, which is taken as a defining attribute of the music, would have been conceivable or attainable without Tudor's participation. However, underneath this substantial difference, both Cage and Stockhausen embraced a parametric conception of sound where musical composition is the determination of vectors of attributes. It is this approach which creates the performance problems Tudor describes above. In the late 50's John Cage offered a course in experimental music at the New School for Social Research. Liz Kotz has pointed out that the original goal of these classes was to introduce the innovations of Darmstadt to the American musical context.

The student response to Cage's course went in quite a different direction. The pieces of this younger generation avoided the technical virtuosity and procedural complexity that seems 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 might be conceived as scores, instructions, or poems. The tactic was adopted by others not directly involved in the classes and, within a few short years, became one of the central tactics of Fluxus.

George Brecht's initial response to Cage was to compose pieces where the indeterminate structure of the piece arose directly from the action rather than being pre-determined. 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." Yoko Ono's word pieces are quite similar to Brecht's, 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, LaMonte Young's text pieces were quite public in conception, with an occasional a dose of inter-generational brattiness. For example, recalling Tudor's performance of *4'33"*, one of LaMonte Young's pieces asks Tudor to continue to open and shut the keyboard lid until he does so silently.

The first buddings of this work were received warmly by both Cage and Tudor. Given Cage's acknowledgement of the role Tudor played in conceptualizing the *Black Mountain Piece*, it is intriguing to note that all three of these people wrote pieces with dedications to David Tudor in this early period. Tudor was directly involved with presenting the earliest pieces, performing works by George Brecht and LaMonte Young in Cologne and participating in the loft concert series organized by Young and Yoko Ono in the winter and spring of 1961. In interviews around this time, Cage explicitly acknowledges Young as making work close in spirit but different in kind from his own. (George Maciunis, perhaps because of his hostility to Stockhausen, met with a much more reserved reception.)

This kind of work appears to have exerted some influence on both Cage and Tudor. In his analysis of Tudor's realization of Cage's *Variations II* (1961), James Pritchett has shown that Tudor's approach was based on the specification of actions and tendencies (complex versus simple) rather than the specification of sounds. Thus, Tudor moved quite far away from Cage's normal mode of working and quite close to the approaches of the younger generation. In an interview, Tudor explicitly acknowledges this:

Tudor: 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 half-way 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 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 it's being my version.

Similarly, Cage's *0'00''*, dedicated to Toshi Ichihyanagi and Yoko Ono, adopts an instruction format. In its call for a maximally amplified 'disciplined action' it can also be seen as a theatrical generalization and simplification of Tudor's electronic realization of Variations II.

Circuits

Word pieces are highly fungible — they can appear on gallery walls, books, or postcards. In the early 60's, they provided a means of growing 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 LeCorbusier's Philips Pavilion in 1958, 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 acknowledgement of his role in the design and conception of the Philips Pavilion. In the early 60's, 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*.

Cage had attempted to build a center of new music research throughout the 40's and his status as a 'musical inventor' was well established. So, it is not surprising that he engaged these emerging possibilities with his customary organizational energy. In retrospect, it also seems evident the combination of intellectual challenge and precise, meticulous preparation required for such technological collaborations to succeed would be appealing to David Tudor. Once engaged, Tudor would be drawn to interact with the possibilities of the technology as directly as possible. This was a level of engagement that Cage did not, perhaps could not, participate in. In the words of one composer, 'as far as technology was concerned Cage was the front man and Tudor the back office'.

For the *Nine Evenings of Theatre and Engineering*, Tudor was scheduled to provide his own concert as well as to assist with many others, ranging from Cage to Deborah Hay. 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. (E.A.T. employed the same tactic, with catastrophic results, during the development of the Pepsi Pavilion for Expo '70.) Tudor's description of the overall project suggests that it was understood to be an inherently ephemeral exploration:

It seems most of the ideas that emerged during Nine 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. [David Tudor Papers, Getty Research Institute]

However, the actual engineering concepts had a longer lasting impact on Tudor than this might suggest. Much of the technology developed for Nine Evenings was 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 control another. In this context, sound is no longer a dissociated, ephemeral experience but a means of command and control. The ideas underlying this “instrumentalization” of sound could 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 a new musical instrumentality. *Bandoneon!* was an initial exploration of this terrain where the sound of the bandoneon acted as a control source that would determine the details of a multi-media environment of lighting, video projection, and sound. The goal was environment so complex as to be ‘unscannable’ by the performer. The bandoneon extended by these sonically based systems of control became a *situation* in which the roles of notation and realization collapse together, making room for an entirely different kind of music making and an entirely different kind of musician. This was the first of his own projects to be based, in John Fulleman’s works, “on his ability to assert just enough control over the equipment to get through a concert.”

In the six years following *Nine Evenings*, Tudor’s involvement with electronics steadily grew and his distinctive approach evolved. Tudor’s own description of that approach is 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. [Austin]

Given the distilled simplicity and acoustic specificity of Alvin 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*, the first of his pieces for which he actually identified himself as a composer, 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. Tudor’s own description of the idea is as follows:

...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. [Schonfeld]

Rainforest is the best known of Tudor’s pieces, in part because the concept is readily understood. One selects an object and the object constrains and shapes all subsequent sonic choices. As one prepares material for the piece, discoveries are made; some sounds “work” for many objects, others do not. To realize the piece, you must collaborate with the object you chose. As a composition, all that must be stipulated are the basic terms of that collaboration, the rest will unfold as ‘nature’. In its initial form, the objects were small and produced small sounds that required amplification. In that form, the piece was similar to *Cartridge Music*, but with a level of indirection. Small sounds requiring amplification were activated by other small sounds rather than by the performer’s physical manipulation of an object. As *Rainforest IV*, the concept becomes the basis for a wonderfully open introduction to his approach to electronic music. A presentation of *Rainforest IV*, part concert, part science fair, part cocktail party does not exclude and distill as Lucier’s music does. Instead, adopting the model of ‘fault tolerance through redundancy’, it trusts that the piece will emerge out of the tuned space of objects and the overlapping social activity.

As his work continued to develop, the defining concepts are 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 as to how he used what they had made. Tudor acknowledges 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.

In later years, Tudor spoke wistfully about the passive and early transistor electronic devices where 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.” Clearly, tactics such as these are difficult to discuss outside of the specific context of the devices themselves, so here are two simple examples.

The “stirrer” was a specially designed potentiometer. These devices, the basis of volume knobs and tone controls, normally have three terminals and can be turned about 240 degrees. The stirrer had five terminals and could be turned all the way around repeatedly. One terminal attached to a wiper that moves closer and further away from the other four terminals. The device could be used to “pan” a sound to four distinct outputs or, ‘backwards’, to select one of four inputs. (All of the possibilities are identified in an article he wrote with Lowell Cross about the device in *Source* magazine.) Of course the inversion could be conceptual rather than literal. In *Dialects*, for example, he used a device intended to remove the pops created by surface noise on records instead to isolate those transients as a source of rhythmic articulation.

Inside Untitled

Untitled, also referred to as *Homage to Toshi Ichiyonagi*, was a pivotal piece for Tudor. It was first performed in 1972 in a series of concerts of simultaneous presentations of both Cage 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. (Perhaps it is significant that, as a recording, the piece relies on vocals by Takaheisa Kosugi.) The complexity of the configuration required for *Untitled* led it to be performed as a combination pre-recorded material and live electronics. A closely related successor piece, *Toneburst*, was performed entirely live. This piece was prepared as a score for Merce Cunningham’s *Sounddance*; it was also the basis for a collaboration with the visual artist Sophia Ogielska at the end of his life. His interest in the latter project was based on the analogy he saw between Ogielska’s manner of working and his own. Both took a limited range of initial material subjected to a wide range of transformations to generate the totality of the work. This was the basic tactic that enabled *Toneburst* to be performed live. 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 adopted at Tudor’s insistence.

Untitled is based on feedback oscillators. It extends an idea first found in a piece he composed for the Pepsi Pavilion, *Pepscillator*, where electronic processors are arranged in a feedback circuit to create an autonomous electronic system with “no input.” The feedback circuit for *Untitled* uses phase shifter, small, and frequency dependent delays, to establish the frequency of the resultant oscillation. However, instead of one delay, Tudor used multiple parallel delays to create an unstable system able to oscillate, in principle, at multiple frequencies. Systems such as this tend to “lock” onto a single frequency unless some additional manipulation is performed. So the circuit employs two parallel systems that can interfere with one another. Finally, Tudor introduced an additional, “formant shifted” feedback path. “Formant shifting” is performed by separating a signal into separate frequency bands with high and low pass filters and then multiplying together (ring modulating) their outputs. This simultaneously transposes the acoustic energy near the cut-off frequency of the filters up an octave and down to sub audio frequencies. The sub-audio frequencies provide the quasi-periodic patterns of articulation characteristic of the piece. The filtering itself creates fixed formants that, tuned appropriately, exhibit vocalic qualities. In this way, the feedback path becomes its own control signal and an ‘instrumentalization of sound’ that began with the *Nine Evenings* no longer requires the introduction of an external sound source rendered by a performer in the traditional way. Perhaps it is significant that, a year later, he gave the workshop that led to his collaboration with a group of younger artists and musicians of varied backgrounds as he sought to introduce them to composition as collaboration inside electronics.

Conclusion

Tudor’s own explanation for his departure from the piano is cast in somewhat 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. [Schonfeld]

It is significant that Tudor singles out Wolff as well as Cage as exceptions. At about the same time that Cage began to work with transparencies, Christian Wolff voiced some dissatisfaction with the fixed nature of the realizations Tudor was in the habit of preparing of indeterminate notations. 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*, 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 characteristic of Tudor's work is a logical extension, perhaps even a logical conclusion, of his role as a performer of indeterminate scores. Of course, electronic configurations, unlike transparencies, produce their own temporal behavior. This creates a musical situation where advanced planning is only partially useful, perfect compliance is impossible, and the concepts of contingency and action are essential. In such situations, Tudor could act as a collaborator, diplomat, and wayward influence on the actions and interactions arising from the confines of his electronic and electroacoustic systems.

NOTES:

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