Reminded by the Instruments

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David Tudor's Music

You Nakai

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All photographs of instruments from the David Tudor Collection at
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for Aevi,
for all the time it took

Suppose everyone had a box with something in it: we call it a "beetle." No one can look into anyone else's box, and everyone says he knows what a beetle is only by looking at his beetle.—Here it would be quite possible for everyone to have something different in his box. One might even imagine such a thing constantly changing.—But suppose the word "beetle" had a use in these people's language?—If so it would not be used as the name of a thing. The thing in the box has no place in the language-game at all; not even as a something: for the box might even be empty.—No, one can "divide through" by the thing in the box; it cancels out, whatever it is.

—Ludwig Wittgenstein, *Philosophical Investigations*, Section 293
(posthumous manuscript, April 1951)

As children we all had a box which we kept hidden; it contained a butterfly wing, a beetle, a lucky penny. For each, that box was private, intimate and secret; and yet we all (most of us) had it. Communication of art is between those boxes, between subjectives, the secret that we all share, each privately.

—Maya Deren, "New Directions in Film Art"
(lecture at the Cleveland Museum of Art, April 1951)

Abbreviations

Institutions/Archives

CIE	*Composers Inside Electronics*
DTP	*David Tudor Papers (GRI)*
DTC	*David Tudor Collection (Wesleyan University)*
E.A.T.	*Experiments in Art and Technology*
GRI	*Getty Research Institute*
IRCAM	*Institut de Recherche et Coordination Acoustique/Musique*
MCDC	*Merce Cunningham Dance Company*
STEIM	*Studio for Electro-Instrumental Music*
TEEM	*Theatre Electronic Environmental Modular System*

Electronics

AM	*Amplitude Modulation*
E.E.G.	*Electroencephalography*
EQ	*Equalizer*
FM	*Frequency Modulation*
L	*Line Level*
MA	*Microphone Level*
PC	*Polarity Control*
PR	*Preamplifier*

Instruments

If the instrument is found in the David Tudor Collection at Wesleyan University its Rogalsky number (from a list compiled by Matt Rogalsky) is attached after its name; "(no #)" for the extant ones without a number.

8Ø	*Multioutput Phase Shifter* (Instrument 0007)
90	*90-degree Phase Splitter* (Instrument 0037)
150	*Sony ECM-150 Electret Condenser Microphone* (Instrument 0141)
180	*180-degree Phase Splitter* (instrument 0018) or *180-degree Phase Shifter* (Instrument 0006)
800	*Sharp RT-W800 Cassette Deck* (Instrument 0446)
AD	*Electro-Harmonix Attack Decay Tape Reverse Simulator* (no #)
AF	*Ibanez Auto Filter*
B E/L	*Guyatone PS-020 Bass Exciter/Limiter* (no #)
B EQ	*Bass EQ*
BFO or **B.F. OSC**	*Beat Frequency Oscillator* (Instrument 0021)

CH/FL	*t.c. electronic Stereo Chorus + Flanger* (no #)
CLIP	*Clipper* (Instrument 0027)
D6	*Sony Walkman WM-D6*
DF	*Boss FT-2 Dynamic Filter*
DG	*Drawmer DS-201 Dual Gate*
D/G	*Lead/Lag Complementary Phase Shifter* (Instrument 0460)
D.SYN	*Drum Synthesizer*
EMU or **ENV.MOD.**	*BNB Kit Envelope Modification Unit* (Instrument 0267)
EX or **EC**	*Electronic Crossover*
FOG or **FH**	*Olson Fog Horn* (Instrument 0461)
FP	*Ibanez FP-777 Flying Pan Phaser*
H.GEN	*Harmonic Generator* (Instrument 0173)
IBN	*Ibanez PQ-9 Parametric EQ* (no #)
INF	*Infinity Intimate Walkman* (Instrument 0354)
K	*Touch Sensitive Photocell Key* (Instrument 0252/0253)
LB EQ	*Loco Box G#-6 6-Band Graphic Equalizer* (Instrument 0303)
LEN or **L.MOD** or **LENKURT**	*Lenkurt Modulator* (Instrument 0116/0174)
M1/M2 or **mike P.A.**	*Olson Microphone Preamplifier TR-86* (Instrument 0022)
MB	*Shin-ei Mute Box Envelope Filter* (Instrument 0472)
MG	*D&R Electronics Multigate*
M.SYN	*Minisynth* (no #)
MT	*Mu-tron III Envelope Filter*
NEXT	*Next SE-100 Signal Gate* (Instrument 0275)
OCT or **OM**	*Electro-Harmonix Octave Multiplexer* (Instrument 0300)
OP or **O.Pa** or **PM** or **MP**	*Olson RA-637 Preampfier Mixer* (Instrument 0237/0238)
OSC	*Oscillating Amplifier*
PC	*Proportional Control System*
P.C. PUSH BUTT.	*Photocell—Push Button Unit*
P/F	*Phaser/Flanger* (Instrument 0039)
PL or **PLS**	*Pulse Generator* (Instrument 0474)
PL. BUS	*BOSS Headphone Amp HA-5 Play Bus* (Instrument 0473)
PP	*Electro-Harmonix Polyphase*
PLL	*Phase-Locked Loop*
P.SYN	*Forrest M. Mims Percussion Synthesizer* (Instrument 0025)
QM	*Four Quadrant Multiplier* (no #)
R1/R2	*Maplin RTX3 Radar Doppler Intruder Detector* (no #)
RF GEN	*Radio Frequency Generator*

RMC or M	*Realistic Stereo Mixing Console* (Instrument 0514)
RST or ST	*Realistic 4-Channel Stereo Mixer* (Instrument 0147)
SAE	*Scientific Audio Electronics 5000A Impulse Noise Reduction System* (Instrument 0333)
SD	*E&MM String Damper* (Instrument 0469)
SPEC. ANLZ or **SPEC**	*Fujitsu Ten Biyo QI-200SD Spectrum Analyzer* (Instrument 0293)
SPK.GEN	*Spike Generator* (Instrument 0173)
SPL or **OS**	*Cybersonic Output Splitter* (Instrument 0002/0000)
SR	*Polyfusion QP-1 Sound-A-Round* (no #)
ST or **SPEC. TRANS**	*Cybersonic Spectrum Transfer* (Instrument 0450)
SYN	*PAiA Synthespin* (Instrument 0265/0511)
TA	*Tunable Amplifier*
TB or **T-Box**	*Tube Box* (Instrument 0448)
TB	*Toneburst Generator* (Instrument 0118)
TC	*Tone Controls*
TC PH	*t.c. electronic XII B/K Programmable Phaser*
TP	*Electro-Harmonix Talking Pedal Speech Synthesizer* (no #)
TP	*Triggered Pulser*
US1/US2	*Maplin Ultrasonic Intruder Detector* (no #)
VCDR	*Vocoder*
VCO	*Voltage-Controlled Oscillator*
VF C/G	*Vesta Fire CG-1 Compressor/Gate* (Instrument 0320)
VO	*Variable Oscillator*
VOX or **VX**	*Vox Repeat Percussion* (Instrument 0257)
WN or **W.N.GEN** or **WH. NOISE**	*White Noise Generator* (Instrument 0493)
Z1/Z2	*Z-amp* (Instrument 0175/0176)

In

The Other Side (A Likely Story)

1

On November 8, 2007, I visited the Getty Research Institute (GRI) in Los Angeles, California. The research center of one of the richest art institutions in the world had then recently added a new acquisition to their archive of twentieth-century avant-garde: the materials of Yvonne Rainer, who choreographed thoughtful dances in the 1960s before switching her focus in the early 1970s to directing very thoughtful films. I admired Rainer's work, especially her films where language and moving images (and to a lesser extent, sound) shared a complex of strategies to bring down what she called "the tyranny of narrative."[1] So together with theater director Yelena Gluzman, I had begun working on the reconstruction of one pseudo-theater piece Rainer had created in 1972 called *Grand Union Dreams*. It was the last major performance the choreographer had made before she turned herself into a filmmaker, and I was interested in the strangeness of this work which was both dance and theater yet also neither, for it appeared to reflect the nature of the transformation she was going through at the time. Our revival was taking place at the Yotsuya Art Studium, an alternative art school in central Tokyo I had helped set up three years earlier. Yelena and I co-taught a peculiar "English" class there, where we could teach whatever we wanted as long as it was in English. Since language plays a significant role in Rainer's films, using them as material for our class seemed like a good idea.

That early November in 2007, I happened to be in San Diego to attend the International Conference on Intelligent Robots and Systems (IROS) with Kenjiro Okazaki, the director of Yotsuya Art Studium. We were co-presenting a paper on Kenjiro's work with the choreographer Trisha Brown (who happened to be a dear friend of Yvonne Rainer and who had appeared in the original production of

[1] Yvonne Rainer, "A Likely Story (1976)," in *A Woman Who: Essays, Interviews, Scripts* (Baltimore, MD, and London, UK: Johns Hopkins University Press, 1999), 138. Rainer explains, "let me insert here that my own involvement with narrative forms has not always been either happy or wholehearted, rather more often a dalliance than a commitment. The reason lies partly in the predominating form of narrative film. The tyranny of a form that creates the expectation of a continuous answer to 'what will happen next?' fanatically pursuing an inexorable resolution in which all things find their just or correct placement in space and time; such a tyranny, having already attained its epiphany in the movies (I think of *Gertrud, Senso, Balthazar, Contempt, Lulu*) such a form has inevitably seemed more ripe for resistance, or at least evasion, than for emulation" (ibid.).

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Grand Union Dreams). The very fact that we had been invited to IROS was a strange side effect of this collaboration. Kenjiro's team had created what we called "poltergeist robots" to dance along with Trisha and her dancers, and although I had joined the project in the capacity of a translator, I found myself being transformed into a poltergeist-robot operator when it became clear that somebody had to tour with these ghostly machines to control their movement from afar.

After our tightly scheduled presentation in San Diego, I had a moment to sit back and relax, and realized I had one free day before I flew back to Tokyo. I then recalled hearing from Yvonne that the Getty Research Institute had recently purchased her papers. So I quickly sent an email to GRI to see if I could arrange a visit, just two days in advance. Fortunately, I managed to reserve a spot in the special collections room. Unfortunately, however, I learned that the materials related to *Grand Union Dreams* could not be viewed because they were still being processed. The only materials that I could see were several DVDs. But since I had already made my reservation, I decided to check what other things they might have.

After a quick internet search, I discovered there was something called the "David Tudor Papers" in their collection. Having written my master's thesis on the music of John Cage, I obviously knew the name of David Tudor. In fact, I had always been fascinated by his performances that I could listen to in the few recordings that were available, which always presented an uncanny mix of wild liveliness and cool detachment no matter what he played. Yet, it never occurred to me that David Tudor's music—especially the electronic ones—could be studied. All the stories I had been hearing about him back in Japan had told me that this legendary pianist of experimental music and well-known pioneer of live-electronic music seldom spoke about what he was doing, never wrote down how he was doing them, and had passed away eleven years earlier without revealing anything to anyone. So I had not even bothered to check if any archive of his materials existed somewhere. But as soon as I started looking through the online inventory of his papers at GRI, I was surprised by the number of boxes they had which was more than 200. Still, my ignorance was to such an extent that I sent an email to Ms. Lois White of GRI the very morning of my visit with the titles of Rainer's DVDs I wanted to see, adding casually that I also wished to see, if possible, the entire "Series III. Electronics (1950s–1990s)" section of the David Tudor Papers. Taking the train from San Diego, I was arriving at the Getty Center around one in the afternoon, yet I somehow thought I could go through all the Rainer footages plus the sixteen Tudor boxes in the four hours before the special collections room closed. I must have imagined that the boxes were rather small.

But when I got to the special collections room, I gasped at the sheer amount of stuff my auxiliary request had summoned from the depths of the archive. As I began going through them, I quickly realized that it was a huge assortment of miscellaneous materials: scribbled notes, sketches of schematics, list of components, calculations, clippings of articles from popular electronics magazines, product brochures, and so on. And in spite of the serious effort by hard-working archivists to organize things chronologically, I could see that many related materials were scattered across many different folders in many different boxes. To make things worse, I knew next to nothing about analog electronics at the time, which is to say that most of the papers I laid my eyes on were written in a language I could not read, let alone understand. But there was one thing I did learn by just staring at them: all the stories I had been hearing were wrong. There was more than enough material here—the "Electronics" section was just one category among eleven—that if enough time was spent going through it all, there must be something one could discover about Tudor's music. As I rode the Pacific Surfliner back to San Diego that evening, I made the quick decision to take on that task myself. Among other things, that meant I would have to move to the United States and become a musicologist for a while.[2]

2

David Tudor had always appeared to me as a giant puzzle in the history of twentieth-century music. Born in Philadelphia on January 20, 1926, he was usually remembered as an extraordinary pianist who was instrumental to the music of many American and European composers in the 1950s, influential to many more. It was often said that his virtuosity—as a pianist as well as a thinker—had inspired composers around him in New York to experiment with how they wrote their scores, which led to the development of so-called graphic notation—a form of musical score which requires the performer to be involved in the process of creating the performance score. Starting in the mid-1950s, Tudor's activities in Europe were known to have triggered the dissemination of American experimental music abroad and its many consequences. At the same time, Tudor was often mentioned alongside John Cage as being one of the founding figures of "live-electronic music," a form of electronic music that was not simply a playback of something composed in a studio but was performed live on stage. People talked about how he had turned away from the piano in the 1960s and started composing his own music using modular electronics of his own design. He had apparently focused on this kind of music for the rest of his life, performing most often as a musician of the Merce Cunningham Dance Company (MCDC), until he passed away on August 13, 1996.

These were well-known stories because more eloquent and famous composers around him had told them on behalf of Tudor, who did not. In fact, one of the things they often spoke about was the fact that Tudor did not speak much. And since Tudor himself remained silent, people who didn't know him only repeated what his friends

[2] I eventually translated Yvonne Rainer's "A Quasi Survey of Some Minimalist Tendencies in the Quantitatively Minimal Dance Activity Midst the Plethora, or an Analysis of *Trio A*" into Japanese, and also wrote an accompanying essay on her works, both of which were published in 2009 (*Jutsu: Journal of the International Center for Human Sciences*, Kinki University, No. 3). The English version of that essay can be read here: "Seeing the Difficulty of Seeing: An Analysis of Yvonne Rainer's Analysis of *Trio A*," academia.edu, accessed December 15, 2018: https://www.academia.edu/9479852/Seeing_the_Difficulty_of_Seeing_An_Analysis_of_Yvonne_Rainer_s_Analysis_of_Trio_A_

and acquaintances had said. Thus, whenever the name "David Tudor" appeared in publications, it usually appeared in the periphery of accounts about other people. He was a dweller of anecdotes and hearsays, somehow everywhere and nowhere at once.

But what was strange was not only how people talked about Tudor; it was also how Tudor talked to people whenever he did so inside the stories that circulated. For example, the one Cage began telling circa 1958 went like this:

> *One day down at Black Mountain College, David Tudor was eating his lunch. A student came over to his table and began asking him questions. David Tudor went on eating his lunch. The student went on asking him questions. Finally, David Tudor looked at him and said, "If you don't know, why do you ask?"*[3]

Christian Wolff told another story of a similarly incredible exchange which took place at the Internationale Ferienkurse für Neue Musik (International Summer Courses for New Music) in Darmstadt in 1961:

> *Adorno [was] somehow trying to latch onto something that he could make an idea out of and an idea which would fit—which somehow could be derived from, needn't repeat but could be derived from—the European intellectual heritage, in his case, primarily Hegelian and Marxist. And David Tudor was constantly sort of evading or, as it were, thwarting every effort on Adorno's part to do this. I mean, they discussed the score and everything like that, and finally Adorno thought he had it and made this rather long disquisition, a very complicated, abstruse—you know, interesting in some respects as far as I remember it, but complicated. And at the end of it—it was a good long thing, a fifteen-minute lecture perhaps, and when he was finished, David Tudor turned to him and said: "You haven't understood a thing."*[4]

The two composers did not just report Tudor's puzzling responses. By repeatedly addressing their dear friend in full name, they also presented "David Tudor" as a puzzling *character*, especially for those who had not known the actual person. All these stories, and the way they were told, served to establish "David Tudor" as a mythological figure, a walking enigma who rarely spoke and spoke in riddles when he did.

But this mystification was not simply something that others did to Tudor. It was apparently a character cultivated by Tudor himself, even when he interacted with people more kindred to him than inquisitive students and abstract philosophers.[5]

[3] John Cage, "Indeterminacy," in *Silence: Lectures & Writings* (Middletown, CT: Wesleyan University Press), 266.

[4] Christian Wolff, "Interview with Ev Grimes (undated)," *Oral History of American Music* (New Haven, CT: Yale University); also quoted in Amy C. Beal, *New Music, New Allies: American Experimental Music in West Germany from the Zero Hour to Reunification* (Berkeley: University of California Press, 2006), 127.

[5] Talking to Teddy Hultberg in mid-May 1988, Tudor offered a slightly different reminiscence of his encounter with Adorno: "I enjoyed talking to him very much, he was like a familiar spirit to me, for he had been a great friend of my teacher Stefan Wolpe and I have experience with different musical worlds,

Merce Cunningham, who worked with Tudor for more than forty years since the early 1950s, reflected during his collaborator's memorial service on August 27, 1996: "As a person he was private, almost secret."[6] Around the same time, Frederic Rzewski, who had known Tudor since the early 1960s, described a similar impression in more detail:

> *Most people have both public + private lives. In David's life these two dimensions seemed to merge mysteriously. Just as in his piano playing there were no nonessential gestures, but every movement was somehow functional, so too in his daily life—or in that part of it which I could observe—there seemed little that was spontaneous, none of those little windows that open momentarily and unexpectedly to reveal a person's soul. Everything seemed methodical, part of a plan.* [. . .] *He was basically inscrutable.*[7]

John Driscoll, who regularly performed with Tudor since the mid-1970s and even became his next-door neighbor for a couple of years in Stony Point, New York, simply looked back on his friend as "the most complicated person I've ever known."[8]

So perhaps mystical periphery was where David Tudor wished and chose to live. And yet, in spite of the enigma of whatever was happening inside him, the influence of what Tudor did in the outside world was profound. His virtuosic ability as a pianist had led composers around him to change the way they composed; when he turned to electronics, his distinct approach inspired younger musicians to start composing music in a similar manner. As Alvin Lucier, another friend and collaborator, recalled in March 1997: "Even those of us who didn't design our own circuits, couldn't help being influenced by Tudor."[9] So all this influence was emanating from an inscrutable source whose workings could not be understood from the outside. To study what David Tudor did, it seemed necessary to somehow open this black box and examine how it worked from the inside.

so I understood Adorno. I admired his books for as far as he was willing to go. At the same time I understood why he couldn't accept the ideas Cage and the American school were bringing that were really going to change the face of music because either you can live with it or you can't, but that didn't change my admiration for him at all" (David Tudor, "'I smile when the sound is singing through the space,' Interview by Teddy Hultberg," Dusseldorf, May 17–18, 1988, davidtudor.org, accessed December 15, 2018: https://davidtudor.org/Articles/hultberg.html).

6 Merce Cunningham, "Statement delivered at David Tudor's Memorial Service (August 27, 1996)," Box 67, Folder 6, David Tudor Papers, GRI.

7 Frederic Rzewski, "Fax to *MusikTexte* (April 8, 1997)," Box 67, Folder 6, David Tudor Papers, GRI.

8 Driscoll used the same expression several times during many private conversations I had with him between 2011 and 2018.

9 Alvin Lucier, "Remembering David Tudor (March 23, 1997)," Box 67, Folder 6, David Tudor Papers, GRI. On another occasion, Lucier detailed: "Tudor made all his devices with inexpensive electronic components, everything he used was home-made. That was very inspiring. The development of experimental music in the United States, that phase of it anyway, started with David Tudor's table of electronics"

3

I was obviously not the first person to realize this. As I started my research I quickly discovered a small number of well-researched papers and books written on various aspects of Tudor's life. Starting from his 1994 doctoral dissertation, John Holzaepfel had conducted a series of meticulous studies on how Tudor realized other composers' scores when he was a pianist in the 1950s.[10] Amy C. Beal, in her 1999 doctoral dissertation as well as the book which followed, had tracked down Tudor's activities in postwar Europe playing the role of the "ambassador of American experimental music," focusing on one particular location, the International Summer Courses for New Music in Darmstadt, where Wolff had witnessed that blunt exchange with Adorno.[11] Tudor's death in the summer of 1996 had also triggered a series of publications dedicated to his life: a special issue of *MusikTexte: Zeitschrift für Neue Musik* in April 1997 collecting reminiscences from friends and collaborators;[12] four consecutive issues of *Musicworks* containing articles about his work and personality;[13] and a special issue of *Leonardo Music Journal* that came out in 2004, with various papers first presented three years earlier at the conference "The Art of David Tudor: Indeterminacy and Performance in Postwar Culture" held at GRI in 2001.[14]

(Lucier, "Thoughts on Installations," kunstradio.at, accessed December 15, 2018: http://kunstradio.at/ZEITGLEICH/CATALOG/ENGLISH/lucier-e.html).

[10] These included: Holzaepfel, "David Tudor and the Performance of American Experimental Music, 1950–1959," PhD dissertation, City University of New York, 1994; "David Tudor and the *Solo for Piano*," in David W. Bernstein and Christopher Hatch, eds., *Writings through John Cage's Music, Poetry, and Art* (Chicago, IL: University of Chicago Press, 2001), 137–156; "Painting by Numbers: The Intersection of Morton Feldman and David Tudor," in Steven Johnson, ed., *The New York Schools of Music and Visual Arts* (London, UK: Routledge, 2002), 159–172; "Cage and Tudor," in David Nicholls, ed., *The Cambridge Companion to John Cage* (Cambridge, UK: Cambridge University Press, 2002), 169–185; "Tudor Performs Cage," in Julia H. Schröder and Volker Straebel, eds., *Cage & Consequences* (Hofheim, Germany: Wolke Verlag, 2012), 111–124.

[11] Beal, *New Music, New Allies: American Experimental Music in West Germany from the Zero Hour to Reunification* (Berkeley: University of California Press, 2006)

[12] *MusikTexte: Zeitschrift Für Neue Musik* 69/70 (April 1997). Many of the original manuscripts in English are archived in Box 67, Folder 6, David Tudor Papers, GRI.

[13] The articles included: John D. S. Adams, "Giant Oscillations: The Birth of Toneburst," *Musicworks* 69 (Fall 1997), 14–17; D'Arcy Philip Gray, "The Art of the Impossible," *Musicworks* 69 (Fall 1997), 18–21; John D. S. Adams and Erin Donovan, "Still Listening: Pauline Oliveros Reflects on the Life and Music of David Tudor," *Musicworks* 70 (Spring 1998), 34–37; David Behrman, "Private Person, Public Figure: David Tudor in the '60s and '70s," *Musicworks* 71 (Summer 1998), 44–46; Peter Zaparinuk, "David Tudor's Performance Composition," *Musicworks* 71 (Summer 1998), 47–51; Stuart Dempster, "Working with David Tudor and the Merce Cunningham Dance Company," *Musicworks* 73 (Spring 1999), 14–19; Matt Rogalsky, "David Tudor's Virtual Focus," *Musicworks* 73 (Spring 1999), 20–23; Adam Barker-Mill, "David Tudor's Sound Table," *Musicworks* 73 (Spring 1999), 24–25; Austin Clarkson, "Composing the Performer: David Tudor Remembers Stefan Wolpe," *Musicworks* 73 (Spring 1999), 26–32; Austin Clarkson, "A Creative Collaboration: Stefan Wolpe's and David Tudor's *Battle Piece*," *Musicworks* 73 (Spring 1999), 32–35.

[14] "Composers Inside Electronics: Music after David Tudor," *Leonardo Music Journal* 14 (2004). Ron Kuivila described the technical nature of Tudor's electronic music in detail for the first time, with a particular focus on the no-input feedback piece *Untitled* ("Open Sources: Words, Circuits, and the Notation–Realization Relation in the Music of David Tudor," 17–23); Nancy Perloff wrote an insightful analysis of *Sea*

In 2003, Eric Smigel had written a doctoral dissertation on Tudor's esoteric concerns, with a special focus on the influence of Antonin Artaud's theater of cruelty.[15] Two years later, Eric Nedelman had submitted another doctoral dissertation which examined how Tudor performed Karlheinz Stockhausen's *Klavierstücke.*[16] Then, in 2006, Matt Rogalsky had tracked the development of *Rainforest*, a rare breed among Tudor's output for having been passed on successfully to a younger generation of musicians with whom he formed a collective called *Composers Inside Electronics* (CIE).[17]

But in spite of all this coverage and eventually some more,[18] it struck me that something always escaped the focus. Each study had revealed particulars, but their well-focused nature made me wonder all the more about how these particulars could be coordinated. The character of "David Tudor" was now much more varied and detailed, yet what lay behind the multiplicity of fragments still remained a mystery. The main problem appeared to revolve around the issue of transition: of how and why Tudor went from being a performer of other people's music to being a composer of his own. "We know David Tudor in two different guises," James Pritchett summarized in 2004. "The first was as a performer of avant-garde music in the 1950s and 1960s; the second as a composer of music using live electronics."[19] But although this mystery of the two guises was almost always mentioned in writings about Tudor, there was surprisingly little in previous scholarship that hinted at how one should think about or around it. The mystery was thus a bit like David Tudor himself—always there, but always out of focus. I had to find a different route.

Tails ("Hearing Spaces: David Tudor's Collaboration on *Sea Tails*," 31–39); and James Pritchett explored how Tudor realized the material of *Variations II* by Cage ("David Tudor as Composer/Performer in Cage's *Variations II*," 11–16). Austin Clarkson wrote a marvelous study on the relationship between young Tudor and his teacher Stefan Wolpe in the late 1940s ("David Tudor's Apprenticeship: The Years with Irma and Stefan Wolpe," 5–10). Musicians who had collaborated with Tudor also wrote about the music they knew best: Driscoll from "Composers Inside Electronics" co-wrote with Rogalsky an essential essay on *Rainforest*, a work he had performed with Tudor since 1973 ("David Tudor's *Rainforest*: An Evolving Exploration of Resonance," 25–30). Bill Viola, another member of CIE, wrote a sensitive reminiscence ("David Tudor: The Delicate Art of Falling," 49–56). D'Arcy Philip Gray, who worked with Tudor as part of MCDC in the early 1990s, wrote an informative report about his little-known works from the 1980s ("David Tudor in the Late 1980s: Understanding a Secret Voice," 41–47). Some documentation of the symposium can be viewed at getty.edu, "David Tudor Symposium," accessed December 15, 2018: http://www.getty.edu/research/exhibitions_events/events/david_tudor_symposium/index.html

15 Eric Smigel, "Alchemy of the Avant-garde: David Tudor and the New Music of the 1950s," PhD dissertation, University of Southern California, 2003.

16 Eric Nedelman, "Performance Analysis of David Tudor's Interpretations of Karlheinz Stockhausen's *Klavierstücke,*" PhD dissertation, University of California, Santa Barbara, 2005.

17 Rogalsky, "Idea and Community: The Growth of David Tudor's Rainforest, 1965–2006," PhD dissertation, City University London, 2006. Matt also began researching Tudor much earlier for his MA thesis: "Live Electronic Music Practice and Musicians of the Merce Cunningham Dance Company," MA thesis, Wesleyan University, 1995. I learned later that he was also involved in bringing Tudor's instruments to Wesleyan University.

18 Back in 2007, neither Martin Iddon's patient tracking of the correspondence between Cage and Tudor (Iddon, *John Cage and David Tudor: Correspondence on Interpretation and Performance* [Cambridge, UK: Cambridge University Press, 2013]), nor Jonathan Goldman's brilliant study of Tudor's involvement with the bandoneon (Goldman, "The Buttons on Pandora's Box: David Tudor and the Bandoneon," *American Music* 30, no. 1 [Spring 2012], 30–60) had appeared yet.

19 Pritchett, "David Tudor as Composer/Performer in Cage's *Variations II*," *Leonardo Music Journal* 14 (2004), 11.

4

As I had discovered on my first visit to GRI, it was not that resources were lacking. Most of the vast amount of materials Tudor left behind had been archived—more or less according to their respective formats—in four major locations, one on the West Coast, two on the East, and one online:[20]

(a) David Tudor Papers at GRI in Los Angeles, California, archives 177.5 linear feet of mostly paper materials—scores, sketches, notes, magazine article clippings, correspondence, receipts, reviews, recipes, program notes—in addition to photographs, many audio recordings, and a few videos—that Tudor owned.
(b) David Tudor Collection, which forms a part of the World Instrument Collection of Wesleyan University in Middletown, Connecticut, houses around 500 instruments that were in Tudor's possession when he passed away. Among these, some 150 were built by him. The rest are commercial and non-commercial devices made by somebody else which Tudor either purchased or received as a gift.[21]
(c) Merce Cunningham Dance Foundation, Inc., Records at the New York Public Library (NYPL) holds many videos and audio recordings of works Tudor was involved as the musician of MCDC since its inception in 1952.
(d) davidtudor.org collects articles, discography, images, chronology of works, and six resourceful interviews with Tudor by different people. It has been maintained since 1997 by John D. S. Adams and D'arcy Philip Gray, who assisted Tudor in many of his later projects as the sound engineer and musician of MCDC, respectively.[22]

Aside from these physical and non-physical materials, Tudor had also been survived by friends who knew and worked with him. When I first met Gordon Mumma, one of Tudor's long-time collaborators, and told him about the endeavor I was embarking on, Gordon immediately blessed me, saying I was "just at the right time since many of us are still here!"[23] And indeed they were, most of them very generous and happy

[20] In addition, there are several collaborators who own personal archives containing a variety of Tudor-related material. They include Gordon Mumma, Julie Martin, Fujiko Nakaya, John D. S. Adams, John Driscoll and Phil Edelstein, Sophia Ogielska and Andy Ogielski.

[21] The state of preservation differs greatly from one instrument to another: some are still operational, others no longer. Rogalsky painstakingly put together a comprehensive list of these extant instruments in 1999. This essential document numbers the instruments—"Rogalsky numbers"—and describes, whenever possible, the presumed function, designer, related composition, date, and a description for each entry. For several relatively simple instruments, Rogalsky also wrote down their interior circuitry. However, as with the paper material, most of the custom-built devices had remained largely unexamined.

[22] Lowell Cross, who worked with Tudor from the mid-1960s onward, has also maintained his very informative website *lowellcross.com* which includes a series of detailed memoirs about his collaborator.

[23] Gordon Mumma, "Conversation with You Nakai," *Roulette*, New York, NY, March 20, 2011.

to talk about their old friend (and indeed some have sadly passed away in the time since).[24] At least when I started, the shortage of research could not be blamed on the shortage of resources. The problem lay elsewhere.

5

Through my preliminary readings, I realized that there was a series of problems that stood in the way of a more comprehensive investigation of Tudor's music. Working alone or together, these problems appeared to bias people to always think about what Tudor did from a more or less fixed standpoint, preventing other possible approaches. They could be grouped into four categories:

(a) *The Problem of Diversity*: As if to confirm the "low threshold of boredom"[25] friends observed in him, Tudor's focus constantly moved from one thing to another—from the organ to the piano, to the amplified piano, to the bandoneon, and to electronics. This made it difficult to establish a central point of focus to view the entirety of his trajectory (other than his mystical character, which served to occult the problem rather than address it).

(b) *The Problem of Concept*: These diverse activities were difficult to grasp because they were difficult to categorize using the traditional polarities used to conceptualize music: "composer/performer," "score/instrument," "composition/improvisation," and so on. Rather than orienting the study, these concepts often lead the researcher astray, lost in the details without being able to coordinate the fragments.

(c) *The Problem of Text*: The first two problems may not have mattered if Tudor had written and/or talked about what he was doing. But he almost never did such a thing, at least not on record. Nor did he write scores in the traditional sense. So in addition to the lack of concept, there was an absence of authorial texts, the material that scholars depend on when traditional concepts fail. What could be studied instead of these "musical texts" were instruments and documents related to instruments that could not be read in the same way as letters on a page.[26]

(d) *The Problem of Literacy*: Musicologists, unfortunately, are usually not trained to trace circuits, understand schematics, or discuss the working of transformers and capacitors. This made them blind to the majority of material Tudor left

[24] The people who have passed away include Pauline Oliveros, Jean Rigg, and Takehisa Kosugi. Also, Jackie Monnier, Tudor's most important collaborator during the 1980s, was unfortunately no longer available for an interview due to health issues by the time I contacted her.

[25] Earle Brown, in John Holzaepfel, "David Tudor and the Performance of American Experimental Music, 1950–1959," PhD dissertation, City University of New York, 1994, 45.

[26] Stanley Boorman, "The Musical Text," in *Rethinking Music* (New York, NY: Oxford University Press, 1999), 403–23.

> behind. But people more well-versed in electronics usually had the opposite problem in coordinating what they understand with all the non-electronic things Tudor did. There was no universal language to process the entirety of his output.

In short, the nature of Tudor's music went against traditional concepts, while the nature of materials documenting his music went against traditional literacy. Yet it appeared to me that these two issues could be dealt with separately. The problems of *Literacy* and *Text* were technical problems that demanded more work. The problems of *Diversity* and *Concept*, on the other hand, demanded not more work but a different way of working.

6

Other than revealing the common problems that people faced, my preliminary readings made me realize that there was at least one piece of common knowledge on which people agreed about this puzzling character: *David Tudor loved puzzles*. As usual, the primary author of this story was Cage, who had described to Holzaepfel in 1988: "He's a great solver of puzzles […] His interest in puzzles invited the whole thing of indeterminacy."[27] But the composer had also added in the ellipsis above: "—and producer of them." That addendum stuck in my mind. I began playing around with an idea that appeared to emerge quite naturally from this peripheral remark: *perhaps the puzzle of David Tudor was a puzzle David Tudor made*. In which case, everything he left behind could be seen as pieces of the puzzle waiting to be put together in one way or another.

In fact, there was something very unusual about the materials he left: there were too many. Tudor preserved not only papers and objects related to his work, but also receipts dating back to the 1940s, crumpled notes with just a single component name, scribbles on the back of envelopes, empty packages of electronic components, letters from strangers, train or bus tickets from here and there. These were things that would not have survived unless somebody made a deliberate and serious effort to preserve them. As Holzaepfel later phrased it nicely in an email to me, Tudor appears to have saved "virtually every other scrap of paper that passed his way."[28] And he did so without telling anyone. One way to quickly explain this behavior is to say that Tudor was a hoarder. But the very desire to compulsively collect objects and the inability to throw them away still reveal his feelings about these materials: that they were valuable

[27] Holzaepfel, "David Tudor and the Performance of American Experimental Music, 1950–1959," vii, also 59.

[28] Holzaepfel, "Email to You Nakai," November 19, 2014. Holzaepfel, who was instrumental in the process of archiving Tudor's material, had made this observation years before.

in spite of what others may think. And as long as hoarding is an act of preservation, the fact that he did so without telling people around him does imply that he believed in—or at least imagined—a time in the future where the potential value of these objects would be realized.

Even if the idea was absurd, the thought that Tudor had composed a giant puzzle at least gave me the necessary hope that it could be solved. And it was not just a matter of hope, for it also gave me a better understanding of what I had set out to do. I was to follow the materials to recover a past that was not only absent but may have been deliberately hidden. My endeavor thus began to resemble the work of a detective. One thing I happened to remember from my childhood love of mystery novels was that detectives solved cases not only by studying physical materials, but also by simulating the mindset and habits of the criminal. That often taught them how materials should be read or even which materials should be read in the first place. It occurred to me that if David Tudor had left a puzzle behind, the best way to solve it was to approach it as David Tudor would have.

Fortunately, Holzaepfel and others had painstakingly revealed how Tudor solved the puzzle-like scores that other composers wrote for him during his pianist days in the 1950s. The pattern of his mind could be learned and fed back to the study of Tudor. Instead of using the musicological tools I had learned in books and classrooms, I would obtain the necessary instruments to probe Tudor's output from that same output—a sort of *reverse-musicology* that gradually forms its methods, concepts, vocabularies, and goals as it proceeds.

When I re-read the extant scholarship with this new mindset, I was struck by an unexpected parallel: my method of deriving the best approach to the material from the material itself was how Tudor approached *his* materials. In the 1950s, he had made specific templates and rulers that matched the scale of the particular graphic score he needed to measure; in the 1960s, he had described his first composition as something that composed itself out of its own instrumental nature; and in the 1970s, he had taught younger composers that sound source should match the character of each individual loudspeaker which is never neutral.[29] In every case, David Tudor appeared to let the specific nature of a given material determine the necessary methods and tools. In other words, my method of simulation was already a simulation.[30]

[29] "Instead of what we consider to be electronic music at present, you would then make your music geared to what the particular loudspeaker can produce, and the whole input becomes simple instead of complex" (David Tudor and Victor Schonfield, "From Piano to Electronics," *Music and Musicians* 20 (August 1972), 26).

[30] This was something that Holzaepfel had already done by approximating the scale of precision with which he read Tudor's materials to how Tudor read the materials of others. In other words, what had produced the first substantial scholarship of Tudor's music was in my view a simulation of Tudor's own patience and meticulousness. I simply expanded the same method to the entirety of Tudor's output.

7

Eventually, through my perusal, I began to realize that there was indeed a general pattern in how Tudor solved his puzzle-like scores for each performance. The procedure could be broken down into a two-step recipe of sorts:

(1) Observe the given material thoroughly in an unbiased way until it reveals its own "nature."
(2) Bias the subsequent approach to the material based on this nature.[31]

This recipe told me what to do: the first was to observe as many materials as possible without setting any particular focus in advance.[32] Exposure was more important than interpretation at this point. The fact that I did not understand electronics thus turned out to be a blessing. So I began frequenting Middletown, Connecticut, to open up the 500 or so instruments archived at Wesleyan University, drawing their circuits without understanding much of what my hand was doing; I began flying across the country to Los Angeles, California, to take thousands of photographs of nearly every single material in the special collections room of GRI without looking for or at anything specific; and back in New York, I began transcribing recordings of Tudor's interviews and panel discussions that I could find at NYPL without giving much thought to what was being said.

I had decided early on that I would take whatever Tudor said to the letter. When something did not make sense to me—which was quite often—I simply registered his riddle-like remarks in the back of my mind without trying to force sense out of them, as I did the circuits at Wesleyan and the schematics at GRI that similarly lay beyond my understanding. In the same spirit, I immersed myself into the literature of occult philosophy to learn what Tudor had learned without questioning their validity.

That exposure to mysticism may have been consequential, however, for a series of fortunate happenstances began to occur. To begin with, as I mindlessly scanned through the thousands of photographs I took at GRI, I realized that Tudor's own

[31] I found out much later that Tudor had already formulated the same procedure in a letter he wrote to Earle Brown on April 15, 1957: "my view is that accuracy of observation has to be considered first; accuracy of representation will follow (in the case where representation's involved)" (David Tudor, "Letter to Earle Brown (April 15, 1957)," Folder 5-39, Earle Brown Music Foundation; partially quoted in Rebecca Y. Kim, "Four Musicians at Work and Earle Brown's Indices," in *Beyond Notation: The Music of Earle Brown* (Ann Arbor: University of Michigan Press, 2017), 129). I thank Kim for showing me a copy of this letter.

[32] This is actually a standard way detectives work in mystery novels, as Robin Winks summarizes neatly: "As with history, the discrete fact counts; initially all facts must be presumed to count equally; in time a pattern emerges by which one may place priorities of significance upon facts as they relate to cause and effect. In time one discovers the modus operandi. One cannot discover it, in history, in detective fiction, or in life, by deliberately preselecting, skimming, omitting as irrelevant an experience. Perhaps detective fiction is for those of us who have never learned to read without moving our lips, for the lip will tell the brain what the eye alone cannot" (Robin W. Winks, *Modus Operandi: An Excursion into Detective Fiction* [Boston, MA: David R. Godine, 1982], 13).

process of learning electronics was traceable from the clippings of popular electronic magazine articles he collected, as well as the notes he took from his readings. He had begun delving into the world of resistors, capacitors, breadboards, and soldering irons at the end of the 1950s when he was already in his early thirties, and never appeared to have grown fully comfortable with the subject matter. In fact, he was still confessing difficulties even as late as September 1989: "I am a person who is terrified of electricity. I knew nothing at all about it. And Gordon [Mumma] helped me get over that. Now I have a lot of experience related to that but I'm still terrified, you know. In a way, it's always going to terrify me. But it doesn't deter me from working at it."[33] Sharing that fear completely, I decided the best way to teach myself electronics was by tracing Tudor's own steps closely.[34]

It was also around the same time in early 2011 that I attended the release party of *Music for Merce* CD box set, where I ran into the very person who had been instrumental for Tudor to get over his fear of electronics: Gordon Mumma.[35] Several months later, as I prepared a paper on John Cage for the annual meeting of the American Musicological Society in San Francisco, I was astonished to find out that the chair of my session was going to be none other than Cage's long-time friend and collaborator, Gordon Mumma. Even though I was not sure what I wanted to find out, I could not miss this chance to interview him about his other good friend. So after delivering my paper, I sat down with Gordon for three hours asking him questions I didn't quite know why I was asking.

I decided to use this serendipity as a trigger to start conducting interviews with other friends and collaborators regardless of my lack of preparation. The first one happened a week after my return to New York from San Francisco, when I spent an afternoon in Long Island with John Driscoll and Phil Edelstein from CIE, the group that had formed around Tudor in the mid-1970s. One of the things I found out that day was that the early repertoire of *Penumbra Raincoast*, a group that preceded the formation of CIE, included, in addition to works of electronic music, a dance named *Chairs/Pillows* choreographed by Yvonne Rainer.

Two years later, in September 2013,[36] I was back in San Francisco, giving a talk on Tudor's *Pepscillator* at the Exploratorium.[37] In the audience that day were John

[33] Charles Amirkhanian, John Cage, Takehisa Kosugi, Gordon Mumma, Michael Pugliese, and David Tudor, "A Kind of Anarchy: Merce Cunningham and Music (September 19, 1989) [videorecording]," MGZIDVD 5-469, Merce Cunningham archives, New York Public Library.

[34] The paper I gave that day was later published as: You Nakai, "How to Imitate Nature in Her Manner of Operation: Between What He Did and What He Said He Did," *Perspectives of New Music* 52, no. 3 (Autumn 2014), 141–160).

[35] Various, *Music for Merce (1952–2009)*, New World Records (80712), 2010, 10 CDs.

[36] I had taken a year-long break from everything since I suddenly became a single parent and decided that the best way to take care of my 18-month-old son Aevi was to travel the world with him following the letter of the places: Tokyo-Osaka-Kashiba-Bali-Lisbon-New York-Killens Pond-Douthat-Troutdale-Enka-Asheville-Ellijay-Yorkville-Eutaw-Whynot-Tallulah-Hideaway-Yantis-Sulphur Springs-Sherman-Nazareth-House-Estancia-Alburquerque-Questa-Taos-Santa Fe-Elmo-Moab-Ballard-Dinosaur-Ruleton-New Cambria-Alma-Mark Twain-New York.

[37] "Interspatial: E.A.T., Cybernetic Serendipity, and the Future of Creative Collaboration," Exploratorium, September 21, 2013.

and Phil, who had happened to stop by the Bay Area on their way to GRI. Partially inspired by the resurgence of interest in Tudor's music among younger people like myself, they had started doing a research project of their own with the hopes of putting together an exhibition. This re-encounter led to two invitations: first, to join CIE to perform Tudor's music;[38] and second, to join a group expedition to Wesleyan University to examine Tudor's instruments.

I had already drawn out almost all the circuits at Wesleyan by that time, but decided to tag along anyway. This trip, which took place in December of that year, turned out to be pivotal. Joining us from Pittsburgh was Michael Johnsen, an extraordinary musician and instrument builder with a deep understanding of analog electronics, who also happened to be interested in Tudor's instruments. We began to work together almost immediately. Meeting Michael determined the scope of my research more than anything else since he very generously played the role of "Gordon Mumma" for my own fear of electronics.

8

Even after I began working with Michael, my inability to understand many of the things I laid my eyes on turned out to be useful, for I tended to worry about seemingly insignificant details that a more learned eye would quickly dismiss—and these often turned out to be significant. My ignorance also forced me to remember the shape of circuits and names of components by rote, and this way of remembering things turned out to be critical for the task of coordinating thousands of materials across distant archives. It was an effective way to bypass the web of preconceptions about what related to what.

Gradually, the pieces of the puzzle began fitting one another: a receipt in one folder at GRI would connect to a component list found in another folder, which would connect to one of the many instruments at Wesleyan, which would connect to a photograph of some performance, which would connect to some recording at NYPL, and so on. Most circuits I had drawn blindly turned out to have corresponding schematics that I had photographed blindly, thereby revealing their source as well as function. In many cases, such coordination of materials also led to deciphering the enigmatic acronyms and abbreviations Tudor used to address instruments in his diagrams. Receipts, source articles, letters, and other materials could then date when a specific instrument was composed or purchased.

Staring at the complex picture that emerged from connecting the puzzle pieces together, it slowly dawned onto me that there was one constant focus that Tudor

[38] I performed *Rainforest I* and *Microphone* on June 21, 2014, at the Summer Solstice Celebration at Socrates Sculpture Park in Queens, New York; and *Rainforest IV* on July 20, 2014, at the Sonic Delights Festival at the Caramoor Center for Music and the Arts, New York.

maintained across his otherwise ever-changing activities: his coordination with specific instruments. This realization, as simple as it may sound, was instrumental in solving the problems of *Diversity* and *Concept*. For if this was the case, I could just ignore the question of whether David Tudor was a performer or a composer, or when and how he made the transition from one to the other. Instead, I could think of him as an instrumentalist who always produced music from his engagement with what he called the "nature" of each specific instrument. If there was a transition, it was never from performer to composer. As Tudor himself had revealed in the title of one of the very few interviews published during his lifetime, it was "From Piano to Electronics"[39]—a change of instrumentation, not of profession.

Seeing Tudor's nature as an instrumentalist also matched the circular method I took to arrive at that realization. In another well-known story, Tudor's virtuosity at the piano and his unique ability to realize extraordinary performances from any sort of material had inspired a peculiar idea in the minds of composers around him—that David Tudor was a "musical instrument." Tudor appears to have been delighted at this thought, probably because it reminded him about the teachings of his favorite author, the occult philosopher Rudolf Steiner. True to the long tradition of esoteric thought, Steiner had preached that each human being was composed as a musical instrument. Tudor's concern about the physical nature of materials was in this way coordinated with a metaphysical concern about his own nature. And if others considered him to be a musical instrument and Tudor happily agreed, approaching Tudor as he did his instruments seemed to be the right way to go. In any case, I had now discovered the nature of my material, so it was time to bias my reading accordingly.

9

It was only on rare occasions that Tudor used language to describe his approach to instruments. One of the very few instances on record happened on September 19, 1989, during a panel discussion titled "A Kind of Anarchy" held at UC Berkeley, which brought together the musicians of MCDC—John Cage, Takehisa Kosugi, Gordon Mumma, Michael Pugliese, and David Tudor. They were there to talk about the role of music in Cunningham's dance. Toward the end of the event, which included Tudor's revelation about his never-ending fear of electronics, the moderator Charles Amirkhanian asked a rather general question: given all the things that are possible in music now, "how does one commit to restrictions so that you can get on with your work?"[40] This triggered an unusually long answer from Tudor:

[39] Tudor, "From Piano to Electronics."
[40] "A Kind of Anarchy: Merce Cunningham and Music (September 19, 1989)," Merce Cunningham archives, New York Public Library.

> *I usually attack those problems from the other end. I mean I don't ever start out from the premise of dealing with what's available and trying to find out what part of it I want to use. I always come from the other side. I'm interested in very specific principles which exist, and I hate the fact that things like synthesizers and reverb devices and all that offer so much possibility. I mean in that case one has to make some choices, otherwise, all the music that everyone makes is going to sound the same. So if you start from the other side there's quite a different way of working, and interestingly enough, it leads to the discovery of things that are not in those synthesizers. Okay, it's a different bargain.*[41]

It was a rare moment. Tudor was revealing how he approached instruments: he did not start from "what's available" but from "very specific principles which exist." Amirkhanian, however, suspected faulty reasoning on the instrumentalist's part since his answer appeared to imply that the product could be reduced to the means of its production:

> *CA: By that reasoning though, everybody who writes a string quartet will end up writing something that sounds the same.*
> *DT: How so?*
> *CA: Because you are using the same instruments, like the same Lexicon, Casio. . . .*[42]

But there were two slippages in this exchange. First, what Tudor said *explicitly* was quite the opposite of what Amirkhanian had understood: music that sounds the same is produced *not* by an instrument being the same but by there being too many possibilities. The problem was not in the specific principles of material but in their apparent lack.[43] Second, what Tudor said *implicitly* went directly against what Amirkhanian had assumed: an instrument does not immediately reveal its specific principles to everybody. In other words, there was no such thing as "the same instrument," as Tudor stressed in his response:

> *No, no, no. We are not speaking of instruments. We are not speaking of instruments. No, we are speaking of ideas. I mean look at people who have written string quartets. Look at John Cage who's written a string quartet. Look at Michael von Biel who's written a string quartet. Look at Benjamin Franklin who's written a string quartet. You can see immediately that the concept of the instrument is different. I mean an instrument is not just an instrument which everybody uses in the same way.*[44]

[41] Ibid.
[42] Ibid.
[43] The premise of this reasoning is that with an instrument that offers too many possibilities, specificity would have to be derived from somewhere other than the instrument itself—a common resource of shared habits (often generalized under the name of culture) that in Tudor's view tended to produce similar results.
[44] "A Kind of Anarchy: Merce Cunningham and Music (September 19, 1989)," Merce Cunningham archives, New York Public Library."

The difference between instruments with specific principles and those that offer too many possibilities was not in the instruments, but in the "ideas" about instruments—by which Tudor meant, as he clarified, how one conceptualized and used them.[45] Everything depended on the nature of particular coordination between an instrument and its user which was based on one idea or another. Starting "from the other side" simply meant that this idea would be derived from the instruments themselves. Tudor had already followed the same circular reasoning thirteen years earlier in 1976, when he wrote the only manifesto-like text he ever authored in his life, with a title that described a specific perspective: "The View from Inside." The short summary of how he did things called for a close *observation* of materials without imposing exterior concepts:

> *Electronic components and circuitry, observed as individuals and unique rather than as servo-mechanisms, more and 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 and suggest their own musical ideas, arriving at that point of discovery, always incredible, where music is revealed from "inside," rather than from "outside."*[46]

This act of observation, however, was not as passive as Tudor made it sound. Instead, it involved an active manipulation of materials that sometimes even appeared to go against their given nature. "David Tudor would often use inputs as an output. Outputs would also be used as inputs," Driscoll recalled in 1996. "It rarely mattered to David what the original intention of the circuit was as long as it produced a range of unpredictable sounds."[47] This unconcern for the "intention" of the maker appears throughout Tudor's activities, as if he thought materials should speak for themselves. Their "musical ideas" were never given in the form of instruction manuals—they had to be discovered through actual use.

Because of this, the view from inside could also turn into a practical method to deal with instruments that appeared to offer too many possibilities. Tudor recalled one such case to John David Fullemann on September 3, 1984: "I had to make a piece, and the only thing available was this synthesizer. So I put all my gain stages into a single

[45] This is a common way of thinking in systems theory: "The real world gives the subset of what *is*; the product space represents the uncertainty of the *observer*. The product space may therefore change if the observer changes; and two observers may legitimately use different product spaces within which to record the same subset of actual events in some actual thing. The 'constraint' is thus a *relation* between observer and thing; the properties of any particular constraint will depend on both the real thing and on the observer. It follows that a substantial part of the theory of organization will be concerned with *properties that are not intrinsic to the thing but are relational between observer and thing*" (W. Ross Ashby, "Principles of the Self-Organizing System," in *Principles of Self-Organization: Transactions of the University of Illinois Symposium on Self-Organization* edited by Heinz von Foerster [New York, NY: Pergamon Press, 1962], 258).

[46] Tudor, "The View from Inside (1976)," Box 19, Folder 12, David Tudor Papers, GRI.

[47] John Driscoll, "Electronics & Cooking (In Memoriam David Tudor) (1996)," Box 67, Folder 7, David Tudor Papers, GRI.

oscillator [*laughing*] and the poor thing doesn't know what it's doing."[48] The observation of "specific principles which exist" thus involved not only ignoring the maker's intentions, but also the apparent well-being of the instrument. To observe was to use, which was also to misuse, depending on how one looked at it. As the research proceeded, I found myself simulating some of that in my approach. After all, Tudor, who enjoyed being a musical instrument, had revealed what he sought in life in an interview from May 1972: "I've always tried to be of use to people."[49]

10

This book is a study of David Tudor's music conducted, as it were, from "the other side." I observe and use the "very specific principles which exist" in Tudor's way of doing things to examine how he observed and used the "very specific principles which exist" in his instruments. My basic assumption is that this focus on *specificity* is what differentiates Tudor's "side" from the others who tended to be more preoccupied with general ideas about sounds than the actual means to produce them. But the tone of generality in such a statement already occults the point I am trying to make, since generality swallows specificity as one possibility among many. The degree of specificity is therefore very important to the research as well. It might do well to *actually* observe things from "the other side."

For example, following Tudor's habit of speech, I use the word "instrument" to refer to any material (usually physical, but not always) that can be used to realize a performance. But since there is no such thing as the "same" instrument outside its particular use, general definitions matter less than the details of how Tudor actually used the word. For this reason, despite the concern for the nature of musical instruments, this book does not pretend to be a proper study in organology.[50]

My investigation instead proceeded by coordinating three types of materials: (a) texts, (b) instruments, and (c) reminiscences (including Tudor's own).[51] I tried to go

[48] David Tudor, "'… performing is very much like cooking: putting it all together, raising the temperature': An Interview with David Tudor by John David Fullemann in Stockholm, May 31, 1984," davidtudor.org, accessed December 15, 2019: http://davidtudor.org/Articles/fullemann.html. Although the interview is dated May 31, this could not have been true since Tudor was nowhere near Stockholm on that day. Fullemann talks about "the performance last night" at the start of the interview which he clarifies as referring to Tudor's concert of *Dialects* at the Moderna Museet in Stockholm. Tudor indeed performed *Dialects* in Stockholm in 1984, but that was on September 2, which reveals the interview to have taken place the following day: September 3, 1984.

[49] Tudor, "From Piano to Electronics," 26.

[50] That said, I do feel a strong kinship with the recent development of "Critical Organology" as exemplified in Emily Dolan's research. The readers of her book *The Orchestral Revolution: Haydn and the Technologies of Timbre* (Cambridge, UK: Cambridge University Press, 2012) will probably observe the parallels between her discussion of eighteenth- and nineteenth-century orchestral music and my analysis of Tudor's music.

[51] For reasons that will be discussed later in Chapter 3, I regarded each act of reminiscence as a specific live performance. This resulted in considering people not speaking *on behalf of* other materials but *along with* them. To make such matters explicit, I tend to write out the date and location of each reminiscence.

as far as possible only by following this triangulation of sorts wherever they led me. Yet the observation of materials could not serve as the endpoint. This is because underlying Tudor's entire output was a spiritual understanding of the world, driven by a profound interest in the supersensible domain that never directly meets the eye or the ear. So the analysis of what he did and how he did them had to be mixed with some speculation about why and what for. In short, Tudor's metaphysics also mattered. This was a complex worldview developed under the strong influence of Rudolf Steiner, whose teachings in turn reflected the long tradition of occult philosophy. In Tudor's activity, however, these spiritual inclinations were always modulated by a very practical interest in solving actual problems. The result was a peculiar form of pragmatic mysticism. The difficulty for research lies in the fact that Tudor deliberately hid these influences, as he confessed to Rogalsky toward the end of his life: "part of my interest in life is, is, you know, spiritual endeavors, which I don't speak about because I don't want them to be identified."[52] Much of my own pushing of material was in order to probe this occult domain hidden from direct observation.

11

When the pieces of the puzzle began to lead me to more unfamiliar places like these, I decided to fabricate a small amount of theory just to get me by, as my Ariadne's thread around the vast labyrinth of materials. What I did was to use Tudor's own habitual wordings and phrases as keywords in my own thinking, conceptual instruments to coordinate otherwise seemingly unrelated activities or ideas. One such thread, for instance, is composed of the pair "nature" and "bias." Tudor used both words, taking the first from Steiner's text, where the term addresses the essence of each particular thing which needs to be observed for interactions between things to occur properly, and the second from the world of electronics, where the term refers to the leaning of each particular circuit (either composed by adding voltage or current, or simply discovered through use) which needs to be observed for the circuit to operate properly. In actual use, Tudor would paraphrase one with the other, as when he talked about loudspeakers in May 1972: "Each output mechanism has its own bias. So I must see what its properties are as a natural phenomenon, and not spend my time making it do something against its nature."[53] Each nature is thus biased. This paraphrase, however, turns the positivity of "nature" into a negativity. Bias does not determine or identify, it only constrains—which gives an unusual perspective on how things like musical scores and instruments work.

[52] Tudor, "Interview by Matt Rogalsky (November 2, 1994)," Tomkins Cove, NY, in Rogalsky, "Live Electronic Music Practice and Musicians of the Merce Cunningham Dance Company," 129; also, "Interview by Rogalsky," davidtudor.org. I briefly contemplated whether I should focus only on the things Tudor wanted to be identified. In the end, I trusted the materials to take me wherever necessary.

[53] Tudor, "From Piano to Electronics," 26.

Using this pair of words to orient myself in the labyrinth resulted in many revelations that are presented in the pages that follow. But how these two terms coordinate is also a good example of Tudor's constant modulation of his metaphysical learnings through the workings of physical objects and vice versa. Because of this, I imagined that by using these and other words he used—like "influence," "occult," "reveal," "material," "virtual," "actual," "realization," "generalized," "coordination," and so on—as instruments to sort out other materials, I would be simulating Tudor's own biases as far as language goes. All in all, I was not interested in making sense of what Tudor did by applying what I already knew or thought; I instead wanted to learn what one needed to know and how one needed to think in order to do the things he did—many of which appeared quite incredible to me at first.

In other words, the theoretical arguments and conceptual polarities that appear here and there are all ad hoc—composed only for the specific purpose of coordinating materials that otherwise would remain apart. They are neither abstractions for abstraction's sake nor the imposition of external philosophies, but practical instruments to tentatively and partially orient oneself through the process of puzzle solving—which happens to be how Tudor himself used "theory." This means that I often tried to simulate Tudor's reasonings regardless of whether I myself "believed" in them (as if I were an actor). Some of these trains of thought fit comfortably with how I had been making sense of things; many others shook and turned the habits of my own mind upside down.

12

The narrative of the book roughly follows chronological order, with some twists and turns here and there. This is because I wanted to portray how one realization led to another in Tudor's trajectory, a "continuity" which I've come to realize he cared about, while also being aware of what he once described favourably as "a coherence [. . .] that's deceptive" that such presentation of materials forms in the reader's mind[54]. This temporal continuity is, however, both enhanced and distorted—clipped—by another kind of continuity: each chapter focuses on a specific instrument, which sometimes requires going back and forth in time. The sections and subsections are modular units of story that are patched together like puzzle pieces to compose a certain configuration (after all, it was Tudor who first had the idea that Cage should write a lecture which consisted of nothing but stories).[55] The section with the same title as

[54] Tudor, "Interview by Fullemann," davidtudor.org

[55] On May 16, 1960, Cage recalled that it was Tudor who first suggested to him the idea of writing a collection of short stories as a lecture: "Once when I was about to write a lecture David Tudor said it would be interesting if you wrote a lecture which consisted of nothing but stories. I wasn't immediately prepared to put that into effect" ("John Cage and David Tudor, Interview with Gordon Mumma and Ed Burroughs, WUOM radio, Ann Arbor, May 16, 1960," CD4 Interviews, CCM Archive, Mills College). It was through Bill Morrison's beautiful film *Dawson City: Frozen Time* that I came to terms with the "tyranny of narrative" problem as described by Rainer.

the chapter is a cheap imitation of the synecdochical structure discovered in Tudor's music (explained in Chapter 3). It is meant to emphasize the focal point for the reader, enhancing the "coherence that's deceptive"—though usually, what is left out of focus in one chapter becomes central in the next.

As far as focuses go, I believe that differently focused studies should complement one another. For this reason, I happily left holes in my coverage of material if they had already been covered by others. Rogalsky's thesis had extensively surveyed the lineage of *Rainforest* series and the development of CIE; Beal's book had captured Tudor's involvement in the Darmstadt music scene in fine detail; Holzaepfel, Martin Iddon, and David W. Bernstein had each written very precise analyses of how Tudor realized other people's material on the piano. I did not have much to add to their discussion.

There are other holes that were not so deliberate. For instance, Tudor's exploration of sound visualization conducted mostly with Lowell Cross, along with the connection of his music with dance and dancers, are two topics related to the visual dimension of his output, something that I always keep at the periphery of my narrative but only really arrive at the end of the book. Another sad lacuna is Tudor's connection to other musicians; in particular, the early influence of Ferruccio Busoni's writings on his development as a virtuoso, the collaboration with his MCDC colleagues,[56] or the relationship with later "noise" musicians such as Borbetomagus. Otherwise, I would have liked to explore the culture of popular electronic magazines and hobby electronics which Tudor perused for materials, paying attention to the roles that fascinating figures such as Rufus P. Turner played in the history of live-electronic music.

But perhaps the biggest hole of all is the complete silence around Tudor's love of cooking and its connection to his music, which has been mentioned by many collaborators and briefly detailed in a short essay by Driscoll.[57] Part of this is because I have opted for a practice-led research on this topic, which seemed to me the only proper way to go as far as Indian food is concerned. So, the story I tell is obviously not the whole story. In any case, one reason for making the research public lies in the hope that there will be other, more capable people who would conduct further inquiry into matters of which I have only scratched the surface.

13

I have so far described this book as a product of my theatrical efforts to simulate the way Tudor did things. That is obviously not the whole story either. For I could not help but be influenced by all the things that surrounded me yet were completely outside of

[56] Kosugi gently refused my request for an interview, saying that he believed Tudor's music should die with Tudor. I respected that opinion. Sadly, Kosugi himself passed away in November 2018.

[57] John Driscoll, "Electronics & Cooking (In memoriam David Tudor)," *MusikTexte* 69–70 (April 1997), 78–79.

the world in which Tudor lived. The most important among them during the phase of research was making my own works of music, dance, and theater as a member of "No Collective," a fabrication to which I dedicated myself throughout the entirety of this project. Although these performances will probably appear to be quite different from Tudor's in the eyes of most people—I only rarely focus on electronics to begin with—a closer observation should reveal how they served as both hunting and testing grounds for most of the ideas scattered throughout the book.[58]

If these performances and the many things I realized by making them biased the process of puzzle solving, two other factors biased the way I wrote about what I managed to solve. They both appeared during the last phase of the project, when I actually started working on the book, which by sheer chance I spent living in San Diego, the city where the research had begun ten years before. They both concerned new connections. The entire manuscript was written under the heavy influence of M.—who prefers to go by initials—and the group of similar acquaintances I met in Southern California who taught me the essence of "microhistory" as formulated by Carlo Ginzburg and others.[59] In their application, microhistory turned from a scholarly technique for accounting the past into a practical method for experiencing the present in everyday life.

But even a stronger influence came from another individual with whom I established an intimate relationship in San Diego: my then-six-year-old son Aevi, whom I single-parented during the weekdays (while he spent the weekends with his mother, Yelena Gluzman, who had moved there from Tokyo). Living in a city where I did not know almost any soul and was not able to see the very few I did because I stubbornly refused to drive, Aevi became my primary, and for most of the time the only, person to talk to about everything that was on my mind. Naturally, the manuscript I was writing formed a large part of our conversation. Like an in-house editor, he would often ask as I picked him up from school, "so, how's the book coming along?" which

[58] In *ECO*, presented at The Kitchen in New York City in May 2011, I (ab)used the principles of *Rainforest*, secretly attaching transducers to several audience seats to turn them, along with the person who happened to be sitting on them, into instrumental loudspeakers (No Collective, "Eco," nocollective.com, accessed December 15, 2019: http://nocollective.com/e.html). *Vesna's Fall* and *House Music*, two pseudo-dance musicals I created in 2014 with the choreographer Lindsey Drury, helped me think about synecdochical structures and giant instruments by actually realizing some (No Collective, "Vesna's Fall," nocollective.com, accessed December 15, 2019: http://nocollective.com/v.html; No Collective, "House Music," nocollective.com, accessed December 15, 2019: http://nocollective.com/hc.html). In *Immaculate Conception*, a doppelgänger chamber music performed in Brooklyn in January 2016, I took Tudor's idiosyncratic realization of Sylvano Bussotti's *Piano Piece for David Tudor 1* as my point of departure, modifying it extensively with my fantasy of finding a film footage of his performance with the sound erased (No Collective, "Immaculate Conception," nocollective.com, accessed December 15, 2019: http://nocollective.com/i.html). In *Past Future Perfect*, a two-week residency project we conducted in Kinosaki, Japan, with the duo *Zen-Go* in February 2018, I translated the idea of material bias to human beings, and we explored people's "habits" as a form of unconscious archi-choreography and the nature of loudspeakers as a form of ventriloquy (No Collective, "Past Future Perfect," nocollective.com, accessed December 15, 2019: http://nocollective.com/pfp.html). The theatrical dance we worked on directly inspired the two sections written during the same residency: the part about material bias (Chapter 1) and likeness to voices (Chapter 8).

[59] For instance, Carlo Ginzburg, "Microhistory: Two or Three Things That I Know about It," translated by John and Anne C. Tedeschi, *Critical Inquiry*, 20 (Autumn 1993), 10–35.

would trigger me to describe the part I had worked on that day, rephrasing things in a manner that a curious first-grader could understand. Then, in the evenings, we would read several pages together as his bedtime story and I would rewrite passages based on his responses after he fell asleep. I tried to make sure that he understood everything. But Aevi's influence is more than just this or that thing I can point to, for the fortune of being with him every day has made me rethink about time, life, and love in a very different way than I used to, and the consequences of this change fill out every page that follows. On my end, the concern for specificity was based on this concern for a very special person, a singular point of orientation that ran against all kinds of generalization.

14

Toward the end of the summer of 2018, as the writing of the manuscript also neared its end, I was left with no choice but to leave the United States with Aevi due to the termination of my visa, which turned out to be impossible to renew in spite of my son being American.[60] The duration of the whole project thus ended up more or less coinciding with the length of time I spent living in the country where David Tudor was born, which led me to reconsider what I had written as an ethnographic report of my observations in what had become, for the time being, a foreign land.

But when I wrote the bulk of the manuscript, I never thought of it as a mere remembrance of things past. My hope all along was not so much to produce a faithful representation of what Tudor did, but to coordinate the scattered pieces of the puzzle to create a lively realization that future readers may use for this or that purpose.

As for history, there is the history of production. Like many people who write books, I rewrote this one many times, each time ending up with something that was not necessarily better but always different. The final version is, therefore, the result of one long series of realizations exposed to many influences, biases, accidents, and deadlines that might have been any other but were actually not. This book records that performance.

Varanasi, January 20, 2019

[60] Things had become especially difficult under the immigration policies of the then-current administration, led by a president who happened to share the same initials as David Tudor, and had taken the oath of office a year earlier on what would have been the latter's ninety-first birthday. It is also because of such a process of objectification I have constantly been subjected to and have battled against since my childhood—being an "oriental" growing up in England and Mexico—that I deliberately stayed away from the rather easy discussion of regarding Tudor as an "American" composer. Accordingly, if there is any interpretation that I wish to prevent in advance, it is the equally lazy maneuver of reducing this study to the "accident," as Cage once said, that its author happened to be born in Japan (Cage, "Happy New Ears," in *A Year from Monday* [Middletown, CT: Wesleyan University Press, 1967], 33).

Chapter 1
Piano

I. Escapement Mechanism

Piano

1

On December 30, 1945, a belated Christmas concert was held at Trinity Church in Swarthmore, a small Pennsylvanian town eleven miles southwest of Philadelphia. According to the program note,[1] the evening was hosted by a choir of singers and one organist who together performed old German, English, Welsh, and French songs, as well as music by composers like George Frideric Handel (Figure 1.1). The church organist, who also performed two solos—*Toccata, Adagio and Fugue in C major* by J. S. Bach and *Pastorale* by César Frank—was a nineteen-year-old virtuoso from Philadelphia who had gotten the job two years earlier when he was just seventeen. Soon after his arrival, he had given a series of concerts at Swarthmore College, right next to the church, the success of which led to his appointment there as well. According to the program note, his name was David Tudor.

2

In the week of April 28, 1947, David Tudor used the back (and front, when he ran out of space) of four copies of the Christmas concert program from sixteen months before to draft a letter addressed to a Mr. Rossin in New York, who had requested his publicity material.[2] Since he had none, the twenty-one-year-old instead offered a recollection of what he had been doing in his life until then—"Below are the facts for what they are worth":

[1] Trinity Church Swarthmore, "Program note, Christmas Music (December 30, 1945)," Box 61, Folder 4, David Tudor Papers, GRI.

[2] David Tudor, "Letter to Mr. Rossin [draft] (April 1947)," Box 61, Folder 4, David Tudor Papers, GRI. The letter can be dated since Tudor writes, "I am going to be in NY next Monday May 5th. . . ." The only year in the second half of the 1940s where "May 5th" fell on a Monday was 1947. Austin Clarkson also quoted this letter at the beginning of his paper ("David Tudor's Apprenticeship: The Years with Irma and Stefan Wolpe," *Leonardo Music Journal* 14 [2004], 5–10). In his footnotes, Clarkson dates the letter as April 1947 referring to "internal evidence" (ibid., 9). According to John Holzaepefel, Mr. Rossin is "probably Alfred Rossin of the National Music League, an organization supporting young musicians" (David Tudor, *Solo for Piano by John Cage, Second Realization, Part 1: Essay and Critical Commentary*, edited by John Holzaepfel, MUSA Volume 30A (Middleton, WI: A-R Editions, 2020), 4).

Reminded by the Instruments. You Nakai, Oxford University Press (2021). © Oxford University Press.
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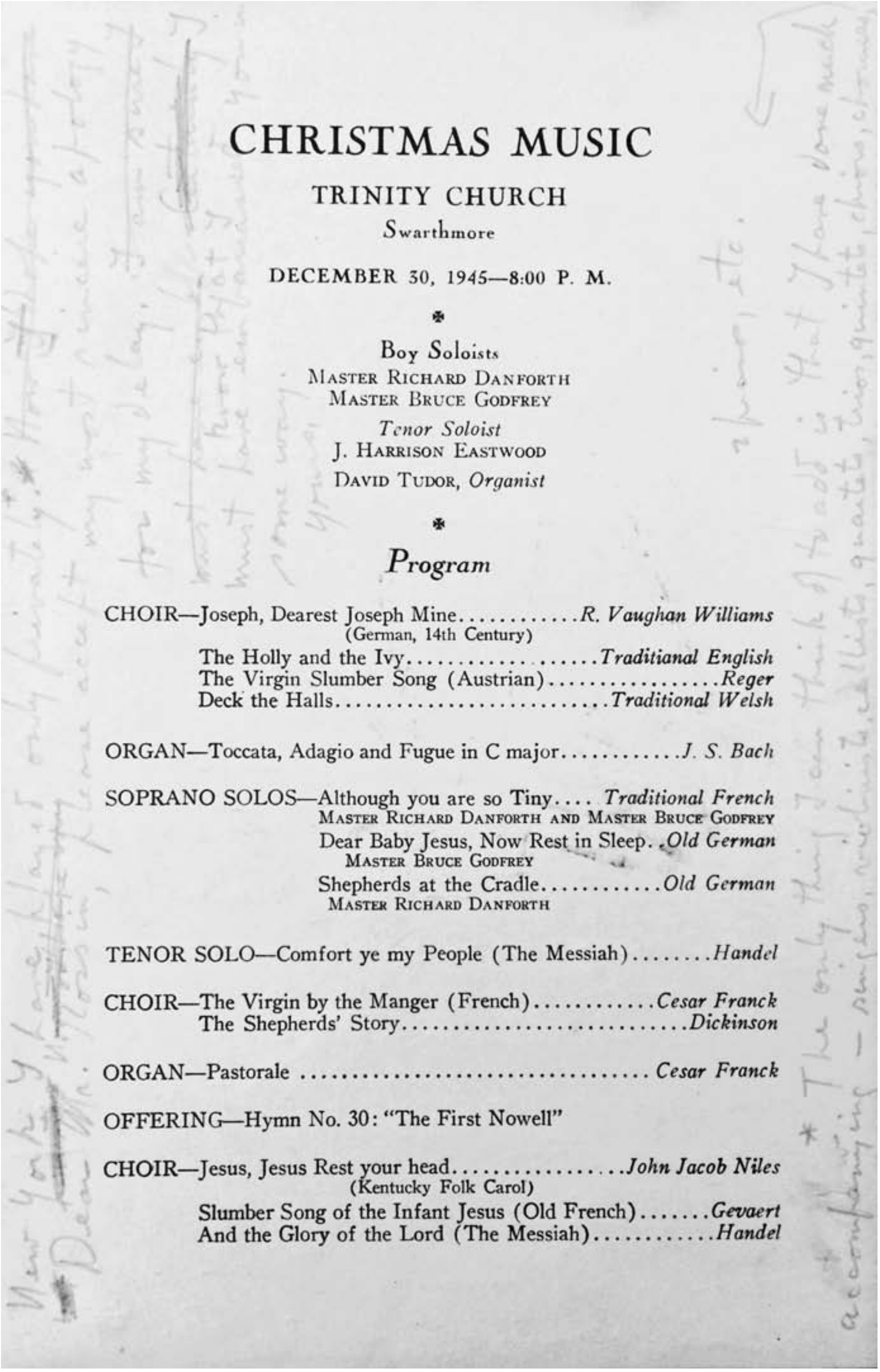


CHRISTMAS MUSIC

TRINITY CHURCH

Swarthmore

DECEMBER 30, 1945—8:00 P. M.

Boy Soloists

Master Richard Danforth

Master Bruce Godfrey

Tenor Soloist

J. Harrison Eastwood

David Tudor, *Organist*

Program

CHOIR—Joseph, Dearest Joseph Mine............*R. Vaughan Williams*
(German, 14th Century)
The Holly and the Ivy..................*Traditional English*
The Virgin Slumber Song (Austrian)................*Reger*
Deck the Halls..........................*Traditional Welsh*

ORGAN—Toccata, Adagio and Fugue in C major............*J. S. Bach*

SOPRANO SOLOS—Although you are so Tiny.... *Traditional French*
Master Richard Danforth and Master Bruce Godfrey
Dear Baby Jesus, Now Rest in Sleep. .*Old German*
Master Bruce Godfrey
Shepherds at the Cradle............*Old German*
Master Richard Danforth

TENOR SOLO—Comfort ye my People (The Messiah)........*Handel*

CHOIR—The Virgin by the Manger (French)...........*Cesar Franck*
The Shepherds' Story...........................*Dickinson*

ORGAN—Pastorale .... *Cesar Franck*

OFFERING—Hymn No. 30: "The First Nowell"

CHOIR—Jesus, Jesus Rest your head.................*John Jacob Niles*
(Kentucky Folk Carol)
Slumber Song of the Infant Jesus (Old French).......*Gevaert*
And the Glory of the Lord (The Messiah)............*Handel*

Figure 1.1 Program of Christmas Music Concert at Trinity Church, Swarthmore, with Tudor's later draft of the letter to Mr. Rosin | December 30, 1945

DTP, Box 61, Folder 4 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

> *Born in Philadelphia Jan 20 1926*
>
> *Went to High school in P.*
>
> *Began to study piano at 6 with local teachers.*
>
> *My father was a church organist and I was so fascinated and attracted by the sound of this instrument that a friend introduced me to H. W. Hawke at St. Mark's Church (one of the largest Phila. Churches), who taught me organ and convential* [sic] *music theory, harmony, counterpoint, etc. He made me his assistant for four years when I was 11–15 afterwards he sent me out on my own and at 17 I became organist at Trinity Church, Swarthmore and Swarthmore College.*[3]

These facts can be enhanced through other materials. When H. William Hawke met the eleven-year-old boy in 1937, he had agreed to teach him for nothing for three years.[4] Within a year the new student had become the organist's assistant, and by the summer of 1940, he was already filling his teacher's position at St. Mark's Church in downtown Philadelphia while the latter retreated to a property near Gananoque in Ontario, Canada.[5] Two years later, on June 26, 1942, the sixteen-year-old apprentice passed the exam to become an Associate of the American Guild of Organists.[6] The following year, his remarkable progress on the instrument, coupled with the ongoing Second World War conscription which had relocated many older musicians from church to military service,[7] resulted in the young organist's joint appointment at Swarthmore.[8]

Tudor's 1947 recollection of facts, however, focuses for the most part on what happened in the four years after he began teaching at Swarthmore College. For during his first year there, Tudor had an encounter he looked back three years later as having

[3] Tudor, "Letter to Mr. Rossin."

[4] This fact appeared in another reminiscence Tudor told Julie Martin on January 26, 1992: "I went to a neighborhood teacher who was very good, and then a singer noticed my interest in the organ and among his many jobs he sang at the church in Philadelphia so he took me there to see the organist, and the organist wrote a letter saying he would teach me for the period of three years for nothing, and eventually he made me his assistant. I think I was eleven" (Tudor, "Interview by Julie Martin (January 26, 1992)," Billy Klüver/Julie Martin Archive).

[5] "I will be away from the Church from July 1st until September 1st, and would like you to play for me during that time. You will be paid $10 a Sunday for this work. I have talked with the Rector about your practicing, and we have decided that you will be allowed to use the organ on Saturday mornings from 9:30 to 11:30, but the organ is not to be used at any other times, except for services, and by the express permission of the Priest in Charge. You will have to abide by this rule absolutely" (H. William Hawke, "Letter to David Tudor (June 12, 1940)," Box 54, Folder 3, David Tudor Papers, GRI).

[6] The American Guild of Organists, "Certification of Associate Membership for David Tudor (June 26, 1942)," Box 97, Folder 3, David Tudor Papers, GRI. Tudor's exam materials are also archived in Box 2, Folder 2.

[7] This fact was brought up by Gordon Mumma when I spoke to him on November 11, 2011, during the annual meeting of American Musicological Society in San Francisco: "In 1941, in the area that he lived which was Pennsylvania around Philadelphia with many old churches, the Second World War conscription got under way and anybody who could read or write and walk was being pulled into the military. This really came along heavily in '42 and '43. The people who were between 18 and 25, 26, and eligible for military service were drafted, and among those were musicians who played the church services. So there was suddenly a vacuum, or quickly a vacuum, of people who made music in churches" (Gordon Mumma, "Interview by You Nakai," San Francisco, CA, November 11, 2011).

[8] Tudor's studies with Hawke are detailed in John Holzaepfel, "David Tudor and the Performance of American Experimental Music, 1950–1959," PhD dissertation, City University of New York, 1994.

"completely changed the course of my life."[9] It involved a change of instrumentation: one evening at a faculty gathering, Tudor saw Irma Wolpe play the piano and "immediately and spontaneously decided to become a pianist."[10]

This was not his first encounter with the piano, of course.[11] Even after shifting his focus to the organ at age eleven, Tudor did not lose touch with the first instrument he had learned, and according to the profiles he wrote in later life, he even took lessons with the pianist Josef Martin between 1941 and 1943. In the 1947 draft, however, the significance of this early exposure to the piano was minimized using a peculiar wording:

> *For 4 years (since 13) ~~I played the piano (but did not study it~~ I didn't study the piano at all (but played it often) until I met Mrs. Wolpe.*[12]

Part of the reason Tudor continued to "play[ed] it often" was that Hawke had at one point told him not to abandon the other instrument. On July 19, 1995, during an interview by Jack Vees conducted toward the end of his life, Tudor speculated upon the reasoning behind his teacher's puzzling suggestion more than half a century before: "I don't know. I would have to guess at it, why he did it, but the two instruments are quite different in their dynamics. And I bet you it was the dynamics of the piano which he thought I was lacking in."[13] Interestingly, he looked back on this lack as conditioned by his own ability: "The different physical exertion that you use to play forte is quite specific and since I could hear it in my mind's eye, I didn't need to do it actually."[14] Hawke's suggestion pointed toward the specific physical nature of piano playing that could not be simulated in the virtual performance of the mind, no matter how virtuosic. Tudor needed to do it *actually*.

9 Tudor, "Letter to Mr. Rossin."

10 Ibid. Holzaepfel wrote in 2006 that Irma Wolpe appears to have played *Dance in the Form of a Chaconne* (1939) by her husband Stefan Wolpe that evening (John Holzaepfel, "Liner Notes," *David Tudor and Gordon Mumma*, New World Records, 80651, 2006, CD). Martin Iddon, however, wrote seven years later in 2013 that it was "Irma Wolpe's performance of her husband's *Toccata* that had first spurred Tudor to seek lessons with her" (Iddon, *John Cage and David Tudor: Correspondence on Interpretation and Performance* [Cambridge, UK: Cambridge University Press, 2013], 172). Curiously, Iddon's claim is based on Irma's own account, which Holzaepfel himself transcribed for his dissertation: "He heard me play Wolpe, he heard me play that 'crazy' music; he heard the *Toccata* and he decided to study with me" (Ellsworth Snyder, "Interview with Irma Wolpe Rademacher," New York City, 1975. Quoted in Holzaepfel, "David Tudor and the Performance of American Experimental Music," 5). In 2016, Holzaepfel clarified that his claim for *Dance in the Form of a Chaconne* was based on his interview with Tudor on January 17, 1992, and is therefore more likely to be true (Holzaepfel, "Email to You Nakai," January 3, 2016).

11 In his interview with Teddy Hultberg in May 1988, Tudor remembered that his first encounter with the piano was through his mother, who passed away when he was still young: "We had a piano at home and my mother had played piano very well when she was alive. I never had any choice: the moment I was shown a piano, I had to see what it was all about and that was that. The organ started much later, because my father played the organ. Since my mother had died, I very often went with my father to his church because he had to work there" (David Tudor, "'I smile when the sound is singing through the space,' Interview by Teddy Hultberg," Dusseldorf, May 17–18, 1988 davidtudor.org, accessed December 15, 2018: https://davidtudor.org/Articles/hultberg.html).

12 Tudor, "Letter to Mr. Rossin."

13 David Tudor, "Interview by Jack Vees and John D. S. Adams (Stony Point, NY, July 19, 1995), 241 a," *Oral History of American Music*, Yale University Library, 5.

14 Ibid.

3

The teacher proved himself right, for "dynamics" was indeed the term Tudor used in the same 1995 interview to reflect upon the lessons with Irma Wolpe: "It was a completely different world for me. It was like *dynamic* impact."[15] Back in 1947, in his more immediate recollection of facts, Tudor had emphasized the sophisticated control of dynamism that the piano enabled—true to its name "piano-forte"—by comparing it to the nature of his other instrument:

> *The revelation of the sensitivity and direct expression of which the piano is capable came as a shock that I can never forget. Many things have since substantiated my decision—if, for instance, one wishes to do something for contemporary music, one must acknowledge the fact that the organ by its indirectness, lack of vitality and dated grandiose character is inadequate for the expression of the extremely complex dynamic and rhythmic inflection of our music.*[16]

The young Tudor used the polarity between "directness" and "indirectness" to explain the difference of dynamics between the two instruments. Unlike the piano key, "directly" coordinated with the hammer that strikes the string whenever it is depressed, the manuals on the organ generate sound only "indirectly" by opening a valve to let pressurized air go through a pipe. In other words, the latter is a *gating* device which does not appear to produce a sound of its own.[17] This physical nature results in two distinct features of the organ, one thing it can do and another it cannot: (a) pressing a key can control the duration of sound indefinitely (as long as there is provision of pressurized air); (b) pressing a key cannot control the dynamics of sound (which must therefore be controlled by a separate interface called the swell pedal). With the piano, pressing a key has the opposite function: it can control dynamics but not the inevitable decay of sound.[18] Despite having a similar keyboard interface, the two instruments behave quite differently. One way to explain this is to say that the organ is a wind instrument and the piano is a percussion instrument. At least that was how Tudor described the latter in a radio interview on May 29, 1972:

[15] Ibid., 8; emphasis added.

[16] Tudor, "Letter to Mr. Rossin." Interestingly, he continues: "Then also there is such a poor audience for organ playing—limited in every respect; any music worth listening to should reach the people of the world in huge numbers. [or: composers may compose for themselves and their select audiences, but music is meant for all of the people" (ibid.).

[17] The early organs did this by a mechanical action of physically transforming the key action into a pushing motion. The pneumatic action invented from the middle of the nineteenth century harnessed the power of the wind already inside the organ to control the valves. Electro-pneumatic action in the twentieth century triggered a precision-made magnet to do the same (Stephen Bicknell, "Organ Construction," *The Cambridge Companion to Organ* [Cambridge, UK: Cambridge University Press, 1998], 23–24). Thus, the development of the organ increased the distance between the physical action on the key and production of sound, a distance that nonetheless always existed in the mechanism of the instrument from the beginning.

[18] Mumma has repeatedly emphasized the influence of Tudor's early exposure to the organ on his later electronic works. His 2013 essay "With Tudor the Organist" brings together a series of important observations on the subject (Gordon Mumma, *Cybersonic Arts: Adventures in American New Music* [Chicago: University of Illinois Press, 2015], 144–150). In particular, Mumma stresses the difference between one organ and another—which brings to mind Tudor's view of each instrument as having a distinct

You see, in my life I've played other instruments beside the piano. I began my work as an organ player, and that is quite a different sound world. And as I go through life, I like to do things which I haven't done before. Also I like very much to discover the nature of... well to discover natural processes in the way I look at things. For instance, the piano became for me more and more a percussion instrument, because that, after all, is its nature.[19]

4

If dynamics was at issue, however, it was not only the nature of Tudor's new instrument that mattered, but also that of his new teacher. For during another recollection on October 4, 1982, Tudor used the same term to describe his impression of how Irma Wolpe played the piano: "because her piano playing was so *dynamic*. It was like the opposite [of the] world I knew. And I just felt I had to get into it right away."[20] So while dynamism was certainly related to the specific nature of the instrument, it was also related to a specific way of playing that instrument: "she threw her physical apparatus completely into her playing," was how he recalled it to Vees in July 1995. "It took me a while to believe what was happening."[21] Unlike the difference between the worlds of organ and piano, the difference between the instrument and the instrumentalist appeared to blur in Tudor's reminiscence.

But this blurring may have very well been what he learned from Irma Wolpe. For Tudor's new piano teacher also happened to be an instructor of Eurhythmics, a method developed by Emile Jaques-Dalcroze in the early twentieth century for translating invisible music into visible bodily movement. And Irma Wolpe's distinct approach to the piano was based on her learnings on this front. In seeking to find a common ground between sound and body movement, Dalcroze presented a view of the human body as an "ideal musical instrument."[22] As such, the students of Eurhythmics, in order to perform (themselves) well, were asked first of all to

nature—and its spatial extension inside the church architecture which trained Tudor to develop an exceptional skill for adjusting to latency—the temporal delay between what he does and the resulting sound. When I talked with him on November 11, 2011, Mumma explained the specific nature of the organ in the following way: "What you do with the organ, the sound doesn't go away. You push the key down and it stays on, right? But there's all this other stuff going on, you got the pedals, all the stops that change the sonority brand, you have all of those other things, and the time lags. And it's a substantial instrument: it's got several keyboards doing all those things. There are major differences with the piano of course—it's a whole different thing" (Mumma, "Interview by You Nakai," San Francisco, CA).

19 KPFA Radio, "An Interview with John Cage & David Tudor, May 29, 1972," archive.org, accessed December 15, 2018: https://archive.org/details/AM_1972_05_29

20 Austin Clarkson, "David Tudor Interview (October 4, 1982, Tape I Side A)," Box 65, Folder 11, David Tudor Papers, GRI. Reprinted as: "Composing the Performer: David Tudor Remembers Stefan Wolpe," *Musicworks* 73 (Spring 1999), 28.

21 Tudor, "Interview by Vees and D. S. Adams," 9.

22 Emile Jaques-Dalcroze, *Rhythm, Music, and Education* (New York, NY: G. P. Putnam's Sons, 1921), 274. The longer quote is as follows: "The whole human body constitutes the ideal musical instrument that is most capable of interpreting sounds in every degree of time: the light limbs executing the rapid, the heavy limbs the slow, passages. It may achieve slow effects—unusual in music—by a flexible succession of gestures, attitudes, and displacements; and, moreover, may, by means of dissociated movements of separate limbs, interpret no matter what polyrhythm" (ibid., 274–275).

understand the nature of this specific instrument: "a perfect understanding of all its muscular possibilities, and be capable of deliberately bringing them into effect."[23]

What made this learning process possible was a double act of "coordination": to coordinate muscular activities inside the body so that the body could then be coordinated with the music it needed to make visible. But for a pianist, there would be a third level of coordination. For if the human body is really a musical instrument, the act of playing the piano becomes a matter of coordination between *two* instruments. The "physical exertion" required to bring forth the dynamics of the piano had to therefore be coordinated with the physical nature of the instrument itself. It was through this realization that Tudor began "studying" the piano, as opposed to just "playing" it: "I recall that she was very conscious of her bodily movements at the keyboard and what they meant to the music," he told Vees on July 19, 1995. "So I began to study the mechanics of playing the piano in greater detail. I hadn't paid any attention to it before."[24] When Clarkson asked him thirteen years earlier whether the influence of Eurhythmics was notable in his teacher's piano playing, Tudor had replied as a matter of course: "Oh, very much so. Her whole attack on the techniques of playing the piano came from studies, and experiences, and working with *coordination*."[25]

5

For this reason, when Irma Wolpe's "quite a different quality of piano playing" left him speechless, Tudor engaged in a peculiar task to understand the nature of how his teacher played the instrument: he opened up the instrument and studied how *it* worked. During the interview with Vees in July 1995, he looked back on what his eighteen-year-old self had done fifty years before. "There were too many things that I didn't understand so I began to study the mechanism of the piano." After long observation, he arrived at a realization:

> *Then it finally dawned onto me that* […] *it's like a lever and there's a point. Technically it's called the escapement—it allows the hammer to strike the string and then release so that the hammer actually falls away from the string and if you can find the right point to press into the escapement action you have absolute control of the dynamics and, as a corollary, you have control over the tone—you can influence the tone.* […] *So that's what I was spending my time studying and practicing the piano to enhance my ability to control that.*[26]

[23] Marie-Laure Bachmann, *Dalcroze Today: An Education through and into Music*, translated by D. Parlett (New York, NY: Oxford University Press, 1991), 148.

[24] Tudor, "Interview by Vees and D. S. Adams," 9. Also, "I became interested in the mechanics. […] [T]hat caused me to look at diagrams of the piano action so that I would understand what was happening, and I benefited immensely from that" (ibid., 6). Many article clippings and notes related to the mechanics of the piano are indeed found among Tudor's papers at GRI (Box 2, Folder 12, in particular).

[25] Clarkson, "Composing the Performer," 28; emphasis added.

[26] Tudor, "Interview by Vees and D. S. Adams," 9.

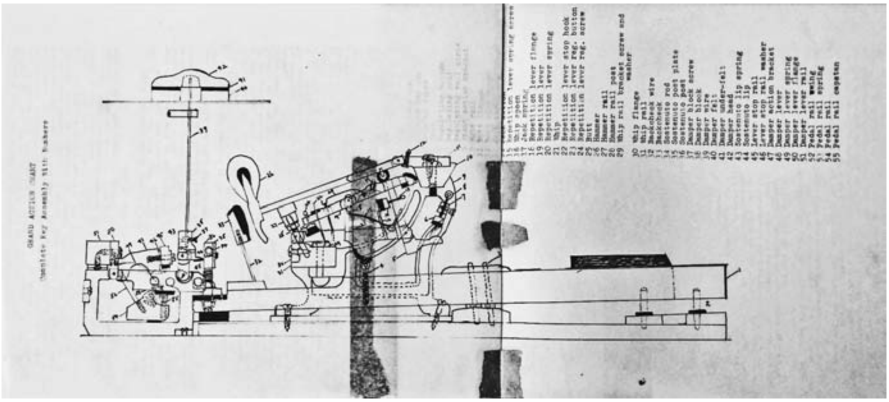


Figure 1.2 Tudor | Copy of Grand Piano Action Chart from an unidentified source | Undated
DTP, Box 2, Folder 12 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

The key to solving the puzzle of Irma Wolpe's distinct pianism was indeed discovered inside the instrument (Figure 1.2): the mechanism invented by Bartolomeo Cristofori in 1710 and developed further by Sébastien Erard and others in the 1800s which goes by the name of "escapement."[27] When a piano key is depressed, the jack and the repetition lever are lifted through the wippen body, thereby pushing the hammer up. At the same time, the key also lifts the damper off the string to let it vibrate when struck. But immediately before the hammer hits the string, the repetition lever stops and the jack is rotated out from the hammer, letting the latter "escape" from its connection to the other parts of the action. From here the hammer simply uses its own inertia to hit the string—single escapement. Once the string is hit, the hammer rebounds and is caught by the backcheck also attached to the key. If the key is then released partially, it triggers the backcheck to let go of the hammer, which is quickly pushed up close to the string by the repetition lever so that the jack can reset to its position—double escapement. This quick resetting of action without the need for a complete key release enables fast repetitions of the same key on the piano. Only when the key is fully released do the hammer and damper return back to their original position.

In other words, contrary to Tudor's own explanation in 1947, his observation of the instrument had revealed the *indirect* nature of the piano's mechanism of sound production.[28] The piano is essentially a *remote-controlled percussion instrument.* The appearance of directness is simply an effect of scale: the connection between the pressing of keys and the hitting of strings usually appears immediate because it happens too quickly in comparison to most other things in human life. The pianist wishing to coordinate with the piano must therefore learn to perform on a miniature scale of time.

27 For a detailed account of how Cristofori invented his instrument, see Stewart Pollens, *Bartolomeo Cristofori and the Invention of the Piano* (Cambridge, UK: Cambridge University Press, 2017).

28 Tudor kept clippings of magazine articles about the piano written from this perspective. Albert Preisman's article "The Piano," published in two parts in the October and November 1953 issues of *Audio Engineering*, analyzed the physical mechanism of how the instrument produces tones (Albert Preisman, "The Piano," *Audio Engineering* [October/November 1953], 26 [Box 36, Folder 2, David Tudor Papers, GRI]). After a careful

Tudor's efforts to enhance his indirect control of the escapement action appears to have done just that. As he looked back during another interview by Holzaepfel on August 3, 1992, "I was very trained to work within a time continuum of one second."[29]

6

Escapement control, or the technique of finding "the right point to press into the escapement action," thus consisted in precise temporal control of key-strikes which allowed the pianist to intervene at different points of the jack-repetition lever-hammer coordination. As a result, Tudor could control dynamics not through muscular force but through the different states of coordination inside the piano. His preparatory notes for a piano seminar, most likely given at the 1959 International Summer Courses for New Music in Darmstadt, include a brief reminder about this effect: "advantage of escapement control/same energy for soft & loud."[30]

Release is another matter. Eric Nedelman investigated Tudor's extremely meticulous articulation of dynamics in his realizations of Karlheinz Stockhausen's

examination of the escapement action, Preisman presents a number of tests to show that the physical nature of the piano biases piano playing in two fundamental ways: (a) tone color cannot be altered independently of loudness; and (b) difference in loudness and quality of the tone is produced by the velocity of hammer strike, not the amount of force. Although "many pianists still believe that they can vary the tone color and not the loudness by varying the touch," Preisman argued this belief was ungrounded: "once a certain final velocity has been imparted to the hammer, both the loudness and tone quality are determined; how you impart that final velocity (how you strike the key) is immaterial" (ibid.). In other words, tone is controlled only as a corollary of dynamic control, for which timing and speed is everything.

Another clipping, going further back in time, is "Lights on Piano Touch and Tone" from the September 1925 issue of *The Etudes Magazine*. This article collected excerpts from Otto Ortmann's book *The Physical Basis of Piano Touch and Tone: An Experimental Investigation of the Effect of the Player's Touch upon the Tone of the Piano* (London, UK: K. Paul, Trench, Trubner, 1925) published in the same year (Otto Ortmann, "Lights on Piano Touch and Tone," *The Etudes Magazine* 43, no. 9 [September 1925], 617–618 [Box 67, Folder 11, David Tudor Papers, GRI]). Ortmann starts by outlining the basis of his approach using the same word that Tudor had used to describe the focus of his study: "The mechanism here described is a machine. A machine is a contrivance by means of which force can be applied to resistance more advantageously than when it is applied directly to the resistance. The action of the piano is a machine which enables us to overcome a resistance at one point (hammer end and strings) by applying a force at another point (the key end). It employs the principle of the lever and is a complex leverage system" (ibid., 617). He proceeds to describe how the specific materials used in piano construction influence its tone—"metal tends to give the tone brilliance, and the use of wood tends to give it 'softness' and 'depth' " (ibid.). He then returns again to the physical nature of piano's contrivance to analyze its particular biases. Given that the piano key is a lever whose movement is strictly limited "by the unyielding wooden action" to a vertical distance of three-eighths of an inch, the conclusion Ortmann reaches is similar to that of Preisman a quarter of century after him: "Any differences of effect of touch upon key-movement must be differences in speed. There is no other variable. From the fundamental law of mechanical action, we know that in addition to the force the distance through which the force acts influence the work done. [. . .] tonal effects are dependent solely upon one thing—the speed with which the key is struck or depressed" (ibid., 618). Note the use of the term "tone" to address the effect of escapement control and the appearance of the same term in the philosophy of Rudolf Steiner, which will be discussed in Chapter 6.

[29] John Holzaepfel, "Reminiscences of a Twentieth-Century Pianist: An Interview with David Tudor," *Musical Quarterly* 78, no. 3 (1994), 635.

[30] Tudor, "Notes for Darmstadt Seminar," Box 107, Folder 10, David Tudor Papers, GRI.

Klavierstücke. By comparing his recordings with recordings by other pianists, Nedelman revealed a peculiar nature of Tudor's piano playing: he was differentiating dynamic levels through control, not only of key attacks but also of their release.

> *[H]is approach is to bring out the attack portion of the piano [soft] note such that the attack is not masked by the previous forte note. This is also accomplished by the quick release of the forte note, which allows the note to decay enough prior to the piano note for the attack to be clearly heard rather than masked. In this way, the length of the note is performed based on its resonance rather than the amount of time the key is held.*[31]

Precise control of the timing of key release in coordination with the state of the damper allowed Tudor to indirectly control—or "influence," to use a term he often used—the future decay of each resonance and thus how the tone ended—"which demands great artifice," he confessed in a letter to Stockhausen written on February 3, 1955.[32]

As Nedelman further observed, unlike pitch articulation, which must be prepared *before* the physical action, resonance needs to be controlled *after* the initial attack through a circular coordination between the performer and the sound that enters the ear and influences the body's manipulation of the instrument.[33] Because of this, dynamics and articulation have traditionally been left for the pianist to control during the performance. In other words, Tudor's distinct approach to the piano focused on the coordinated feedback between the pianist, the keyboard, and the resulting sound that occurs *only in the real time of performance*: "the success of Tudor's performances stems from his particular attention to the feedback of the resonance of the piano in order to control the timing of the attacks and releases of the notes, as well as the overall dynamics of the notes being performed."[34] True to the lessons of Eurhythmics, Tudor coordinated his own perception—input—and movement—output—with the mechanism of the piano. A feedback loop was thus formed between the *two* instruments.

7

Tudor's focus on the escapement mechanism explains well the specific nature of his pianism, remembered by those who worked closely with him: the exceptional control of tone color and the incredible ability to move with utter ease from one dynamic range to another in a split second. As John Cage recalled circa 1970: "The most remarkable thing was his ability to play by making sounds of opposing intensities

[31] Eric Nedelman, "Performance Analysis of David Tudor's Interpretations of Karlheinz Stockhausen's *Klavierstücke*," PhD dissertation, University of California, Santa Barbara, 2005, 171.

[32] David Tudor, "Letter to Karlheinz Stockhausen (February 3, 1955)," Box 59, Folder 6, David Tudor Papers, GRI.

[33] Nedelman, "Performance Analysis of David Tudor's Interpretations of Karlheinz Stockhausen's *Klavierstücke*," 44.

[34] Ibid., 186.

succeed one another. He knew how to produce a sound of any amplitude at all after a very loud sound. He had a prodigious sense of the qualities of each sound. And he clarified everything he touched."[35] Merce Cunningham offered a similar reminiscence in 1989: "It was astonishing, the amount of energy displayed with the minimal effort. The way he made fortes—very, very loud sounds—you could watch and you couldn't see how anyone could make such a loud, distinct, clear sound with such little visible effort."[36]

It remains uncertain whether Irma Wolpe had actually made the same realization as her student. When Vees asked him in July 1995 if she was doing something similar, Tudor gave a vague answer: "Yeah. She was my inspiration. That's how I knew that it was possible."[37] But even if her methods were different and the similarity of results only a matter of appearance, the actual process of solving the puzzle had made Tudor realize what the nature of his new instrument was. A change of instrumentation followed accordingly: "I gradually dropped my activity as an organist."[38] At the end of 1945, he was still playing the organ at the Trinity Church Christmas concert. But when Tudor used the concert program to finish off the draft of his letter sixteen months later, three years had passed since meeting and studying with Irma Wolpe, and the young pianist was ready to move on. As he contemplated on what words to use to publicize himself, Tudor wrote and then scribbled out a "fact" about his current mastery of the instrument as if it were an accomplished one: "Most of my purely mechanical ability is fortunately well adapted to the piano, so my piano study with Mrs. Wolpe …"[39] He instead concluded the letter by revealing his near-future plans:

> *am planning to strike out on my own as a pianist after next season. I have played much piano and organ, but only locally—Swarthmore, Phila., Settlement School, etc. In New York I have played only privately.*[40]

[35] John Cage, *For the Birds: John Cage in Conversation with Daniel Charles* (Boston, MA: Marion Boyars, 1981), 126.

[36] Merce Cunningham, "Interview with John Holzaepfel, 31 July 1989, New York City," quoted in: Holzaepfel, "The Roles of David Tudor in the Early Repertory of the Merce Cunningham Dance Company," in *Merce Cunningham: Creative Elements*, edited by David Vaughan (New York, NY: Routledge, 2013), 48–49. Cunningham told another version of this recollection at Tudor's memorial service on August 27, 1996: "It was also mysterious to me, to many others too, how David produced the sound he did. There never seemed to be a great flourish of arm raised, yet the sound that came out was forte, forte. How did he produce it with such a minimum of gesture?" ("Statement delivered at David Tudor's Memorial Service (August 27, 1996)," Box 67, Folder 6, David Tudor Papers, GRI). Tudor had himself recalled in September 1980, "Merce Cunningham greatly admired the way I played the piano: being a dancer he could see that I was trying to do things with minimum effort and maximum efficiency …" (Massimo Villa and Stefano Bonagura, "David Tudor: nei meandri del possibile," *Fare Musica*, December 1980 [Box 65, Folder 7, David Tudor Papers, GRI]).

[37] Tudor, "Interview by Vees and D. S. Adams," 9.

[38] Clarkson, "Composing the Performer," 28.

[39] Tudor, "Letter to Mr. Rossin."

[40] Ibid.

Music of Changes

1

In late August 1948, one year after drafting his publicity letter, Tudor moved to New York.[41] He had already been frequenting the city, located just a couple of hours from his hometown, usually to visit the apartment of Wolpes on the Upper West Side. In addition to taking piano lessons with Irma, Tudor studied composition and analysis with her husband Stefan. So when the latter left Philadelphia soon after the classes had started, the student began commuting to New York to see his teacher. To be sure, Tudor was never so happy about composing himself.[42] But his advanced skills at the piano, exceptional ability to sight-read, and serious dedication to new music quickly made him an important collaborator for Stefan's own compositions. By 1947, Tudor was in New York almost every week, and spent most of the summer that year with the Wolpes as Stefan composed the remaining parts 5 to 7 of *Battle Piece*, working closely with him.[43]

But the change of address also brought about a change of relationships. For one thing, Tudor had met the classic saxophonist Sigurd Rascher in early 1948 and began touring with him as his accompanist.[44] But distancing was also a problem at home: Irma and Stefan's marriage was falling apart. As Irma revealed thirty years later, the only reason they were still together at the time, as far as she was concerned, was because of the young students they shared:

> *This time I started having my two boys, Jack Maxin and David Tudor. They were my constant companions and my great love. I had two boys to raise, and they saw in Stefan the father figure. They needed Stefan very much, and they came every week*

[41] He signed the lease for Apt #22 on 69 East 4th Street on August 16, 1948 (Nathan Hoffspiegel, "Apartment Lease for 69 East 4th Street, New York, NY (August 16, 1948)," Box 116, Folder 3, David Tudor Papers, GRI). The lease started on September 1, and a bill of lading for transporting household goods from Philadelphia to the new New York address is dated August 26, so he appears to have moved around then (Morroney Transportation Co., Inc., "Uniform Household Goods Bill of Lading for Motor Carriers (August 26, 1948)," Box 116, Folder 3, David Tudor Papers, GRI). According to Holzaepfel, while Tudor claimed to have moved to New York City in 1947—which is also the year Holzaepfel wrote down in his dissertation (Holzaepfel, "David Tudor and the Performance of American Experimental Music," 8)—later research revealed a mover's inventory dated August 25, 1948 (Holzaepfel, "Email to You Nakai," January 3, 2016). Holzaepfel suspects Tudor's original claim meant that by 1947 he was spending more time at the Wolpes' apartment in New York than at home in Philadelphia.

[42] When Clarkson interviewed him on October 4, 1982, Tudor recalled his earlier difficulty in the following way: "I didn't find that my [composing] work was convincing. I think even more fruitful I found [Stefan's] classes in analysis. You see his teaching in composition always had an underlying basis of sort of Beethoven-like continuity, which he himself used or didn't use at will. I think it was an underlying method that he used with students to get them started. When I was doing it myself, I was not inspired. I suppose I don't belong to that stream in composition. And it was years after that I realized that I was doing work that I could call my own" (Clarkson, "Composing the Performer," 28).

[43] Holzaepfel, "Comments on the Manuscript of *Reminded by the Instruments*," March 30, 2019.

[44] Their collaboration would continue over the span of fifteen years until what appears to have been their last concert on January 8, 1963, at the Anthroposophical Society Auditorium in New York. Rascher was

> *to New York. I couldn't deprive them of Stefan. It was my feeling of responsibility for these boys which kept me together [with him] for a few more years.*[45]

In 1949 Irma separated from Stefan and married the mathematician Hans Rademacher, who taught at the University of Pennsylvania. By then, Tudor had stopped taking piano lessons with her.[46] Also by then, through the dancer and choreographer Jean Erdman for whom he worked as an accompanist, Tudor had begun to work closely with another composer in New York City.

2

One day in 1949, John Cage knocked on Tudor's door at Apartment 22, 69 East 4th Street.[47] According to the composer's own recollection almost thirty years later, this may have even been before late March when he embarked on a six-month trip to Europe with Merce Cunningham.[48] Around this time, in an attempt to diversify the music for his partner's dance, Cage had started using works by composers other than himself. Then the inevitable occurred—a score written by another composer turned out to be too difficult for him to play in the role of Cunningham's accompanist. As he recalled on December 20, 1978: "the music was beyond my technical ability and that was first the case with the Ben Weber piece."[49] Through Jean Erdman, with whom

an avid follower of anthroposophy, and so was Tudor by that time, having joined the Anthroposophical Society in America in July 1957.

[45] Austin Clarkson, "Interview with Irma Wolpe Rademacher (November 22, 1979)," Recollections of Stefan Wolpe by former students and friends, accessed December 15, 2019: http://ada.evergreen.edu/~arunc/texts/music/wolpe/wolpe/Irma_Wolpe_Rademacher.html

[46] As he reminisced to Clarkson on October 4, 1982, one reason for Tudor stopping his lessons with Irma was his focus on the writings of Ferruccio Busoni, Stefan's friend and teacher: "One thing that Stefan and I definitely have in common is an interest in his great friend Busoni. […] How transformed my own studies became when I started to work on Busoni! Those ideas are so important—notation is the work of the devil. Stefan never believed that, but he knew it. [When did you get in touch with Busoni?] It was through Stefan's talking about it. I recall at one point I felt an inadequacy in my handling of the piano, and I realized that I needed something that I had to find. So I began to study everything I could about Busoni, including all of the students who had ever written anything about him. It went so far as finally I stopped studying with Irma. Probably, by continuing meticulously with her methods, I might have come on what I needed, but I also needed the background in it a great deal. I needed to understand what virtuosity was about. A lot of things happened because of that. I worked very intensely on lines that Busoni had put down" (Clarkson, "Composing the Performer," 32). Clarkson also examined the collaborative procedure through which Wolpe composed and Tudor realized *Battle Piece*, concluding that this experience served as a prototype for Tudor's later collaboration with other composers (Clarkson, "A Creative Collaboration: Stefan Wolpe's and David Tudor's *Battle Piece*," *Musicworks* 73 [Spring 1999], 32–25).

[47] It is from Holzaepfel's research that I first learned that the initial encounter between Cage and Tudor did not take place through their mutual friend Morton Feldman, as is generally thought, but earlier (Holzaepfel, "David Tudor and the Performance of American Experimental Music 1950–1959," 25). Also see Holzaepfel, "The Roles of David Tudor in the Early Repertory of the Merce Cunningham Dance Company," in David Vaughan, ed., *Merce Cunningham: Creative Elements* (New York, NY: Routledge, 2013), 45–50.

[48] David Vaughan, "Interview with John Cage, 1978-12-20/1979-01-18," Merce Cunningham Dance Foundation Collection, Jerome Robbins Dance Division, New York Public Library.

[49] Ibid. The piece was Weber's *Ballet, Op. 26* written for a small orchestra.

the pair had been performing regularly since arriving in New York seven years before, Cage heard about a brilliant pianist she had been working with recently.[50] Tudor offered his version of reminiscence four decades later, on October 23, 1987:

> *John came to my door one day and delivered to my hands a score by Ben Weber, an American composer that he planned to choreograph, and he needed to have someone make a recording that he could rehearse with. Then later on, I had a more closer introduction to John through the auspices of Morton Feldman.*[51]

According to the story Cage made popular by retelling it so many times, he met Feldman sometime toward the end of January 1950, at Carnegie Hall following the American premiere of Anton Webern's *Symphony, Op. 21* (1928). Among the things he had brought back from his recent trip to Europe was the score of *Second Piano Sonata* written by a young French composer named Pierre Boulez. Upon discovering that this material had been sitting in a publisher's house unpublished, the American composer proposed to take it back with him and publish it in New York.[52] Two days after meeting Feldman, Cage showed his new friend the work he had carried across the Atlantic. The younger composer's response was simple: "there is only one person in America who could play that and that is David Tudor"[53]—a fellow student of his teacher Stefan Wolpe, and a piano virtuoso who was just a year younger than Boulez. Cage very likely remembered who this was, for Cunningham's choreography *Pool of Darkness*, which relied on Tudor's recording of Weber's music during rehearsals, had been premiered by another pianist, Maro Ajemian, just two weeks before, on January 15 at the Hunter Playhouse in New York.

[50] "When David Tudor first came to New York, he was playing for me and he went on a couple of tours with me, and then John met him then there was this big tag […] John was getting in there with these new ideas and David was getting caught up in it" (David Vaughan, "Interview with Jean Erdman, 1983-06-08," Merce Cunningham Dance Foundation Collection, Jerome Robbins Dance Division, New York Public Library).

[51] Tudor, "Merce Cunningham Symposium at the Southern Methodist University (October 23–24, 1987)," Merce Cunningham Dance Foundation Collection, Rodgers and Hammerstein Archives of Recorded Sound, New York Public Library. The sequence of events also aligns with Cage's recollection: "I had met David earlier, before I went to Paris I think it must have been, and gotten him to play the Weber. Then when I came back from Paris, and Morty said David would be able to play the Boulez and it was then that we were often together" (Vaughan, "Interview with John Cage, 1978-12-20/1979-01-18," Merce Cunningham Dance Foundation Collection, NYPL).

[52] "I have met as many composers as I could in Paris that year, and I was struck mostly by Boulez. I was at the time an editor of the New Music Edition which Henry Cowell started, and since Pierre's music had been sitting in one publisher's house […] for something like three years, unpublished, I suggested to him that I take it back to the United States to have it published here, and he was thrilled" (ibid.). According to Cage, this also led to Boulez's score being published in France as well: "I was in a bar across the street, and first one publisher and then another came up to me, and they knew I was leaving, and I'd been there for six months or so, and they said after all your experiences here who do you find the most interesting in composer? And I said, Boulez. I said it's so interesting that I'm taking the music back to the United States to have it published. And they said it's not your problem it's the French problem. [*laughter*] So they made appointments for me to bring the music to them with Pierre the next morning before I sailed, you know. And he had made an appointment with one publisher, then another publisher came afterwards and wanted us to come to him earlier with all the music …" (ibid.).

[53] Ibid.

By early fall of that year, when Cage officially asked him to be the pianist for the American premiere of Boulez's difficult music, Tudor had not only already obtained a copy of the score from Feldman but had also been working on it since spring. After some significant struggle, Tudor premiered *Second Piano Sonata* on December 17, 1950, at Carnegie Recital Hall—"magnificently" in the words of Cage, who served as his page-turner.[54]

3

Having witnessed Tudor's well-developed "mechanical abilities" firsthand, Cage spent a large part of the following year composing a new piece that was not only dedicated to, but also conceived specifically for this extraordinary pianist he had encountered by chance. For this endeavor he took recourse to another material that had come his way around the same time, similarly by chance: a copy of the recently translated *I Ching: or, Book of Changes*, an ancient Chinese text of divination that his then-student Christian Wolff had given him in the early months of that year as a token of appreciation for the lessons.[55] Perhaps it was because of this incredible piece of luck that Cage decided to relegate matters to chance.

The process of composition can be written out in the form of a recipe, as the composer once did himself:[56]

(1) Prepare two types of materials: (a) a chart of 64 or more possible values—"the universe of possibilities"[57]—for each different parameter of sound (which in this case were pitch and timbre, duration, dynamics, tempi, and number of voices); (b) a rhythmic structure—empty frames of time—based on a specific series of proportions (which in this case was 3: 5: 6 ¾ : 6 ¾ : 5 : ⅛);

[54] Cage, "Letter to Pierre Boulez (December 18, 1950)," in *The Boulez-Cage Correspondence*, edited by Jean-Jacques Nattiez (Cambridge, UK: Cambridge University Press, 1993), 77.

[55] Pantheon Books, a New York–based publisher founded by Wolff's parents Helen and Kurt Wolff in 1942, had released the first complete translation of the ancient Chinese treatise: *The I Ching: or, Book of Changes*, translated by Richard Wilhelm and Cary Baynes (New York, NY: Pantheon Books, 1950).

[56] Tudor's papers contain a note in Cage's hand offering the recipe for selecting values from the charts:

Procedure:

1. *Toss for no. of voices; this toss also gives tempo.*
2. *Toss for sounds (individually for each voice) (if static keep but toss again).*
3. *Toss for Duration of sounds and Silences*
4. *Toss for dynamics.*

Continue.
Only allow voices that exist within duration of structural limits (for this purpose toss dynamics whenever needed)
(Cage, "Procedure (undated)," Box 179, Folder 2, David Tudor Papers, GRI.)

[57] For instance, "The limited nature of this universe of possibilities makes the events themselves comparable to the first attempts at speech of a child or the fumblings about of a blind man" (Cage, "Composition as Process: 1 Changes," in *Silence: Lectures & Writings* [Middletown, CT: Wesleyan University Press], 27).

(2) Use the *I Ching* to select specific values from the charts, coordinating them together to compose sound events;
(3) Accommodate the events within the rhythmic structure applied to both the macro and the micro-scale of the work.

The "procedure," as Cage once called it, was simple but laborious.[58] As a system of divination, the *I Ching* uses 64 hexagrams encompassing all the different patterns made by six stacked lines which could either be broken or not. The sum of possibilities is therefore computed as six binary digits ($2 \times 2 \times 2 \times 2 \times 2 \times 2 = 64$). So if the values that each parameter may take are arranged in an 8×8 chart, Cage could employ any act of chance, such as tossing coins to first select one hexagram, and then map the result onto the chart to determine the corresponding parametric value. But this also means that the *I Ching* itself only served as a template to format the given repository of materials. The actual task of coordinating the atemporal universe of possibilities and the empty frames of time fell on the human composer, who happened to be a workaholic: Cage opted for the most laborious task of throwing three coins six times to select one hexagram out of 64—which determined just a single parametric value for a single sound event. This naturally led him to spend a good amount of 1951 tossing coins everywhere he went.[59]

The *Music of Changes* in this way became the first composition where chance operations were used throughout. Since Cage also labored to make the universe of possibilities as large as possible by composing as much diversity as possible for each parameter, the range of values was pushed to an extreme, producing idiosyncratic sound events and combinations thereof.[60] In his 2012 study, David W. Bernstein carefully analyzed the actual process that Cage undertook to create the score, revealing how the composer made more choices than he likes to admit, even modifying the results of chance operations after trying them out on the piano.[61] The complexity of a score thus composed through a collaboration between the *I Ching* and the composer's labor backstage was acceptable only because there was a performer who could realize what had thus been written. The

[58] Cage, "Procedure (undated)."

[59] Technically speaking, there are more efficient ways to randomly select one number out of 64. At the very least, the process could be expedited by throwing one coin and not three, since there are only two values that one line can take. But Cage faithfully followed the *significance* of hexagrams, which taught him that each line was composed of three parts. Similarly, he could have simply bypassed the role of *I Ching* when explaining the mechanism since it was no more than a template, and the actual source of chance was *his* own act of throwing coins. But again, it was the *significance* of the ancient Chinese text of divination that was instrumental as far as the composer was concerned. The labor of flipping coins had to be coordinated to a text that someone in China had composed more than two and a half millennia ago probably because it was a better story—as a corollary, it reclaimed the authorial position of the composer on another level.

[60] For the sound chart, the odd-numbered cells were assigned silences, and the even-numbered cells, a variety of pre-composed sound materials (from single notes, dyads, and aggregates to more complex arrangements of notes, flourishes, chords, and trills under the rubrics of "constellations," and furthermore to auxiliary sounds like noise produced in or on the instrument's body). The selection of pitch used up all twelve tones of the chromatic scale. A similar extremity is found in the duration and dynamics charts.

[61] David W. Bernstein, "John Cage's *Music of Changes* and Its Genesis," in Julia H. Schröder and Volker Straebel, eds., *Cage & Consequences* (Hofheim, Germany: Wolke Verlag, 2012), 67–84.

coordination with the specifics of Tudor's own body was therefore central to the piece. Thirty-seven years later, while talking to Teddy Hultberg in May 1988, Tudor recalled a strange question that Cage had asked him while composing *Music of Changes*: "how many arms should I assume that you have?"[62] To which he remembered answering eight. "That may have been what influenced him to make the composition with eight voices."[63] Wolff, who had given Cage the *I Ching*, reflected another twenty-seven years later, while talking with Richard Bernas on March 24, 2015: "I don't think John Cage would have written *Music of Changes* if it hadn't been for David Tudor."[64]

4

By outsourcing the process of composition to the flipping of coins, Cage reasoned that the resulting score would preserve the extreme diversity of the universe of possibilities since the selection of values was freed from the bias of his own particular mindset. But even so, a simple inequality always existed at the basis of chance operations: what one starts with is always larger than what one ends up with. The act of throwing coins *reduces* the initial totality to realize only one possibility among many. This reduction is necessary, of course, for the very function of chance operations in *Music of Changes* was to compose a specific yet non-intentional temporal sequence from the atemporal universe of possibilities. The inequality was a corollary of time. Consequently, what Cage often talked about when talking about the piece was musical continuity—or a lack thereof. Using a term originally used by Feldman, Cage spoke of "no-continuity," which "simply means accepting that continuity that happens," as opposed to "making that particular continuity that excludes all others."[65] In other words, the composer understood the continuity produced by chance, free from the particular biases of his memory and taste, as an absence of one.

But the problem of specificity persists. Even if the listener on the receiving end was happy to accept whatever (no-)continuity that happened, the performer who must make that (no-)continuity actually happen had to engage with the specifics of how the composer notated the output of chance operations on paper. And there are obviously more ways than one to write down "that continuity that happens"—which is to say that the nature of notation imposes a bias of its own. Indeed, as Bernstein and Martin Iddon have both observed, the main problem Tudor faced in his realization of *Music of Changes* was the conflict between *two* forms of measuring (no-)continuity that coexisted in Cage's

62 Tudor, "Interview by Teddy Hultberg."
63 Ibid.
64 Christian Wolff and Richard Bernas, "Prof. Christian Wolff in Conversation with Richard Bernas (March 24, 2015)," Podcast, New Music Insight Lectures, School of Advanced Study, University of London. James Pritchett has also made a similar observation: "It was Tudor's unique abilities that made *Music of Changes* possible for Cage; without them, such a work would have been a mere compositional exercise" (James Pritchett, *The Music of John Cage* [Cambridge, UK: Cambridge University Press, 1996], 78).
65 John Cage, "Lecture on Something," in *Silence*, 132.

score. Although the rhythmic structure defined macro-scale proportion *across* bars as a change of tempo following the metric division of music, micro-scale proportion *within* each bar was defined by equating the spatial length on paper with the duration of notes (2½ cm = a quarter note; 10 cm for each bar). Mapping space to time in this way was the composer's attempt at facilitating the writing of the complex rhythm produced by chance operations. But since the tempo of music got faster or slower following the metric division, the actual time corresponding to a given space also became shorter or longer accordingly.[66] One way to write down musical time collided with another.

Tudor took matters into his own hand: using two mathematical formulae devised by Hans Rademacher, the mathematician who Irma Wolpe had remarried after her divorce from Stefan—applying one to places where the tempo doesn't change and the other to places where it does—he converted the entire metrical time of *Music of Changes* into clock time. Then he simply wrote down the appropriate timing for each sound event in his score and used a stopwatch in performance.[67] Tudor's solution to the puzzle of multiple temporalities in *Music of Changes* would be adopted by Cage in his subsequent pieces, where spatial length was equated with duration in clock time. In this way, the "no-continuity" of sounds was made possible by the physical and mechanical continuity of a time-keeping instrument—or so it appeared.

5

On August 4, 1978, the pianist Joseph Kubera, who was touring with the Merce Cunningham Dance Company at the time, started taking piano lessons from Tudor in order to learn the *Music of Changes*. The sessions continued sporadically until 1994, two years before Tudor's death. Kubera took notes of what he was told on each occasion. These seven materials—among which only three are dated: August 4, 1978; November 19, 1981; March 22, 1994—offer a rare glimpse into the nature of Tudor's realization process.

His comments oscillate between two focal points: (a) close observation of Cage's materials, the score as well as the charts, which informed (b) specific performance techniques developed with some poetic license to the same materials. For instance, out of the original chart of parameters, Tudor singled out two as being the most important for the performer: sound and superimposition. The other charts were, he bluntly judged, "not so important."[68] The two parameters he chose were in charge of determining the composed density of material on two scales: the sound chart indicated whether a sound event was a single note or an aggregate (as Tudor reminded his student, these "were derived, composed; not subject to chance"[69]); and the superimposition chart indicated the number of voices—or necessary arms—in a given section. In both cases, the charts revealed the

[66] As Iddon notes, "the combination of both forms of notation causes the temporal meaning of each 2 ½ centimeters to be fluid, consistently in motion" (Iddon, *John Cage and David Tudor*, 38).

[67] Tudor, "Notes for the realization of *Music of Changes*," Box 7, Folder 18, David Tudor Papers, GRI.

[68] Joseph Kubera, "Notes from Sessions with David Tudor," Private archive of Joseph Kubera.

[69] Ibid.

prehistory of the notes on the score which became occulted once the results of chance operations were coordinated and written down as sound events.

In this way, Tudor went on pointing out specific biases he had observed in the given material, which supposedly lacked any specificity as it was produced by chance. "When 2 adjacent dynamics [appeared]," he noted, "John tended to like p[iano]'s for the longer values."[70] Or, since "there are a tremendous number of f[orte]'s," he suggested it would help the student "to obtain more differentiation in degrees of P[iano] than degrees of F[orte]."[71] In particular, "the short attacks in f[orte] […] are hard to differentiate one from the other." To solve this problem and "to emphasize a short attack […] to achieve variety within the fortes," he recommended the use of pedals "even if not called for."[72]

Tudor did not simply accept the given (no-)continuity; he observed it carefully. And based on this observation he made a series of decisions, some of which were not called for in Cage's score. The written score, as well as some of the charts, were treated equally as "materials" to compose a specific performance. In other words, once he realized what the nature of the material was, he set clear priorities regarding what should happen during the actual performance, even at the expense of other things: "Better to skip some details (but still playing everything) when fast—to get sonorities. Hear the details more important than absolute speed."[73]

6

One particular topic that Tudor naturally had a lot to tell Kubera about was time and timekeeping, which he had himself struggled to solve back in 1951. In keeping with his solution of using a stopwatch, Tudor's advice consisted mostly of how to count and therefore experience time in ways other than the conventionally musical. The eye must be trained "to read space at correct speed," Tudor tutored, "Read, measuring by eye, (notation in space). Measure your accuracy against a stopwatch, computing amount of time between MM [metronome] markings + converting to minutes + seconds."[74]

In May 1972, Tudor reminisced to Victor Schonfield how his former teacher had failed to grasp the same lesson of *Music of Changes*:

> *Years later, about 1958, Stefan Wolpe had become very concerned about Cage's ideas, which he had met through Cage's writings, so I lent him the scores. Then, after he had been studying* Music of Changes*, he met Cage at a party and he told him, 'I love your music, but you're a liar!' The notation treated lengths of space as equal to lengths of time, so that four beats equaled four inches. This led to things like a rest of three-sevenths of a beat, and there was Stefan Wolpe trying to feel it in his physical organism, as musicians were taught to do up to that time. What he meant to say was that he couldn't feel it.*

70 Ibid.
71 Ibid.
72 Ibid.
73 Ibid.
74 Ibid.

> *But I could, because by that time I was in a different musical atmosphere. I was watching time rather than experiencing it. That difference is basic. Even playing pieces which last an indefinite length of time your relationship to time is different, because you are now able to telescope some periods and to microscope others at will.*[75]

But there is surely more than one way to "watch" time. And if Tudor's eyes were focused on measuring the space in the score, they could not have been so attentive to the hands of the stopwatch. Indeed, following Tudor's guidelines to his student, the stopwatch appears more like an instrument to measure the accuracy of one's own measurement. The eyes reading the score are not led by the external machinery, only supported by it. Which means that there must have been another timekeeping mechanism *inside* the instrumentalist, independent of the ever-changing tempo or rhythm of the music. Once trained, therefore, the performer could even go against the count of the stopwatch—"Hear the details more important than absolute speed."[76] If anything, absoluteness was a matter of internal measurement, not external: "In playing, *think* of the time as absolute except when tempo is stable (subdivide). Place by eye rather than rhythmic pulse."[77]

7

Despite agreeing that *Music of Changes* accomplished "freedom," the composer and the pianist understood the meaning of this freedom quite differently. For Cage, who wanted to accept all forms of continuity, freedom consisted in the possibility of getting *outside* of any specific mindset: "It is thus possible to make a musical composition the continuity of which is free of individual taste and memory (psychology) and also of the literature and 'traditions' of art."[78] On Tudor's side, however, freedom was discovered *inside* a specific mindset that was required to perform the piece, as he continued his recollection in May 1972:

> 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 physical preparations for the next instant, so I had to learn to put myself into 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.*[79]

[75] David Tudor and Victor Schonfield, "From Piano to Electronics," *Music and Musicians* 20 (August 1972), 24.
[76] Kubera, "Notes from Sessions with David Tudor."
[77] Ibid.
[78] Cage, "Composition: To Describe the Process of Composition Used in *Music of Changes and Imaginary Landscape No. 4*," *Silence*, 59.
[79] Tudor, "From Piano to Electronics," 24.

The composer spent time throwing coins on trains, writing down values from charts at a desk, and even trying out the results of chance operations at the piano—a time of composition outside the (no-)continuity of performance, in which he could freely go back and forth between the possibilities of the chart and the specificity of coordinated sound events. Accordingly, the freedom Cage discovered lay in the choice between one form of continuity (based on taste, memory, or tradition) and another (based on chance). For the pianist, however, contemplating the materials on the level of possibilities was not part of his "adventure." Even the many hours and pages spent translating Cage's tempo into clock time and studying the composition of sound events from the charts were all dedicated to a single cause: to actually perform the specific results of chance operations already fixed on the score. Thus, his freedom was discovered inside the (no-)continuity of performance and "for a whole hour at a time." In this way, "the right frame of mind" Tudor put himself in coordinated with the nature of the score Cage had composed. They were both quite specific matters. In 1972, the composer also looked back and reflected on what his pianist did twenty years before—or rather, what he had transformed himself into: "When I composed *Music of Changes*, David Tudor applied himself completely to that music. At that time, he *was* the *Music of Changes*."[80] Another twenty years later, on January 26, 1992, Tudor, who was no longer the *Music of Changes*, would reminisce somewhat differently: "Cage began his work on the *Music of Changes* in 1950 which is when he accepted the possibility of using chance procedures in his music. So I perceived the whole thing as a change which had come about in music."[81] As far as the composer was concerned, Tudor himself was the change he thus spoke of. And Cage was far from being alone in this view.

Synergies

1

Tudor gave the premiere of the entire *Music of Changes* on New Year's Day 1952 at the Cherry Lane Theatre in New York. The program also included two other works written specifically with Tudor in mind: Feldman's *Intersection 2* and Wolff's *For Prepared Piano*. The former was an early "graphic score" where instead of writing notes on staves to instruct the sounds to be produced, the composer drew a sequence of grids (assigning each box a corresponding tempo of MM = 158) with three vertical layers indicating relative height of pitch, in some of which he inscribed numbers to indicate how many keys should be played. The specifics of pitch, duration, dynamics, and rhythm were left for Tudor to determine. Wolff's piece, on the other hand, was his first experiment with the prepared piano, an instrument his former-teacher Cage had composed in 1938 by inserting screws and bolts and other miscellaneous materials into the strings of a grand piano. In writing the piece, the seventeen-year-old

80 Cage, *For the Birds*, 178.
81 Tudor, "Interview by Martin."

composer used a regular staff notation but moved from one bar to the next in a different sequence than how the score is usually read—for instance, moving vertically down to the bar below.[82] As a result, when the composed score was performed horizontally, the music acquired the appearance of constantly dissected continuity.

In this way, composers began writing scores for Tudor that required him either to determine the specifics of realization or to realize a continuity produced by a system external to their own minds. To a varying degree, the realization will be indeterminate for the composer and determined by the performer. Having observed how Tudor operated, composers were simply encouraging him to do the work he was doing anyway. But neither the paternalistic story of composers giving the performer more and more freedom and responsibility because the latter was capable of handling it, nor the fraternal tale of the performer becoming a sort of co-composer are good descriptions of what was actually happening. For one thing, it was Tudor who called the shots, as Cage later revealed to Holzaepfel in the summer of 1989: "What you had to do was to make a situation that would interest *him*. That was the role he played."[83] For another, what interested Tudor was not always so obvious.

2

One day in November 1952, eleven months after the premiere of *Music of Changes*, Earle Brown, who had just moved to New York in August of that year, wrote another score for Tudor. This was the second in a series of works, each of which took the name of the specific month and year when it was written as its title, all collected later as *Folio*. In the first piece, written a month earlier—and therefore titled *October 1952*—Brown had dispensed with symbols for silences (rests) but still kept standard staff notation. For the following month, he decided to considerably increase the degree of indeterminacy. He drew additional lines filling the space between rows of five-line staves to obtain fifty some lines, across which he scattered standard musical notes (Figure 1.3). Furthermore, the score could be read in any direction: "left to right or right to left, up, down, or whatever."[84]

Brown would reflect much later, in September 1995, that the composed material "forces the performer into making choices and being creative."[85] To express this imposition

[82] "The rhythmic structure of each of the four movements was laid out as five systems of five bars, and the material was simply composed onto that grid in configurations other than the usual horizontal. Thus, in the first movement, which was composed vertically instead of horizontally but is *read* in the usual manner, what appears as bar 6 in the score was in fact the second bar of Wolff's composed continuity, and bar 11 was the third bar" (Philip Thomas and Stephen Chase, *Changing the System: The Music of Christian Wolff* [Farnham, UK: Ashgate, 2013], 55).

[83] Holzaepfel interviewed Cage twice, on July 31 and August 12, 1989 (Holzaepfel, "David Tudor and the Performance of American Experimental Music," 57).

[84] John Yaffé, "An Interview with Composer Earle Brown," *Contemporary Music Review* 26, no. 3–4 (June–August 2007), 300.

[85] Ibid. Brown continued in his authorial, composer-like tone: "It seems like I'm doing a dastardly deed on the performer, because I've taken more and more away from him, taken more security away, taken more information away. He's thrown more and more into his own volition, based on my stimuli" (ibid., 300).

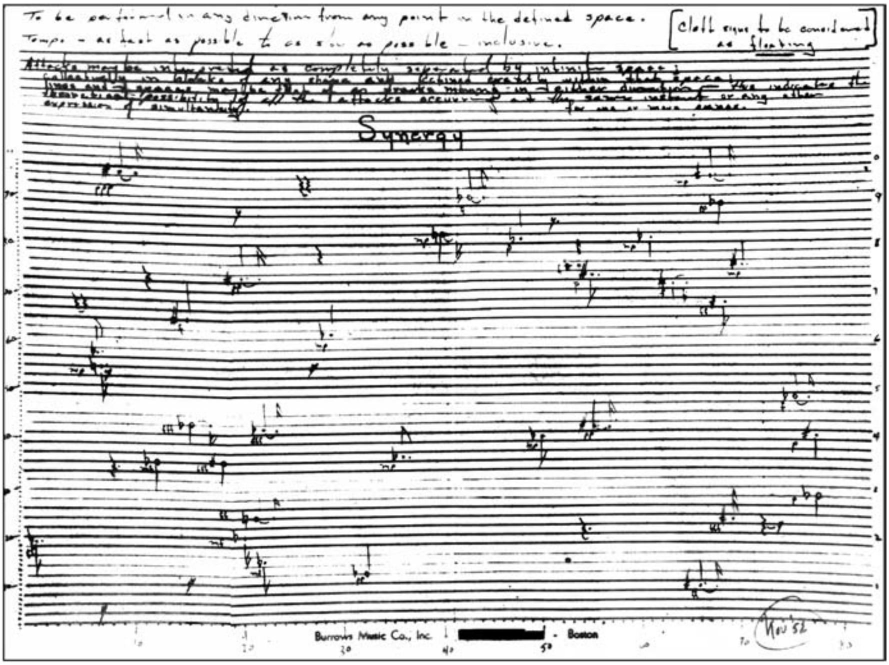


Figure 1.3 Earle Brown | *November 1952 (Synergy)* | 1952
DTP, Box 6, Folder 2 | Getty Research Institute, Los Angeles (980039) | Copyright © 1961 (Renewed) by Associated Music Publishers, Inc. (BMI) International Copyright Secured. All rights reserved. Used by permission.

of creativity on the performer, the composer added a subtitle which he borrowed—or "chose" to borrow—from Buckminster Fuller: *Synergy*, which he explained as "the result of two or more forces coming into contact with one another, the result of which is unpredictable."[86] Of course, the two "forces" in this case were the composer, represented by the score of *November 1952 (Synergy)*, and the performer, which is to say Tudor:

> *I have an idea, I put it on paper, I give it to, say, David Tudor, and he does something else with it. I make it highly ambiguous, I don't know what David's going to do with it, and sometimes David doesn't know what he's going to do with it. So it's like creating something, sending it out into the world, and having it be a force.*[87]

But what Tudor did with the material of *November 1952 (Synergy)* probably went beyond all forms of synergetic possibilities Brown may have imagined: considering the score not worthy of realization, he simply stuck it in a drawer.[88]

Seven years later, on August 29, 1959, Stockhausen delivered the fourth lecture on "Music and Graphic" at the International Summer Courses for New Music in

86 Ibid.
87 Ibid., 302.
88 David Gutkin, "Drastic or Plastic?: Threads from Karlheinz Stockhausen's 'Musik und Graphik,' 1959," *Perspectives of New Music* 50, no. 1–2 (Winter–Summer 2012), 296.

Darmstadt, during which he spoke on behalf of Tudor, who was assisting him that afternoon. One thing he revealed was the reason behind the failure of synergy back in *November 1952*:

> *[Tudor] said, this score [Brown's] had laid in his drawer for years, and he had never interpreted it; he was not able to find contact with it. He said, 'Why?' Because in this graphic the sound object had already been specified. He had to play on the keys, he had to play specified durations.*[89]

What interested Tudor was, on the contrary, "the condition of a graphic still prior to the stage of the specification of a sound object."[90] If the spokesperson who spoke on behalf of the person in the same room without raising his immediate objection is to be trusted, already by the end of 1952, Tudor had developed a preference for specifying the sound object himself. Whatever synergy desired by the composer needed to follow this condition.

3

On January 20, 1954, fourteen months after *November 1952*, Brown composed another piece for Tudor, who happened to be turning twenty-eight that day. Having forgotten about his birthday party until Cunningham reminded them in the backstage of the Brooklyn Academy of Music, Brown and Cage each wrote a new work on the spot, using pieces of cardboard they found lying around. Cage punched holes through his cardboard which when read from top to bottom became the score of *Music for Carillon No. 2*, and when turned upside down, the score of *Music for Carillon No. 3*. Brown's present also reflected the spontaneity of the occasion: given the lack of both staff paper and time, he dispensed with staves altogether (as he had previously done for *December 1952*) and simply drew four layers of two continuous borderlines indicating the outer limits of the keyboard. The space in between was filled with layers of horizontal lines of different lengths and thickness, the former indicating duration and the latter, dynamics or clusters. Like *November 1952 (Synergy)*, the score could be read from any direction (Figure 1.4).

This time Tudor's reaction was altogether different. He responded enthusiastically, even suggesting a name for the piece, as Brown recalled in September 1995:

> *The title actually came from David. He called me up once and said, 'I'd like to play that piece you wrote for me on my birthday next month.' 'You mean you can actually play it?' I asked. 'Sure,' he said, 'and I think we should call it* Four Systems.*'*[91]

[89] Stockhausen, quoted and translated in Gutkin, ibid.
[90] Ibid.
[91] "It was at the Brooklyn Academy of Music rehearsals for *Spring, Women and People* [*sic*], Merce's choreography of my *Indices*, that John and I found out it was David Tudor's birthday. We were backstage,

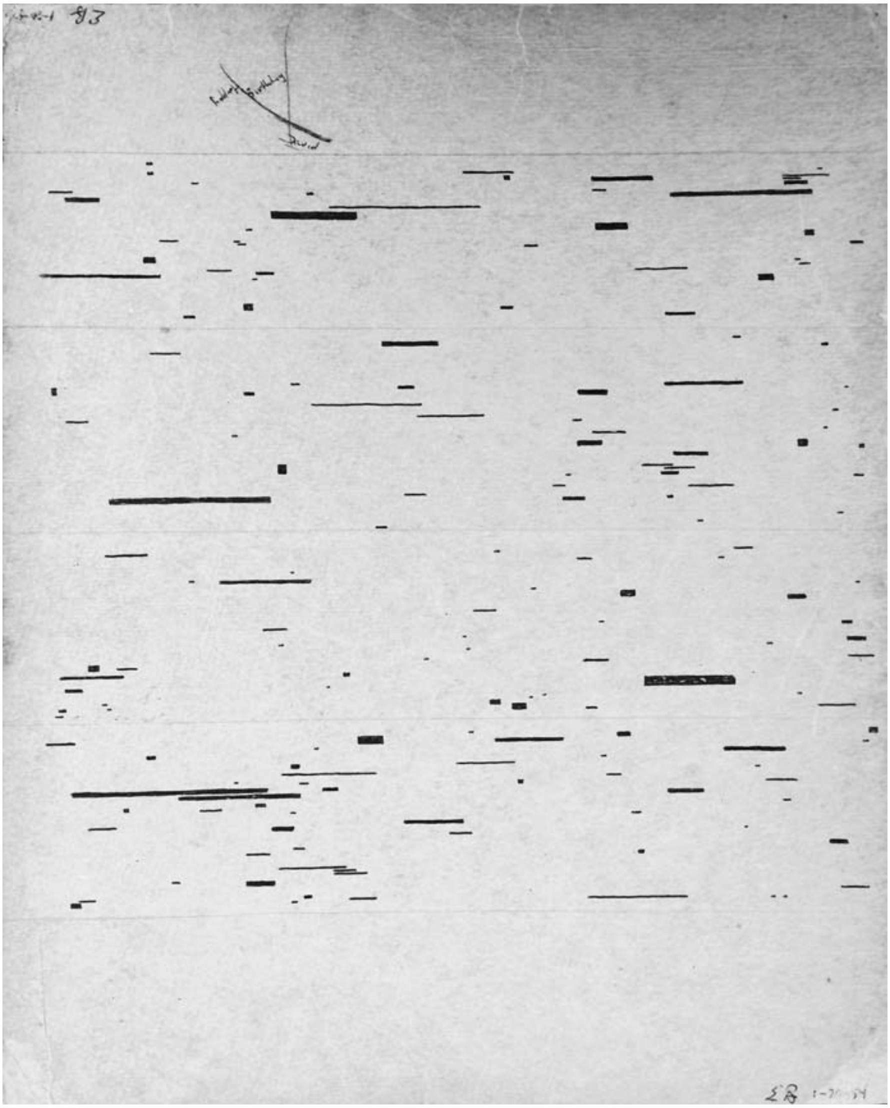


Figure 1.4 Earle Brown | *Four Systems* | 1954

After premiering the piece directly from the cardboard score on April 28, 1954, at the Carl Fischer Hall in New York, Tudor created a separate realization score in early

and Merce said, 'Are you coming to the studio for David's birthday party?' John and I just looked at each other … I immediately found a piece of cardboard, and John found something. John wrote *Music for Carillon I* [*sic*], and I wrote four systems of piano music, right there on the spot. We presented them to David that night, at the party" (Yaffé, "An Interview with Composer Earle Brown," 304–305).

October of that year as he sailed to Europe.[92] This was a practice he had recently started, beginning with Feldman's *Intersection 3*, which was premiered alongside *Four Systems*.[93] In his 1994 doctoral dissertation, Holzaepfel presented a detailed analysis of how Tudor realized *Four Systems*. Among other things, he described Tudor's use of two instruments to accurately measure the horizontal lines: (a) a template with 88 tracks covering all the keys of the piano to determine exact pitch; and (b) a pair of calipers to determine exact duration. Using them, Tudor made multiple measurements of Brown's score read from different directions, coordinating the results into a realization score which he wrote on staff notation. The material that the composer didn't even think he could actually play thus managed, quite unexpectedly, to "find contact" with Tudor.

4

Four Systems remained in Tudor's repertoire for almost six years until December 1959. In the meantime, it also became the music for Cunningham's dance *Galaxy* which was premiered at the University of Notre Dame in Indiana, on May 18, 1956. Two weeks later, on May 30, Tudor was again at the Carl Fischer Concert Hall in New York premiering another piece Brown had written for him as a sequel to *Four Systems*, following the synergetic success of the previous work. This time it was not Tudor who came up with the rather easy title of *Four More*. Brown, who now had access to proper materials, kept the system of horizontal lines but drew them on staff paper (Figure 1.5). As a result, the vertical axis of the score was no longer mapped onto the keys of the piano; the coordination with the instrument now went back to the symbolic conventions of how to read staff notation. Brown's use of accidentals and clef signs also changed the significance of a given horizontal line without changing its spatial position.[94] In other words, Tudor could not use his template anymore.

5

Tudor performed *Four More* two more times after the premiere during the winter of 1956.[95] Sometime in early spring of the following year, he told Cage he had found

[92] Holzaepfel, "David Tudor and the Performance of American Experimental Music," 100.

[93] Iddon has observed how Tudor's realization of Cage's *Music for Piano* series which began in 1952 already involved him re-notating the composer's score: "The performance of piece from *Music for Piano* was the first occasion on which Tudor felt it necessary to prepare his own score from which to perform" (Iddon, *John Cage and David Tudor*, 50).

[94] Following Tudor's own example, Brown also equated spatial length of the lines with their duration in clock time.

[95] In Vienna at the Akademie für Musik und darstellende Kunst on November 30; and in Zurich at the Kunstgewerbemuseums on December 12.

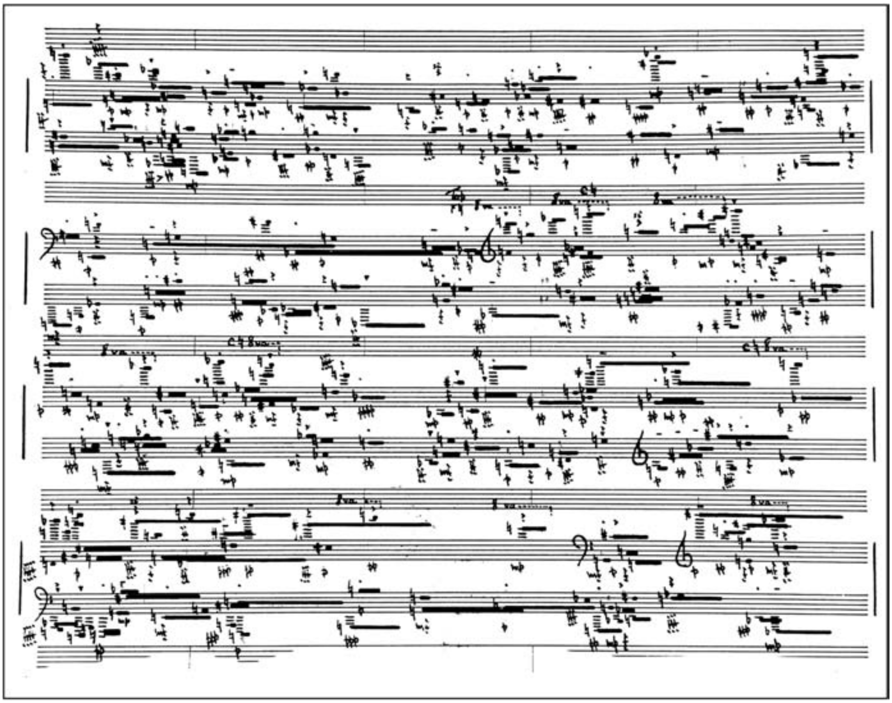


Figure 1.5 Earle Brown | *Four More* (System 3) | 1956
DTP, Box 170, Folder 3 | Getty Research Institute, Los Angeles (980039) |

a problem in the notation of Brown's new piece. His confidant proceeded to tell the composer of *Four More* that David Tudor had found his score "impossible." On April 1, Brown wrote to the pianist to clarify what he had meant.

> *Sorry to hear that you consider* 4 More *to be "impossible"—seems of course to be very difficult and extreme in its demands but "possible"—as any score is both possible and impossible. If you understand why I write such an "impossible" score, and you still find it impossible, then it must be.*[96]

He ended the letter with a comment which reflected what he had learned from the previous failure of synergy:

> *I'm rather cultivating the unknown quality which results from the un-control by asking for more than is literally possible and listening to the untenable result—but, as in this case, one of the possibilities is no result at all.*[97]

96 Earle Brown, "Letter to David Tudor (April 1, 1957), Box 51, Folder 10, David Tudor Papers, GRI.
97 Ibid.

On April 15, Tudor wrote back a no-nonsense reply. The problem was not the mismatch of Brown's score with Tudor's skills but with Brown's own ideas:

> *what's the fuss?*
> *don't you know that I think everything's possible?*
> *and I've already played* 4 more *and don't consider it abnormally difficult.*
> *your letter sounds to me as if there's been some bad reporting on John's part, so let's try to make it clear.*
> *you're probably aware that I'm not completely satisfied with your works always, and I have tried to tell you before that this is not due to any difficulties or impossible demands—naturally these when they exist are all part of the 'sport.' rather it's because I sometimes feel that your scores are not always the best examples of the ideas that you profess. for a specific instance, we've discussed before the fact that the differences of duration which you prize so very highly will only be heard thru great distortion of what you have actually notated. and there's not much use in altering what's already made. shouldn't such matters (as the degrees of difference desired) be carefully considered when composing? it's a question of seeing what's important in the end result.*[98]

In spite of this problem, and in spite of Brown's renewed understanding that the result might be no result at all, Tudor kept the piece in his repertoire, playing it once in November 1957 and twice again in November 1959, before putting it away in his drawer.

Thirty years later, Cage reflected back and clarified what caused what. "[Tudor's] interest in puzzles invited the whole thing of indeterminacy."[99] But while composers sought to compose puzzle-like scores that would interest Tudor, the specifics of Tudor's interest—what *kind* of puzzle he was looking for—remained itself a puzzle. Nevertheless, it was Tudor who had the final say in the possibility of synergy. It was as if composers were all experimenting with an indeterminate instrument, handing it various forms of input just to observe what happened—including, as Brown had learned the hard way, nothing at all.

Material Bias

1

On June 15, 1989, during an interview with Holzaepfel, Wolff recalled the distinct way Tudor used to address the scores composers wrote for him: "He would ask, not 'Do you have a new piece?', but 'Do you have some new material?' "[100] Scores were

[98] Tudor, "Letter to Earle Brown (April 15, 1957)," Folder 5-39, Earle Brown Music Foundation; partially quoted in Kim, "Four Musicians at Work and Earle Brown's Indices," *Beyond Notation: The Music of Earle Brown* (Ann Arbor: University of Michigan Press, 2017), 129.

[99] Cage, "Interview with Holzaepfel," quoted in Holzaepfel, "David Tudor and the Performance of American Experimental Music," 59.

[100] Holzaepfel, "David Tudor and the Performance of American Experimental Music," 58.

indeed "materials" that Tudor used to realize a piece, increasingly so as they became more and more puzzle-like. Following Cage's wording, the same situation is usually described from the side of composers who saw the difference between the material they produced and the music Tudor produced as a matter of "indeterminacy." But "indeterminacy" is a term both too general—any score is indeterminate in relation to its performance[101]—and too relative—how indeterminate something is depends on from where one is looking at things. In his 1957 letter to Brown, Tudor posed this problem of relativity to the composer who claimed to be cultivating the unknown:

> *as for the 'unknown' that you wish to have in operation, how about this question: who doesn't know it? looking at such a piece as 4 more (or any other whatever) realizations are 'seen,' so to speak "at a glance," and then actions are made in accordance with this 'seen'—so is there an unknown worth talking about?*[102]

As Brown later remembered, composers who were writing indeterminate material shared "a feeling that we could perhaps present him with scores and possibilities."[103] But on Tudor's side, the task was reversed: what he needed to do instead was to reduce the possibilities to arrive at a specific presentation.

Toward the end of his letter to Brown, Tudor revealed a two-step recipe of sorts for accomplishing this goal: "my view is that accuracy of observation has to be considered first; accuracy of representation will follow (in the case where representation's involved)."[104] Thirty-two years later, on April 3, 1989, he would repeat a similar observation to Larry Austin: "For me, the concept of observation is primary [. . .] I need to observe something in a way that I don't put any prejudice. I want to see what it tells me."[105] Stockhausen also reported in his 1959 Darmstadt lecture that, according to Tudor, "graphic structures existed on the paper as any formation in nature."[106] Unbiased observation of material reveals how music should be (re)presented. Tudor's comments to Kubera indeed oscillated between a detailed observation of Cage's score to determine its nature, and the use of poetic license

[101] For example, Tudor reminisced to Holzaepfel on August 3, 1992, how he once had to differentiate two performances of *Music of Changes* for a recording, deliberately rendering the supposedly "determinate" score indeterminate: "They were all recorded in Germany. I know I made two recordings of the *Changes*. And the second recording was a challenge to me, because I had to find a way to make it different from the first recording. So I arranged to perform it as one piece. The first recording exists in four different movements. The second recording I made from the beginning to end without a pause" (Holzaepfel, "Reminiscences of a Twentieth-Century Pianist," *Musical Quarterly* 78, no. 3 (1994), 631). It is because of this specificity of each performance that cannot be reduced to the status of the score that I do not use Holzaepfel's otherwise useful distinction between "implicative" and "non-implicative scores" (Holzaepfel, "David Tudor and the Performance of American Experimental Music," 77). Instead, I focus on the difference between textual and physical biases within a given material, as well as that across different materials.

[102] Tudor, "Letter to Brown."

[103] Brown, quoted in Holzaepfel, "David Tudor and the Performance of American Experimental Music," 58.

[104] Tudor, "Letter to Brown."

[105] David Tudor and Larry Austin, "A Conversation, April 3, 1989," davidtudor.org, accessed December 15, 2018: http://davidtudor.org/Articles/austin.html

[106] Stockhausen, quoted in Gutkin, "Drastic or Plastic?," 267: "Die graphischen Strukturen existieren auf dem Papier wie irgendwelche Bildungen in der Natur, sagt Tudor."

in realizing a particular (re)presentation whose "accuracy" was no longer in relation to the material but to its "nature" thus revealed. The obvious premise here is that the appearance of a score may not be one and the same with its nature. Because of that, being faithful to the material could lead to an appearance of infidelity.[107]

2

The two-step recipe enabled Tudor to solve a dilemma inherent in the process of realizing any music: (a) to be attentive to the entire universe of possibilities offered by the given material; and (b) to reduce the same possibilities to actually materialize a performance.[108] Cage had used chance operations to deal with the same problem, composing scores through choices less biased than those he would himself have intended. Tudor's solution instead resorted to observing the nature of materials thus composed and given to him. One reason he could do so was because the universe of possibilities he was dealing with had already been materialized. Even when chance was used, or even when the degree of indeterminacy increased, the composed score was never neutral. So the bias necessary to reduce possibilities did not have to be outsourced to the flipping of coins; it could be found inside the given material itself.[109]

In other words, Tudor's process of realization entailed not one but two realizations: (a) to first *realize* the bias of material through unbiased observation; (b) to then *realize* its (re)presentation by biasing the subsequent approach to the material accordingly. For instance, as Holzaepfel reported, observing the nature of Feldman's

[107] In later years Tudor would describe a similar principle guiding his approach to electronic instruments, for instance on September 29, 1985, during a workshop at the Mobius Art Center in Boston: "You use the natural state of the components for what they give you, not what they are supposed to do. The description of one of these components is telling you something that the designer thinks that it should do, then you put it to test and you find out that it doesn't do that" (David Tudor, "Workshop at Mobius Art Center, Boston (September 29, 1985)," Box 2A, C75, David Tudor Papers, GRI).

[108] The terms "realization," "possibility," and "actually" might remind some people of a pair of polarities that appear in the philosophy of Henri Bergson and Gilles Deleuze: *virtual-actual* and *real-possible*. Since Tudor also uses the term "virtual," those readers might be curious about how these concepts coordinate with one another. I do not explore that concern. But if one were to be schematic about things, it could be said that "virtual," in Tudor's use (which I discuss in Chapter 9), is a relative term which depends on the status of "real": if what is "real" is considered as the "actual" experience, what is "virtual" is the mechanism beyond such experience that does not make an appearance but conditions appearances; if what is "real" is, on the contrary, understood as the mechanism conditioning appearances, what is "virtual" is the "actual" experience staged by those mechanisms. So the pair of polarities can be cross-coupled to form another set of pairs—virtual-real (as a matter of focus) and possible-actual (as a matter of realization)—which themselves oscillate between the binary of mechanism and appearance. What is more important for the task at hand than such abstract maneuvering of concepts, however, is how Tudor actually used these and other polarities to solve specific problems. In most such cases, the purity of concepts is distorted and modulated by other materials involved, as will be observed in later chapters.

[109] For this reason, Philip Thomas equates chance with measurement: "Tudor's version represents a very calculated realization, one which takes its cue from Cage's own methods in that, once the parameters of any given piece have been decided upon, the subsequent internal decisions (essentially those that affect the detail or content) are given over to chance—or, in this case, measurements" (Philip Thomas, "Understanding Indeterminate Music through Performance: Cage's *Solo for Piano*," *Twentieth Century Music* 10, no. 1 [2013], 95).

material—fast overall tempo (MM = 176), the frequency of high pitch density, as well as the subdivision of pitch quantities within individual registers—Tudor realized that *Intersection 3* was "a study in clusters."[110]

In the case of *Intersection 3*, however, the complexity of realizing such material then led Tudor to prepare a separate performance score, thus adding an extra labor in this second phase of realization. And to compose his own material, Tudor took measurements of the composed material using templates, calipers, and rulers of his own design to obtain numbers which determined parametric values or temporal structure—as has been observed in his realization of *Four Systems*. That is to say, in keeping with the two phases of realization, the bias of material is also twofold. The composed material not only constrains what is possible through the *textual* properties of what is written on paper, but also through the *physical* properties of what is written, along with that of the paper it is written on.

3

Indeterminacy that takes recourse to the bias of materials.[111] But if the "procedure" of chance operation is observed carefully, one may realize that even Cage relied on such bias to generate the unforeseen. After all, he had spent most of the year 1951 throwing coins everywhere he went to determine the parametric values for *Music of Changes*. Each coin toss is biased by the specific materials involved in the act of chance, starting from the coin and Cage's body, and extending to the particular subway or elevator he happened to be on. The same is true for the method of obtaining notes from the imperfections on paper which he began in 1952 as a quicker alternative to the time-consuming process of throwing coins. Instead of reducing the process of realization to probability or statistics, chance operations preserve the material bias of each coin or each paper, a degree of specificity that cannot be reduced to any preconceived universe of possibilities—or "procedure," for that matter.

Cage once attributed the idea of indeterminacy to "[David Tudor's] presence on Earth."[112] But this simply meant that as a composer, he was willing to let David Tudor decide things in the same way that he let coins or paper take the lead. And as with these materials, the pianist whom he had encountered by sheer chance enabled music he never thought possible. Talking to Daniel Charles circa 1970, the composer looked

[110] Holzaepfel, "David Tudor and the Performance of American Experimental Music," 61–62.

[111] The focus on bias reveals the distinction between determinacy and indeterminacy as a spectrum instead of a polarity; as a matter of degree, rather than of kind. For example, a musical score can be understood as a textual bias which constrains, through written signs—language or musical symbols—, the possibility of what can be done. Tudor's approach reveals other forms of material biases that are not textual but physical. The negative nature of "bias" is also reminiscent of the approach in Cybernetics, discussed later in Chapter 4. For instance, see the formulation by Gregory Bateson in "Cybernetic Explanation (1967)," in *Steps to an Ecology of Mind* (Chicago, IL: University of Chicago Press, 2000), 405–416.

[112] Cage quoted in Holzaepfel, "New Perspectives on the History of the 'New York School,'" paper delivered at the April 1990 meeting of the Sonneck Society, Hammond, VA, 22.

back on what had by then become almost two decades of working together: "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. [. . .] Tudor was present in everything I was doing."[113] Four years later, he again reflected on the heavy influence of Tudor on his works: "Beginning with my *Music of Changes*, and continuing through *Variations VI*, my music always had David Tudor in mind."[114]

But while he was vocal about the role that Tudor played, Cage was also vocal about "letting sounds be themselves," and much more frequently so. And in those cases, he tended to be silent about the role of materials for accomplishing that goal, perhaps fearing the reduction of sounds to the means of their production. The focus on the autonomy of sound thus occulted the bias of materials.

Yet encounters are of course never one-sided. Meeting Cage and composers around him was fortunate on Tudor's part as well, for the nature of materials he was given could enable what he was really after. If it didn't, he would simply stick it in his drawer for years. In his 1994 dissertation Holzaepfel made the critical observation that Tudor's primary objective in performing the music he chose to perform in the 1950s was to explore the nature of his instrument, the piano: "his devotion to new music was due not only, perhaps not even primarily, to new sounds but to new possibilities for piano-playing. In other words, Tudor appears to have been motivated by a need to change ingrained habits of playing the piano."[115] For example, in his realization of *Intersection 3*, "Tudor extended the variety and complexity of cluster-writing beyond precedent."[116]

Tudor's choice of material was thus biased by the instrument of his choice. Indeed, his repertoire throughout the decade—pointillist works that coordinated discrete musical parameters with extreme precision and speed (whether via chance or choice)—coordinated well with his exploration of the piano as a remote-controlled percussion instrument, an exploration based on meticulous control of timing "within a time continuum of one second."[117] In other words, as the anecdote of *Four More* reveals, Tudor's choices were by no means random—the composers were just as instrumental to Tudor as he was to them. But this also meant that if the instrument changed its nature, so would the nature of his realization.

113 Cage, *For the Birds*, 178.

114 Cage, "The Future of Music," in *Empty Words: Writings '73–'78* (Middletown, CT: Wesleyan University Press, 1979), 185.

115 Holzaepfel, "David Tudor and the Performance of American Experimental Music," 85. He also writes: "Tudor's role in the composition of American experimental music during this period and his legacy as a pianist are intertwined: his overriding interest in the music lay in the challenges presented by its notational problems, problems Tudor regarded as puzzles. And his solutions were, throughout the 1950s, invariably in terms of what he could do with the piano, either by extending existing techniques or inventing new ones. In this regard, the dissertation is a contribution to the history of piano-playing" (ibid., v).

116 Ibid., 62.

117 Thomas describes the inevitable yet ironic outcome of this endeavor, namely that Tudor's personal—or rather impersonal—choices have become generalized into a "style" of performance of experimental music: ". . . there is also much within the score that looks considerably more gestural, at times even flamboyant. Tudor's realization either ignores such pieces through omission, or defines them in such a way that they conform to the aesthetically bounded and highly refined collections of single sounds that

4

As far as the piano was concerned, Cage had already once changed its nature. In 1938, as the twelve-year-old Tudor was making fast progress on the organ in Philadelphia, the twenty-six-year-old composer was on the West Coast, working as an accompanist for the modern dance class at the Cornish School in Seattle. One day a student dancer named Syvilla Fort asked him to write for her choreography *Bacchanale*, to be performed at the school in several days. Since the dance "suggest[ed] Africa,"[118] Cage's first thought was to write percussion music, as he had been doing for some time. But the school theater had no space for his percussion ensemble. The only available material was a piano placed at one side of the stage. To solve this problem, Cage put the blame on the instrument that happened to be there, as he recalled in 1972: "I decided that what was wrong was not me but the piano. I decided to change it."[119] He did so by inserting screws and bolts into the strings of the piano, effectively turning the keyboard instrument into a portable percussion ensemble: "to place in the hands of a single pianist the equivalent of an entire percussion orchestra […] With just one musician, you can really do an unlimited number of things on the inside of the piano if you have at your disposal an exploded keyboard."[120] The prepared piano was thus composed as a virtual percussion instrument, which incidentally matched the view of the nature of the *un*-prepared piano Tudor would attain shortly afterward.[121]

5

Sixteen years later, in the summer of 1954, Cage wrote the last set of works that he would compose for the instrument of his invention: two pieces for the prepared piano to be performed simultaneously by Tudor and himself on their first European tour

characterized the experimental music of the 1950s to such a degree. In so doing, he establishes a performing tradition (or, at least, a reference point) that is not only symptomatic of the time but also, paradoxically, a subversion of the piece. If the score for the *Solo for Piano* could be said to be a direct response (and possibly a challenge) to the creativity of Tudor, Tudor's response to Cage's score transcends the expectations it projects, foreshadowing the even more radical approach that Tudor adopted with Cage's *Variations II* a few years later" (Thomas, "Understanding Indeterminate Music through Performance," 94).

118 John Cage, "How the Piano Came to Be Prepared," johncage.org, accessed December 15, 2019: http://johncage.org/prepared_piano_essay.html. The provenance of this text is described in a footnote: "This text was originally written in 1972 as a foreword for Richard Bunger's *The Well-Prepared Piano* (The Colorado College Music Press, Colorado Springs, 1973; reprinted Litoral Arts Press, 1981). It was slightly changed for reprinting in John Cage, *Empty Words: Writings '73–'78* (Wesleyan University Press, 1979), and has been further revised for the present circumstance" (ibid.).

119 Ibid.

120 Ibid.

121 Erdman, who introduced Tudor to Cage, recalled that the latter eventually talked about the *un*-prepared piano in a similar way: "Every time I asked him [to write a piece], he would accept it but he would always say 'I don't approve of that kind of art.' [*laughter*] And it was so much so with *Ophelia* that he said, 'I don't approve climaxes, that's 19th century.' I didn't realize there was a climax in that dance myself, but umm […] I had to have it for the piano because I was starting to tour, and he said, 'I'll treat the piano as a percussion instrument, which it is.' So he wrote this beautiful piece with its climaxes and everything. [*laughter*]" (David Vaughan, "Interview with Jean Erdman, 1983-06-08," Merce Cunningham Dance Foundation Collection, Jerome Robbins Dance Division, New York Public Library).

which took place later that year in October and November.[122] Together they belonged to a series of works the composer was working on at the time, called variously as "Ten Thousand Things," or "Time-length Pieces," which all had the exact duration of music down to milliseconds as their title.[123] *34'46.776" for a Pianist* was the only prepared piano piece composed specifically with Tudor in mind, a much more difficult material than *31'57.9864" for a Pianist* which Cage wrote for himself to play.

In fact, Tudor was not only on Cage's mind when the piece was composed—he was also living in the same house. In July of that year, the two collaborators, along with their partners M. C. Richards and Cunningham, had all moved from Manhattan to a plot of land some 40 miles north of the city in a small town called Stony Point. The architect Paul Williams, who purchased the property, had the vision of setting up an artists' community, which became known as the Gate Hill Cooperative. Almost forty years later, on January 26, 1992, Tudor, who was the only one among the original members who still lived in the same community at the time, reminisced to Julie Martin how Cage composed *34'46.776" for a Pianist*: "That piece was composed while John was here, living in this house." They had just started their country life and were still sharing one house as they waited for other houses to be completed. "So I was rehearsing it, I had the piano in the other room at that time."[124]

The physical intimacy is reflected in the nature of material. The notation is written on traditional staves with more or less regular musical notes to convey pitch and duration (Figure 1.6). But Cage added three bands above the staves where he scattered points obtained by marking the imperfections on the paper. For each note to be played, these points specified three parameters of physical coordination between Tudor's body and the instrument, which the composer thought were responsible for the dynamics of sound: the degree of force, the vertical distance from the keyboard, and the speed of attack. In composing the piece, Cage asked Tudor the same question he had asked when composing the *Music of Changes* three years earlier: "How many arms shall I assume that you have?" Tudor's answer this time had doubled, if a much later recollection from August 3, 1992 is to be trusted:

> *And I thought about it, I thought about it very seriously, just for a few minutes. I said "Sixteen," because he'd made me think about it, about the way your hands can play.* [. . .] *And it had to deal with the actions you could make in one second. So I was very trained to work within a time continuum of one second. And I thought about how many things I can do in one second. So I thought, "I have to double that number." So that's what I did.*[125]

[122] These were premiered on October 17, 1954, with considerable difficulty, during Cage and Tudor's first major European concert at the Donauschingen Music Festival in Donaueschingen, Germany.

[123] Iddon has observed the influence of Tudor in these titles: "Having seen the legion of decimal places to which Tudor's calculations ran in working out the durational characteristics of *Music of Changes* and the *Two Pastorales*, the titles of the pieces contained with the *Ten Thousand Things* series [. . .] can hardly be seen as other than a continuation of Cage's playful response to Tudor's methodical processes" (Iddon, *John Cage and David Tudor*, 45).

[124] Tudor, "Interview by Martin."

[125] Holzaepfel, "Reminiscences of a Twentieth-Century Pianist," 635.

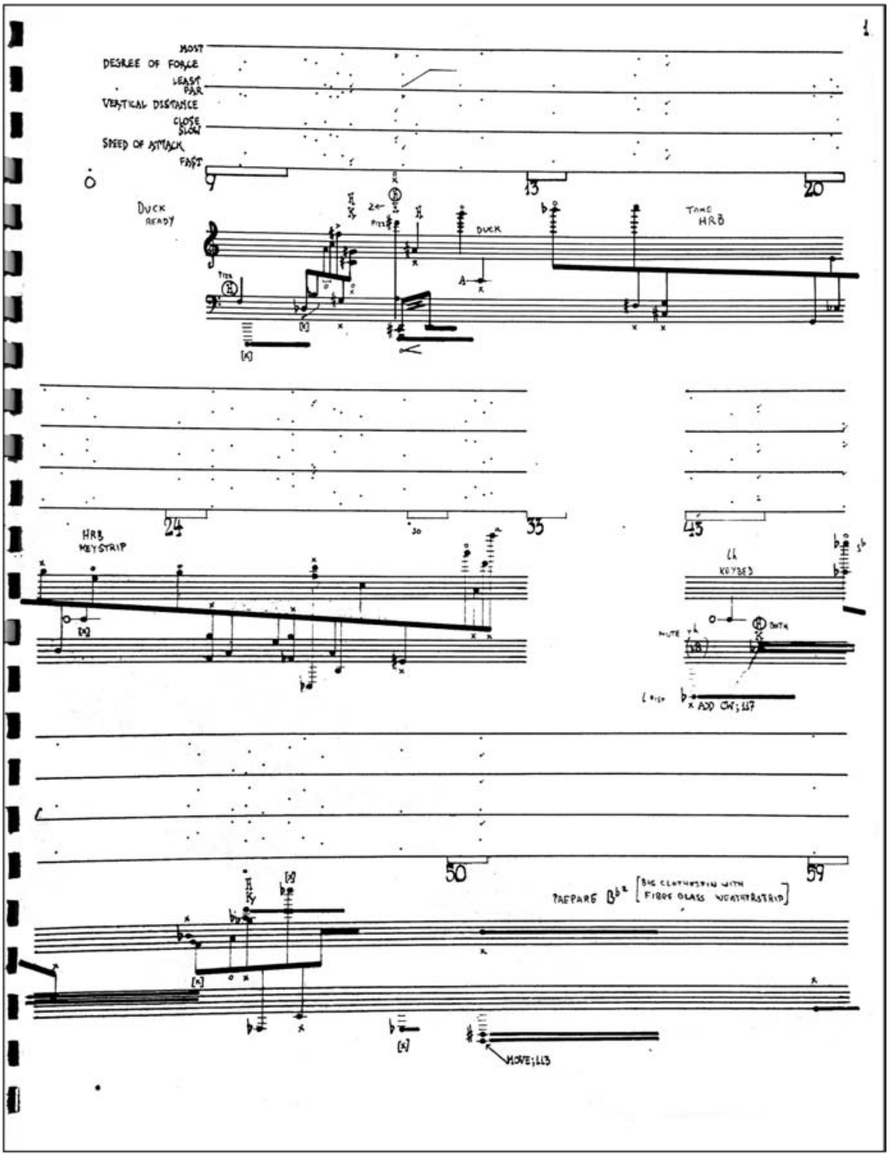


Figure 1.6 John Cage | *34'46.776" for a Pianist* (first page of Tudor's copy with his notes) | 1954

Cage's instructions also reflected the specific way Tudor approached scores: "The notation may be read in any 'focus' (as many or as few of its aspects as desired being acted upon)"; "Where impossibilities are noted (of any kind), the pianist is free to use his own discretion."[126] If Tudor had become *Music of Changes*, it was as if this new material was trying its best to become *David Tudor*. In the same reminiscence from August 1992, Tudor even appeared to suggest that the process of composition—which he called by its nickname derived from the fact that Cage had also instructed the auxiliary use of many whistles—was more of a collaboration: "John was composing the "Whistle Piece" [*34′46.776″*], which had been commissioned, and we were working on it together."[127]

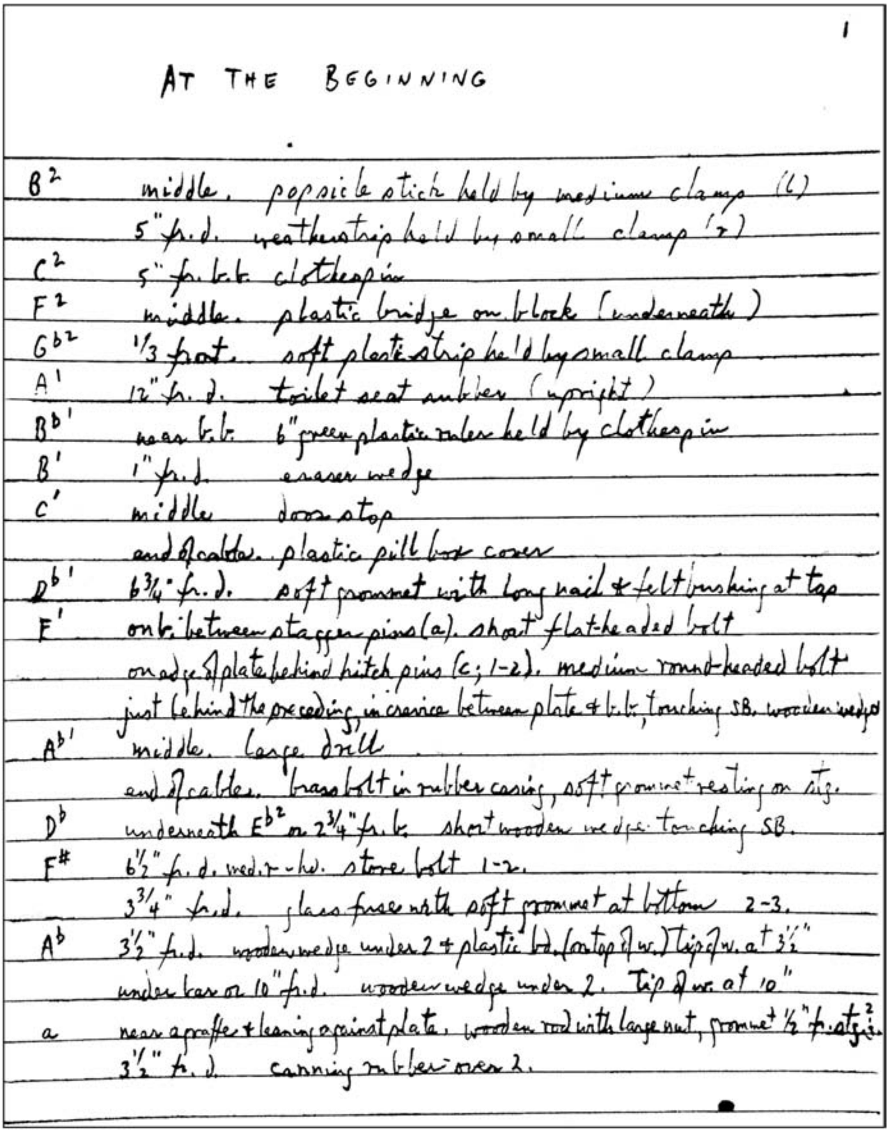
Despite the surface similarity with Brown's *Four More*—the use of staves or note heads prolonged horizontally to indicate duration—Tudor's response to *34′46.776″ for a Pianist* was entirely different. He went as far as calling it his favorite piano piece according to Kubera, who also remembered the reason Tudor liked it, which had to do with the appearance of music: "He said it reminded him of the sound of insects."[128]

6

The nature of Cage's score thus appears to find direct contact with Tudor's specific virtuosity focused on the exploration of escapement mechanism through physical coordination with the piano. But that was not all, for the prepared nature of the instrument had inspired the composer to ask something else of his pianist: to compose materials of his own. Contrary to all previous works for the prepared piano, the two final scores written for the instrument only specify the category of things each string should be prepared with. The performer is asked to choose not only the actual material but also the exact location where it should be inserted, as well as to change the preparation during the performance by adding or subtracting materials, or by moving the ones already inserted.

Thus, the material Tudor was being asked to compose this time was the physical instrument itself. If the textual bias composed by Cage required Tudor to keep his focus on the keyboard, the physical bias Tudor composed himself shifted his attention elsewhere: to the interiors of the piano, the bellows of the instrument he had once opened up to understand its nature, which was now exposed not only to plain sight but also to direct manipulation.[129]

[126] Cage, *34′46.776″ For a Pianist* (Score), Peters Edition.
[127] Holzaepfel, "Reminiscences of a Twentieth Century Pianist," 630.
[128] Kubera, "Interview by Nakai," Staten Island, NY, April 28, 2017.
[129] Curiously, Cage talks about his experience with the prepared piano as revealing to him the non-generalizability of musical instruments. "When I first placed objects between piano strings, it was with the desire to possess sounds (to be able to repeat them). But, as the music left my home and went from piano to piano and from pianist to pianist, it became clear that not only are two pianists essentially different from one another, but two pianos are not the same either. Instead of the possibility of repetition, we are faced in life with the unique qualities and characteristics of each occasion" (Cage, "How the Piano Came to Be



1

AT THE BEGINNING

B2 middle. popsicle stick held by medium clamp (l)
5" fr.d. weatherstrip held by small clamp (r)
C2 5" fr. b.b. clothespin
F2 middle. plastic bridge on block (underneath)
Gb2 1/3 front. soft plastic strip held by small clamp
A1 12" fr. d. toilet seat rubber (upright)
Bb1 near b.b. 6" green plastic ruler held by clothespin
B1 1" fr.d. eraser wedge
C1 middle door stop
end of cable. plastic pill box cover
Db1 6 3/4" fr. d. soft grommet with long nail & felt bushing at top
F1 on b. between stagger pins (a). short flat-headed bolt
on edge of plate behind hitch pins (c; 1-2). medium round-headed bolt
just behind the preceding, in crevice between plate & b.b., touching SB. wooden wedge
Ab1 middle. large drill
end of cable. brass bolt in rubber casing, soft grommet resting on strg.
Db underneath Eb2 on 2 3/4" fr. b. short wooden wedge touching SB.
F# 6 1/2" fr. d. med. r-hd. stove bolt 1-2.
3 3/4" fr.d. glass fuse with soft grommet at bottom 2-3.
Ab 3 1/2" fr.d. wooden wedge under 2 + plastic bd. (on top of w.) Tip of w. at 3 1/2"
under bar or 10" fr.d. wooden wedge under 2. Tip of w. at 10"
a near agraffe & leaning against plate. wooden rod with large nut, grommet 1/2" fr. at 2.
3 1/2" fr. d. canning rubber over 2.

Figure 1.7 Tudor | *34'46.776" For a Pianist,* list of materials for preparation (first page, corresponding to strings B2-a) | Undated (presumably 1954)

DTP, Box 180, Folder 2 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

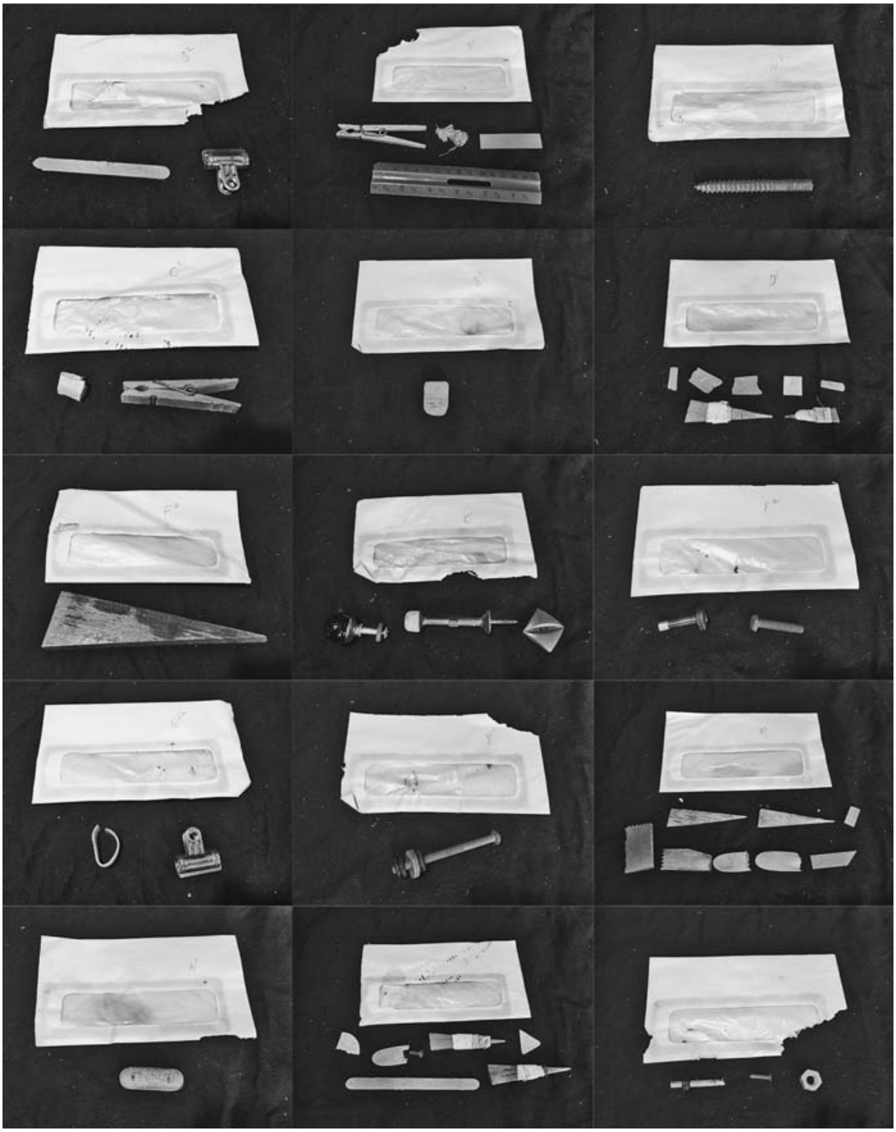


Figure 1.8 Tudor | *34'46.776" For a Pianist,* materials for preparation (corresponding to strings B2-a)
DTC | World Instrument Collection, Wesleyan University

Tudor appears to have been thrilled. Among his papers at GRI are pages that list descriptions of physical objects, ordered according to the pitch of the corresponding string (Figure 1.7).[130] Among his instruments archived at Wesleyan University is a collection of objects, each stored in a separate envelope on which the corresponding pitch is written (Figure 1.8). The two sets of materials, now divided in two archives at opposite ends of the country, coordinate perfectly, revealing the extensive nature of Tudor's preparation. The instrumentalist thus began composing his own instrument.

II. David Tudor

Cues

1

On August 3, Holzaepfel asked Tudor, who was turning sixty-six that month, to reflect on his decision more than thirty years earlier to prepare a separate performance score for a material composed by Christian Wolff. The interviewee explained it was simply due to the degree of indeterminacy:

> *Oh, how many choices he offered. And the more choices he offered, the more it was necessary to write it out. In earlier works, he didn't give that possibility. But when you offer a plethora, when you have twenty-four different pitches you can choose from and it doesn't make any difference to him what they are—the point is, it makes a difference to you. It's a possibility that he didn't think of, that it would make a difference to the performer.*[131]

But this may have also been the result of a change of instrumentation, as Wolff himself recalled more recently on March 24, 2015: "[A] lot of piano music was written in those years by all of us, and it was written precisely for an instrument that one might call "David Tudor," if you will."[132] For the composer focusing on the specificity of *David Tudor* as an instrument, it may not have mattered which choice he made as long as he was the one who made it.

Prepared"). This condition of each instrument being different is more apparent in the case of the organ, which always differs in one way or another from one church to another as discussed in later chapters.

130 Tudor, "List of Materials for *34'46.776" For a Pianist*," Box 180, Folder 2, David Tudor Papers, GRI.

131 Holzaepfel, "Reminiscences of a Twentieth Century Pianist," 636. While going through the manuscript of this book, Holzaepfel made a small adjustment to convey exactly how Tudor answered (adding the "Oh" at the beginning) which I have kept (Holzaepfel, "Comments on the Manuscript of *Reminded by the Instruments*").

132 Wolff and Bernas, "Prof. Christian Wolff in conversation with Richard Bernas (March 24, 2015)."

Wolff was speaking for others as well. In 1989, Holzaepfel assembled the recollections of composers who had worked with Tudor in the first half of the 1950s and discovered what he called “one of the most unexpected, even astonishing, aspects of Tudor’s work”:[133] the pianist was working completely alone, without consulting any of the composers about how to realize the materials. The reminiscence of the same composers three decades later portrayed Tudor as a black box whose internal mechanisms were unknown, but nonetheless always output extraordinary results from any input material. Cage recalled: “There was never any conversation.... Nor did I consult with him about what he could do, or what he couldn’t do—none of that. One assumed he could do *everything.* (In fact, hearing him perform was proof.)”[134] Wolff agreed: “When a piece was turned over to David, there was simply no anxiety. You didn’t worry, you knew that something would happen. My *main* anxiety would be more that I had made something that wasn’t good enough [to interest him].”[135] Feldman put it most succinctly: “I go to the concert and hear a miracle.”[136] Indeterminacy thus appears to be a corollary of the ignorance on how Tudor’s “virtuosity of mind” worked. The music performed by Tudor was unforeseen because the mechanism that produced it was unseen.

But this was of course not the whole story, since the composers also did their best to match the material they wrote to Tudor’s specific nature, even if the details of his realization process remained occult. After all, Cage kept asking how many arms the pianist had, and Brown was anxious to know why the synergy had failed. Similarly, the particular kind of indeterminacy Wolff composed was coordinated to Tudor’s physical abilities rather than to his own ignorance.

2

After taking lessons with Cage for six weeks in 1950, Wolff inverted his teacher’s focus on the universe of possibilities and wrote music based on impossibilities. “I was [...] writing pieces which were impossible to play due to aspects of rhythm, fingering or keyboard layout,” he looked back during an interview with Victor Schonfield in 1969. “The impossibility would force the performer to discover a solution of his own.”[137] For instance, in one early piece, *For Piano I* (1952) “a chord spanning over four octaves with different attacks, durations, and dynamics” appears.[138] But these impossibilities were not utter absurdities that lay completely beyond the universe of possibilities. Instead they were biases carefully composed around the thresholds of the instrument(alist)’s physical capabilities, the peripheries of Tudor’s coordination with the piano.

[133] Holzaepfel, “David Tudor and the Performance of American Experimental Music,” 56.
[134] Ibid., 57.
[135] Ibid., 58.
[136] Ibid.
[137] Christian Wolff, “Interview with Victor Schonfield (1969),” in *Occasional Pieces: Writings and Interviews, 1952–2013* (New York, NY: Oxford University Press, 2017), 40.
[138] Michael Hicks and Christian Asplund, *Christian Wolff* (Urbana: University of Illinois Press, 2012), 20.

In 1956, as if to reenact the nature of his music in real life, an impossible situation forced Wolff to discover a new solution. Under a severe time constraint to write a piece for the piano duo of himself and Frederic Rzewski, Wolff drafted a simple score consisting of a series of time brackets and number of notes to be played in each bracket (notated using a colon as if they were ratios), along with a separate collection of pitches to choose from. Continuing the theme of impossibility, the length of time brackets varied from moderately long (e.g., a minute) to extremely short and irregular (e.g., seven-eighths of a second). "What we did was a kind of improvisation," Wolff described thirteen years later to Schonfield. "It made a music that, as far as sound went, was just as intricate and interesting as the stuff that we were making when we wrote everything out. This was a revelation."[139]

From this "experiment in 'composed' improvisation,"[140] as he called it, Wolff wrote a piece toward the end of the following year for Tudor and Cage to play together with another straightforward title: *Duo for Pianists I*. The material only offered constraints of various degrees—time brackets, number of notes, collection of pitch material—leaving the two pianists to each determine the actual performance.[141] As usual, Tudor composed his own realization score for the premiere, which took place on December 15, 1957, at the Harvard-Radcliffe Music Club in Boston, Massachusetts.

For the second work in the series, composed half a year later in July 1958, Wolff modified his system of "composed improvisation" using a cue he had picked up from Stockhausen's *Klavierstück XI*, a new piece for the piano which Tudor had premiered at the Carl Fischer Hall in New York on April 22 of the previous year.[142] For the eleventh entry in the series of complex piano music in which Tudor specialized, Stockhausen had scattered multiple fragments of composed passages on one large sheet, with the instruction to play them in any order following the movement of the performer's eyes. In Wolff's eyes, however, this appeared to be "a little bit of scam because what was supposed to determine the indeterminate sequence was your roving eye."[143] So instead, he decided to use one material that the performer had no control over as the agent of determination: the sounds produced by another performer. Thus, in *Duo for Pianists II*, the fragmentary sequence of events assigned to each pianist is coordinated using

[139] Wolff, "Interview with Victor Shonfield," 40.

[140] Christian Wolff, "Program Note for *Duo for Pianists I* (1957)," in Wolff, *Cues: Writings and Conversations* (Cologne, Germany: Edition MusikText, 1998), 488.

[141] I do not go into the details of Tudor's realization, as Holzaepfel has conducted a very thorough analysis. See "David Tudor and the Performance of American Experimental Music," 135–159.

[142] Stockhausen's piece appears to be itself remotely cued by earlier works of Feldman and Brown who had separately written scores in 1953 where the sequential order of fragments or pages was left indeterminate: *Intermission 6* and *Twenty-five Pages*. As Tudor recalled in May 1972, when Stockhausen first revealed the idea of writing a piece where the performer decided on the sequence of events, the pianist almost discouraged him: "I said I knew someone who was already doing one, and he said, 'In that case I shall not compose it.' So I retracted, and said it was just an idea my friend was thinking about, and told him he mustn't consider any other composer but should go ahead and do it anyway, and that led to *Klavierstück* No 11" (Tudor, "From Piano to Electronics," 25).

[143] Christian Wolff, "In a Kind of No-Man's Land: Conversation with Cole Gagne (March 24, 1991)," in *Cues*, 244.

sonic "cues," specific kinds of sound that performers had to listen for during the performance (e.g., 'middle ff,' 'low mute,' etc.) to determine what to do next.

Since ten cues were assigned to each performer independently,[144] there was no overall understanding about which sound functioned as a virtual conductor for the other. With only a series of local conditions awaiting the input of specific sounds and with no global time to order the events in advance, the situation was not only unforeseeable, but it became so in different ways for each performer.[145] As Wolff explained to Schonfield in 1969, obviously with Tudor in mind: "I decided to place chance completely outside his [the pianist's] control by making his ear the vehicle. Pieces like my *Duo for Pianists II* (1957) place him in an unforeseen situation without warning, simply through the exercise of his hearing: one performer plays something, and the other recognizes it as his own one."[146] Which is to say, the specific bias of each ear became the source of indeterminacy in real time. Like the earlier inversion of Cage's concern for possibilities into a method of impossibilities, Wolff had again taken his former teacher's teaching and turned it inside out.

3

As the most well-known of all the well-known stories by Cage goes—"Anybody who knows me knows this story. I am constantly telling it"[147]—the composer visited the anechoic chamber at Harvard University in the summer of 1952.[148] Wolff had enrolled there the previous fall, and his friend, Ted Schultz, a graduate student of acoustical engineering, had connections to the echo-free room engineered to absorb all reflections of sound. In the winter of 1957, Cage reminisced:

[144] According to Wolff's own description from 1960: "Each of the two pianists makes his particular continuity of structural units (they total fifteen and are from 1/16 to 42 1/5 seconds long) and is dependent for the successive choice of what units to play not, as in Stockhausen, upon a straying eye, but upon what he has heard. Ten kinds of sounds (for example highest octave fortissimo, pizzicato in the middle register, eleven seconds of silence) as heard from one piano are cues to the units which the other will play, and vice versa. A given cue may refer to one unit or to a set of alternatives (two or three). A unit may be played any number of times during a performance, depending on how often it is cued. One unit or pair of units needs no cue and so can be used to start the piece and to return to during the piece when one has either not heard or missed a cue" (Wolff, "On Form (1960)," in *Occasional Pieces*, 23).

[145] The multiplicity of local perspectives that attempt to read one another, each according to its own biases, is reminiscent of the basic mechanism of Greek tragedy where drama develops through the impossibility of attaining a global view of events. After obtaining a doctorate from Harvard University, Wolff taught Classics at his alma matter from 1962 as a scholar of the ancient tragedian Euripides, before moving to Dartmouth College in 1970.

[146] Wolff, "Interview with Victor Schonfield (1969)," 40.

[147] Cage, "How to Pass, Kick, Fall and Run," in *A Year from Monday: New Lectures and Writings* (Middletown, CT: Wesleyan University Press, 1967), 134.

[148] Although the view that the anechoic chamber experience occurred in 1951 is dominant, there is a discrepancy in Cage's own account about when the event took place. "Experimental Music: A Doctrine (1955)" describes the visit as follows: "one enters an anechoic chamber, as silent as technologically possible in 1951" (Cage, *"Experimental Music,"* 13). However, thirty years later, in "An Autobiographical Statement" (1989), Cage recalled that he went to Harvard immediately after "the happening at Black Mountain College"

> *I entered [the anechoic chamber] at Harvard University several years ago and heard two sounds, one high and one low. When I described them to the engineer in charge, he informed me that the high one was my nervous system in operation, the low one my blood in circulation.*[149]

The moral of the story is also well-known: this experience had revealed that "actual" silence did not exist, that there are always sounds to be heard, and that "silence" was simply sounds that were not intended and therefore not heard. Since each ear is biased differently, there was also no such thing as silence in general.[150] The act of listening could not be encompassed within the composed universe of possibilities.

What Wolff must have realized is the other side of this moral that emerges as a corollary. For if ears are indeterminate and there is no such thing as silence in general, then *there is neither such thing as sound in general*. As solitary listeners who are conditioned to hear different sets of sounds, it is not even certain that the performers are listening to the "same" music.

Yet "an ear alone is not a being"—as Cage would write in 1962.[151] The listener in Wolff's music is also an instrumentalist. As Dalcroze taught, the ear is coordinated with other body parts, which are further coordinated with the instrument and other materials—the hands on the keyboard, the foot on the pedal, the eyes scrolling across the score. And although Wolff probably was not thinking about Eurhythmics, the specific term he used to address the relationship between sonic cues and cued events happened to also be "coordination." The sonic coordination between what one performer plays and what another hears triggers a shift in the physical coordination between the instrumentalist and other materials. When the ear was turned into a vehicle, sound turned into an instrument of remote control for the production of sound. Coordination was always possible but also always indeterminate.

in the summer of 1952, and subsequently composed *4′33″* which was premiered in August of the same year (Cage, "An Autobiographical Statement," johncage.org, accessed December 15, 2018: http://johncage.org/autobiographical_statement.html). In an email interview on February 13, 2012, Wolff remembered that it was his friend at Harvard, Ted Schultz who arranged Cage's visit to the anechoic chamber (Wolff, "Email Interview with You Nakai," February 13, 2012). Since Wolff enrolled at Harvard in the fall of 1951, this leaves no chance of Cage going there before then.

[149] Cage, "Experimental Music," in *Silence*, 8.

[150] "Until I die there will be sounds. And they will continue following my death. One need not fear about the future of music." But the future of music was conditional as far as the business of composition was concerned: "But this fearlessness only follows if, at the parting of the ways, where it is realized that sounds occur whether intended or not, one turns in the direction of those he does not intend. This turning is psychological …" (Ibid., 8). This condition reduces the specificity of listening to a general program to remove intention from the act of composing music. As a matter of psychology, the physical bias of each ear is occulted once again in favor of unbiased neutrality.

[151] Cage, "Happy New Ears!," in *A Year from Monday*, 32.

4

In 1959, Wolff composed *For Pianist*, in which he tried to address a "dilemma" inherent in his system of cues: the application to a solo performer.[152] In the absence of a second performer, the composer focused solely on the physical coordination between the instrumentalist and his instrument. Once again he resorted to impossibility, pushing the feedback loop between Tudor's body, the piano, and the resulting sound to an extremity. For one thing, instead of a duo between two pianists, he had written a duo between the pianist's two hands: "What may be the most striking (and daunting) new aspect of the piece is the remaking of the two hands into a veritable 'duo,' functioning somewhat independently, with hand-crossings being choreographed diagrammatically."[153]

The cues similarly explored the peripheries of coordination across ten pages of material (Figure 1.9). As Wolff looked back in 1991: "What I did was set up situations in which the pianist was asked to do something which could not be totally predictable."[154] For example, the score would tell Tudor to make a sound "as softly as possible." Wolff imagined three kinds of possible outcomes for this task: Tudor could either succeed, or fail in two ways; he could either play too strongly, or too softly so that nothing is heard. Otherwise, the score would tell Tudor to pluck a piano string "as hard as possible," the result of which could either be that he manages to produce a clear sound, or a neighboring string is also touched; in the latter case, that string could either be of the same pitch or different. Like this, Wolff went on imagining the successes and failures of Tudor's physical coordination with his instrument at the threshold of possibility. These cues in turn determined how discrete sequences scattered on the page were coordinated. "Whichever results will determine alternate paths he must directly follow." As a result, the pianist was drawn "into labyrinthian complications."[155]

There were two forms of possibilities at work in this labyrinth: the possibility of what Tudor and his piano can do (the task—"as soft as possible"), and the possibility of something possible *actually* happening (the three results). In other words, the cues Wolff selected this time were not items in Tudor's universe of possibilities, like the repository of pitch materials or the pre-composed charts of parametric values. They were instead possibilities related to the realization of specific possibilities. What *can* be done in principle *can* also fail in practice. Even if the results were laid out in

[152] "The whole notion of cueing is obviously a dilemma when you're writing solo pieces. I addressed it once. I wrote a piano piece called *For Pianist*, in which I tried to work out situations that would produce cues that were not perfectly controllable by the player. What I did was set up situations in which the pianist was asked to do something which could not be totally predictable" (Wolff, "In a Kind of No-Man's Land," 250).

[153] Hicks and Asplund, *Christian Wolff*, 27.

[154] Wolff, "In a Kind of No-Man's Land," 250.

[155] Wolff, "Liner notes," *For Piano I/For Pianist/Burdocks*, WERGO, WER 60063, 1972, LP.

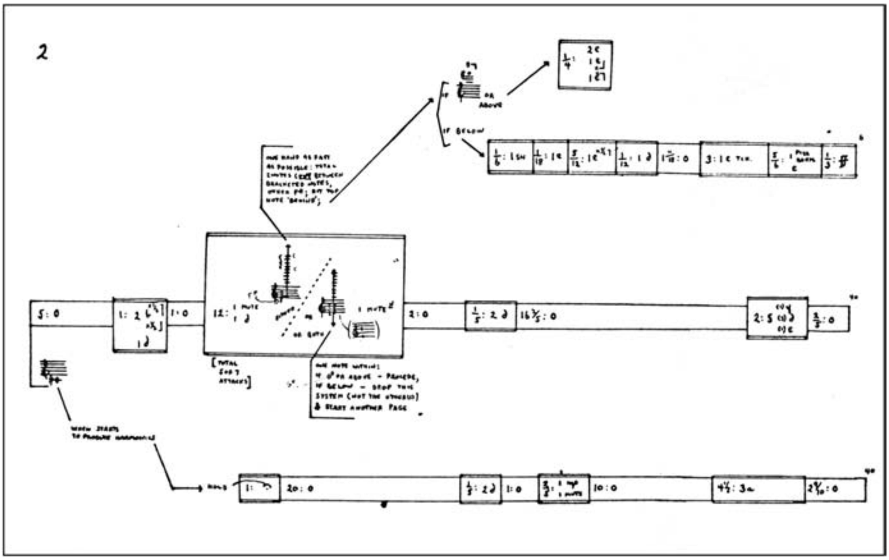


Figure 1.9 Christian Wolff | *For Pianist* (page 2) | 1959

advance, they could not be simulated in the virtual performance of the mind. Tudor needed to do it *actually*.

5

In composing the labyrinth of *For Pianist*, one thing Wolff aimed was to restrain Tudor's usual way of doing things, as he reminisced to Schonfield in 1969: "This was also partly a reaction to Tudor, who would always work out a piece fully beforehand."[156] However, the composer's challenge to make preparations as difficult as possible was met by the performer's effort to make his preparation as thorough as possible. For each page of material, Tudor composed a separate realization score working out the time brackets and sound events, as well as all the possible scenarios diverging from the success or failure of coordination. He essentially created an entire map of all the "alternate paths" he might follow to get around the labyrinth.

The strangeness of this solution is reflected in the strangeness of the material Tudor composed (Figure 1.10).[157] Each realization score, corresponding to a page

[156] Wolff, "Interview with Victor Schonfield," in 41.
[157] Tudor, "Realization Scores of *For Pianist*," Box 13, Folder 4, David Tudor Papers, GRI.

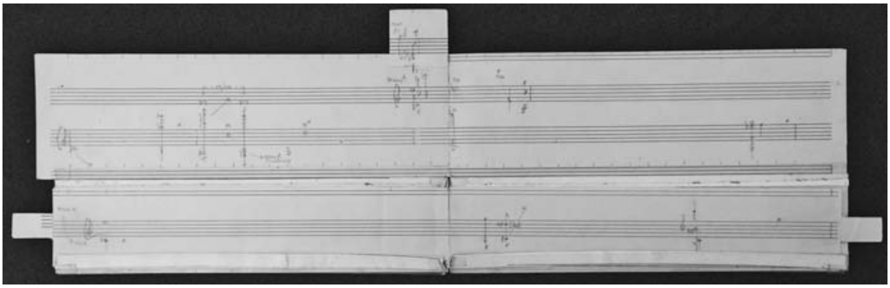


Figure 1.10 Tudor | *For Pianist,* realization score (page 2) | 1959
DTP, Box 13, Folder 4 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

of Wolff's material (or three to a page in the case of page 6 containing three discrete systems), is written proportionally on either a fragment of staff paper with only the necessary number of staves (pages 1, 3, 4, 5-1, 5-2, 6A, 6B, 6C, 10) or multiple fragments patched together in irregular ways (pages 2, 7, 9, 11).[158] Each paper is divided into twenty-one time-units of one second marked on the top and bottom edges. Aside from accommodating sequences of more than twenty-one seconds, patching together multiple fragments allowed Tudor to create parts that could be pulled out to precisely align sequences whose starting point was cued by other events. Like a movable book, Tudor's map was interactive; it was something he could manipulate during the performance to adjust the material to what was actually happening in real time.

Talking to Holzaepfel on August 3, 1992, Tudor revealed a peculiar reason for why he always read from a score—either written by the composer or his own realization score—when he played the piano.[159] It was in order to prevent committing the music to memory before it happened:

> *When I began to play contemporary music, I needed to see the score in front of me.* [. . .] *to me, the score has to be as clean as a whistle, because I perform it by*

[158] Tudor made two realizations of the tiny page 5. Page 8 does not exist since the composer did not compose it. On October 18, 1959, ten days before the premiere of the piece, Wolff wrote to Tudor explaining: "no, i'm afraid page 8 isn't done + i find that my stuff for the piece is in a bag locked up where i can't get it for another 3 weeks + there's no piano i could use" (Christian Wolff, "Letter to David Tudor [October 18, 1959]," Box 60, Folder 6, David Tudor Papers, GRI).

[159] Tudor was famous for his extraordinary capacity to sight-read a score, to immediately coordinate what his eyes read with the manipulations of piano keys, as described in an article published in 1960: "Tudor's ability to read at sight is almost legendary. Cowell, one of Tudor's great admirers, says that the young pianist read off his music without any trouble, 'with all four arms going at once, including taking care of the tone clusters.' [. . .] 'It was phenomenal,' Cowell says. 'Usually it takes pianists months to work some of my music out. Tudor went through it at sight.' His former composition teacher, Stefan Wolpe, says that Tudor can read 'with the speed of light.' Tudor, even though he seldom practices anything that by the wildest stretch of the imagination could be conceived as traditional music—Webern is a dated relic in his circle—has kept up his reading ability. Not long ago, while talking about Louis Moreau Gottschalk, the Civil War composer, he pulled out a great pile of Gottschalk's music and, continuing to talk, ran through

> *looking at it, seeing it, and trying to realize what's there in sound. That's the only way it comes to life. If you're reading something you studied before, how can you bring it to life?* […] *That's the point with contemporary music: you don't want to memorize it, because if you do, you'll be missing something, because you're creating it. And you have to give the music the chance to speak. So if something occurs to you, at the moment when you're doing it, you don't want to be encumbered by something you remember.*[160]

Difficult passages and fingerings may be memorized in advance, perhaps even worked out on a separate piece of paper, but once they were technically internalized—which is to say, the physical coordination established—the score would be there to serve as a reminder:

> *When I played it, I only had to be reminded. So I saw my realization in the back of my mind. But I wasn't encumbered by having to look at it.* […] *I had respect for what was printed on the page.*[161]

The realization scores Tudor created were in this way external preparations made to prevent internal preparations. Tudor needed a map to maneuver himself through the performance without memorizing his path in advance. As a performer he would go through it no matter what, one way or the other. So the score in front of him was another set of material that biased his trajectory from the outside. He just had to take a glance at it.

Nevertheless, what he remembered in August 1992 was how his wish to keep the score "as clean as a whistle" reached a limit with *34'46.776" for a Pianist*, which also happened to be called the "Whistle Piece":

> *What marks I do have in the score are directions to myself. Like my score of the whistle piece. It's full of directions; it's what to do, when. The notation is so complicated. You cannot see it at a glance.*[162]

The interactive map fragments of *For Pianist* five years later signaled a further limit of possibilities. It was as if Tudor was bringing out the templates and flexible rulers he had designed to navigate himself through the composers' materials directly into the performance space; he was taking measurements in real time to find his way out of the labyrinth. Like the movable materials of preparation in the "Whistle Piece," the movable maps thus became yet another set of instruments the pianist's body had to coordinate with during the performance, alongside the keys

piece after piece without missing a note" (Harold C. Schonberg, "The Far-out Pianist," *Harper's Magazine* [June 1960], 50).

[160] Holzaepfel, "Reminiscences of a Twentieth Century Pianist," 633.
[161] Ibid., 634.
[162] Ibid., 633.

of the piano. The score was no longer something to be merely looked at. The nature of its bias was becoming increasingly more physical.

6

Following its premiere at the Staatliche Hochschule für Musik in Cologne on October 28, 1959, *For Pianist* stayed in Tudor's repertoire for four years until its last performance at Goddard College in Plainfield, Virginia on December 11, 1963. When he talked with Holzaepfel three decades later, Tudor reflected on Wolff's challenge with a typically concise wording: "The piece was terribly frustrating. But the music was beautiful."[163] He had used the same adjective once before in May 1972 to describe the special character of Wolff's music to Schonfield:

> *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. Right from the beginning they had a very individual cast, and I don't know of a single one he's written that wasn't very beautiful.*[164]

Wolff did not compose music—did not express a composite view. Instead, he composed cues, partial conditions that biased the performer to varying degrees while performing. Talking with Bernas in March 2015, Wolff himself explained his distinct approach to indeterminacy as being connected to the nature of "live performance":

> *Why not introduce this notion of indeterminacy in the actual process of performance, rather than in the compositional process?* […] *One characteristic of live performance, and not recording, is that they are always different. Two pianists playing the same Beethoven sonata, the timings would be different, the phrasings would be different.* […] *Never mind all other kinds of contingent issues, the quality of the piano, the acoustics of the space, the mood of the audience, the mood of the pianist, just the simple fact that playing piece live, once and then again, there will always be some slippage between the score and what is actually presented to hear.* […] *I as it were took that notion, that performance is always different, and ran with it, so to speak.*[165]

Performances are always different because there is always some slippage in the coordination of materials. No matter how determinate all the materials may be, indeterminacy remains due to the simple fact that most coordination—both internal and external to an instrument—is actualized only during performance. The composer arranges the materials so that any realization is biased to varying extents. But bias

[163] Ibid., 636.
[164] Tudor, "From Piano to Electronics," 26.
[165] Wolff and Bernas, "Prof. Christian Wolff in conversation with Richard Bernas (March 24, 2015)."

only constrains—the specificity of each live performance cannot be completely reduced to the pre-composed universe of possibilities. Wolff's system of cues amplified this condition by un-coordinating *David Tudor*'s usual coordination and biasing the instrument to form new ones on the spot.

7

These observations are far-reaching, for during a workshop he gave at the Mobius Art Center in Boston on September 29, 1985, Tudor would speak about his approach to an electronic instrument in a similar manner:

> *Every time I've had to use the synthesizer, or a synthesizer component, I had something outboard to it that then would change the way it operates. It's mostly because all the considerations of the voltage, you know, where voltage needs to correspond to what the output signal level is—that's all coordinated. And if you manage to uncoordinate that, then you are in a completely different position.*[166]

The resemblance was not by chance. Nine years earlier, in 1976, Tudor had drafted a technical information sheet for a week-long series of performances at the Festival d'Automne à Paris, which was held in late October of that year. He was appearing as part of Composers Inside Electronics (CIE), a group he had co-founded with younger musicians. The six-part program was filled by electronic works composed by him or other members of the group. However, for Program 4, Tudor included one non-electronic work for "piano, percussion and other instruments," to be performed by at least eight performers in two quartets, adding the necessary disclaimer given his group's name: "this is not electronic."[167] The material he selected was by Wolff, a group piece written three years before called *Changing the System*, which still used the system of coordination through sonic cues.

Changing the System was dropped from the final program for one reason or another.[168] When interviewed more than three decades later, neither John Driscoll nor Phil Edelstein, who performed with Tudor as CIE, could recall Wolff's piece being mentioned as a candidate for the Paris concert. But they recalled something else: before naming themselves "Composers Inside Electronics," which they did only starting from that same festival in Paris, they had operated under another name, "Penumbra

[166] Tudor, "Workshop at Mobius Art Center."
[167] "David Tudor Proposal: Preliminary Technical Info," Box 19, Folder 1, David Tudor Papers, GRI.
[168] When I asked why *Changing the Systemd* did not make it onto the final program, Driscoll responded: "It was tricky because what we had to do was to get all of these people assembled at Stony Point before we went, to actually rehearse some of these different pieces, because a number of us had never done any of those works. I would guess we spent about a week almost at Stony Point, sort of rehearsing, getting equipment together, packing equipment, etc., because it was a big operation. [. . .] So just the logistics of getting all of the equipment for all these pieces was huge" (John Driscoll and Phil Edelstein, "Interview by You Nakai (November 19, 2011)," Long Island, NY).

Raincoast," whose repertoire included, following Tudor's suggestion, *Changing the System*. "That became one of the reference pieces," Edelstein traced his memory on November 19, 2011, and speculated in retrospect why they had made an exception for Wolff's material:

> *It was really a school for listening, that was the training ground, to a certain extent. And you know, David was never quite explicit about that as Pauline [Oliveros], or Christian [Wolff] was, but it was there, you had to be able to do it.*[169]

Wolff's music traverses the categories of instruments because, whether using electronics or not, human performers need to learn how to listen—to learn how to bias their listening, in the same way that one would bias an electronic instrument to take in some input and not others. As far as coordination was concerned, there was not much difference between the two.

Back in the summer of 1959, as Tudor worked his way through the labyrinth, he appears to have begun contemplating a similar analogy: if the coordinated feedback between his body and instrument could be un-coordinated, he could also "prepare" that same coordination by inserting physical materials into the loop—just as he had done with the piano in the "Whistle Piece" five years earlier. *David Tudor* could prepare himself as he did his instrument. In fact, by the time Wolff's piece was premiered in late October, he had already done so.

Pieces of Flesh

1

On May 22, 1959, just as Wolff was starting to work on *For Pianist* in the spare time of his army service at Fort Sam Houston in San Antonio, Texas, Sylvano Bussotti sent a large parcel to Stony Point, New York from Florence, Italy. Inside were scores for a new collection of works he called *Five Piano Pieces for David Tudor*. An accompanying letter explained the reasoning behind the title:

> *By the title "piano piece for David Tudor," given to five compositions of this cycle (one of them still lacking), I did not intend a dedicacy* [sic] *or an exterior "hommage"; but I consider you rather as an instrumental means, just as I could call another work "piece for big orchestra." I allow myself to think of you not as of somebody playing the piano, and as you aren't the piano, I see you between as a sort of Minotaurus of the pianistical mythology.*[170]

[169] Ibid.
[170] Sylvano Bussotti, "Letter to David Tudor (May 22, 1959)," Box 51, Folder 8, David Tudor Papers, GRI.

Instead of being the pianist drawn into a well-composed labyrinth, Tudor was now the monster dwelling inside, although the difference may have mattered little given that the complex meandering routes were originally designed to prevent the Minotaur from getting out. But Bussotti may have not been thinking about labyrinths at all. The twenty-eight-year-old Italian composer had met Tudor and Cage a year before at the International Summer Courses for New Music in Darmstadt. And like so many other participants that year who attended Tudor's concerts (with Cage at the other piano) or Cage's lectures (with Tudor at the piano) during their two weeks stay, Bussotti was strongly inspired by what the Americans had brought across the Atlantic: the idea of indeterminacy, the graphic scores, the theatrical performances, the virtuosity of David Tudor.[171]

The Italian composer, however, was not at all interested in the denial of personal expression Cage preached. Quite to the contrary, he applied whatever method he learned to compose music filled with subjectivity and intimacy. Indeterminate graphic notation became "an attempt to avoid the mediation of 'composition,' to achieve a direct communication of the composer's being to and through the interpreter."[172] Similarly, in Bussotti's hands, Cagean theater was transformed into a "Theater of Eros," which he spiced up "with the added inspiration of [Antonin] Artaud's 'theater of cruelty.' "[173] In Erik Ulman's summary, "the intention was fundamentally magical and egocentric."[174]

Having been mesmerized by Tudor's extraordinary piano playing, Bussotti decided to extract several piano works from the extravagant song-cycle *Pièces de Chair II* [Pieces of Flesh] he was working on at the time and group them separately as pieces for *David Tudor*, the instrument. The *Five Piano Pieces for David Tudor*—which actually ended up being seven—were written using a variety of notational styles following "a continuous scale from known notation to the unknown." *Piece* 2 and *5* are for the most part conventional, whereas *Piece 1*, *3*, and *4* use new forms of graphic notation that have made this work famous. As David Gutkin observed, the basic procedure for obtaining the graphics in all three pieces consisted in the distortion of the standard staff.[175]

171 After arriving to Darmstadt on September 2, Tudor and Cage performed and lectured almost every day except for the weekend: September 3, Cage and Tudor, Concert for Two Pianos; September 5, Cage and Tudor, Lecture: "Changes"; September 8, Cage and Tudor, Lecture: "Indeterminacy"; September 9, Cage and Tudor, Lecture: "Communication"; September 10, Tudor, Kompositionsstudio (Tudor played Franco Evangelisti's *Proiezioni Sonore*, and Bo Nilsson's *Bewegungen*); September 11, Tudor, Zweites Kammerkonzert (joining the Domaine Musical performance of Brown's *Pentathis for Nine Solo Instruments* conducted by Bruno Maderna); September 12/13 Tudor, Kompositionsstudio (same program as September 10). On September 10, Tudor wrote home to his then-partner M. C. Richards: "people are very friendly, tho general opinion is we're a bit crazy" (David Tudor, "Letter to M. C. Richards (September 10, 1958)," Box 26, Folder 2, Mary Caroline Richards Paper, GRI).

172 Eric Ulman, "The Music of Sylvano Bussotti," *Perspectives of New Music* 34 no. 2 (Summer 1996), 192.

173 Ibid., 189.

174 Ibid., 192.

175 David Gutkin, "Drastic or Plastic?," 268. "Bussotti plays with the emerging conceptual tension between notation as self-effacing code or graphically autonomous presence primarily through manipulations of the most conventional signifier of musical time: the staff." However, Gutkin's subsequent analysis of *Piece 1* strangely leaves out everything about "battuto muto" and the nature of the score as a finger tablature.

The package Tudor received also contained Bussotti's descriptions of each score in Italian, although the composer specifically told his instrument to only skim through them. He was more interested in whatever bias Tudor would impose on the material than the other way around:

> *The explanatory notes, which I unfortunately can send you only in Italian, are not yet to be considered as definitive. I hope you can have them translated by somebody.* [...] *I should be glad to know that you glance only once and with one single eye over these notes, because everything you will discover yourself when studying the musical notation will be more interesting for me, and more important for my further work.*[176]

The instrument appears to have happily followed these words.

2

Piece 1 is composed of three systems, each starting from a number, and each with a fixed duration of 30 seconds, 15 seconds, and 45 seconds (Figure 1.11). Five or fewer lines proceed in parallel or diverge in different directions, merging with other groups or running by themselves, some returning back to the original cluster. The notation is relatively straightforward: the five stave lines are not used as indicators of pitch, but are mapped onto the five fingers of each hand indicated as "MD" (*mano destra* = right hand) or "MS" (*mano sinistra* = left hand). The small white circles placed on each line is a key attack. The letter "U" indicates the use of fingernail (*unghia*). The instruction placed in parentheses beneath the title reads: "Tutto nell'orbita del pp, sempre [Everything in the orbit of pp, always]."[177] Bussotti's explanatory notes clarified what this means: Tudor is to play "battuto muto [mute beat]," hitting the keyboard or the lid with his fingertip or fingernail without actually depressing the keys.[178] Instead of coordinating with the internal mechanism, Tudor now coordinated solely with the interface of the instrument. The score was essentially a tablature for fingers, choreographing their movement as they mimed the very act of piano playing.

Appropriately for a piece taken out from *Pieces of Flesh*, Bussotti thought of this as a sensual exercise, involving an extreme development of "the sensitivity of touch in all its imaginable applications."[179] The result, he described, was "a constantly varied rhythm." Other than the faint rhythm of fingers tapping keys, audible sounds were only to occur either by accident or at the black notes where pitch-class and octave register were specified with an alphabet and a number. These black notes are inscribed on a line, whereas the white circles are always in-between lines.

176 Bussotti, "Letter to David Tudor (May 22, 1959)."
177 Tudor's copy of the score is found in Box 174, Folder 2 and 3, David Tudor Papers, GRI.
178 Sylvano Bussotti, "Explanatory Notes for *Pieces de Chair II*, Page 8," Box 174, Folder 3, David Tudor Papers, GRI.
179 Ibid.

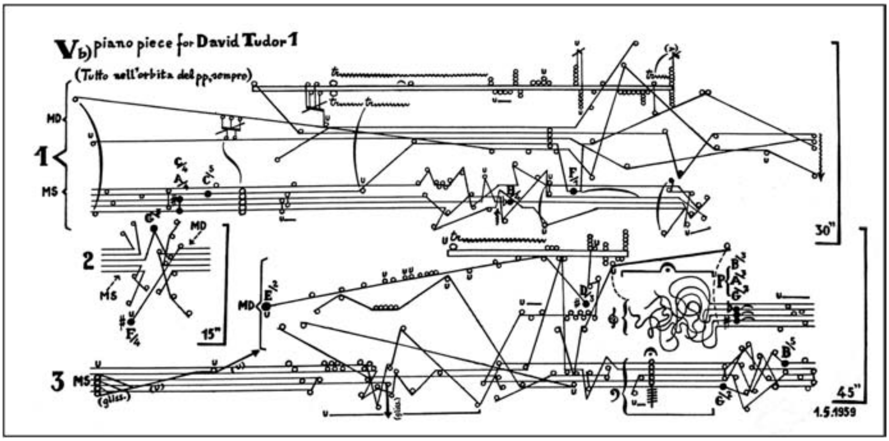


Figure 1.11 Sylvano Bussotti | *Piano Piece for David Tudor 1* | 1959
DTP, (Box 174, Folder 2 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

Tudor transcribed Bussotti's graphic score for *Piece 1* across nine pages with a four-stave system composed by cutting a ten-stave music in half (Figure 1.12).[180] This turns out to be puzzling material. Although the four staves are connected, there are no clefs to indicate pitch register. However, the large black notes correspond to the black notes in Bussotti's score, each of which cued Tudor to depress a key and produce a sound of a specific pitch-class and octave register. So the position of these notes can be used to reveal the identity of the clefs, which are found to be treble 8va, treble, bass, and bass 8vb (from top to bottom). The numbers written above the bar line, starting from .10 and moving in increments of .10, indicate that each page accommodated ten seconds of material. The nine pages therefore add up to 90 seconds, corresponding to the total duration of the three systems composing *Piece 1*.

However, Tudor did not follow such rigid space-time coordination in dividing Bussotti's material across the nine pages, nor in writing down the divided material on each page. He moves some notes or group of notes up or down quite freely. But since the white circles for finger tapping and small black circles for fingernails in his realization score resemble the general placement of circles and lines in the graphic score, the two materials appear to coordinate well, especially if "you glance only once and with one single eye."

Besides this loose coordination is another coordination of a more formal kind: Tudor also assigned his right hand to the upper two staves and left hand to the lower two. How material is distributed between the two hands in Bussotti's graphic score completely matches how they are distributed between the upper and lower

180 Tudor, "Realization score of *Five Piano Piece for David Tudor Piece 1*," Box 174, Folder 2, David Tudor Papers, GRI.

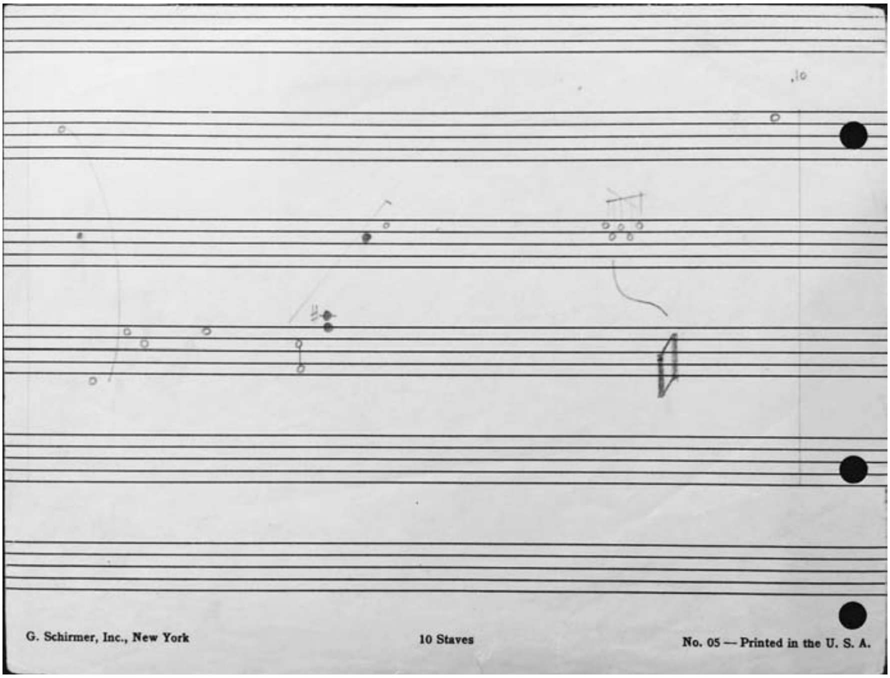


Figure 1.12 Tudor | *Piano Piece for David Tudor 1,* realization score (first page) | 1959
DTP, (Box 174, Folder 2 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

pair of staves in Tudor's realization score. When a note to be played by one hand was located pitch-wise in the other stave, he extended a slanted half bracket from the appropriate stave to indicate this fact.

But these similarities occult a fundamental difference between the two scores: *Tudor's five lines are staves indicating pitch height, not the five fingers of his hands*. As all the notes besides the black ones with specific pitch and several trills are Five notated between the lines, there is a chance that Tudor may have assigned the notes on the lines to his fingers for the most part. But this causes three slippages in the coordination of materials: (a) the mismatch between two forms of notation (stave for black notes, finger tablature for all others); (b) the mismatch between the number of lines and fingers resulting from assigning two staves to each hand; and (c) the mismatch between the actual position of notes in the two scores.

The last problem—the loose coordination of where the notes are placed—turns out to be the most serious, as the specific transpositions Tudor makes throughout his realization—for instance, changing the first group of white circles assigned to his left hand from 5-1-3-2 to 5-1-2-1—appear inexplicable unless they are seen as attempts to accommodate the choreography of fingers to actual pitch: from 5-1-3-2 to F3-G4-E4-G4. But in that case, what is puzzling is what Tudor did not write down: *fingerings* of any sort. All in all, the Minotaur who was told to only glance over the notes with one eye appears to have set the coordination with Bussotti's material loose enough so that he could determine which pitch to play and with which hand, even at the expense of ignoring the question of which fingers, the very question that had been central to the composer.

3

The material for *Piece 3* consists of around one hundred hand-drawn pseudo-parallel horizontal lines that at times merge, bifurcate, or are interrupted by figures of various kinds—diagonal lines, large slurs, arcs composed of small black triangles, arrows, blank spaces, points and dots of different sizes (Figure 1.13). According to Bussotti's explanatory notes, the vertical axis indicates frequency, and the horizontal indicates time in some unspecified duration, while the lines are to be mapped onto the keys of the piano (though with some indeterminacy: "the number of lines is greater than the number of keys and less than the number of strings corresponding to the keys").[181] The appearance of this score is reminiscent of *November 1952* where Brown had filled up the space between rows of staves with additional lines, hoping for potential

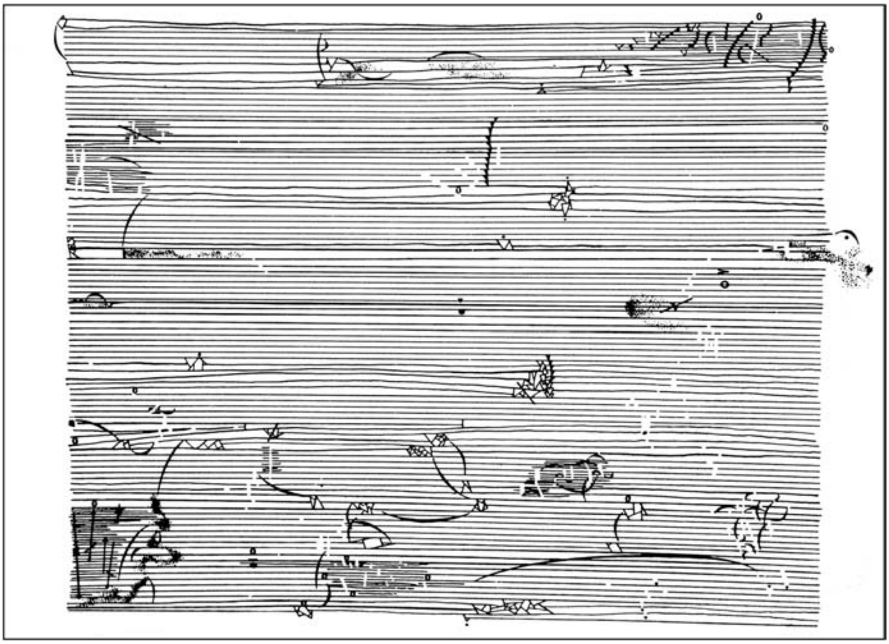


Figure 1.13. Sylvano Bussotti | *Piano Piece for David Tudor 3* | 1959
DTP, Box 174, Folder 2 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

[181] Bussotti, "Explanatory Notes, page 9."

synergy. Indeed, Tudor had noted this likeness during the same 1959 Darmstadt lecture by Stockhausen, where he revealed sticking Brown's score in his drawer for years. But the similarity was only pointed out to make the differences clear. When Tudor disapproved graphics where the sound object was specified, he was making a comparison with the nature of *Piece 3*: "In contradistinction to this is Bussotti's graphic, the condition of a graphic still prior to the stage of the specification of a sound object."[182]

However, when he was given full control over the specification of sound objects, Tudor exercised his powers only loosely. As with *Piece 1*, he wrote out his realization on four staves with the same clef designations from treble 8va to bass 8vb.[183] Following the suggestion in the explanatory notes that "materialization of sound events […] occurs every time the eye sees a figure that breaks, interrupts, covers, deviates, and contradicts the normal flow of lines,"[184] Tudor started from the left end of Bussotti's score and transcribed any graphic event disrupting the lines as a sound event. Diagonal line structures were mostly interpreted as glissando, black triangle arcs as sweeping across the piano strings, and blank spaces as rubbing or tapping the strings. Although the height of each line corresponded to frequency, the irregular nature of the handwritten lines prevented them from serving as neutral measuring templates; they instead also became material to be measured: "These irregularities introduce a flexible element in the act of measurement where each line will be open to different interpretations of frequency, with more than one line attributed to the same frequency."[185]

Perhaps because of this degree of material bias in the staves themselves, in *Piece 3* Tudor loosened coordination in the horizontal axis of time as well. The spatial position of a graphic event in Bussotti's score matches only relatively to the point of occurrence of a sound event in Tudor's realization score. Moreover, following the mention of "cammini a ritroso del tempo [returning paths of time]" in the explanatory notes, Tudor used ligatures to transport his reading from one point in time to another, sometimes moving backward in Bussotti's graphic score to pick up some event he left out the first time around.[186] "Time will therefore not flow regularly," the composer had explained.[187] Reflecting this nature, unlike the realization score of *Piece 1*, or any other piece until then for that matter, Tudor's score for *Piece 3* carries no indication of how much time is assigned to each page, or whether all the pages are assigned the same duration.[188]

This change concerning how time is notated on paper is reflected in a change concerning how time is dealt in performance. Among the collection of tapes he owned that are now archived as part of the David Tudor Papers at GRI is an undated (though probably

[182] Lecture 4, quoted in Gutkin, "Drastic or Plastic?," 296.
[183] Tudor, "Realization score of *Five Piano Piece for David Tudor Piece 3*," Box 174, Folder 2, David Tudor Papers, GRI.
[184] Bussotti, "Explanatory Notes, page 9."
[185] Ibid.
[186] For instance, page 3 of the realization score returns back to the left end of the graphic score, transcribing the events in the range of G4 to E7.
[187] Bussotti, "Explanatory Notes, page 9."
[188] Pedal markings are inscribed throughout the 16 pages and Tudor leaves ample space for resonance to reflect the dust-like dots in the material.

from the early 1960s) recording of Tudor performing all the five Bussotti pieces consecutively, following their numerical order.[189] This material reveals that Tudor's performance coordinated with his realization score in terms of notes, but not in terms of speed. Even in *Piece 1*, where Tudor appeared to have assigned ten seconds to each page of his realization score, the duration of each system did not follow Bussotti's specifications: the third system, which is supposed to last 45 seconds, actually takes almost 90 seconds. In *Piece 3* the gap between the score and performance is even wider, fluctuating between a minimum of ten seconds per page (page 14) and a maximum of one minute (page 1). Space-time notation, the coordination between the spatial length on paper and temporal duration in clock time that grew out of Tudor's effort to solve the puzzle of multiple temporalities in *Music of Changes* a decade before, was virtually abandoned.

4

But the most significant decision Tudor made for his realization of *Piece 3* was not written anywhere in his score. Like in the "Whistle Piece," he prepared the instrument, although this time the specified instrument was not the piano but himself: *David Tudor* played the piano wearing gloves (Figure 1.14). In a review published in the *New York World-Telegram and Sun* on April 5, 1960, writer Ed Wallace described Tudor's recital at the Living Theatre from a week before, which included the US premiere of Bussotti's *Five Pieces*.[190] The concert had "scared the daylight out of" some learned critics as "Mr. Tudor hit them with music so progressive that it can't be written on a five line staff."[191] Wallace depicted the performance as a fight between the pianist and the piano which at one point even saw a black key come off the instrument and leap through the air "like a tiddly wink." At another point, "our boy put on heavy work gloves (yellow ones), went inside the old box and made extensive and noisy revision." When interviewed after the concert, Tudor had explained the use of this auxiliary material as a sensual but practical concern: "The gloves leave me free, inside. [. . .] I have greater mobility—and I'm less likely to hurt my hands."[192]

[189] Tudor, "*Five Piano Pieces for David Tudor* (undated)," Box 13A, R49, David Tudor Papers, GRI.

[190] After premiering three of the *Five Pieces* (*Pieces 2*, *3*, and *5*) on August 29 at Darmstadt during Stockhausen's lecture, Tudor performed the same three pieces on six different concerts across Europe before returning to New York in early December. On March 28 of the following year, he presented the US premiere of the *Five Pieces* at the Living Theatre in New York City where all the five pieces were performed for the first time. The concerts in Europe where the *Five Pieces* were performed are as follows: October 28, Studiokonzert at Sttatliche Hochschule für Musik in Cologne (according to the program note, Tudor performed *Pieces 2*, *3*, and *4* on this occasion. This anomaly was probably due to the fact that for this concert, the Bussotti piece was billed and performed as an excerpt from *Pieces de Chair II*, with other pieces from the collection performed by or with Bariton William Pearson and Siegfried Rockstroh playing percussion (Hochschule für Musik Köln, "Program, Studiokonzert [October 28, 1959]," Box 71, Folder 12, David Tudor Papers, GRI); November 11, Ridotto Teatro Eliseo, Rome; November 12, Conservatorio B. Marcello, Venice; November 14, Centro d'arte, University of Padova; Internationale Gesellschaft für Neue Musik, Mozartsaal, Vienna; November 20, Die Reihe III: Musikalische Jugend Oesterreichs Internationale Gesellschaft für Neue Musik, Vienna.

[191] Ed Wallace, "War on the Keys: Above Ground Test Deactivates Piano," *New York World-Telegram and Sun*, Tuesday, April 5, 1960 (Box 63, Folder 2, David Tudor Papers, GRI).

[192] Ibid.

Figure 1.14 Tudor performing (or rehearsing) *Piano Piece for David Tudor 3* wearing gloves | Mary Bauermeister's Atelier, Cologne | June 16, 1960
Photo: Manfred Leve | Klüver/Martin Archive |

But in May 1993, Kurt Schwertsik remembered hearing another explanation during the 1959 Summer Courses in Darmstadt: "For the Bussotti piano pieces he played one of them with gloves, and when someone asked him why, he answered, 'to obtain a sufficient degree of uncertainty [Um einen genügenden Grad der Unsicherheit zu gewährleisten.]' [*laughter*]"[193] Uncertainty—indeterminacy—was no longer only composed by writing signs on paper. It was also, and more so, composed as a feature of the instrument by Tudor, inserting physical materials in the feedback loop between himself and the piano to bias and disrupt habitual forms of coordination. And obviously, the more he did so, the more he moved away from his own established approach to the instrument based on a precise remote-control of its escapement mechanism.

Bussotti's desire to bypass "the mediation of 'composition' " and attain immediacy was coordinated to his view of *David Tudor* as an instrument. In the absence of an instrumentalist playing the instrument, the instrument that plays itself was given a blank cheque. The focus on *David Tudor* placed the authority of the composed score out of focus—explanatory notes were to be read with one eye only, coordination did not need to be precise. Any resulting performance could now be regarded as revealing

193 "Gespräch III: Kurt Schwertsik (19. Mai 1993)," in Markus Grassl and Reinhard Kapp, *Darmstadt-Gespräche: Die internationalen Ferienkurse für Neue Musik in Wien* (Wien, Austria: Böhlau, 1996), 48.

the nature of the instrument. And the instrument himself appreciated all this, as he told Wallace in spring 1960: "Two years ago I met a young composer in Germany who wrote five pieces for me. In this work, called 'Pieces of Flesh,' he tried to leave me as free as he could."[194] But freedom from one kind of material simply moved the focus onto other materials. The flesh was not as immediate as the composer made it sound.

Affective Athleticism

1

One day toward the end of May 1959, as he read Bussotti's letter that arrived in the big parcel, *David Tudor* was reminded about a book he had first read some nine years before. It was a reading that had caused "a definitive breaking point" in his approach to the piano. On August 6, 1995, as he sat down with Vees for one of the last interviews of his life, Tudor tried to recall what he had recalled thirty-six years before:

> *When I did the* Five Piano Pieces*, Artaud was constantly in my mind,* [. . .] *because of what Bussotti told me, I think it was in a letter,* [. . .] *that he was writing the piece for* David Tudor *the instrument. And that immediately told me what the work was about. Somewhere, in some other article, I explained why I had chosen to perform one of the pieces mute style, so I was just, as it were, tapping the keys instead of [pressing them]—and the idea was strictly due to Artaud, because it had to do with a physical representation of the music through non-articulation, and* [. . .] *part of my technique was robotics.*[195]

The mentioned article, if it exists, has not been found. But this recollection reveals what Tudor realized back in 1959: the designation of "David Tudor" as an instrument set him to think about Antonin Artaud, the French playwright and actor who had also been a major influence on Bussotti's "Theater of Eros." Artaud's book *Le Théâtre et son double* had been translated into English as *The Theatre and Its Double* by the poet M. C. Richards just a year before. She had first obtained a copy of the original French publication from her partner, who happened to be none other than David Tudor.[196]

In a letter written on April 1, 1997, Richards reminisced the encounter which happened by accident almost:

> *Knowing I was an admirer of Jean-Louis Barrault, David had given me Barrault's* Reflections on the Theater. *I was surprised to come upon his glowing chapter on Artaud, of whom I had never heard. He said that if he were going to give a survey course*

[194] Wallace, "War on the Keys: Above Ground Test Deactivates Piano."
[195] Tudor, "Interview by Jack Vees (August 6, 1995), 241 e," *Oral History of American Music*, Yale University Library, 28.
[196] Antonin Artaud, *The Theatre and Its Double*, translated by M. C. Richards (New York, NY: Grove Press, 1958).

on the history of dramatic criticism, it would include Aristotle, Horace, Sydney, Corneille, Craig, and Artaud. Artaud, he said, was the most important voice in this century. I was shocked + intrigued since, as I say, I had never heard of him— + had taught "the history of dramatic criticism." I mentioned to David at supper that night how strucked [sic] *I was by what I had read in Barrault's book. David asked me if I would like to see a copy of* Le Theatre et Son Double [sic] *(which Barrault had cited as the most important work). He then went to the back of our railroad apartment, + returned with a typed manuscript of the work.* [. . .] *He apologized for having omitted the accent marks. I was bowled over by the amazing coincidence, + began at once to read the manuscript.*[197]

How Tudor came across the writings of Artaud is one of the most famous stories about him. In the fall of 1950, as he worked on a difficult piano sonata that Cage had brought back from Paris earlier that year, Tudor began to realize a strange fact. The score written by the young French composer somehow wreaked havoc on his well-known ability to handle complex notation. His training "as a musician of precision" was failing. The problem concerned continuity, as Tudor looked back in May 1972:

I found a sort of constant breakdown in the continuity. [. . .] *Boulez had written no counterpoints, no second voices, and you couldn't subordinate any voices at all, as there was nothing leading, nothing on which the music centered itself.*[198]

According to another recollection on October 4, 1982, it was not that the piece was technically too difficult: "I could play everything, but I had to stop every two measures. I couldn't put it together."[199] But with the material presenting no continuity of its own, the solution had to be brought in from somewhere else. The question was where.

I had three months to study the piece, and after two months I became vitally concerned that it would be full of lapses and holes, and I would somehow have to supply enough energy to let the thing continue . . .[200]

With less than a month left for the concert, Tudor desperately looked around for any other material that could help him coordinate with the piece. One day, as he read through a French article that Boulez had written in 1948,[201] Tudor's eye caught a passage toward the end in which the composer brought up an particular author as the model for his approach: "I have a personal reason for giving such an important place to the phenomenon of rhythm. I think that music should be collective hysteria and magic, violently modern—along the lines of Antonin Artaud . . ."[202]

197 M. C. Richards, "Letter to *MusikTexte* (April 1, 1997)," Box 67, Folder 7, David Tudor Papers, GRI.
198 Tudor, "From Piano to Electronics," 24.
199 Clarkson, "Composing the Performer," 31.
200 Tudor, "From Piano to Electronics," 24.
201 This was Boulez's first published article: "Propositions," *Polyphonie 2* (1948), 65–72.
202 Pierre Boulez, *Stocktakings from an Apprenticeship* (New York, NY: Oxford University Press, 1991), 54; quoted in Holzaepfel, "David Tudor and the Performance of American Experimental Music," 32.

Tudor had most likely never heard that name before. But he rushed to obtain a copy of *Le Théâtre et son double*, Artaud's major treatise on theater from 1938. Then he took his French dictionary out and began reading in the earnest.[203] The text worked quite literally like magic, as he told Clarkson in October 1982.

> *I read a lot of Artaud and I began to understand the intention of the musical continuity.* [. . .] *I realized I was now in a different situation, in the presence of a different type of musical continuity than I was used to, and all of a sudden I was able to play it.*[204]

2

But like magic, the actual mechanism producing the effect may be occulted behind a decoy, a deceptive appearance that captures the viewer's attention. For Artaud, the "text" was just such a lure as far as theater was concerned. That was why he called for the emancipation of theater from both written and spoken texts in his 1938 book. The nature of his art form was not in dialogue and psychology, which belonged more appropriately in books; it was rather in the physicality of the stage: "the stage is a concrete physical place which asks to be filled, and to be given its own concrete language to speak."[205] To do so, Artaud regarded the "language of the *mise en scène* as the pure theatrical language," which he proceeded to describe as being magical:

> *It is in the light of magic and sorcery that the mise en scène must be considered, not as the reflection of a written text, the mere projection of physical doubles that is derived from the written work, but as the burning projection of all the objective consequences of a gesture, word, sound, music, and their combinations. This active projection can be made only upon the stage and its consequences found in the presence of and upon the stage; and the author who uses written words only has nothing to do with the theater and must give way to specialists in its objective and animated sorcery.*[206]

Eric Smigel and Holzaepfel have both analyzed just what sort of magic Tudor realized through his reading of Artaud. They reached similar conclusions. According to Smigel's observation in his 2004 dissertation, the pianist took the theater director's call for the projection of physical materials on stage and applied it to his own material—by which the scholar meant sound: "The most crucial correlation between Artaud's notion of theater

[203] In her letter of April 1, 1997, M. C. Richards told a slightly different recollection of the encounter: "David had borrowed the book [*Le Théâtre et son double*] from a dancer who brought it from France. While working on the Boulez sonata, he had asked Pierre what he had been preoccupied with during the period of its composition. Boulez responded (by letter) that he was reading Mallarme's "Coup de Dés" and Artaud's *Le Theatre et Son Double* [*sic*]. What a wonderful story, + how characteristic of David to be so thorough in his musical approach" (M. C. Richards, "Letter to *MusikTexte*"). This letter from Boulez, if it exists, has not been found.

[204] Holzaepfel, "David Tudor and the Performance of American Experimental Music," 24.

[205] Antonin Artaud, *The Theatre and Its Double*, 37.

[206] Ibid., 73.

and Tudor's new perception of musical continuity concerns the objectification of the materials. […] One must conceive of sound as a discrete physical object, an occupant of both space and time."[207] Holzaepfel also understood Tudor's sudden acquisition of necessary skills in more or less the same way in his 1994 dissertation: "The purpose of this 'purposeful aesthetic violence' was to disrupt musical continuity—musical syntaxes, in other words—so that the life of the music is in each moment rather than in the connections between them. This, I believe, is what Tudor meant by 'a change in musical perception.' "[208]

In both readings, the lesson of Artaud is taken as a matter of translating his aesthetics of theater to the domain of music. Apparently, that triggered a sudden change in Tudor's perception of musical continuity. But this would be very strange, for such a process is *primarily psychological and guided by the text*—which is to say, something that belonged more appropriately in books, as far as Artaud was concerned. That the mere affirmation of no-continuity suddenly transformed how Tudor perceived music still sounds too magical. The "constant breakdown in the continuity" was the problem to be solved and not the solution.

What appears to have cast a spell on these readings is another series of texts. Under the influence of Tudor, Cage had also started reading *Le Théâtre et son double* in 1951 while composing *Music of Changes*. And he was, as usual, quite eloquent about what he thought. Already on May 22 of that year, Cage wrote a letter to Boulez, where he coordinated what he was reading with what he was composing:

> *I have been reading a great deal of Artaud (because of you and through Tudor who read Artaud because of you.) I will soon send you a copy of the first part of the piano piece. The essential underlying idea is that each thing is itself, that its relations with other things spring up naturally rather than being imposed by any abstraction on an "artist's" part (see Artaud on an objective synthesis).*[209]

Cage thus read in Artaud an idea which he then wrote about and told many others: the materials of music—sounds—can be treated like physical objects, as separate entities which coexist on stage without any need to compose their relationship or place them

[207] Eric Smigel, "Alchemy of the Avant-garde: David Tudor and the New Music of the 1950s," PhD dissertation, University of Southern California, 2003, 45–46.

[208] Holzaepfel, "David Tudor and the Performance of American Experimental Music," 36.

[209] John Cage, "Letter to Boulez, May 22, 1951," in Cage and Boulez, *The Boulez-Cage Correspondence*, edited by Jean-Jacques Nattiez and Robert Samuels (Cambridge, UK: Cambridge University Press, 1993), 96. The reference to "objective synthesis" is puzzling, since this term never appears in *The Theatre and Its Double*. The only place I have been able to locate Artaud using this wording is in a short treatise written in 1927, which is about neither theater nor music, but motion picture: "Cinema exalts matter and reveals it to us in its profound spirituality, in its relations with the spirit from which it has emerged. Images are born, are derived from one another purely as images, impose an objective synthesis more penetrating than any abstraction, create worlds which ask nothing of anyone or anything" (Antonin Artaud, "Cinema and Reality," in *Antonin Artaud: Selected Writings*, ed. Susan Sontag (Berkeley: University of California Press, 1988), 152). It is possible to interpret this passage as Artaud transferring his basic ideas on theater to the moving images. Thus, it praises the pure generation of images, the very material of cinema, over its subjugation to abstraction, which is to say the text. Read in this way, the term "objective synthesis" can also be fed back to the discussion of theater and stage. However, even in that case, it is necessary to consider what provides the "synthesis." A mere projection of disparate objects might be considered objective but that would not entail any synthesis. Cage assumed this to happen "naturally" on the level of each audience member whose ears had attained unbiased neutrality.

in a common narrative.[210] As Smigel observed, this aesthetic coordinated nicely with the method of chance operations the composer was beginning to use at the time.[211] Following the completion of *Music of Changes*, Cage would organize the theatrical event at Black Mountain College in the summer of 1952, by expanding (or returning) the method of objective synthesis from sounds to the coexistence of disparate activities in a dining hall.[212] In other words, the composer read Artaud primarily as a theater director.

3

Cage credited Tudor as having jointly conceived the *Black Mountain College Event*. Nevertheless, it appears that the pianist read Artaud quite differently than the composer. Indeed, during the interview with Clarkson on October 4, 1982, he had even revealed which specific part of *Le Théâtre et son double* he paid attention to:

> *I went to the library and I got my French dictionary out, and all of a sudden I saw that there was a different way of looking at musical continuity, having to deal with what Artaud called the affective athleticism. It has to do with the disciplines that an actor goes through. So all of a sudden I found I could play a movement through. It was a real break-through for me, because my musical consciousness in the meantime changed completely.*[213]

"An Affective Athleticism" is the twelfth and virtually last chapter of the book, followed only by two brief appendix-like notes. It is also a surprising conclusion, for Artaud suddenly presents a different approach to his Theater of Cruelty. Unlike the rest of the treatise, written mostly for directors and theorists concerned with the general *mise-en-scène* of theater, the final chapter imagines another kind of audience: *actors*. And because of this, what it describes is a specific technique. Smigel's description of Tudor's reading of Artaud as "dealing with abstract theories" does not apply

[210] "The idea I had from reading [*The Theater and Its Double*] was that all the elements of theatre can be viewed independently one from the other, with none being subordinate to a narrative thread that goes through everything" (Cage, in Geoff Smith and Nicola Walker, *New Voices: American Composers Talk about Their Music* (Portland, OR: Amadeus Press, 1995), 76).

[211] "Cage's reference to 'an objective synthesis' concerns Artaud's description of the 'magic and sorcery' of the mise-en-scène […]. For Cage, the individual elements of the gamut of musical materials—their sonorities, durations, and dynamics—had their 'own intrinsic poetry,' with which the composer did not wish to interfere. Cage thus considered what Tudor would have called 'nature' or 'bias' of materials arranged by chance operations as 'poetry' " (Smigel, "Alchemy of the Avant-garde," 40).

[212] Wolff also had a specific relation to theater, though to a much older theater than Artaud's. As mentioned in footnote 145, the composer taught Classics at Harvard University and Dartmouth College, specializing in the subject matter of Greek tragedy. The focus of the theater he knew was therefore not on putting disparate objects on stage, but rather on doublespeak and miscommunication—characteristics that also happen to be found in his system of sonic cues. In this sense, though Wolff himself was not directly involved, the discrepancies between multiple testimonies and recollections of what exactly happened inside the dining hall of Black Mountain College on that late August day of 1952 point to a theatrical aspect of the same event that resonates more strongly with the kind of music Wolff will be composing several years later than Cage's theory of objective synthesis.

[213] Clarkson, "Composing the Performer," 31.

here.[214] The realization that Tudor paid special focus on this last section of the book is also supported by materials in the archive: the only typed copy of the translation of *The Theatre and Its Double* found among Tudor's papers is that of Chapter XII.[215]

"Affective Athleticism" is a technique that enables actors to locate and train the mechanism of the body that supports the movement of affects. According to Artaud, there was a specific point of focus at the center of it all:

> *This question of breath is in fact primary; it is in inverse proportion to the strength of the external expression. The more sober and restrained the expression, the deeper and heavier the breathing, the more substantial and full of resonances. Similarly an expression that is broad and full and externalized has a corresponding breath in short and broken waves. It is certain that for every feeling, every mental action, every leap of human emotion there is a corresponding breath which is appropriate to it.*[216]

Much like how Tudor would later use the input of an electronic instrument as output and output as input, Artaud reasoned that since breath accompanies all the doings of the body, the coordination could be traced in reverse—everything the body did and felt could be controlled by it. This would allow the actor not only to access the immaterial from the material,[217] but also to go beyond what the mind deemed possible. Like Tudor and composers around him, Artaud turned to the physicality of material to attain the unforeseen: "an actor can arrive by means of breath at a feeling which he does not have."[218] As a corollary, the basis of theatrical time lay in the mechanism of breathing and not of feeling. What mattered was athletics, not aesthetics.

Affective Athleticism thus turned out to be precisely what Tudor was looking for: the art of creating temporal continuity, which instead of being grounded in the psyche of the performer, composed the psyche as an effect of bodily action.[219] As a seasoned occultist, Artaud referred to the Kabbalah to outline a systematic approach to the tempo of breath, categorizing three kinds of temporality: (a) *neuter* or *androgynous*, which was balanced; (b) *masculine*, which was expanding; and (c) *feminine*, which was contracting. The six permutations of these breath types composed the universe of possible control points, with an additional seventh element which was beyond breath and by which the actor could penetrate into all the other breaths: the bloodstream.[220]

[214] Smigel, "Alchemy of the Avant-garde," 22.

[215] David Tudor "Typed copy of *The Theater and Its Double* (Chapter XII)," Box 67, Folder 13, David Tudor Papers, GRI.

[216] Artaud, *The Theater and Its Double*, 134.

[217] "To know that the soul has a corporeal expression permits the actor to unite with this soul from the other side, and to rediscover its being by mathematical analogies" (ibid., 135).

[218] Ibid., 137.

[219] Artaud even compared the temporality of passions controlled by the breath to that of music: "To understand the secret of the passionate time—a kind of musical tempo which regulates their harmonic beat . . ." (ibid., 135).

[220] "the actor carries in himself the principle of that seventh state, of that blood-route by which he penetrates into all the others each time his organs in full power awaken from their sleep" (ibid., 137).

4

It is quite possible that Tudor already knew a thing or two about the coordination between breathing, rhythm, and feeling when he first browsed through the pages of Artaud's book, as this topic appeared frequently in the writings of his beloved author Rudolf Steiner. In anthroposophy, respiratory movement and its frequency were understood as the physical foundation of musical perception of time. "Feeling must be seen as related to that vital rhythm which is centered in, and connected with, the respiratory system," Steiner wrote circa 1917. "The psyche, in experiencing emotion, is supported by the rhythmic process of breathing."[221] His focus was on the rhythmic rising and falling of the cerebrospinal fluid caused by respiration. When breathing out, the fluid in the brain descends through the spinal column to the diaphragm area, as opposed to when breathing in, when the same fluid is pushed back to the brain. The experience of music arises, according to the occult philosopher, when this inner rhythm of respiratory movement coordinated with the perception of tone passed from the inner ear to the brain. To account for the physiological mechanism of the human body, Steiner curiously resorted to the same idea as Dalcroze: "What streams in through the ear as tone, the impressions of sound that live in us, becomes music as it meets the inner music that comes about because our whole organism is a remarkable *musical instrument*."[222] Thus, similar to what Artaud taught, it was the physical nature of this instrument that conditioned the metaphysical experience of music.

Tudor was certainly committed to all this, which Steiner called "the occult basis of music."[223] In an undated draft of a letter addressed to a friend—which Holzaepfel deduced as being written in the summer of 1946 or 1947[224]—the twenty-or-so-year-old pianist had written affectively:

> *For me music exists as a spiritual reality which will continue to exist after every composer and every page of notes and dynamics are destroyed, and every performer must struggle to make the positive facts of this reality audible to a listener.* [...] *Music must be a direct spiritual experience !!*[225]

[221] Rudolf Steiner, "Principles of Psychosomatic Physiology," in *The Case for Anthroposophy: Selections from Von Seelenrätseln* (London, UK: Rudolf Steiner Press, 1970); available online at Rudolf Steiner Archive & e.Lib, accessed December 15, 2019: https://wn.rsarchive.org/Books/GA021/English/RSP1970/GA021_c07.html

For more details and updated study on the anthroposophical understanding of the nature of respiration in connection to the experience of music, see Armin J. Husemann, *Human Hearing and the Reality of Music* (Boston, MA: Anthroposophic Press, 2013), Chapter 3, "The Experience of Music and Its Basis in Physiology."

[222] Rudolf Steiner, "The Effects of Music, and the Human Experience of Tone," in *MUSIC: Mystery, Art and the Human Being* (Forest Row, UK: Rudolf Steiner Press, 2016), 139. Emphasis added.

[223] Rudolf Steiner, *The Inner Nature of Music and the Experience of Tone: The Occult Basis of Music* (New York, NY: Anthroposophic Press, 1982); available online at Rudolf Steiner Archive & e.Lib, accessed December 15, 2018: https://wn.rsarchive.org/Lectures/19061203p01.html

[224] Holzaepfel, "Email to You Nakai," November 16, 2017.

[225] David Tudor, "Undated draft of letter to 'Shirley,'" Box 61, Folder 4, David00b Tudor Papers, GRI.

But the true lesson was, again, how this apparently immediate metaphysical experience was actually mediated by the physical mechanism of the body. The few surviving notes Tudor took from his reading of Artaud indeed all focus on the problem of breath: aside from copying the chart of three temporalities, he wrote out the two fundamental principles of Affective Athleticism: "breath in inverse proportion to external expression / every breath has three kinds of time."[226] By 1959, the lesson had been learned well enough that Tudor could teach it to others. At the Summer Courses in Darmstadt that year where he assisted Stockhausen's lecture on graphic scores and premiered the *Five Piano Pieces* dedicated to him, Tudor also gave five piano seminars of his own. The preparatory notes for these classes, written just around the time Bussotti's letter had reminded him of Artaud, contain a nice summary of Affective Athleticism:

> *discuss body movement / contraction expansion / free—muscular / rhythm only when necessary; watch instead / rhythm connected to bloodstream / not to abolish connection but thru watching instead of body feeling to make new kinds of rhythm / in irregular rhythm no preparation visible in breath / body for rhythm / breath for longer sections.*[227]

5

As Tudor stated quite clearly to Schonfield in May 1972, what was necessary was *not* to come to terms with no-continuity. It was rather to establish a "different type of musical continuity," "another kind of musical continuity"[228] that would make up for the apparent no-continuity in the music Boulez had written. If reading Artaud's book worked like magic, it was because the material that became objectified in Affective Athleticism was never sound, but the actor-pianist himself.[229] By un-coordinating his physical continuity from his psychological continuity, Tudor operated as a machine—as a musical instrument. The freedom gained was the freedom to persist in his own physicality. The change of perception was simply its outcome. Nine years later, Tudor would recall this discovery when one composer regarded him as an instrument.

But several things had happened in the meantime. For instance, while speaking to Julie Martin on January 26, 1992, Tudor gave another reason for his liking Cage's *34'46.776" for a Pianist* which had more to do with himself than with what the music reminded him of "I remember that when we did the piece for Donaueschingen there was a piece for two prepared pianos, and John had this concept called 'auxiliary

[226] David Tudor, "Notes taken from Artaud," Box 111, Folder 23, David Tudor Papers, GRI.
[227] David Tudor, "Notes for Darmstadt Seminar," Box 107, Folder 10, David Tudor Papers, GRI.
[228] Tudor, "From Piano to Electronics," 24.
[229] This also explains, from another angle, why Tudor's realization while working on Boulez's piece led to the pianist's subsequent use of a stopwatch to measure time, which he started using from *Music of Changes*. Affective Athleticism was a training ground for Tudor to use his own physicality as a clock-like instrument to articulate time. "I was *watching* time rather than *experiencing* it. That difference is basic" (Tudor, "From Piano to Electronics," 24).

sounds.' "[230] "Auxiliary sounds" were, as Cage explained in a letter to a Miss Epstein on April 23, 1961, "any sounds produced by means other than those provided by a piano (e.g., percussion instruments, wind produced sounds, mechanical or electrical sounds, etc.)"[231] In other words, it was all the sounds the pianist made using instruments other than the piano. Tudor continued his reminiscence to Martin in January 1992:

> *John said, "well, I have all these whistles, so we should use them." So you know me,* [laughs] *I got involved and I started collecting whistles right and left!* [laughs] *In the end, amongst ourselves, we always called that the "Whistle Piece."* […] *and I just said to John one day, "don't you think that it's a little foolish to be blowing these whistles all the time?" And John said, "I've never minded appearing foolish." And I really appreciated that. In a way I enjoyed feeling like an actor—I've always enjoyed that as a part of the process of performing. Eventually I think all performers get involved in that, can't help it. It was something that my training made me frown upon, but it's something that I began to appreciate and occasionally I would welcome it.*[232]

Tudor thus came to terms with feeling like an actor through the use of auxiliary sounds (Figure 1.15). But what made the sound of whistles "auxiliary," even in a piece nicknamed after the instrument, was the centrality of the piano. If Tudor feared appearing a little foolish blowing whistles it was because of this duplicity in performance: a pianist not playing the piano and doing something else instead. And if he had come to terms with feeling like an actor, it was probably because his exclusive coordination with the instrument was not so exclusive anymore. This relativization of the piano through auxiliary sounds led to two changes: on the one hand, it triggered Tudor to coordinate more and more with other instruments; on the other, it altered the very nature of piano playing, turning the role of the pianist into a role-play.

6

The theatricality of auxiliary sounds indeed became central to the "move towards theatre from music" that Cage began promoting in the mid-1950s, starting with a lecture titled *45' for a Speaker*. This piece was another entry in the *Ten Thousand Things* series he had begun writing in October 1954, immediately after finishing the two prepared piano pieces, and "just in time to catch the boat for Rotterdam with David Tudor."[233] Twelve hours after leaving Manhattan, the ship they were on collided, forcing them to return to New York and take an airplane instead. As a result, "*45' for a Speaker* was written on trains and in hotels and restaurants during the course of a European tour."[234]

230 Tudor, "Interview by Martin."
231 John Cage, "Letter to Miss Epstein (April 23, 1961)," in *The Selected Letters of John Cage*, edited by Laura Kuhn (Middletown, CT: Wesleyan University Press, 2016), 242.
232 Tudor, "Interview by Martin."
233 John Cage, "45' for a Speaker (1954)," in *Silence*, 147.
234 Ibid.

Figure 1.15 Tudor blowing whistles | Mid-1950s
Photographer unknown | Klüver/Martin Archive | All rights reserved

In composing the lecture, Cage used the same rhythmic structure as the "Whistle Piece" to facilitate simultaneous performance—*45′ for a Speaker* was indeed premiered during the same tour at the Composers' Concourse in London while Tudor performed the new prepared piano piece.[235] But he also carried over the idea of auxiliary sounds: "The piano parts had included noises and whistles in addition to piano and prepared piano

[235] A letter from Tudor to M. C. Richards, probably written on October 27, reports: "new lecture for London it's a riot gets read at different speeds tomorrow night we do it for the first time" (Tudor, "Letter to M. C. Richards (October 27, 1954)," Box 26, Folder 1, Mary Caroline Richards Paper, GRI).

tones. For the speaker, I made a list of noises and gestures. By means of chance operations, determining which noise or gesture and when it was to be made, I added these to the text."[236] Cage thus turned his lecture into theater by using the "Whistle Piece" as his model. The term "theatre" indeed makes an appearance in *45′ for a Speaker*, for the very first time in Cage's published writing, following a remark on the prepared piano:

> *Each prepared piano is prepared differently. Objects are placed between the strings and the piano sound, to all these various characteristics, he* [sic] *is transformed with respect to all of its characteristics. Music is an oversimplification of the situation we actually are in. An ear alone is not a being; music is one part of theatre. "Focus" is what aspects one's noticing. Theatre is all the various things going on at the same time. I have noticed that music is liveliest for me when listening for instance doesn't distract me from seeing.*[237]

7

On Tudor's side, however, there was something else going on which was not simply about adding more things on stage for people to see. When Bussotti regarded *David Tudor* as an instrument in 1959, Tudor was reminded of Artaud. On July 19, 1995, as he tried to recall the details of what he was on his mind thirty-six years before, Tudor began talking about an obscure character that the French playwright and actor had created for himself.

> *DT. I think he attributed a lot of his creative ideas to having studied mime.*
> *JV. It was more a physical thing.*
> *DT. Yes, and there was a very interesting part of the book,* The Theater and Its Double*, he often refers to I believe it was an article that he had published that was called* Artaud le Momo. Le Momo *was a name that he performed as a mime. At one point Artaud I believe, worked with a theatrical group and so he had to have a name for himself and so he called himself* Artaud le Momo. […] *He* [Boulez] *said explicitly that he would not discuss aesthetics because he believed that artists should follow the lead coming from Artaud and that was theater and mime, and incidentally dance.*[238]

"Artaud le Momo," otherwise known as "Artaud the Madman," does not appear anywhere in *Theater and Its Double*—neither the character nor the poem Artaud wrote

[236] John Cage, "45′ for a Speaker," 146.
[237] Ibid., 149. The starting point of this move toward theater was identified in retrospect as *Water Music*, which Tudor had premiered on May 2, 1952, using objects that within a couple of years would be categorized under the rubric of "auxiliary sounds": "a radio, whistles, water containers, a deck of cards, a wooden stick, and objects for preparing a piano." Subsequent "theater" works by Cage appears to have been instrumental to Tudor's viewing of the entire space of performance as an instrument.
[238] Tudor, "Interview by Vees," 27–28.

with that title. But the lesson Tudor learned from Artaud's study of mime naturally brings to mind the mute tappings of the keys in the realization of Bussotti's *Five Piano Pieces for David Tudor*, which in the same 1995 interview Tudor indeed called an "idea [. . .] strictly due to Artaud, because it had to do with a physical representation of the music through non-articulation."[239] *Artaud le Momo* thus finds its double in *David Tudor* the instrument, and the former's miming in the latter's robotics—both arts focusing on the performer's body as a physical instrument.

In this way, if auxiliary instruments remained in the periphery of a stage defined by the centrality of the piano, Tudor could drag that periphery into the center by inserting other materials into the feedback loop between his body and the piano. The theater of a pianist doing something other than playing the piano would then turn into a theater of a pianist doing something other *by* playing the piano. Theatrical duplicity would be embedded in the instrument itself: the piano would *act* as if it were no longer the piano. In fact, what ended up changing the nature of Tudor's instrument once and for all involved a strange act of theatrical role-play.

Games with Simple Variations

1

On May 29, 1956, a young Swedish composer wrote a letter to Tudor which he attached to a recent score of his own and mailed to Stony Point, New York: "I take the composition will interest you, and that you will have an opportunity of executing it at your visit to Sweden this summer."[240] The sender was Bo Nilsson, a nineteen-year-old resident of the small mining town of Malmberget, 70 kilometers north of the Arctic Circle. "It's like the furthest north you can get and still be in civilization," was Tudor's much later description to Martin on January 26, 1992.[241] Being geographically located at the periphery of new music led Nilsson to engage in an unusual task: he learned music only through what he heard on the radio. As Tudor recalled amusingly to Martin:

> *After meeting him and talking to him I realized he knew all about music from listening to radio!* [. . .] *The further north you go, the clearer radio reception is. If you live within the arctic circle, you can hear everything, all the broadcast from all over. No, it's the nature of radio transmission.*[242]

Lending his ears to music transmitted from Cologne and elsewhere, the young Nilsson developed a taste for the *effects* of a serial manipulation of materials such as those

[239] Ibid., 28–29.
[240] Bo Nilsson, "Letter to David Tudor (May 29, 1956)," Box 57, Folder 7, David Tudor Papers, GRI.
[241] Tudor, "Interview by Martin."
[242] Ibid.

he heard in Stockhausen's music. From 1955, he began corresponding with Bengt Hambraeus, another Swedish composer and organist who was nine years Nilsson's senior (yet still only twenty-six himself), asking about new music and technical matters of composition. Hambraeus had attended the Summer Courses in Darmstadt from 1951. At the end of his first letter to Tudor, Nilsson proudly reported his opus no. 6 *Frequenzen* would be performed at the same epicenter of new music that year.[243]

2

But the material he sent to Stony Point was something even newer: opus no. 8 *Schlagfiguren*. The score indeed appeared to be a serious serialist piece coming from Cologne or elsewhere. It was divided into four parts, each of which was subdivided into 31 to 36 blocks of varying lengths (from a minimum of half a measure, to a maximum of 11 measures) placed above the notes. Each block was assigned a tempo chosen from 20 available tempi on a scale ranging from 50.0 to 95.0 beats per minute in increments of 2.5 beats. The total serialist in Nilsson also prepared a corresponding scale of 20 degrees for dynamics, starting from 1.0 (pppp) and going up to 10.5 (ffff) in increments of 0.5; he then assigned a specific degree to almost every note he wrote. When performed, the music quickly moved between regions of extremely fast movement and extremely slow movement, interspaced with explosive hits of single notes or chords which were often given ample time to resonate in space.

The fact that Tudor liked Nilsson's material is apparent. But why he liked it—"the sort of virtuoso-ish Darmstadt-y kind of thing,"[244] as Gordon Mumma would later describe—is puzzling. For one thing, the "sound object" appears to have been already specified. Nevertheless, Tudor decided to include the piece in his repertoire for the European tour that winter. When the letter informing the composer about this decision arrived in Sweden on October 31, Nilsson wrote back the same day, informing Tudor that he had already started working on the second piece for the pianist—though the latter was addressed somewhat differently:

> *Dear James Tudor* [sic]*,*
> [. . .]
> *I am going to send You my piano cycles no. II as soon as it is ready. In this work is the tempo constant (60/4 per min.)—and put in its place time-differences with 2:3:4:5: 6:7 :8:9:10:11:12:13:14:15:16.*[245]

[243] Bo Nilsson, "Letter to David Tudor (May 29, 1956)".
[244] Matt Rogalsky, "Telephone Interview with Gordon Mumma (November 3, 1994)," in Rogalsky, "Live Electronic Music Practice and Musicians of the Merce Cunningham Dance Company," MA thesis, Wesleyan University, 1995, 136–137.
[245] Bo Nilsson, "Letter to James Tudor (October 31, 1956)," Box 57, Folder 7, David Tudor Papers, GRI.

Indeed, in the new work *Bewegungen*, which Tudor received shortly afterward, the tempo-block system was replaced by an ever-changing time signature and rhythmic ratios, set against the constant tempo of 60 beats per minute from start to end.

3

Tudor performed *Schlagfiguren* in at least two concerts during the 1956 European tour.[246] On January 26 of the following year, Nilsson heard the pianist's realization of his piece—on the radio as always,[247] this time broadcast from Westdeutscher Rundfunk in Cologne. He was particularly impressed by "the precision in regards to time values and intensities" which happened to be the parameters he started the composition from. Within an hour of the radio program, he was writing again to David Tudor, whose name he got right this time, announcing a third work he planned to compose for him. The teenage composer had decided to set up a more difficult challenge. When he finally completed the material a year later, on March 20, 1958, Nilsson sent Tudor a postcard where he defined freedom in a very different way from Bussotti: "The 'Quanten' [*sic*] specifically has a very wide margin of freedom. For you it simply means: as accurately as possible to the notated symbols."[248]

In *Quantitäten*, as the piece became named in the end, all pitch intervals (extending up to 1:128) were set in inverse proportion to the notated time value (with the maximum span of 1:4). Thus, "the stipulation of the greatest possible velocity applies itself strictly speaking to the lowest tone (C1), towards the top it retards itself up to quadrupled effective duration (C5)."[249] In other words, tempo decreased as the frequency range increased to incorporate higher pitch throughout the twelve systems of the composition irregularly laid out on a single sheet of paper—"contrary," as Art Lange pointed out in 1996, "to the laws of physics where by nature the resonance of lower pitches lasts longer."[250]

In this way, Nilsson's three piano pieces all demanded precise articulation of duration and dynamics on a miniature scale, even to an extreme threshold where the exercise of control entered into conflict with the physical nature of the instrument. As such, they turned out to be challenges tailored to Tudor's most refined ability on the piano: escapement control. But this also happened to be what Tudor himself was doing at the time using other materials—Wolff's system of cues to explore the indeterminacy of coordination; Bussotti's pieces of flesh to modulate the feedback loop between himself and the piano; Cage's custom-made score which led him to compose

[246] One was at the Internationale Gesellschaft für Neue Musik Sektion Oesterreich in Vienna on November 30; the other was at the I. M. A. Concert in London on December 18.

[247] "And hoping we'll meet each other sometime and not just have to exchange greetings by letter" (Bo Nilsson, "Letter to Tudor [January 26, 1957]," Box 57, Folder 7, David Tudor Papers, GRI).

[248] Bo Nilsson, "Postcard to David Tudor (March 20, 1958)," Box 57, Folder 7, David Tudor Papers, GRI.

[249] Tudor, "Translation of instructions for *Quantitäten*," Box 194, Folder 1, David Tudor Papers, GRI.

[250] Art Lange, "Liner Notes," *David Tudor: Piano Avant-Garde 1956–1960*, Hat Hut Records, 6181, 1996, CD.

his own instrument. So despite all appearances, Nilsson's material provided a point of contact. If Tudor welcomed these challenges, it was because coordinated control was never an end in itself. In a letter to Stockhausen written circa 1955, Tudor had indeed described the nature of his approach to the piano as follows: "Now my pianistic method involves (usually) doing things with a precise control, as fast as this control can be exercised; and at that point to push beyond into the area where control might be lost (or forgotten) and where the act of playing becomes a 'dangerous' matter."[251]

4

In February 1957, soon after listening to Tudor play *Schlagfiguren* on the radio, Nilsson wrote an article titled "Spel med enkla Svangningar (Games with Simple Variations)" which was published in the journal *Musikrevy*.[252] A year later, as he neared the end of composing *Quantitäten*, Nilsson sent a copy of this article in Swedish to Tudor (Figure 1.16). On the surface the text appeared to be a theoretical commentary on an electronic music piece *Würfelspiel* (Dice Game) that Nilsson was writing back then. Of course, the young composer of Malmborget did not have access to any actual electronic instrument other than the radio. But the radio was enough—just as he had done with non-electronic music, Nilsson began composing electronic music through what he had learned from listening to transmissions from around the world. According to Larry Engstrom, Nilsson's first electronic work, *Audiogramme*, was composed through a remote control of sorts: "Nilsson sent specifications and numbers through the mail to the Electronic Music Studio in Cologne, where they then produced the actual sounds."[253] But the restless youngster could not wait. By the time the composer Gottfried Michael Koenig, who kindly accepted the job of realizing *Audiogramme*, had completed his task, Nilsson had already finished another electronic music without ever hearing how the first actually sounded.

"Spel med enkla Svängningar" began by outlining the general situation of electronic music at the time of its writing, celebrating the "new music mindset" that technology had enabled: new tone systems, new sounds, new intensity scales with precisely measured values, and new continuity of time.[254] Nilsson first compared the development of electronic music with that of nuclear physics in the era of atomic energy. Then, in the second half of the article, he described the techniques used to compose *Würfelspiel* based on a serialist treatment of materials that had been processed by what he called

[251] The quotation marks around the word "dangerous" suggest an external reference—perhaps Artaud again: "The best way, it seems to me, to realize this idea of *danger* on the stage is by the objective unforeseen, the unforeseen not in situations but in things" (Artaud, *The Theatre and Its Double*, 43–44).

[252] Bo Nilsson, "Spel med enkla Svängningar (Games with Simple Variations)," *Musikrevy*, IV (1957), 147–150.

[253] Larry M. Engstrom, "Contemporary Swedish Music for Solo Trumpet and Trumpet in Mixed Chamber Ensembles with a Performance Analysis of Selected Works of Bo Nilsson, Foke Rabe, and Tommy Zwedberg," Ph.D. dissertation, University of North Texas, 1991, 131.

[254] Nilsson, "Spel med enkla Svängningar (Games with Simple Variations)," 148.

Särtryck ur Musikrevy nr 4

an meinen Freunde
David Tudor
mit herzlichem Gruss
von Bo Nilsson
25. 5. 58

Bo Nilsson

SPEL MED ENKLA SVÄNGNINGAR

■ Avsikten med denna artikel är att i första hand behandla den elektroniska musikens elementäraste beståndsdelar och förutsättningar, såsom de ter sig ur tonsättarens synvinkel, samt att — med tanke på den (åtminstone just nu) pågående musikdebatten — försöka ge den intresserade en adekvat bild av det omfattande förarbete som döljer sig bakom varje nytt elektronverk (därmed även något om begreppet »seriell teknik»), för att slutligen nå kommunikationskedjans tredje och sista part, lyssnaren-kritikern.

Ämnet — elektronisk musik — har behandlats ett otal gånger tidigare i pressen — i mer eller mindre diffusa framställningar. Jag har därför ansett det nödvändigt att med en allmän redogörelse bringa de alltför många förutfattade meningarna kring företeelsen i en något klarare dager.

Den elektroniska studio som f. n. håller på att ta form i Stockholm är nog ett av de mest lovande bevisen på den — trots allt — positiva viljan och det stora intresse denna nya musikform väckt bland våra yngre komponister. Initiativtagarna till detta är bl. a. Bo Wallner, tonsättarna Bengt Hambræus och Knut Wiggen. *Alea jacta est!*

Företrädare och pionjär för denna relativt nya riktning är den unge rhenländaren Karlheinz Stockhausen, född i Köln 1928 och tillsammans med teoretikern Herbert Eimert där flitigt verksam vid WDR:s studio för elektronisk musik (grundad 1953 på initiativ av några ljudtekniker, däribland den kände fonetikern Werner-Meyer Eppler, verksam vid »*Institut für Phonetik und Kommunikationsforschung der Universität Bonn*»).

Av Stockhausens elektroniska produktion (hitintills 3 nummer) har vi i svensk radio endast hört hans »*Gesang der Jünglinge*» i Nattövning, vilket kanske gav oss en aning om de praktiskt taget obegränsade möjligheter det elektroniska musikskapandet av i dag erbjuder i fråga om klangligt raffinemang, kontrapunktiskt- och tidsstrukturellt detaljarbete. De förskjutningar av rumsdimensionen som Stockhausen uppnått i detta arbete, saknar tills vidare motstycke inom såväl den »konkreta» som den elektroniska musikens korta historia: stycket är komponerat för 5-kanalig magnetofon + 15 högtalare (fördelade i 5 grupper) — tillsammans omfattande frekvenser från undre till övre hörselgräns — vilka genom olika fasförskjutningar projicerar det spektralstrukturella förloppet inom ramen för ett plastiskt rumsligt totalskeende genom hela verket. »*Gesang der Jünglinge*» är otvivelaktigt den elektroniska musikens allra viktigaste arbete hitintills. Vad som i fortsättningen är att vänta från Stockhausen är naturligtvis omöjligt att förutspå — i varje fall kan vi bereda oss på åtskilliga intressanta studier från det hållet. Av tonsättarens hittillsvarande produktion (som f. ö. är rätt anspråkslös) finns endast ett par kompositioner publicerade på Universal-Edition i Wien (däribland det elektroniska partituret »*Studie II*»; UE 12466 LW).

I och med denna snabbskiss av Stockhausen och hans verksamhet har vi närmat oss ett arbetsfält som hör framtiden till och som mycket väl kan ses som en musikalisk parallell till den samtida kärnfysiken och atomforskningen: komposition med elektronisk materia.

På samma sätt som rymdens allra minsta energipartiklar analyseras, sönderdelas och omvandlas till annan verksam substans, på samma sätt som de fyra elementen fått träda i bakgrunden för det periodiska systemets funktionslära,

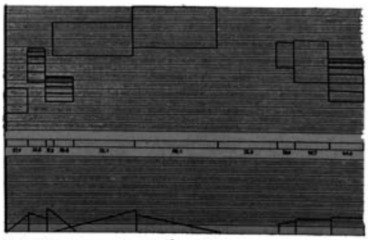


Figure 1.16 Bo Nilsson | “Spel med enkla Svängningar,” with the score of *Audiogramme* | 1957

DTP, Box 193, Folder 4 | Getty Research Institute, Los Angeles (980039)

"aleatory modulation" (which, he explained, was "actually a high-brow expression for reverberation"). At one point the composer introduced an "integral formula" for calculating the so-called logarithmic frequency distances of interrelated tones. From the way sound materials were measured to the way the score looked, everything was reminiscent of Stockhausen's *Studie II* whose published scores Nilsson owned. But the likeness was not only about *what* was discussed; it was also about *how* it was discussed. The article's pseudo-scientific language and heated rhetoric reminded the reader of many similar articles written by composers like Stockhausen, published in journals like *Die Reihe*. Just as with his music, Nilsson had simulated the style of others.

5

Before he delved into the analysis of his own music, however, Nilsson spent a few paragraphs outlining the basic "prerequisites" for the production of electronic music. There were three fundamental rules:

(a) The vibration from the frequency range that are audible always have to start in the middle of the audible frequency range, and from this "centre" it goes successively up or down towards the limit of audibility.
(b) Length of every tone in time inversely proportional to its definitive interval-height. From that follows that by successive growing frequency distance [abstand] from the middle part of the scale you have to make the length of the tone smaller.
(c) The intensity series have to be analogous with the growing frequency distances proportionally shortened with the length of the tone: the directions from the middle part of the field to top + bottom of audibility you have to recognize them […] thru the shortened length + the intensity of the tone.[255]

In other words, (a) always measure frequency range starting from the center of audible range; (b) the greater the frequency range, the shorter the duration of each tone; and (c) the greater the frequency range, the greater the intensity of each tone. The more wordy translation quoted above is actually by Tudor, who read the article in Swedish and translated the three rules into English.[256] The reason he did so, as well as the reason Nilsson sent the article to him in the first place, is not so difficult to understand: the inverse relationship between frequency range and tempo set in *Quantitäten* is simply a reversal of rule (b). In other words, as the precisely measured intensity scale also reveals, Nilsson's piano music was grounded in his theatrical foray into electronics. In both cases he was speculating music without having recourse to actual material. They were both virtual works in this sense.

The same was true about Nilsson's paper. The formula presented as being at the core of *Würfelspiel* was something the composer had randomly copied out from a

[255] Ibid.
[256] Tudor, "Translation of 'Spel med enkla Svängningar,'" Box 194, Folder 1, David Tudor Papers, GRI.

book of mathematics his uncle owned, in the same way that he had imitated the score of Stockhausen's electronic music.[257] The article he sent Tudor was a hoax: something composed to appear authentic although the authenticity was in appearance only. The young Nilsson was simply playing the *role* of being a composer of new music, as if he were an actor—writing articles like these was part of the "game."

6

In 1961, Nilsson admitted in public that he had been "bluffing":

> *His music was not at all serialist. He had developed such a fine ear for this genre and adapted the very complex notational technique that gave the impression of being deterministic. This confession created some turmoil in Sweden and Germany.*[258]

But the bluff was about how he wrote his pieces. The pieces did what they did regardless of how they were made. For the boy who only knew music through the radio, maybe the only thing that mattered was the *appearance* of what was heard. For the serialist composer who was not composing serially, authenticity may have only existed in performance. It would be easy to dismiss these claims as a brilliant teenager's naïveté if it weren't for the fact that Tudor appears to have harbored similar feelings, as glimpsed for instance in his advice to Kubera: "Better to skip some details (but still playing everything) when fast—to get sonorities."[259]

But Tudor did need to un-coordinate his self-discipline as a pianist to be okay about being an actor—about being a pianist doing something other than playing the piano: "It was something that my training made me frown upon it."[260] The turning of the pianist into a role-play seems to have had one major consequence for Tudor: he got tired of playing that role.

> *One of the reasons I gave up the piano was because people from all over the world would send me scores knowing that 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 that through a set of finite circumstances one could be led into something completely open.*[261]

[257] Ekaterina Gur'evna Okuneva (Екатерина Гурьевна Окунева), "Композитор-авангардист Бу Нильсон: Забытый 'гений из Мальмбергета' (The Avant-Garde Composer Bo Nilsson: A Forgotten 'Genius from Malmberget')," *Problemy muzykal'noj nauki: Rossijskij naučnyj specializirovannyj žurnal/ Music Scholarship: Russian Journal of Academic Studies* 2, no. 9 (2011), 201.

[258] John David White and Jean Christensen, *New Music of the Nordic Countries* (New York, NY: Pendragon Press, 2002), 468.

[259] Kubera, "Notes from Sessions with David Tudor."

[260] Tudor, "Interview by Martin."

[261] Tudor, "From Piano to Electronics," 25.

After his confession in 1961, Nilsson abandoned his serialist approach and started writing music in a more traditional and popular style. He wrote mainly for film and television and "contributed to the introduction of musical postmodernism in Sweden."[262]

7

Tudor also sought to end the pretense. In May 1972, talking to the conductor Richard Bernas in London during a duo European tour with Cage—the same interviewer that Wolff would talk with forty-three years later about the indeterminacy of live performances—Tudor reflected back on these early years when he coordinated his body with the piano and auxiliary materials in trying to realize the "most complex piano music." In his reminiscence, this experience was summarized using a lovely metaphor: "Tudor describes his work on these pieces as a 'Yoga of a couple of years' duration.' "[263]

With works like *Quantitäten*, the exploration of escapement control had reached a limit. One thing that could be changed was the instrument itself. This theatrical problem of changing roles would be solved through Nilsson's own theatrical act which, as a side effect of his challenge to Tudor, brought about a more radical change to the piano than all the pseudo-serialist maneuvers combined. In an addendum to the instructions for *Quantitäten*, Nilsson casually suggested the use of electronic amplification to extend the scale of the dynamics on the piano. Before he introduced musical postmodernism to Sweden, the twenty-year-old had introduced "live-electronic music" to the world.[264]

[262] White and Christensen, *New Music of the Nordic Countries*, 468.

[263] Richard Bernas, "Mister Natural," *New Statesman*, May 26, 1972, Box 67, Folder 13, David Tudor Papers, GRI.

[264] "Live-electronic music" in the broad sense has existed since the dawn of electronic music, as Mumma described in his essay on the genre: "the earliest electronic music was live-electronic music" (Mumma, "Live-Electronic Music," in John Appleton and Ronald Perera, eds., *The Development and Practice of Electronic Music* [Englewood Cliffs, NJ: Prentice-Hall, 1975], 287). Here I am using the same term in a much narrower sense to address the particular kind of electronic music that Tudor and Cage began to perform around this time in the late 1950s. Their music which used electronics in a live performance without tape was called by this name in comparison to both *musique concrète* and *elektronische musik* that relied on tape and was not considered live. On October 20, 1954, Tudor and Cage performed the "Whistle Piece" and other works (*Perspectives* by Brown; *Intersection 3* by Feldman; and *For Prepared Piano* by Wolff) at Cologne in a program titled "Musik der Zeit 1954–1955," which they shared with electronic tape music made locally at Westdeutscher Rundfunk [WDR] (*Glockenspiel and Etüde über Tongemische* by Herbert Eimert; *Komposition Nr. 5* by Karel Goeyvaerts; *Formanten I* and *II* by Paul Gredinger; *Seismogramme* by Henri Pousseur; and *Studie I* and *Studie II* by Karlheinz Stockhausen). Four days later, Tudor wrote to M. C. Richards, reporting: "big success in Koln our part followed by first presentation of Kolnische elektronische musikische they watched the reaction to this from above somebody said 'that's not living' ha-ha" (Tudor, "Letter to M. C. Richards [October 24, 1954]," Box 26, Folder 2, Mary Caroline Richards Paper, GRI).

Chapter 2
Amplified Piano

Amplified Piano

1

On September 19, 1989, during a panel discussion at the Wheeler Hall in UC Berkeley that assembled the musicians from the Merce Cunningham Dance Company (MCDC), the moderator Charles Amirkhanian asked John Cage to say a couple of words about "the nature of electronic music." As usual, the composer replied with an anecdote:

> *I think the important thing about it, and this idea comes to me from David, if I recall it was at a gas station on the Pennsylvania Turnpike, about the time that Kennedy . . . wasn't Kennedy killed then?. . . that David suggested using contact microphones in a situation where they weren't necessary.*[1]

John F. Kennedy was assassinated on November 22, 1963. From mid-October to late November of that year, MCDC was on tour around the country, which had by chance started from Tudor's old workplace, Swarthmore College. After going through the Southwestern and Southern states for five weeks, the group headed north, performing their last show at Southern Illinois University on November 21. Tudor's handwritten schedule dates the return to New York three days later, on the 24th.[2] Around the time the thirty-fifth president was killed, therefore, Cage and Tudor were making their way back to Stony Point from Carbondale, Illinois, most likely via the Pennsylvania Turnpike. At the 1989 discussion, Cage did not comment any further on the implications of this puzzling suggestion. As usual, Tudor, sitting next to him, remained silent.

2

Electronic amplification was born out of the desire to transmit sounds across distance. Earlier telegraphs used battery-operated relays—electrical switches which

[1] Charles Amirkhanian, John Cage, Takehisa Kosugi, Gordon Mumma, Michael Pugliese, and David Tudor, "A Kind of Anarchy: Merce Cunningham and Music (September 19, 1989)," Merce Cunningham archives, New York Public Library.

[2] David Tudor, "Handwritten Schedule for MCDC Tour (Fall 1963)," Box 15, Folder 23, David Tudor Papers, GRI.

Reminded by the Instruments. You Nakai, Oxford University Press (2021). © Oxford University Press.
DOI: 10.1093/oso/9780190686765.001.0001.

could activate large current by using small ones—to strengthen signals that had been weakened by traveling far. With the invention of the telephone in 1876 and especially of the wireless radio in 1901, engineers began to search for more powerful and efficient ways to reinforce transmitted signals that now included not only telegraphic pulses of dots and dashes, but also voice and music transduced into electrical waves. The first operational electronic amplifiers appeared in 1912, when Edwin Armstrong and others began to wrap feedback around the Audion, a vacuum tube device Lee De Forest had invented six years earlier.[3] Returning the output to the input of the device, which the inventor himself had likened to a relay in the first place, enabled signals to be "regenerated," increasing their strength each time the process was repeated.[4]

By the mid-1950s, amplifier technology had developed enough to make it possible for a teenager living near the Arctic Circle to listen to music from across the sea while sitting in his room. But Bo Nilsson certainly did not take his radio apart to examine how it worked. The sentence-long brevity of the addendum he attached to the instructions of *Quantitäten* reflected the speculative nature of what he was asking Tudor to do:

> *This piano piece should in performance in a concert hall be fortified with the help of one or more loudspeakers, whose level (in "10.5") is as high as possible.*[5]

Other than the correspondence between the maximum value of intensity and the highest level of amplification, Nilsson provided no information about the process of "fortification." He could not, since other than his radio he probably had no materials to examine how the technology actually worked. In fact, this type of composition was the young composer's specialty: "In 1956, encouraged by Hambraeus, he wrote a three-minute piece for organ, *Spiralen und Kulissen*, which proved to be unsuitable for the instrument, as it went beyond its ambits and demanded nineteen dynamic nuances as well as crescendi and diminuendi from ffff to pp. with unchanged registrations both in manuals and pedals."[6] But it so happened that in composing materials for Tudor, what mattered was precisely pushing the instrument to the threshold of impossibility. And whatever the composer had written, *David Tudor* would try to do it, actually. Tudor's foray into live-electronic music thus began with a bluff.

[3] For a detailed account of De Forest's invention of the Audion and its subsequent development by Armstrong and others, see Sungook Hong, *Wireless: From Marconi's Black-Box to the Audion* (Cambridge, MA: MIT Press), 2001.

[4] Ibid., 186.

[5] Tudor, "Translation of instructions for *Quantitäten*," Box 194, Folder 1, David Tudor Papers, GRI.

[6] "From Darmstadt to Stockholm," in Kerala J. Snyder, *The Organ as a Mirror of Its Time: North European Reflections, 1610–2000* (New York, NY: Oxford University Press, 2002), 313. Also recall how Nilsson composed the score for *Audiogramme*, his first electronic composition, around the same time he wrote *Quantitäten*. Like the latter piece, mailed to Tudor, the composer simply sent this score to the place he hoped could realize it: the electronic music studio at WDR. It so happened that Gottfried Michael Koenig very kindly agreed to take on the job and *Audiogramme* was realized in 1958. For more information, see Gottfried Michael Koenig, "Bo Nilsson," *Die Reihe* 4 (1958), 85–88 (English translation in *Die Reihe* 4 [1960], 85–88).

3

On September 9, 1958, Tudor premiered *Quantitäten* in Darmstadt, during Cage's talk "Communication," which formed the third and last part of his "Composition as Process" lecture series. Nilsson's piece was performed twice in between sections of the talk.[7] Five days later, on September 14, Tudor played *Quantitäten* again for a recording session at WDR in Cologne.

Tudor and Cage stayed in Europe, touring with Cunningham and his dancer Carolyn Brown until November 2. Two weeks after the WDR recording session, they were in Stockholm, where Tudor gave the first performance of all three pieces by Nilsson in a concert at Fylkingen on September 29.[8] The group was also invited to perform at the opera house in the Swedish capital, and, as Amy C. Beal notes, "Bengt Häger suggested to Cunningham that he might include music by a Swedish composer."[9] The three piano pieces already in Tudor's repertoire were perfect for the occasion. "In just a few days, Cunningham choreographed a duet for himself and Brown called *Night Wandering*,"[10] which was premiered at the Royal Swedish Opera on October 5. Four days later, on October 9, Tudor performed a "Pièce" by Nilsson at the concert "Formes nouvelles de la Pratique instrumentale [New Forms of Instrumental Practice]" held in the French pavilion auditorium at the Brussels Expo.[11] It is not known whether the piano was amplified on any of these performances. For one thing, probably neither Tudor nor Cage was carrying (or even owned) any microphones or amplifiers on this tour.

After returning to New York, Tudor performed *Quantitäten* in a concert at La Maison Française of New York University on March 19, 1959. Cage's remark written for the occasion suggests that the piano was amplified this time:[12] "Nilsson's latest piece for piano, *Quantitäten*, written especially for David Tudor, requires for its performance microphone and amplification, reflecting the composer's special interest in the sound of loud-speakers."[13]

[7] The recording of this lecture, including Tudor's two performances of *Quantitäten*, has been released as John Cage and David Tudor, *Communication (Darmstadt Aural Documents Box 2)*, NEOS 11213, 2012, CD.

[8] Other works in the concert were: *Cercles pour Piano* (1955) by Bengt Hambraeus, *Klavierstück XI* by Stockhausen, *Two Pianos* by Feldman, *Duo for Pianists* by Wolff, *Four Systems* by Brown, *Winter Music* and *Variations I* by Cage.

[9] Amy C. Beal, "A Short Stop Along the Way": Each-Thingness and Music for Merce," *Music for Merce 1952–2009*, New World Records, 80712-2, 2010, CD.

[10] Ibid.

[11] Journées internationales de musique expérimentale, "Program note, Formes nouvelles de la Pratique instrumentale (October 9, 1958)," Box 71, Folder 7, David Tudor Papers, GRI.

[12] Nilsson's pieces were performed only on two other occasion during 1959 and 1960. One was a concert at the Village Gate, New York, on June 7, 1959, where the "3 Pieces for Piano" received their US premiere, and the other was a concert at the Living Theatre on March 28, 1960, where the same pieces were again billed as "First U.S. performance" (Living Theatre, "Program note, David Tudor concert [March 28, 1960]," Box 72, Folder 2, David Tudor Papers, GRI).

[13] John Cage, "Remarks before a David Tudor Recital [La Maison Française NYU Concert on March 19, 1959]," in Richard Kostelanetz, ed., *John Cage: Writer* (New York, NY: Cooper Square Press, 2000), 72.

By the time *Night Wandering* returned to Europe two years later, in September 1960, the situation had changed greatly. Cage had composed *Music for Amplified Toy Pianos* earlier that year—which Tudor had been performing since its premiere on February 25 at Eastern Michigan University—and had just completed a new piece called *Cartridge Music*, focusing on the amplification of small sounds using phonograph cartridges as contact microphones, which was premiered as a broadcast on Radio Bremen on September 15. On March 28, Tudor had given a concert at the Living Theatre in New York City, where he performed *Quantitäten* amplified, as Eric Salzman informed posterity in a review for the *New York Times*: "Bo Nilsson's 'Quantitaeten' [*sic*] was mainly different in that the piano was electrically amplified. Another good trick; but again the substance was slim."[14]

Accordingly, when Tudor went to Europe in late May of that year and Cage began corresponding with him to prepare for the upcoming tour in the fall, their exchange revolved around the issue of available equipment. On June 15, Tudor wrote, "besides Solo [for Piano] we like toy piano & cartridge music—can you bring the pianos, microphones & cartridges?"[15] Cage responded six days later, "I cd. bring pianos, microphones and cartridges. Will look into shipping possibility."[16] Although they had collected quite a lot of equipment by then—"I will bring 1 or 2 dozen cartridges. […] Let me know whether you have been able to use the contact mike and cartridge you took with you in Europe with the amplifiers there"[17]—Cage decided not to specify how many should be used, since "the number we will use will depend on the loudspeakers and amplifiers available."[18] With the necessary equipment at hand, *Night Wandering* was performed at least three times during this tour.[19]

4

There are six available recordings of Tudor's realization of *Quantitäten*: (1–2) two performances during Cage's lecture at Darmstadt on September 9, 1958;[20] (3) the recording at WDR in Cologne on September 14, 1958;[21] (4) another performance at Darmstadt a year later, on August 28, 1959;[22] (5) a filmed performance of *Night*

[14] Eric Salzman, "Recital Is Given by David Tudor," *New York Times*, March 29, 1960 (Box 63, Folder 1, David Tudor Papers, GRI)

[15] Iddon, *Cage and David Tudor*, 112.

[16] Ibid., 116.

[17] Ibid.

[18] Ibid., 119–120. "Wd. also appreciate for composition purposes some information about the range of amplitude in your experience (those little drawings you make after testing the amplifiers)" (ibid., 119–120).

[19] September 28–29 at the Hebbel Theater as part of Berliner Festwochen; October 2–3 at Münchner Kammerspiele; and October 5 at the Friedrich-Wilhelm-Gymnasium in Cologne.

[20] John Cage and David Tudor, *Communication (Darmstadt Aural Documents Box 2)*, NEOS (11213), 2012, CD. The second performance (track 7) is also part of the following recording: David Tudor, "Piano 1958 Ferienkurse II. Teil, 1958," Box 8A, CIIB, David Tudor Papers, GRI.

[21] David Tudor, *Piano Avant-Garde: Recordings 1956–60*, Hat Hut (6181), 1996, CD.

[22] David Tudor, "Piano 1959 Ferienkurse, 1959," Box 8A, CIIIA, David Tudor Papers, GRI.

Wandering for a live television transmission by the Finnish Broadcasting Company on September 18, 1964;[23] and (6) another performance of *Night Wandering* recorded during MCDC's Latin American Tour in the summer of 1968.[24] A quick comparison reveals a difference in length between the first three versions, which are all approximately 3′45″, and the latter three, which are all a minute shorter, around 2′45″. This shortening was very likely made for *Night Wandering*: the length of music had to coordinate with the choreography. Indeed, Tudor's papers contain many pages of calculation for the three Nilsson piano pieces, where he not only translated the scores' metrical time into clock time but did so for several different tempi, comparing the total lengths before arriving at the final duration for each piece.[25] *Quantitäten*, positioned in the middle, after *Bewegungen* and before *Schlagfiguren,* was to take place between 4′45″ and 7′30″, thus lasting 2′45″.

But what is puzzling is what the recordings do not reveal: the effect of amplification. In the WDR recording, there is a slightly audible feedback triggered by the low F#1 in the fifth system, assigned with the maximum intensity degree of 10.5 and a long fermata to prolong the resonance. The 1968 *Night Wandering* was certainly fortified electronically, for Gordon Mumma, who was working with MCDC at the time and recorded the piece, remembered assisting Tudor specifically for this task.[26] But even then, amplification remained strangely occult.

5

This inaudible nature of amplification may be connected to Tudor's puzzling suggestion that Cage had quoted in his answer to Amirkhanian: to use contact microphones in a situation where they weren't necessary. For one thing, Nilsson's call for amplification appeared to do exactly that. Not only were the sounds of the piano audible without using microphones, but the minuscule divisions of intensity scale were also precisely controllable by Tudor's well-known ability to differentiate dynamics. So electronics appeared to "fortify" what was already possible, to do no more than extend the scale of what non-electronic instruments could already do.

Talking to Matt Rogalsky by telephone on November 3, 1994, Mumma recalled that in addition to extending dynamics as instructed in the score, Tudor had another, more practical reason to amplify the piano, which had to do not with what Nilsson had written, but with the actual sounds produced when realizing what he had written in the context of touring:

[23] Heikki Seppälä and the Finnish Broadcasting Company, "Nightwandering (1964-09-18) [video recording]," MGZIDF 1761, Merce Cunningham archives, New York Public Library. Also available online at "Night Wandering (1958), Performed in 1964," Robert Rauschenberg Foundation, accessed December 15, 2019: https://www.rauschenbergfoundation.org/art/archive/64v00300

[24] Various, *Music for Merce: 1952–2009, Box 1*, New World Records (80712-2), 2010, 10CDs.

[25] Tudor, "Calculations for *Night Wandering*," Box 193, Folder 4, David Tudor Papers, GRI.

[26] Gordon Mumma, "Interview by You Nakai (November 4, 2016)," Vancouver, BC.

> *[T]he character of the pianowriting [in Nilsson's pieces] was the sort of virtuoso-ish Darmstadt-y kind of thing* [. . .] *and the problem was of course, that touring around, they're in these high school auditoriums, and godforsaken places with clunky pianos, and it sounded like shit.* [laughs] [. . .] *David took some of these contact microphones, well he tried various things, contact mics, air mics, and the like, to amplify it, well, not so much to amplify the piece but to be able to equalize it. Amplify it enough to equalize it. And he got to where the thing was like some unreal piano, something in four-space, or n-space* [. . .] *He got really taken with dealing with the timbral possibilities of equalization.*[27]

In other words, this was a second case of "using contact microphones in a situation where they weren't necessary." In addition to (or rather instead of) extending the dynamics of the piano, Tudor began using electronic amplification in *Quantitäten* to modify the sound spectrum of the instrument so that it would sound more like itself. Whereas the former use focused only on dynamics, expecting the amplifier to be as neutral for all other parameters of sound, the latter use focused on timbre, revealing the amplifier as also an equalizer and the process of amplification as involving parameters other than just dynamics. But this extended role of electronics as an instrument of disguise was necessary given the nature of Nilsson's material—full of spaces to let the timbre of sounds or chords resonate—and inevitable given the nature of instruments used to perform that material—"clunky pianos" that "sounded like shit." Tudor thus followed the addendum but once again exercised some poetic license in his realization.

6

According to what Earle Brown recalled twenty-seven years later, in 1985, sometime after his return to New York from Europe in 1958, Tudor recorded *Quantitäten* for Capitol Records. As no other document verifying this recording session has been found, Brown's memory may have mixed it up with Tudor's session at WDR, which the composer, who participated in the International Summer Courses for New Music in Darmstadt that year, may have also attended.[28] Whichever recording studio it was,

[27] Matt Rogalsky, "Telephone Interview with Gordon Mumma (November 3, 1994)" in Rogalsky, "Live Electronic Music Practice and Musicians of the Merce Cunningham Dance Company," 136–137. More recently, Mumma confirmed again: "It was not, in a sense, amplified. It was an adjustment of the 'acoustic lighting,' alright? [. . .] It was a matter of adjusting the sonority in a way. [. . .] It really wasn't amplification in that sense—it was equalization" (Mumma, "Interview by You Nakai," Vancouver, BC).

[28] Although Brown remembers the recording taking place at Capitol Records under his supervision, the only studio recordings of *Quantitäten* from this period that I have been able to identify are that of WDR and another one made for Sveriges Radio on September 29. Brown's account implies that Cage also attended the session, which means that the Capitol Records session, if it happened, must have taken place after the composer's return to New York on March 7 of the following year. Recall also that the piano was already amplified at the La Maison Française concert on March 19. It is possible, though unlikely, that Brown organized another session sometime between March 7 and 19, the recording from which was never released. In any case, the specific date of the recording session does not affect my observations here.

the available instruments there reminded Tudor of Nilsson's suggestion to electronically "fortify" the piece. The outcome was something neither he nor Cage—let alone the composer in Malmberget—foresaw:

> *The use of contact mikes is basic to amplification, and the first time John experienced them was for* Quantitaten [sic] *by Bo Nilsson, the Swedish composer. It's the first piece of music I know of that calls for an amplified piano, and Merce choreographed it for himself and Carolyn, in Sweden. I was working then as a recording engineer for Capitol Records. David Tudor came in and we recorded his playing of* Quantitaten *with four or five contact mikes going to different loudspeakers. I put a mike on each loudspeaker, and we got the most incredible piano sound. It scared David right out of his wits. After that, John began using contact mikes frequently.*[29]

Contact microphones used in an unnecessary situation thus changed the situation entirely. In contrast to amplifying small sounds that otherwise could not be heard, as Cage would do in *Cartridge Music*,[30] amplifying a piano transformed the very nature of the instrument:

> *[Tudor] was so engaged by the, not so much the loudness possibility, 'cause heaven knows they experimented with micro-sounds before, this wasn't a micro-sound piece, this was like, already loud enough.* [. . .] *in* Cartridge Music, *you can't tell where the hell the sounds are coming from, but when you're working with the piano or other instruments, an identifiable source, and then extending them, um, to where they begin to lose their identity, that was . . . Tudor was very engaged with that.*[31]

Although the nature of Nilsson's material led Tudor to focus on making the piano sound more like a piano, the nature of electronic amplification also disrupted the precise control of release and resonance the pianist had carefully developed on his instrument. The depressing of a key could now activate a tone of indefinite duration and unforeseeable resonance. In short, Nilsson's short addendum rendered Tudor's technique of escapement control totally useless. The same electronics that enabled the piano to disguise its identity also made the piano lose its identity—it would cease to be a remote-controlled percussion instrument. Just as with the transition from organ to piano fourteen years earlier, Tudor soon found himself with another kind of instrument whose specific bias demanded another kind of physicality altogether.

[29] Earle Brown, "The Forming of an Esthetic: Merce Cunningham and John Cage (1985): Panel Discussion with Earle Brown, Remy Charlip, Marianne Preger Simon, and David Vaughan," in Richard Kostelanetz, ed., *Merce Cunningham: Dancing in Space and Time* (New York, NY: Da Capo Press, 1988), 64.

[30] For a study of Cage's use of amplification both in his works and as a metaphor in his discourse, see You Nakai, "How to Imitate Nature in Her Manner of Operation: Between What Cage Did and What He Said He Did," *Perspectives of New Music* 52, no. 3 (Autumn 2014), 141–160.

[31] Rogalsky, "Live Electronic Music Practice and Musicians of the Merce Cunningham Dance Company," 137.

Another kind of approach to the control of duration, dynamics, and resonance had to be devised. And for that, Tudor needed another kind of material.

Variations II

1

Between February and March 1961, while in residence at the Center for Advanced Study in Wesleyan University, Cage composed a new collection of materials for Tudor. Using a format he had been exploring for about three years by then, it consisted of eleven sheets of transparencies, five with single points and six with single lines. Tudor was to "superimpose them partially or wholly separated on a suitable surface."[32] By measuring the perpendiculars—"by means of any rules"—from a point to a line, he could determine the values for six parameters of sound: frequency, duration, amplitude, timbre, point of occurrence in an established period of time, and structure of event (Figure 2.1).

Cage had composed the very first set of transparency materials back in January 1958 as a belated birthday present for Tudor, who had turned thirty-two that month. This earlier collection included six sheets, one with points of varying sizes, and five with five lines on each, which corresponded to the limit value of a parameter (lowest frequency, simplest overtone structure, greatest amplitude, least duration, and earliest occurrence within a decided upon time). To determine the actual values, Tudor was to similarly superimpose the sheets and measure the perpendiculars from the points to the lines. Since this birthday present was titled *Variations*, the new set of materials three years later became *Variations II*. Like the first piece, it had been composed as a personal gift for the pianist.

2

Cage was very clear about the nature of what he had composed: the eleven transparencies were intended as "a kind of puzzle"—"almost impossible to understand!"[33]—for Tudor, who not only loved conundrums but was a genius at solving them.[34] *Variations II* was in this way "a piece entirely due to [Tudor's] presence on earth."[35] As such, it presented a universe of possibilities at its extreme: "as indeterminate as I have yet managed."[36] James Pritchett even went so far as to describe the work as encompassing

[32] John Cage, "Instructions for *Variations II*," Box 8, Folder 7, David Tudor Papers, GRI.
[33] Cage, quoted in Kenneth Silverman, *Begin Again: A Biography of John Cage* (Evanston, IL: Northwestern University Press, 2012), 175.
[34] Cage, *For the Birds*, 128.
[35] Cage quoted in: Holzaepfel, "New Perspectives on the History of the 'New York School,'" paper delivered at the April 1990 meeting of the Sonneck Society, Hammond, Virginia, 22.
[36] Cage, "Letter to Peter Yates (September 11, 1961)," *Selected Letters*, 248.

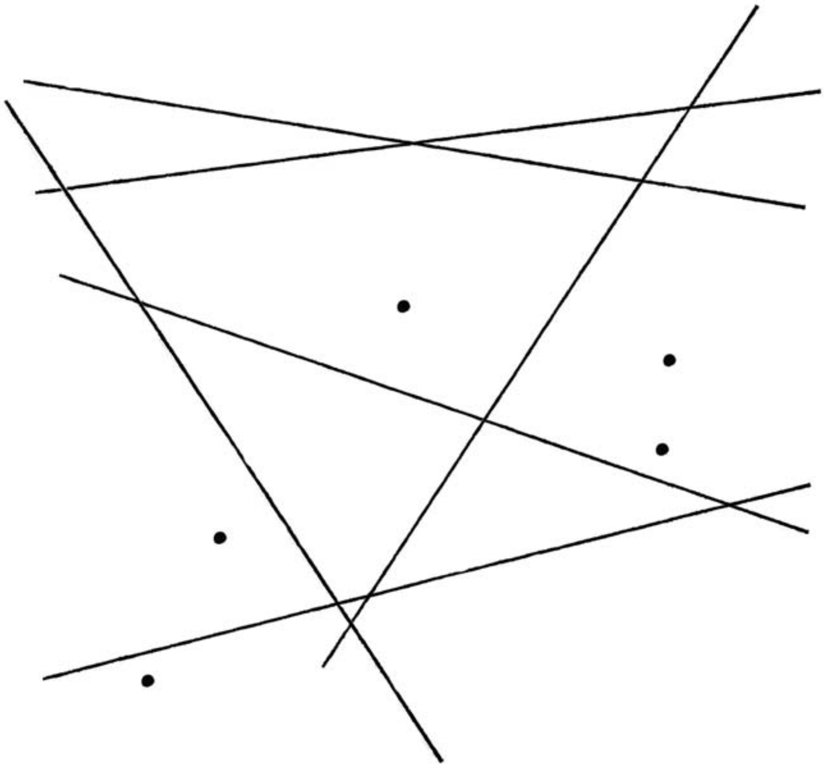


Figure 2.1 John Cage | *Variations II,* possible superimposition of transparency materials | 1961

"any piece of music that could possibly be created."[37] But in spite of all the exaggeration, such accounts only tell half of the story.

In virtually all of his works after 1952—which is to say, in all of the works he admitted always composing with Tudor in mind—Cage had used the physical bias of materials to compose scores that were not biased by his own intentions. In the *Music for Piano* series (1952–1956), the *Music for Carillon* series (1952–1967), and the *Ten Thousand Things* series (1953–) including *34'46.776" for a Pianist*, the marking of imperfections on a given piece of paper generated scattered points, which were then converted into musical notes.[38] At the basis of this method was the realization that no two pieces of paper are identical: there will always be some slippage between the idea of paper in the

[37] Pritchett, "David Tudor as Composer/Performer in Cage's *Variations II*," *Leonardo Music Journal* 14 (2004), 11.

[38] For a detailed study of this process see Philip Thomas and Martin Iddon, *John Cage's Concert for Piano and Orchestra* (New York, NY: Oxford University Press, 2020), Chapter 1.

mind and an actual one. The process of making materials was itself a live performance in the sense that Wolff observed, each biased differently and therefore singular.[39] Similarly, space-time notation equating a measurable length on paper to duration in clock time depended more than anything on the physical size of the actual score.

The use of transparencies[40] was therefore continuous with the composer's decade-long exploration of the physical nature of musical notation,[41] influenced primarily by how his pianist approached composed scores in his realizations. In other words, the materials of *Variations II* not only presented an unprecedented degree of possibilities concerning sounds that could be realized through them; they also presented an unprecedented degree of specificity concerning their own physical nature. To solve the puzzle, one had to coordinate directly with the bias of material: the size of each sheet, the thickness of lines and points, the degree of transparency affecting the visibility of superimposition, the cutting out of sheets and "extra materials," the spatial arrangement of multiple layers, the scale used to make the measurements.

The nature of *Variations II* thus lay in a paradoxical duality: no other score in Cage's entire output—and quite possibly in the history of music, for that matter—had attained such a degree of universality in terms of possible sound, *as well as* such a degree of particularity in terms of actual material.[42] But a material that biases the possibilities of sound production through its specific physicality usually goes by the name of "musical instrument."

3

Tudor's solution to the "almost impossible" puzzle Cage had composed for him was idiosyncratic even by his own standards: given a set of materials that resembled a musical instrument, he composed a musical instrument of his own and adjusted the

[39] What indeterminacy in composition (which is to say, chance operations) and indeterminacy in performance share in common is their focus on the physical specificity of materials. Any result—a particular hexagram, a particular performance, a particular sound—obtained through the physical nature of materials external to the mind is indeterminate because it is unforeseen to that mind.

[40] These included: *Variations I* (1958), *Music Walk* (1958), *Fontana Mix* (1958), *Theatre Piece* (1960), *Music for Amplified Toy Pianos* (1960), *Music for "The Marrying Maiden"* (1960), *Solo for Voice 2* (1960), *Cartridge Music* (1960), *Variations II* (1961), *Variations III* (1963), and *Variations IV* (1963).

[41] The use of transparencies developed out of Cage's earlier use of the same sheets, whose imperfections he observed and amplified to obtain scattered points in the *Music for Piano* series. The most important difference introduced in the later materials is that the transparencies were now multiple and mobile—in other words, modular.

[42] For instance, Thomas DeLio's analysis of *Variations II* reduces indeterminacy to a matter of statistics: "the sonic structure resulting from such a superimposition will invariably be that of some *statistical* correlation of several distributions of sound elements" (Thomas DeLio, *Circumscribing the Open Universe* [Lanham, MD: The University Press of America, 1984], 12; emphasis added); "the structure of *Variations II* is the complete range of all such *statistical* complexes made available by the composer through the score" (ibid., 19; emphasis added). But statistics only serves to reduce the actual "sonic structure" realized from Cage's material yet again to the totality of the universe of possibilities. The required analysis which can account for the specificity of each realization is therefore not statistical but *causal*. Also see Judea Pearl and Dana Mackenzie, *The Book of Why: The New Science of Cause and Effect* (New York, NY: Basic Books, 2018).

reading of materials to *its* nature. His solution essentially turned the puzzle into a part of the solution.[43] One of the first things Tudor realized while observing Cage's new gift was what was missing: the composer had left unspecified not only *what* instrument to use but also *how many*. As he explained to Teddy Hultberg twenty-seven years later, in May 1988: "it didn't have to be one instrument, it could have been many instruments."[44] To be sure, the instructions for the first piece in the *Variations* series had already left instrumentation completely open. But in early 1958 when he realized *Variations I*, Tudor does not appear to have placed any particular significance on this fact—understandably, since it was before the premiere of *Quantitäten* and thus before the piano was amplified. Three years later, however, the lack of specification concerning the number of instruments became useful as he was now pursuing a new kind of instrument: "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."[45]

The amplification of the piano was not a mere "fortification" of what already existed. As Tudor continued his reminiscence to Hultberg in 1988: "It's not just amplifying the instrument, but the whole thing taken together is an instrument of its own."[46] What he had composed was indeed an elaborate new composite instrument made up of many instruments:[47] air microphones set above and below the piano; contact microphones as well as phonograph cartridges (with plastic rods and other materials inserted in the place of needles) attached to various places inside the piano; an assortment of objects placed above the tuning pins for rubbing, scraping, and hitting the strings, including thimble, ruler, rubber, beater, and cloth (reminiscent of things he had selected seven years earlier to prepare the piano in *34'46.776" for a Pianist*). All the inputs from various microphones went into an amplifier with a gain and tone control, and out from several loudspeakers set around the piano. In order to facilitate the generation of acoustic feedback, the sustaining pedal was kept down, increasing

[43] Benjamin Piekut has observed that the dependence of Cagean indeterminacy on Tudor undermined its goal: "the successful performance of Cagean indeterminacy in the 1960s […] depended upon a performer who had already internalized the expectations of the composer, significantly undermining Cage's well-known goal of accepting the unforeseen. From this perspective, Cage's work evidences a peculiar status as both model and mirror—a mock-up of utopian anarchism and register of hegemonic liberalism" (Piekut, *Experimentalism Otherwise: The New York Avant-Garde and Its Limits* [Berkeley: University of California Press, 2011], 25). However, the nature of this "expectation" was quite paradoxical as it was the expectation to be surprised in unexpected ways.

[44] David Tudor, "Interview by Teddy Hultberg," davidtudor.org.

[45] Ibid.

[46] Ibid.

[47] Frank Hilberg used the term "instrumentarium" to address the composite instrument Tudor had composed (Hilberg, *David Tudors Konzept des "Elektrifizierten Klaviers" und seine Interpretation von John Cages "Variations II"* [Saarbrücken, Germany: Pfau, 1996]). But I follow Tudor's own terminology and keep the old name, so to speak, of "instrument," in order to focus on how Tudor pushed the familiar concept. Also holding onto the same name makes it easier to understand the nesting of different logical scales and their entanglement in seemingly singular "instruments" that Tudor would explore later.

the sensitivity of strings to vibrate in resonance to whatever sound was coming out of the loudspeakers.[48]

4

In a manuscript for a book on "20th Century Techniques," written in 1974 but never published, Raymond Wilding-White described the instrument Tudor composed for *Variations II* based on an interview with him:

> *The medium chosen by Tudor was amplified piano. The nature of this amplification was such that neither the quality nor the duration of the output could be predicted—as Tudor puts it, "you could only hope to influence" the instrument—and thus Tudor had to re-interpret Cage's instructions.*[49]

This description reveals two important details about what Tudor did: (a) his instrument rendered indeterminate the two parameters central to escapement control: duration and tone quality (which is to say timbre); (b) Tudor proceeded to "re-interpret" what Cage had composed according to the nature of what he had composed.[50] A different kind of instrument called for a different kind of coordination. So in his reinterpretation, Tudor stopped doing what he had done in all the previous realizations of transparency materials: the precise measurement of perpendiculars to obtain numbers for parametric values. Instead, he simply eyed the distance between a dot and a line, and grouped them in two categories only: "simple" or "complex."[51] This polarity

48 My description here follows Tudor's 1990 account in Hilberg's booklet (ibid.) as well as observations made while watching the footage of "Musik im Technischen Zeitalter," as discussed below.

49 Ray Wilding-White, "David Tudor: 10 Selected Realizations of Graphic Scores and Related Performances (1974)," Box 19, Folder 2, David Tudor Papers, GRI.

50 Tudor presents a similar reflection in a draft for a program note on *Variations II* written when the piece was revived in the early 1980s: "My realization of *Variations II* evolved from a decision to employ the amplified piano, conceived as an electronic instrument, whose characteristics orient the interpretation of the 6 parameters to be read from the materials provided by the composer" (Tudor, "Draft of Program Note for *Variations II* [ca. 1980]," Box 8, Folder 7, David Tudor Papers, GRI).

51 The materials of *Variations II* differed in two notable ways from the first piece in the series, written in January 1958. In *Variations I*, there were six transparencies: one with twenty-seven points of four different sizes, and five with five intersecting lines on each. The size of the points determined the "structure" of the sound event (number of sounds making up an aggregate or a constellation of sounds), and the performer could decide which parameter was assigned to which particular line. But since the relationship between multiple lines and points on each sheet were fixed, the relationship between those lines and points when superimposed were also relatively fixed. Which is to say that the degree of bias imposed by the composer was much greater compared to *Variations II* where only one element was inscribed on each transparency. More significantly for Tudor's realization process, however, the parameters assigned to each line in *Variations I* were described using superlatives, which implied a continuous scale: lowest frequency, greatest amplitude, simplest overtone structure, least duration, and earliest occurrence within an established period of time. As David P. Miller observed, the specification of values in the second piece without these superlatives no longer presupposed a continuum. Instead, "one may work with a gamut, where a range of values, not necessarily continuous, are assigned positions in an array" (David P. Miller, "The Shapes of Indeterminacy: John Cage's *Variations I* and *Variations II*," *Frankfurter Zeitschrift für Musikwissenschaft*, 6. Jahrgang [2003], 22). Tudor's reading makes full use of this nature of the material.

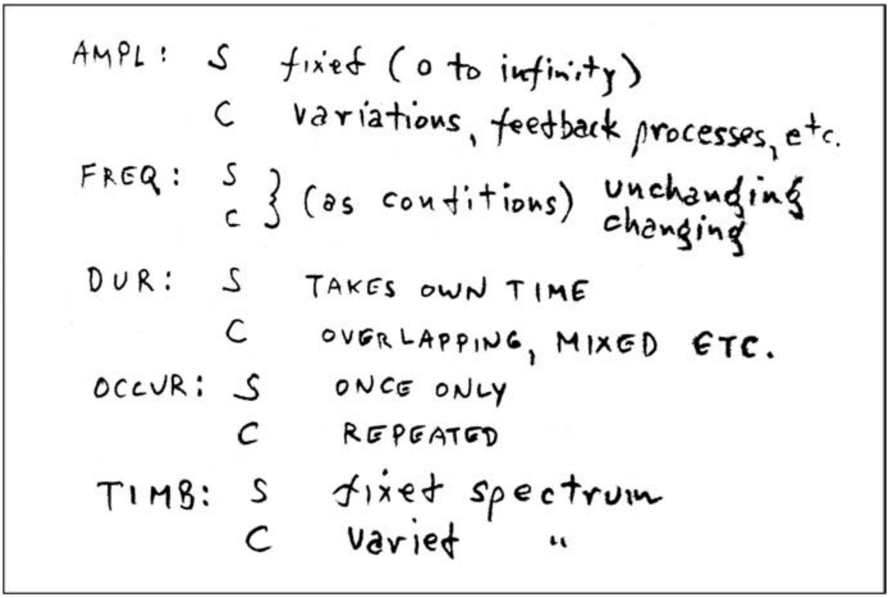

AMPL: S fixed (0 to infinity)
C variations, feedback processes, etc.
FREQ: S } (as conditions) unchanging
C changing
DUR: S TAKES OWN TIME
C OVERLAPPING, MIXED ETC.
OCCUR: S ONCE ONLY
C REPEATED
TIMB: S fixed spectrum
C varied "

Figure 2.2 Tudor | *Variations II,* notes of parameters | Undated
DTP, Box 8, Folder 7 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

meant different things for each parameter, as an undated handwritten note found among his papers explains (Figure 2.2):[52]

Amplitude: "simple" could take any value (0 to infinity) but had to be fixed; "complex" meant non-fixed, and varying through feedback and other processes.
Frequency: "simple" could take any value but had to remain unchanging; "complex" meant changing.
Duration: "simple" could be of any length but had to take its own time; "complex" meant overlapping or mixed with other events.
Occurrence: "simple" could happen at any point, but once only; "complex" meant that it would be repeated.
Timbre: "simple" could be any kind of spectrum but had to be fixed; "complex" meant varied spectrum.
Structure: "simple" meant a single event; "complex" meant two or more simultaneous events.

Tudor then wrote out the values obtained using a new form of notation he had devised. These "nomographs,"[53] as he called them, represented each sound event with a square.

[52] Tudor, "Description of parameters for *Variations II*," Box 8, Folder 7, David Tudor Papers, GRI.
[53] The term "nomograph" (also called "nomogram") usually refers to a form of diagram which aligns several sets of scales in parallel to enable a quick and precise calculation of formulas by drawing a straight line across the scales and reading the value at the intersections. Tudor may have borrowed the term from this

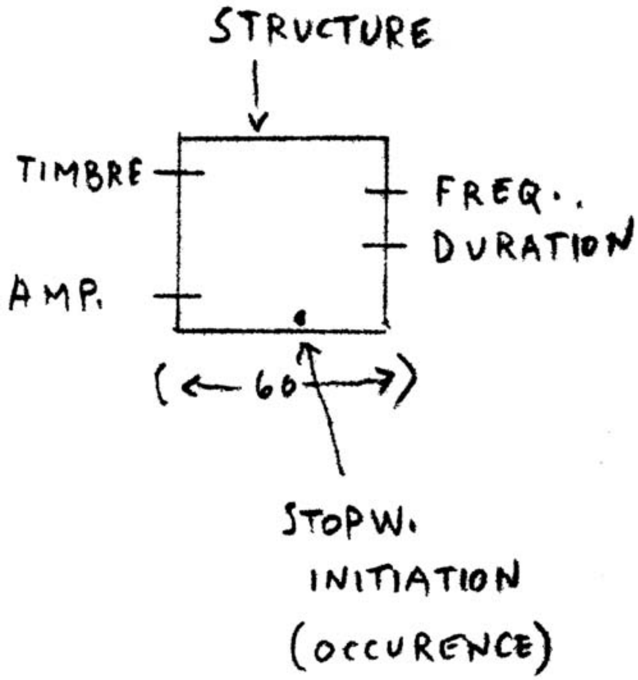


Figure 2.3 Tudor | *Variations II,* explanation of nomographs | Undated
DTP, Box 8, Folder 7 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

Inside the square, the four parameters of timbre, frequency, duration, and amplitude were each assigned a row in that vertical order, and a dashed line was drawn on the left or right margin of the square to indicate whether the value was "simple" or "complex." The point of occurrence was specified on the bottom row by the horizontal position of either a dot or an X, again indicating "simple" or "complex" respectively. Structure was indicated by the presence or absence of an extra square—a double square meant complex (Figure 2.3). Tudor made 50 readings of sound events altogether, drawing the nomographs onto narrow strips of paper each containing 8 or 9 squares (Figure 2.4).

5

But Tudor's papers also contain another kind of material related to the realization of *Variations II* besides these nomographs: several notes listing objects and actions,

general usage. A cut-out of a magazine article on nomograms for RC circuit design is also found among his papers, though it is from a later publication (Donald W. Moffat, "RC Differentiator Design Nomograms," *Electronics World*, July 1968 [Box 37, Folder 9, David Tudor Papers, GRI]).

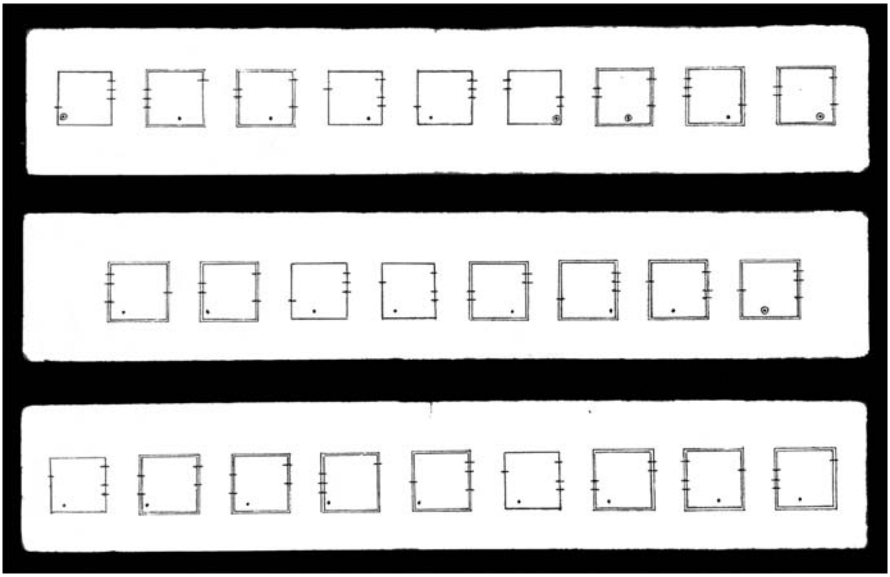
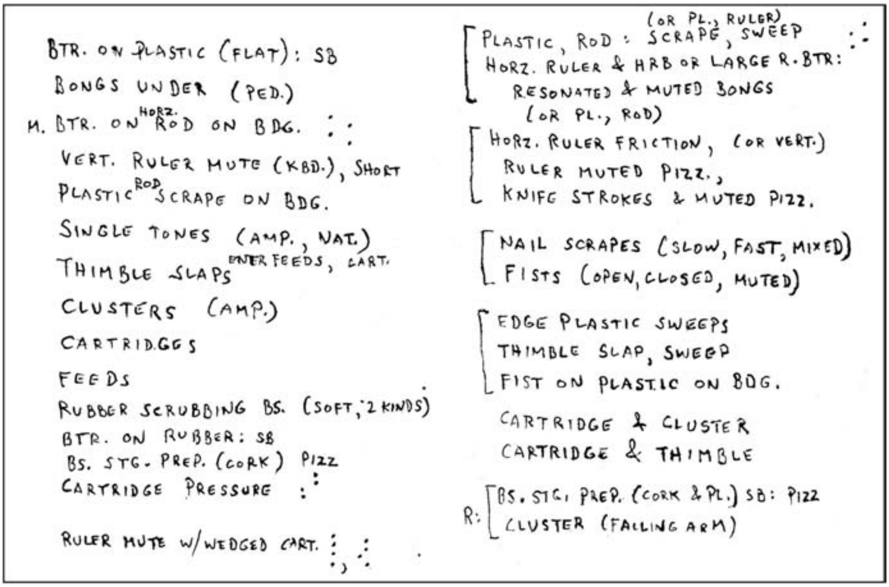


Figure 2.4 Tudor | *Variations II,* nomographs | Undated
DTP, (Box 8, Folder 7) | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

categorized under the same polarity between "complex" and "simple." These were probably prepared on different occasions for actual performances and can be divided largely into two groups according to their content.[54] The first group [A] is composed of five sets of notes, in which the objects and actions belonging to each category (simple/complex) are listed separately in either a single or double column. A close observation suggests the order in which they were made: [A-1] the roughest-looking note, where objects/actions are scribbled across the page in lowercase letters; [A-2] a two-column note, also written in lowercase but now in cursive handwriting, repeating the entries from the first note with some new object/actions added and others omitted; and finally, [A-3] three sets of almost identical notes all written in uppercase. The first two of these

[54] Pritchett briefly mentions these notes in his study but somehow only counts the five sets in the first group, leaving out the second group entirely: "There are five documents listing sounds; each has slightly different contents" (Pritchett, "David Tudor as Composer/Performer in Cage's *Variations II*," 15). In contrast to his careful analysis of the nomographs, Pritchett's observation of these "lists of actions" is hurried and vague, regarding them only as a puzzling yet essentially trivial addendum to the primary material: "A great deal about these lists is unknown [. . .] It is not possible to associate particular actions with particular nomographs. Finally, it is not clear how many, if any, of these actions were actually used in a given performance. However, these lists do give a sense of the kinds of ways in which Tudor interacted with the amplified piano" (Ibid). Iddon also takes note of the same materials in passing, but is similarly quick to dismiss them as being peripheral *because the listed objects/actions cannot be coordinated well with the nomographs* (which he keeps calling "the notation," and appears to regard as the ground for Tudor's realization against which all other materials are measured): "the notation does not allow for any particular one of these forms of action to be specifically determined at any point [. . .] mapping them [the object/action list] directly onto the parameters Tudor used for his notation is not a simple task [. . .] It seems most likely, then, that these were lists that ultimately played only a tangential part in Tudor's realization as such" (Iddon, *John Cage and David Tudor*, 183).



BTR. ON PLASTIC (FLAT): SB
BONGS UNDER (PED.)
M. BTR. ON HORZ. ROD ON BDG.
VERT. RULER MUTE (KBD.), SHORT
PLASTIC ROD SCRAPE ON BDG.
SINGLE TONES (AMP., NAT.)
THIMBLE SLAPS ENTER FEEDS, CART.
CLUSTERS (AMP.)
CARTRIDGES
FEEDS
RUBBER SCRUBBING BS. (SOFT, 2 KINDS)
BTR. ON RUBBER: SB
BS. STG. PREP. (CORK) PIZZ
CARTRIDGE PRESSURE
RULER MUTE W/WEDGED CART.

PLASTIC, ROD: (OR PL., RULER) SCRAPE, SWEEP
HORZ. RULER & HRB OR LARGE R. BTR:
RESONATED & MUTED BONGS
(OR PL., ROD)
HORZ. RULER FRICTION, (OR VERT.)
RULER MUTED PIZZ.,
KNIFE STROKES & MUTED PIZZ.
NAIL SCRAPES (SLOW, FAST, MIXED)
FISTS (OPEN, CLOSED, MUTED)
EDGE PLASTIC SWEEPS
THIMBLE SLAP, SWEEP
FIST ON PLASTIC ON BDG.
CARTRIDGE & CLUSTER
CARTRIDGE & THIMBLE
R: BS. STG. PREP. (CORK & PL.) SB: PIZZ
CLUSTER (FALLING ARM)

Figure 2.5 Tudor | *Variations II*, list of objects and actions [A-3c] | Undated
DTP, Box 8, Folder 7 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust
Abbreviations: "BTR" = beater; "SB" = soundboard; "PED" = pedal; "VERT"./"HORZ". = vertical or horizontal direction in which the triangular scale ruler is used to stroke the strings; "KBD" = keyboard; "BDG" = bridge; "BS. STG." = bass string; "PL" = plastic; "R" = Regular.

[A-3a, b] contain the same objects/actions in the same order, but the third [A-3c] is a two-column note which extends the list with additional entries (Figure 2.5). Although there is no indication of how the objects/actions are grouped, comparison with other lists reveals that the left side is "simple" and the right side is "complex." This is also confirmed by the grouping of multiple objects/actions on the right side using a bracket.

The second group of notes [B] is composed of only two sets sharing the same list of objects and actions, almost entirely different from that of the first group [A]. One set [B-1] sorts out the entries according to the simple-complex polarity, while the other [B-2] mixes both categories, creating a sequence of sorts, perhaps used for a specific realization (though this does not necessarily mean that the list was written before the performance, since Tudor could have documented what he did after the act).

6

Three peculiar details can be observed in these notes:

(a) With the exception of one [B-2], they all lack any indication of sequence between the objects/actions. The lists are reminiscent of Cage's universe of possibilities, atemporal chart of materials waiting to be arranged into a particular continuity in one way or another. This suggests that Tudor may have selected objects/actions out of these lists *during* the performance without deciding on their order in advance.

(b) Aside from two [A-3b, c], they all lack any correspondence with the nomographs. In the two exceptions, the nomographs are represented by four dots indicating the position of four parameters. Since the dots are drawn *after* the name of objects/actions, Tudor very likely started thinking about the coordination only once he wrote down all the possibilities. Other observations enhance this view: the dots are attached to only four objects/actions; two possible configurations are written for a single object/action ("RULER MUTE W/ WEDGED CART"). The correspondence, in other words, appears to have been an afterthought.

(c) Since the four dots are attached to objects/actions contained inside a list, the simple-complex polarity that categorizes the lists themselves can only be either one of the two remaining parameters that are not represented by the dots: point of occurrence or structure. The bracketing of multiple objects/actions on the "complex" side reveals that it is indeed the latter.

When coordinated, these observations suggest a puzzling procedure: Tudor appears to have first listed out the objects and actions he could perform on the amplified piano, sorted them out into a polarity based solely on whether each should be performed alone or in combination, and only then referred to his nomographs. In other words, the nomographs may not have been the endpoint of Tudor's realization. Sometime after making them, Tudor decided to coordinate the simple-complex polarity with just one parameter—that of structure. The remaining five parameters that Cage listed in his instructions were treated as peripheral for the actual performance. The question is why.

Field Conditions

1

When James Pritchett studied Tudor's realization of *Variations II* in 2001, he explained the simplification of procedure from the complexity of the instrument:

> *the system is so complex that its behavior can never be totally predicted: the amplification of the piano made it, to some degree, an uncontrollable instrument.* [. . .] *Clearly, given a performing resource of this nature, a precise approach to realization-through-measurement would be completely inappropriate and futile. Indeed, it was the unpredictability of the amplified piano that not only shaped Tudor's rather*

> *stylized approach to the* Variations II *notation but was the controlling factor in his manner of interpreting the score he had so produced.*[55]

What is true for Tudor's reading of the transparencies is also true for his making of the nomographs. To deal with the complexity, it is explained, Tudor simply switched the level of his control: "Tudor did not interpret the measured parameters as describing the *sounds* to be produced, but instead as describing the *actions* to be performed."[56] Tudor's own comment quoted in Wilding-White's manuscript is cited as proof: "These two terms [simple or complex] apply to the process (involved in creating the sound) and not to the product (i.e. the sound produced)."[57] In short, the reasoning is that (a) Tudor abandoned precision in the reading of Cage's material, and (b) readjusted his understanding of the score as specifying sound to that as specifying action, because (c) the amplified piano was uncontrollable and unpredictable. The problem with this three-step argument is that each of its step is misleading.

2

Precision, action, uncontrollability, and unpredictability are all relative terms whose nature differs according to the *scale of observation*. So the specifics—just what *kind* of precision, action, uncontrollability, and unpredictability—matter. Otherwise uncontrollable and unpredictable instruments had existed from before, for instance in the form of the radios which Cage was fond of using. Tudor certainly understood this, as he wrote in the preparatory notes for his 1959 Darmstadt seminar: "important piece where one can accustom oneself to the idea that anything can happen / WATER MUSIC / […] nos. on tuning dial are written instead of sounds, whatever happens being acceptable (station, static, silence)."[58]

Similarly, the shift of focus from sound to action had already taken place long before the piano was amplified. For instance, even though Cage's scores for the prepared piano were written in staff notation, the various objects inserted in the strings resulted in a note representing not its usual pitch, but which key to press, when, and how. That is to say, the prepared nature of the instrument had revealed that traditional staff notation was in fact a tablature.[59] Tudor yet again knew this very well, as he wrote

[55] Ibid., 14. Iddon also makes a similar observation about the indeterminacy of the instrument resulting from its complexity: "The way in which the electronics interacted with one another, and with the mechanism of the piano, had the effect of making the actual results of any physical action almost impossible to predict accurately" (Iddon, *John Cage and David Tudor*, 186).

[56] Ibid. Iddon again follows suit: "the interaction of parameters as he had notated them necessarily caused him to undertake actions the results of which he would not know at the point of making them;" (Iddon, *John Cage and David Tudor*, 183).

[57] Wilding-White, "10 Selected Realizations."

[58] Tudor, "Notes for Darmstadt Seminar," Box 107, Folder 10, David Tudor Papers, GRI.

[59] As such, it is a relatively recent addition to the long lineage of tablatures for lute and other instruments that extends at least from the fifteenth century, and going further back in time depending on how one looks at things. For instance, even though neume notation is often discussed as one of the first instances of musical writing in the history of Western music, one particular nature of neumes is that, regardless

in the same Darmstadt seminar notes: "cage and prepared piano / [. . .] notating musical actions on the part of the performer."[60]

When Tudor explained that the simple-complex polarity applied to "the process (involved in creating the sound)" Pritchett thought he was talking about "action." But any action to produce sound must always act upon one physical material or another. And most of what Tudor actually wrote down in his list were names of objects. In other words, he coordinated Cage's parameters with neither sounds nor simply actions, but primarily with instruments.

The switch to the simple-complex polarity was therefore not a mere simplification. The appearance of less precision is biased by the idea of precision as something to be measured, and of composition as something written on paper. Everything Tudor did in his realization was coordinated to the nature of his new instrument which demanded not less precision but a *different kind of* precision—just as Boulez's score had demanded "a different kind of continuity" ten years before. Meticulousness was not abandoned but redefined. The question is not whether the amplified piano was unpredictable and uncontrollable, but in which specific ways it was so.

3

On July 26, 1987, Tudor looked back on what was so new about the instrument he had composed twenty-six years before:

> *I had been working with amplifying the piano in terms of realizing this score, and I began to see that I had to consider it as a completely new instrument. Therefore if you try to tabulate settings of electronic equipment in relation to ordinary acoustic parameters, you're dealing with conditions that are not precise in the way you're accustomed to think of precision. You're dealing with field conditions where the difference between 3 and 4 is rather the difference between 1 to 5 and 2 to 8.*[61]

of the never-ending arguments about where they came from, they are always found written above texts of hymns to be sung. In other words, the only reason for regarding neumes as the first instance of notation lies in the belief that these signs are "musical" but the alphabets composing the main text are not. However, this belief is grounded on an arbitrary distinction between the two forms of signs, both of which actually instruct the singer how to articulate and use her instrument, which is to say the voice. The argument Shane Butler makes on the performativity of ancient written text can be expanded to analyze texts written in alphabet as tablatures for the voice: Butler, *The Ancient Phonograph* (Cambridge, MA: MIT Press, 2015). For further inspiration, see also the later writings of Friedrich Kittler (*Musik und Mathematik I: Hellas 1: Aphrodite*, [Munich, Germany: Wilhelm Fink, 2006]; *Musik und Mathematik I. Hellas 2: Eros* [Paderborn, Germany: Wilhelm Fink, 2009]); and his primary source material, Barry B. Powell, *Homer and the Origin of the Greek Alphabet* (Cambridge, UK: Cambridge University Press, 1991).

[60] Tudor, "Notes for Darmstadt Seminar." This description coordinates with Liz Kotz's much later observation: "Although Cage's score for the *Sonatas and Interludes* still looks conventional, the function of notation has begun to move away from representing sounds toward an operational model, indicating actions" (Liz Kotz, *Words to Be Looked At: Language in 1960s Art* [Boston, MA: MIT Press, 2007], 38).

[61] David Tudor, "Interview with Peter Dickinson, Ibis Hotel, London, July 26, 1987," in Peter Dickinson, ed., *CageTalk: Dialogues with and about John Cage* (Rochester, NY: University of Rochester Press, 2006), 84–85.

Field conditions involve a different kind of difference—and by corollary, of precision. Talking to Hultberg a year later, in May 1988, Tudor explained the same difference between differences, using the case of Cage, who couldn't tell the one from the other:

> *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.*[62]

In both reminiscences, Tudor was talking about something very specific. Against the common observation that the transparencies of *Variations II* contain the possibility to make any piece of music, he had realized an inherent bias in Cage's material: its universe of possibilities may have encompassed all sounds, but *not all sound-producing means*. Parameters of sound always appear to neutralize the physicality of instruments used to realize them. But instruments are never as seemingly neutral as sounds are, which makes Cage's transparencies coordinate better with some than others. The composer who left instrumentation open in his score was probably not thinking about any specific instrument other than *David Tudor*. But the parameters he listed in the instructions were actually tailored to a particular coordination between *two* instruments that he had become so used to that he now took for granted without realizing so: *David Tudor* playing the piano.[63] This habitual instrumentation would have surely controlled all the specified parameters with absolute precision. But Tudor was now playing something else—or rather, the piano was playing another role. And Cage's six parameters were not distributed as evenly on the amplified piano as they had been on the piano. The nomographs, in spite of their good looks, were mere redrawings of the same parameters. This would explain why they appear to have become peripheral at one point in the process of realization. Tudor must have realized that the nature of his new instrument was not a mere fortification of the unamplified piano, as he claimed over and over again, for instance in April 1967, on the very last occasion when *Variations II* was performed before its revival in 1980: "In it the piano is merely a part of an electronic complex."[64] Which is to say that the primary interface Tudor had in mind was not the keyboard—it was *the dials on an amplifier*, the only part of his "electronic complex" he was actually talking about in both reminiscences.

[62] Tudor, "Interview by Teddy Hultberg."

[63] In other words, Cage's habit had universalized this particular instrumentation as a neutral and natural standard encompassing all instruments. And what did not fit this norm became universalized negatively as being nonexistent, just as when certain types of continuity were deemed as no-continuity, and certain forms of precision as an absence of one.

[64] Tudor, "Program note, Troisiéme Concert de la Société de Musique Contemporaine du Québec (April 5, 1967)," Box 76, Folder 4, David Tudor Papers, GRI.

4

It is not clear what amplifier Tudor used for the premiere of *Variations II* at the New School in New York City on March 25, 1961, or for any of the subsequent performances throughout that year. The receipts he kept only reveal the purchase of two *Lafayette PK-522 Three-Transistor Amplifier* kits a year later on April 24, 1962, followed almost immediately by another Lafayette product, the *PA-292 Transistorized Microphone Mixer* on May 7.[65] As their names indicate, these instruments all used "transistors," a small electronic component that could amplify signals, which had been invented fifteen years before, in 1947. The three co-inventors were all physicists working for Bell Labs, the research facility of American Telephone and Telegraph Company (AT&T)—a corporation with an obvious interest in the development of a more robust and efficient form of amplification to replace the old vacuum tubes. Transistors began to populate the internal circuits of commercial products in the 1950s, and by the start of the following decade, they had made their way into popular electronics magazines and amateur hobbyist kits, two major resources for Tudor's pursuit of electronic music. The market at the time was dominated by Lafayette Radio Electronics. One of their products, *PA-292 Transistorized Microphone Mixer*, was advertised in the September 1962 issue of *Electronics Illustrated* as a cheap substitute for an instrument that was still an expensive novelty back then:

> *Professionals use a device called a mixer which is capable of accepting several different inputs and mixing them in any desired proportion into a single signal.* [. . .] *The amateur can get the same kind of professional results with an ingenious low-cost transistorized mixer—one that can be built for under $20. Each channel of this mixer can take up to four signals from microphones, tuners, phonographs, recorders, etc. The level on all four of the mixer inputs can be varied independently and combined into a single output.*[66]

In addition to mixing four signals into one, the transistor inside the *PA-292* also amplified signals from each input separately. It had a "gain"—the amount of amplification expressed as the ratio of input to output voltage—of 2,[67] which equals 6 decibels (dB) in the logarithmic unit it is usually calculated to compress the larger scales of amplification into a smaller scale.[68] As Tudor would summarize later to John David

[65] Lafayette Radio Electronics, "Receipt for *PA-292* (May 7, 1962)," Box 120, Folder 1, David Tudor Papers, GRI.

[66] Harry Kolbe, "Stereo Mike Mixer," *Electronics Illustrated* (September 1962), 67.

[67] Lafayette Radio Electronics, "Model PA-292 4 Channel Transistorized Microphone Mixer manual," Box 41, Folder 6, David Tudor Papers, GRI.

[68] Logarithm converts nonlinear exponential series that increase by multiplication into linear series that increase by addition. Human perception of loudness of sound (among many other sensory perceptions such as that of frequency) follows nonlinear logarithmic scale which allows us to perceive both subtle differences in small sounds as well as huge differences over a wide range of amplitude.

Figure 2.6 *Lafayette PA-292 Transistorized Microphone Mixer*
DTC, Instrument 0146 | World Instrument Collection, Wesleyan University

Fullemann on September 3, 1984: "It's all gain stages of one kind or another"[69]—which is to say, all electronic instruments are amplifiers of one kind or another.

Many instruments using the *PK-522 Amplifier* as well as five *PA-292 Mixers* are among the David Tudor Instrument Collection at Wesleyan University (Figure 2.6).[70] When the 500 or so instruments arrived there from Stony Point in 1996, Matt Rogalsky created an inventory, giving each item a number, according to which one of the *PA-292* is "Instrument 0146" and all the others are collectively labeled "Instrument 0449."[71]

These amplifiers had only one control: gain. Other, slightly more sophisticated ones that Tudor sometimes used later to perform *Variations II* could add a second parameter: tone, the equalization of frequency components. By filtering out particular frequencies, the tone dial would affect "timbre" and could be used to influence the overall "frequency" (especially of feedback). But this also means that these two parameters were interdependent and could not be controlled separately.[72] The same is true for "points of occurrence" and "duration": the starting and ending of a sound event must be controlled either outside the amplifier, or by turning the gain control on and off. As for "structure of an event," there was no choice but to resort to other

[69] David Tudor, "'. . . performing is very much like cooking: putting it all together, raising the temperature,' Interview by John David Fullemann," September 3, 1984, Stockholm, davidtudor.org, accessed December 15, 2019: http://davidtudor.org/Articles/fullemann.html

[70] Tudor had bought a second copy of *PA-292* on June 19, 1963 (Lafayette Radio Electronics, "Receipt for *PA-292* [June 19, 1963]," Box 120, Folder 4, David Tudor Papers, GRI).

[71] Two of the *PA-292*s—Instrument 0146 and one of the 0449—are modified with two additional inputs. The instrument number 0449 also applies to twelve other similar transistorized microphone mixers sold from different companies: two from Calrad, two from Olson, four *Lafayette 99-4563*, three *Lafayette 99-4535*, and one *AMD 44-460*.

[72] Tudor noted the same observation in his corrections for Wilding-White's draft: "dynamics; timbre / change w / variations of amplitude / characteristics of sound produced thru use of contact mics" (David Tudor, "Corrections to the Draft of '10 Selected Realizations of Graphic Scores and Related Performances,'" Box 19, Folder 2, David Tudor Papers, GRI).

means. So among the six parameters that Cage specified, the amplifier seems most suited to controlling "amplitude"—which may sound as a matter of course.

Yet, what Tudor realized by actually performing the works of Nilsson and Cage was that amplitude control was not as obvious as it seems. The composers were wrong about the nature of this instrument. The amplifier does not obey simple linear measurement—the continuity that Nilsson imagined between Tudor's dynamics and the amplifier's gain did not exist. The former could be specified as a point on a scale, but the latter was a "field condition": the difference between the dial setting 3 and 4 might not make any difference.[73] As far as Cage's parameters go, then, the only difference that could be specified with any precision for amplifiers was *whether or not there was a difference*. Tudor's polarity reflects this realization. What he specifies as "simple" are all discrete points on a scale that formerly would have been obtained through precise measurement: fixed amplitude, unchanging frequency, particular duration, determinate spectrum, and a specific point of occurrence. "Complex" values, in turn, are those that do not follow such measurement. So precision was not abandoned—it was simply relativized as "one" value. No longer was there any meaningful difference between one fixed value and another, but only between the fields of fixity and non-fixity. The very form of difference now differed. The new instrument had rendered the previous scale into a point on a new scale.[74] One extraordinary material documenting Tudor's actual realization of *Variations II* further amplifies these observations.

Musik im technischen Zeitalter

1

On January 21, 1963, Tudor and Cage appeared on the German TV show "Musik im technischen Zeitalter," hosted by the composer and musicologist Hans Heinz Stuckenschmidt. Invited to give a televised presentation of his music, Cage organized

[73] Perhaps surprisingly, Cage's treatment of the amplifier's gain and tone control in *Cartridge Music*, which preceded *Variations II*, was reminiscent of Tudor's later polarity: the movement of dials was instructed without specifying the degree of alteration. Nevertheless, in their realizations both Cage and Tudor determined fixed points of control.

[74] This realization by Tudor explains why Cage started to reflect critically on the use of "measurements" in *Variations II*, which he abandoned in the next piece of the same series. In other words, Cage discarded measurement after *Variations II* because Tudor had discarded it in his realization. "I have wished to renounce measurements, whether of pitches or their durations or the length of time between them. This movement on the part of my ideas is reflected in my *Variations, Variations II, Variations III* and *Variations IV.* The first two of these (1958 and 1961) involve measurements to be made by performers from the superimposing of transparent materials provided by me. These measurements fix (or suggest) the point in total sound-space-time of a sound to be produced since they deal with its various parameters. [. . .] In *Variations III* the principal of single notations on single transparent sheets is kept, but instead of there being lines and points (and measurements to be made), there are only circles (and no measurements to be made). The fact that we are continually active and that all of this activity is productive of music—no distinction between art and life being asserted—is what this work invites one to realize" (Cage, "Letter to Edward Downes [March 31, 1965]," *Selected Letters*, 315).

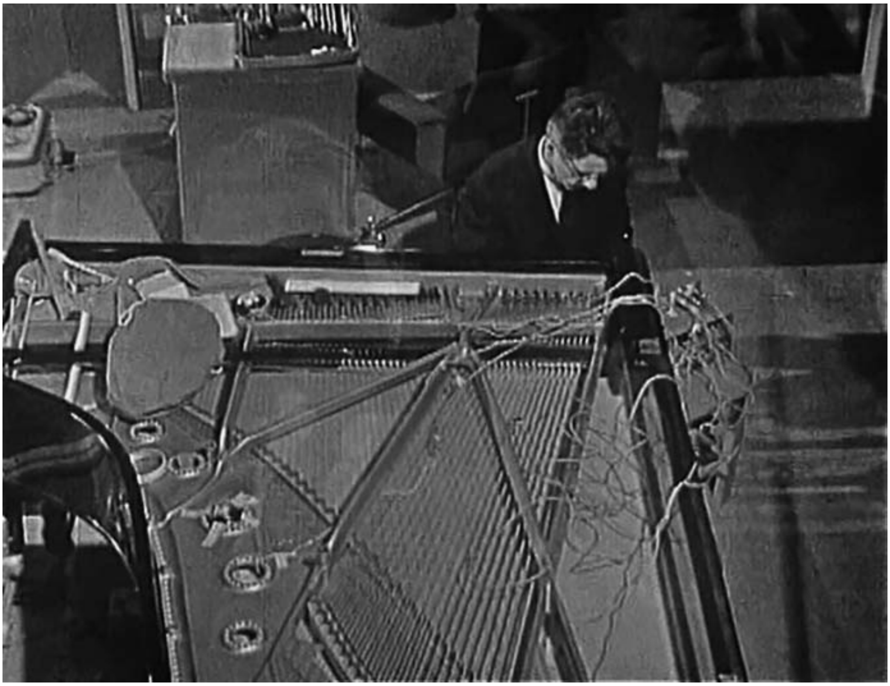


Figure 2.7 Amplified piano for *Variations II* | January 21, 1963
Stillshot from "Musik im technischen Zeitalter"

a live event where he performed *Variations III* for the first time, while Tudor used two amplified pianos to perform *Variations II* simultaneously with *Fontana Mix*, yet another set of transparency materials from 1958.[75] It was as if Tudor and Cage were bringing the superimpositions of materials realized by transparencies onto the stage.

The third piece in the *Variations* series focused on the amplification of sounds that "actions" created as a side effect, with a set of transparencies to determine the details and location of their occurrence. The ones Cage chose included answering Professor Stuckenschmidt's questions while smoking, typewriting letters, and reciting what he had typed, all with contact microphones attached to his body and the various objects employed. Eighty minutes of this thunderous concert were broadcast live by Sender Freies Berlin to the peaceful homes of local West Berliners from 6 p.m. on an otherwise usual Monday evening. The camera also turned frequently to the audience assembled

[75] It appears that *Variations II* was a last-minute addition since the letter Cage sent to Stuckenschmidt two weeks before the broadcast does not mention the piece at all: "Our plans for the broadcast is the following: 1) a performance throughout the broadcast time by David Tudor of two of my compositions simultaneous—i.e., superimposed—*Variations III* and a new realization by Tudor of *Fontana Mix*: 2) a performance throughout the broadcast time—i.e., superimposed on the above Tudor performance—of *Variations III*. *Variations III* will on this occasion take the form of speech and speech preparation together with any necessary translations or comments, and, furthermore, with any questions from the audience, both the audience in the hall and the audience viewing the broadcast" (Cage, "Letter to Hans Heinz Stuckenschmidt [January 2, 1963]," *Selected Letters*, 280).

Figure 2.8 Amplifiers for *Variations II* | January 21, 1963
Stillshot from "Musik im technischen Zeitalter"

at the Berlin University of Technology, most of whom looked puzzled—at one point a very disturbed looking Paul Hindemith (or someone with an uncanny likeness to the German composer who passed away that year) appears on-screen (44′15″–27″).

Which is also to say that a copy of the broadcast still exists.[76] In the footage, Tudor is seen moving back and forth between the two amplified pianos on stage, playing *Variations II* on one and *Fontana Mix* on the other. Each piano is heavily amplified: four contact microphones or cartridges attached to the soundboard and strings (mostly bass strings); two contact microphones or cartridges attached to the webs of the cast-iron frame; and two cartridges placed by the tuning pins (Figure 2.7). All the sounds picked up go into a small four-channel microphone mixer with gain controls looking a lot like the *PA-292* which Tudor already owned by then, and another larger amplifier under it which has both gain and tone control (Figure 2.8).[77]

[76] *Musik im technischen Zeitalter: John Cage mit David Tudor*, January 21, 1963, Sender Freies Berlin, ZKM, 1963. I am very grateful to the Staatlichen Instituts für Musikforschung in Berlin for providing me with a copy of this tape. The following analysis is based on this copy. The same footage can also be seen on YouTube: "John Cage + David Tudor—Musik Im Technischen Zeitalter 1963," YouTube, accessed December 15, 2019: https://www.youtube.com/watch?v=9IAWKjvt6A4

[77] On January 2, Cage had written to Stuckenschmidt about the plans for the broadcast and what equipment were necessary. For Tudor, in addition to two grand pianos with three pedals each, the composer requested:

2 amplifiers with at least 3 high impedance inputs each
2 standing microphones, one of which should have an on and off switch connected with the microphone. One or both of these has to go into one of above amplifier. If one microphone is low impedance it must have its own amplifier.

2

The camera switches back and forth between the two performers during the program, offering only a partial view of what Tudor is doing. But the outline of his performance can still be followed. He starts on the amplified piano at the far end of the stage. The nomographs laid above the tuning pins reveal that this is the instrument for *Variations II*. Tudor is initially looking at a sheet of paper, presumably one of the notes with the list of objects/actions (Figure 2.9). He takes his time to decide what to do.

For the first event, Tudor stands at the spine of the piano and scrapes the bass strings with the edge of a thick plastic disc for about thirty seconds. He then moves to the bent side and scrapes another set of bass strings with what looks like a thimble (Figure 2.10), hitting the frame after ten seconds or so. He stops for a moment and then continues to scrape the bass strings with the thimble, now adding force, with an occasional fist strike on the plastic disc laid on the hitch pins of the strings being scraped. This goes on for about fifty seconds. Everything so far corresponds to the fourth group under the category of "complex" in the note [A-3c], three actions and objects joined with a square bracket: "EDGE PLASTIC SWEEPS," "THIMBLE SLAPS, SWEEPS," and "FIST ON PLASTIC ON BDG."

The camera then turns to Cage and no amplified piano sound is heard for two minutes, during which Tudor moves to the *Fontana Mix* instrument. Here, Tudor spends the next six minutes striking keys and immediately controlling the amplifier with both hands to modulate the resulting resonance and feedback (Figures 2.11 and 2.12). Otherwise, he scrapes the bass string with one hand while manipulating the tone control with the other.

The time spent on each amplified piano varies between six and twenty minutes. Overall, there is more striking of keys in the *Fontana Mix* instrument, while there is more action on the strings in the *Variations II* instrument: scraping and striking them with a triangular scale ruler, different shaped rubbers, or a pipe cleaner inserted into a cartridge; otherwise directly rubbing or pressing the cartridges on them (Figures 2.13 and 2.14).

Cage requested three more amplifiers for himself:

And for me:

1. *Amplifier with mixer with 8 high impedance inputs on a table with sufficient space to write and typewrite.*
2. *Amplifier with Lavalier microphone preferably with on-off switch plus 3 additional high impedance inputs. This set-up should be associated with a speaker's pulpit.*
3. *Normal table microphone associated with a low table and chair, the amplifier having three additional high impedance inputs.*

He also added, "All amplifiers must have 2 tone controls (bass and treble) and they must be under the control of the performers. The entire production of sound and speech should issue from as many independent loud-speaker systems as possible in relation to the five amplifiers (at least 2 and preferably more loud-speaker systems)" (Cage, "Letter to Hans Heinz Stuckenschmidt [January 2, 1963]," *Selected Letters*, 280).

Figure 2.9 Tudor reading his notes at the start of the performance with nomographs placed above the tuning pins (4′42″) | January 21, 1963
Stillshot from "Musik im technischen Zeitalter"

Figure 2.10 Scraping strings with a *Thimble*, with a *Plastic Disc* on the hitch pins (8′54″) | January 21, 1963
Stillshot from "Musik im technischen Zeitalter"

Figure 2.11 Hitting strings while manipulating the amplifier dials (14′21″) | January 21, 1963
Stillshot from “Musik im technischen Zeitalter”

Figure 2.12 Playing low keys while manipulating the amplifier dials (16′19″) | January 21, 1963
Stillshot from “Musik im technischen Zeitalter”

Figure 2.13 Scraping strings with a *Wire* inserted in a *Cartridge* (19′37″) | January 21, 1963
Stillshot from "Musik im technischen Zeitalter"

Figure 2.14 Scraping strings with a *Triangular Scale Ruler* (23′30″) | January 21, 1963
Stillshot from "Musik im technischen Zeitalter"

An amplified Slinky is hanging from a metal stand next to the *Fontana Mix* instrument. Tudor hits and places it inside the instrument at various moments, stretching and wiggling it on the strings (Figure 2.15). At one point Tudor installs a gyroscope on one of the webs in each amplified piano, taping it onto the cast-iron frame and winding a string around its spin axis (Figures 2.16 and 2.17). Afterward, the string is pulled and the sound of the spinning wheel is picked up by a nearby cartridge (Figure 2.18).

All the events performed on the *Variations II* instrument during the broadcast can be matched with the objects and actions in Tudor's notes. In the order of their appearance they are:

EDGE PLASTIC SWEEPS / THIMBLE SLAP, SWEEP / FIST ON PLASTIC ON BDG.
HORIZONTAL RULER FRICTION, RULE MUTED PIZZ., KNIFE STROKES[78] & MUTED PIZZ.
RUBBER SCRUBBING BS. (SOFT; 2 KINDS)
CARTRIDGE & CLUSTER
GYROSCOPE
CARTRIDGE PRESSURE
FEED(BACK)

This specific sequence does not correspond to the only note that aligns the events in a temporal order [B-2]. The events in the broadcast are mostly selected from the first groups of notes [A], though "GYROSCOPE" only appears in the second group [B]. Tudor may have selected from the two groups of notes or used a different note which has not survived.

3

At one point in the broadcast, about 27 minutes into the program, Professor Stuckenschmidt read out a question from the audience which the interpreter on stage translated: "Mr. Cage, why do you prepare the piano? Are you trying to achieve a new tone color as it is used on organ stops? Or are you criticizing the piano because in your opinion it is obsolete as an instrument and no longer useful?"[79] Cage answered immediately: "No, I would never say that the piano is obsolete. It is extremely useful." A burst of laughter arose from the audience. Cage, looking indifferent, continued: "I was reading, oh, about eight months ago, a book of the architect Le Corbusier, and he used the terms 'instrument' and 'tool.' A tool, for instance, is like a knife. When you use a knife, that is to say, to cut something, it doesn't leave itself on the thing that is cut. Whereas when you … rather when you play ah …" He stopped there as Tudor began

[78] "Knife strokes" refers to Tudor's karate chops on the strings.
[79] *Musik im technischen Zeitalter*. All the quotes that follow are taken from the same footage.

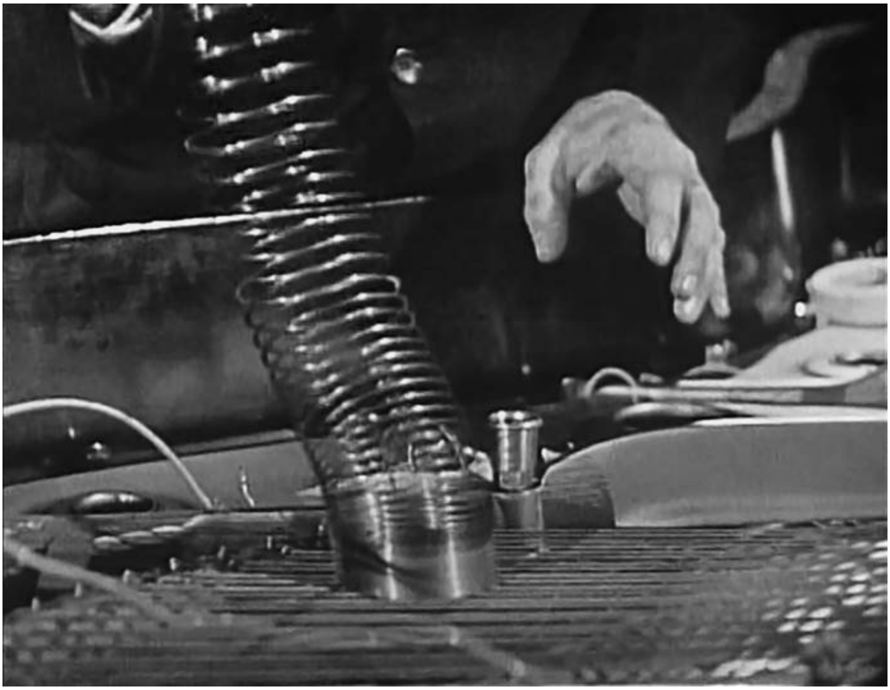


Figure 2.15 *Slinky* on piano strings (60'00") | January 21, 1963
Stillshot from "Musik im technischen Zeitalter"

Figure 2.16 Setting up a *Gyroscope* (close-up) (47'09") | January 21, 1963
Stillshot from "Musik im technischen Zeitalter"

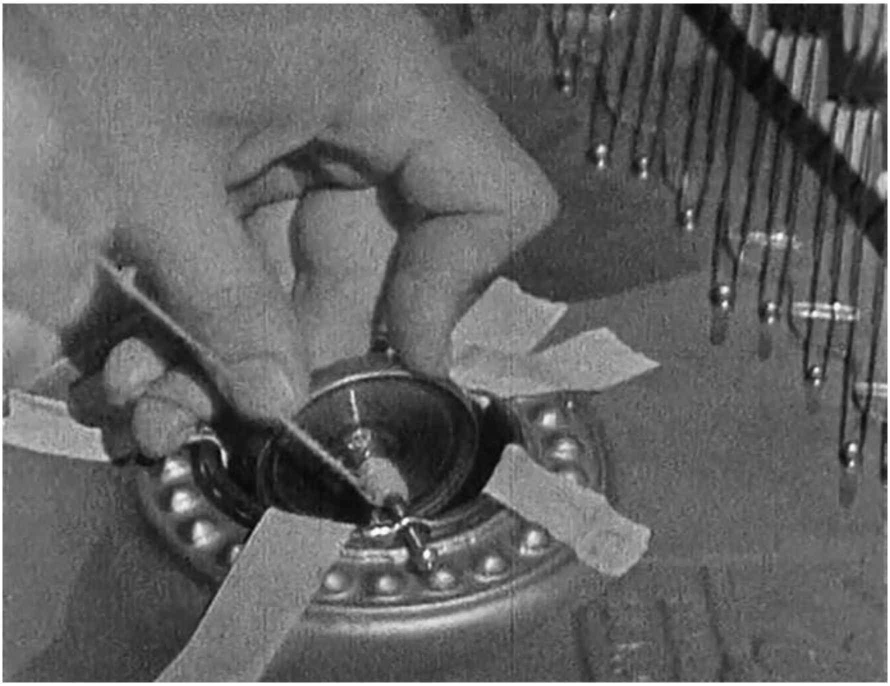


Figure 2.17 Setting up a *Gyroscope* (47'09") | January 21, 1963
Stillshot from "Musik im technischen Zeitalter"

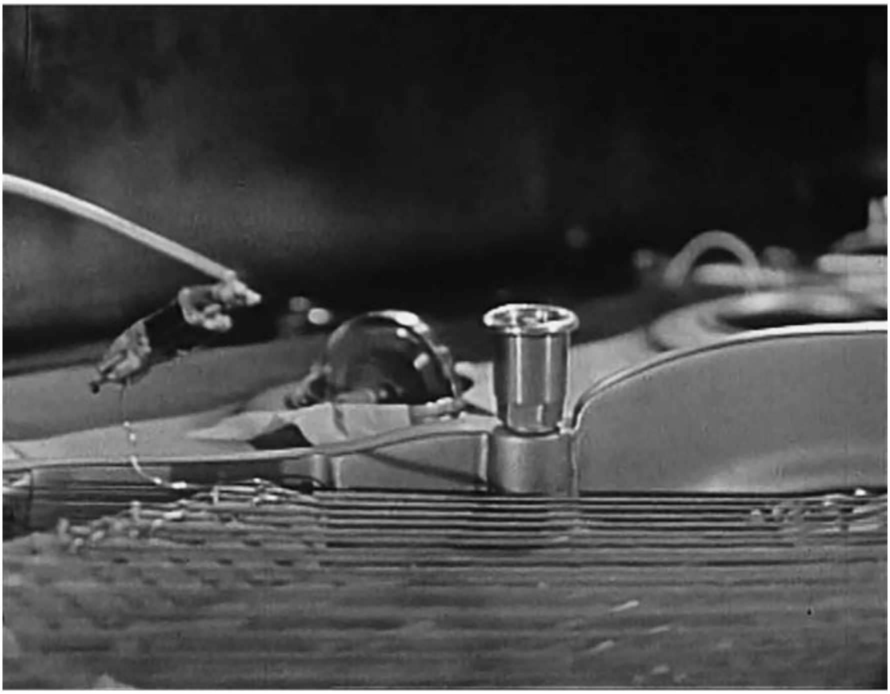


Figure 2.18 *Gyroscope* rotating after Tudor pulls the strings (56'50") | January 21, 1963
Stillshot from "Musik im technischen Zeitalter"

scraping the strings of one of the amplified pianos and the fortified sound coming out from the loudspeaker was scattered all over what he had to say. Cage waited until Tudor was done to continue his thoughts: "… in opposition to a tool, we have the piano as an instrument. And when the piano is not prepared, unlike a knife, it leaves its tones scattered all over the music that was played on it. We try to turn the piano then, by constantly changing it, into something that resembles a tool rather than an instrument."[80]

Eight months before, in May 1962, Cage had written a text titled "Rhythm Etc." as an homage to Tudor in which he indeed referred to his then-recent reading of Le Corbusier's book *The Modulor.*[81] The composer took the polarity between "tool" and "instrument" from the architect, and called for the disguise of one as the other:

> *we must dispense with instruments altogether and get used to working with tools. Then, God willing, we'll get some work done. It can be put this way too: find ways of using instruments as though they were tools, i.e., so that they leave no traces. That's precisely what our tape-recorders, amplifiers, microphones, loud-speakers, photoelectric cells, etc., are: things to be used which don't necessarily determine the nature of what is done.*[82]

Cage certainly had more experience with actual technology than Nilsson.[83] But he nonetheless conceived of electronic instruments as means to transcend the dirty materiality of acoustic instruments. Very much like his transparency materials, electronics were neutral "tools," only presenting possibilities and no biases. That is why they were to be taken as models when approaching non-electronic instruments like the piano, so that the latter may be used *as if* it were a tool.

Cage may not have thought about the implication of this formula for Tudor, to whom the text paid homage, and who also happened to be the most important of all his "instruments." As with the tossing of coins, Tudor made possible things that Cage had never thought possible. If anything, he was the "thing to be used which necessarily determined the nature of what is done." But precisely because of this, Cage could switch his responsibility "from the making of choices to that of asking

[80] Ibid.
[81] Cage, "Rhythm Etc.," in *A Year from Monday*.
[82] Ibid., 124.
[83] On January 4, 1961, Cage wrote to Lawrence Morton proposing a program for the Monday Evening Concerts series in Los Angeles that included *Atlas Eclipticalis*, a new piece which called for a "maximum electrification of the orchestra." He described the requirements: "David Tudor will use two contact microphones on the piano and must have control of the amplifier to which these are connected (or amplifiers). As many of the remaining 12 players as possible should also have contact microphones. This possibility is determined by the amplifiers available—the number necessary being reduced if mixers are available. These amplified sounds should go to as many different loudspeakers differently situated as you are able to gather together" (Cage, "Letter to Lawrence Morton [January 4, 1961]," *Selected Letters*, 239). Three paragraphs later he apologized: "I am sorry my remarks above the electrical equipment are so vague. This is due partly to my not being an electronic expert, and partly to my wishing to go as far as your resources will permit towards the total electrification of the ensemble" (ibid.).

questions."[84] Whatever answer is obtained became a matter of chance and the act of accepting them a matter of discipline. If instruments could disguise themselves as tools, it was because their bias had been generalized to such an extent that it became a virtual ground for measuring other instruments, just like the coordination between Tudor and the piano, which Cage took for granted. It did not determine the nature of what was done because it had itself become nature.

But Tudor assumed a different responsibility for himself, as he revealed one day in March 1968 to his collaborator Lowell Cross, who later recalled: "Once after an all-Cage concert at the University of Rochester, he said to me, 'I believe that it's my responsibility to add as much dirt as possible to the performance.' "[85] This responsibility turns Cage's formula on its head: the necessary thing to do to get any work done is to see even "tools" as "instruments." Just as he realized the instrumental bias of Cage's seemingly neutral transparencies, the way Tudor changed the piano was indeed quite the opposite of turning it into a transparent tool.

4

Throughout the performance of "Musik im technischen Zeitalter," the primary actions occur on the tone and gain controls of the amplifier, which are manipulated almost as often as sound is produced on the strings and many times simultaneously using both hands. The keyboard is now just one of the many secondary interfaces used to excite the strings or trigger feedback. The attacks using objects concentrate on the bass strings to produce greater resonance, but also to exploit the physical bias of the wound strings: the distinct erratic rhythm prominent in the recordings of *Variations II* was produced by the resistance of the copper windings to Tudor's scrapings.[86] All in all, the piano is used as a resonance chamber with a variety of interfaces dispersed across its body, coordinated with electronic means to amplify or change the quality of its sound.

What is surprising is how the amplified piano appears to be a much more controllable instrument than has been imagined.[87] Or more precisely, there is a specific way in which this "electronic complex" is unpredictable. In fact, Tudor had already revealed this to Wilding-White in 1973: "The nature of this amplification was such that *neither the quality nor the duration* of the output could be predicted."[88]

[84] Bill Womack "The Music of Contingency: An Interview," *Zero* 3 (1979); also in Richard Kostelanetz, ed., *Conversing with Cage* (2nd edition) (New York, NY: Routledge, 2003), 45.

[85] Lowell Cross, "Remembering David Tudor: A 75th Anniversary Memoir," lowelcross.com, accessed December 15, 2018: http://www.lowellcross.com/articles/tudor/coda.html

[86] David Tudor, *Variations II, in New Electronic Music from Leaders of The Avant-Garde*, Columbia Masterworks, Music of Our Time (MS 7051), 1967, LP.

[87] Though the apparent absence of air microphones near the piano—possibly due to the setting for broadcast—might have influenced this to a certain extent.

[88] Wilding-White, "10 Selected Realizations."; emphasis added.

In the unamplified piano, escapement control had allowed the pianist to influence the quality of tone through precise control of duration. As Cage looked back on Tudor's abilities as a pianist, "He had a prodigious sense of the qualities of each sound."[89] In the amplified piano, however, the main source of indeterminacy was acoustic feedback between the microphones, loudspeakers, and the piano as a resonance chamber, which introduced the possibility of unpredictable quality in addition to indefinite duration. The nature of Tudor's new instrument went directly against the nature of his old instrument. And as if to amplify this very difference, Tudor had composed his new instrument around feedback.

5

Still, the ways in which quality and duration were indeterminate differed. Quality could neither be controlled by fixed points nor decomposed into separate parameters of timbre, frequency, and dynamics (to stick to Cage's original categories). However, it could be *modified* by turning the dials on the amplifier—as Tudor occasionally did toward the end of the broadcast, as well as in the available recording from 1967.[90]

Duration was indeterminate for a different reason. Tudor could always turn the dials completely off to cut the feedback and turn it back on to restart it. But unless he intervened, feedback could go on and on. The problem therefore concerned not the impossibility of precise control, but rather the necessity of arbitrary stop, which is to say *gating*. And this was not only about feedback. Unlike the unamplified piano whose sounds decay naturally, most sounds produced by the amplified piano did not end on their own. As a result, duration turns out to be the most puzzling parameter in Tudor's realization of *Variations II*. For one thing, neither the nomographs nor the lists of objects and actions contain any specification about when things end. The parameter of occurrence, or when things start, is written in the nomographs as the relative point of "stopwatch initiation," but there is no corresponding point for its termination. According to Tudor's description, duration, if "simple," meant simply to "take its own time." Or as he explained to Wilding-White in 1973: "Duration would refer to the time required to produce the sound."[91] However, with the exception of the gyroscope, which must stop its spinning sooner or later, and the Slinky, which also must stop its wobbling at some point, none of the other sound events listed by Tudor appears to have any specific duration to call its own.[92]

[89] Cage, *For the Birds*, 126.

[90] Tudor, *Variations II*, in *New Electronic Music from Leaders of the Avant-Garde*.

[91] Wilding-White, "10 Selected Realizations."

[92] Pritchett's description follows Tudor's linguistic explanation without analyzing how he actually performed the work: "The notes about the interpretation of duration, for example, show very clearly the difference between describing a sound and describing a process. Sounds with simple durations 'take their own time'—the duration is determined by the sound itself without need for any intervention on the performer's part. Complex durations are those that require the performer to conceive, manage or invent them: ones that overlap, etc." (Pritchett, "David Tudor as Composer/Performer in Cage's *Variations II*," 14).

How Tudor determined duration was also what puzzled Cage most about his realization, as he confessed to Daniel Charles circa 1970:

> *So, using my transparencies, he obtained directives concerning the simplicity or complexity of each musical event, and I believe he let them establish their own time. In other words, for each sound, he responded to the information supplied by the transparencies and their combinations requiring, for example, a complex overtone structure, simple frequencies, and a complex amplitude for a given sound. Once he had found these characteristics, I think he sought a time duration which would respond to the whole of these characteristics, that is, which would let this whole find its own time. I believe this is the case, but I'm not sure about it, as far as duration is concerned.*[93]

The footage of the 1963 broadcast offers only a few clues, most of them concerning what Tudor did *not* do. It reveals that the physical nature of the piano were not used to this end—the duration of scrapings, for instance, does not appear to be determined by the particular length of the strings being scraped.[94] One possibility is that Tudor was simply using the point of occurrence of the following event to determine the end of the previous one. In that case, the indeterminacy of duration would only apply to the very last event in the performance—which could then be easily determined by the length of the entire event, itself determined by some other external factor. However, such articulation of time imposed from outside does not sit well with the definition of duration as something internal to the events themselves. Moreover, Tudor not once appears to be consulting a stopwatch during the entire broadcast. This suggests that he may have regarded "the point of occurrence" as an *auxiliary* parameter—as he seems to have done with all the other parameters except structure. In other words, he may have replaced all kinds of measurement—including that of time—with a quick "observation," not only in reading Cage's transparency materials, but also in reading the face of his stopwatch during the performance.

6

Whatever it was that determined how long a sound went on for, the extremely long sounds generated by feedback was a radical departure from the extremely short sounds Tudor had been focusing until then. But this was also a strange return of sorts, for such sounds with no end were reminiscent of the organ sound produced through the mechanism of constant wind supply—itself realized by an electrical power supply in modern instruments—and the function of keys as gating control. Much later, as he

[93] Cage, *For the Birds*, 128–129.
[94] As Tudor would later do for the realization of Toshi Ichiyanagi's *Music for Piano No. 4* (1963), where the physical nature of the piano itself was used to determine the duration of events.

talked with Jack Vees on July 12, 1995, Tudor reflected on the influence of his early exposure to this giant instrument on the style of his electronic music:

> *You could say that my sound imagination was controlled by [the organ], and even to this day, you could see the traces in my own music. For instance, one aspect that seems very obvious to me is the aspect of the group duration.* [. . .] *You know, how long I continue with one idea without recessively introducing variations. That comes from the fact that when dealing with the organ, you* don't have a specific duration, *that's a part of the music that you create.*[95]

A year earlier, in spring 1994, Tudor had explained to his collaborator Sophia Ogielska what he was doing with electronics using a fantastic metaphor: "imagine a huge piano few miles, twenty miles long. I play the piano and run very fast to the end, and the sound that already started, it never disappears, so it repeats itself endlessly."[96] Aside from the physical scale, he could have been describing the amplified piano.

With this new instrument, Tudor no longer needed to focus on the minuscule scale of doing things on "a time continuum of one second."[97] That is why he appears to have shifted his scale of observation in actual performance, now focusing on the difference, not between one sound and another, but between one sound *character* and another: "group duration." In the end, what the list of objects and actions reveals are (the composition of) these dramatis personae that populate Tudor's realization, yet could no longer be specified with parameters of discrete sounds. At the same time, the autonomous nature of feedback which could generate sound even when he did not, gave him the freedom to un-coordinate himself from the network of instruments while the performance was going on. Tudor's theatrical duplicity had now been enhanced: he was free, not simply to perform something other than the piano, but also to do something other than perform. His instrument could act on its own, generating sound characters that could hold the stage for him as he listened or moved about. As Alvin Lucier recalled on April 22, 2017, Tudor had once revealed to him jokingly the reason—under what kind of influence—he delved more and more into electronics: "alcohol goes very well with electronic music; it's not so good with piano playing!"[98]

Co-Compositions

1

In May 1988, Tudor looked back on his realization of *Variations II* and admitted to Hultberg, "When you go that far, then in a sense you are co-composer."[99] He did not say in what sense. Tudor certainly did not collaborate with Cage on preparing the

[95] Tudor, "Interview by Jack Vees (Stony Point, NY, July 12, 1995), 241 r," *Oral History of American Music*, Yale University Library, 3.
[96] Sophia Ogielska and Andy Ogielski, "Telephone Interview by You Nakai," September 24, 2018.
[97] Holzaepfel, "Reminiscences of a Twentieth-Century Pianist," *Musical Quarterly* 78, no. 3 (1994), 635.
[98] Alvin Lucier, "Interview by You Nakai," April 22, 2017, Middletown, CT.
[99] Tudor, "Interview by Teddy Hultberg."

transparency materials or writing the instructions for how to use them. What he composed was a new instrument whose nature then biased his reading of Cage's puzzle-like material. As Pritchett observed, "the compositional strategy of Tudor's *Variations II*—the design of a complex, uncontrollable electronic instrumental system that must then be explored through performance—is one that clearly defines Tudor's early work as a composer."[100] Co-composition in this sense enhances the notion of "composition" to include, other than the writing of scores, the making of instruments. Composing instruments that make music, rather than making music, is an act one step removed, similar to composing materials for making scores, rather than making scores. One peculiar result of this shift in logical scale was visible throughout the broadcast of "Musik im technischen Zeitalter": a second amplified piano, almost identical to the first, used to perform *Fontana Mix*. Just as Cage's *Variations II* was not limited to any specific instrument, Tudor's instrument was not limited to any specific composition. The physical configuration of composed objects could now reframe the textual configuration of composed signs.

2

During the interview with Victor Schonfield in May 1972, Tudor made a puzzling remark about the nature of notation:

> *there is a paragraph in Busoni which speaks of notation as an evil separating musicians from music, and I feel everyone should know that this is true. I had been completely indoctrinated with the idea of faithfulness to notation in the early days, and if you think of notation as being complete then you see what Busoni meant—it can't possibly be complete. Notation is an invention of the devil, and when I became free of it, through pieces like Cage's* Fontana Mix *and* Music Walk*, and later Bussotti's* Piano Piece for David Tudor No. 3*, it really did a lot for me.*[101]

These words can be difficult to understand in two different ways. On the one hand, for those who identify Tudor with his precisely notated realizations from the 1950s, the demonization of notation may not make sense. On the other hand, for those who agree with him about the demonic nature of notation, Tudor's claim that he was freed from this evil through pieces by Cage and Bussotti that *still involved notation* may not make sense. But in the realizations of these works, the very role of notation had changed. The materials that liberated Tudor from the devil's invention no longer served as determinate or indeterminate text specifying what actions to perform or

[100] Pritchett, "David Tudor as Composer/Performer in Cage's *Variations II*," 16.
[101] Tudor, "From Piano to Electronics," 24.

which sounds to produce. Rather, they functioned as *pre-texts* of sorts that imposed biases and offered guises when composing his own electronic complex.

When he talked with Fullemann twelve years later, on September 3, 1984, Tudor made a revealing remark about the nature of such complexes: "Unless there is a formal structure the performance is like performing the possibilities which are in front of you. And so what's in front of you becomes the composition."[102] An instrument is a universe of possibilities materialized. Like notation, it biases the performance of music, but it does so even in the absence of notation. This became an issue at one point during the 1989 panel discussion at UC Berkeley, when the moderator Amirkhanian commented on the difference between the works Tudor played in the 1950s and those he played in the 1960s. He described the earlier ones as imposing so much control, comparing them with the later ones where "you have an almost anarchic situation where there doesn't seem to be that kind of control." Tudor retorted immediately: "Well don't forget that the equipment imposes control."[103]

What defines the works Tudor started performing in the 1960s is not less control, just as his simple-complex polarity for *Variations II* did not mean less precision. Instead, what happened was a change in the primary nature of control from textual to physical. The act of composition became more and more about coordinating discrete objects in space, rather than discrete signs on paper. Tudor had of course been doing this for some time already, moving materials for preparation inside the piano as well as moving the piano around the stage to equalize its sound. But one important realization he had made while observing the material of *Variations II* was the indeterminacy concerning the number of instruments used—"it didn't have to be one instrument, it could have been many instruments."[104] The use of many instruments enabled Tudor to compose different sound characters along with their specific degrees of determinacy and indeterminacy by adding or subtracting components from the electronic complex. The act of composition is thus generalized as an act of coordinating a variety of materials—both textual and physical, and each with its own degree of bias—that together constrain the performance of music without ever determining it completely.

3

In mid-June 1960, Tudor stopped by West Berlin for four days as he exchanged letters with Cage about the necessary equipment for the upcoming tour in the fall, which was to include *Cartridge Music* and other works that required amplification. But when he went shopping during his short stay, it was not electronics that he sought, but a new acoustic instrument. Together with the Argentinian composer Mauricio Kagel,

102 Tudor, "Interview by John David Fullemann."
103 "A Kind of Anarchy: Merce Cunningham and Music (September 19, 1989)."
104 Tudor, "Interview by Teddy Hultberg."

whom he had met in Darmstadt two summers before, Tudor purchased a bandoneon, an accordion-like instrument that produces sounds by stretching and squeezing the bellows with both hands to control the flow of pressurized air that goes through the reeds. This mechanism allowed the notes played to continue indefinitely without resorting to feedback. The likeness to the pipe organ was by no means an accident: the German inventor Heinrich Band had indeed conceived the instrument in the 1830s as a substitute for the giant instrument to be used in small churches—it was a simulation of the organ, made compact and portable. In 2008, Mumma recalled asking Tudor what was the most amazing nature of this instrument back in September 1965. His friend's answer signaled his departure from Artaud's Affective Athleticism and the control of breath to manage microscopic rhythms: "See if you can breathe this long . . . ahhhhhhh [*imitates the sound of a long sustained tone on the bandoneon*]."[105]

On August 16, 1961, one summer after purchasing the bandoneon, Tudor wrote to Wolfgang Steinecke, the director of the Summer Courses in Darmstadt, expressing frustration at his slow development on his new instrument: "this makes me quite sad, because there is nothing which interests me more."[106] Another summer later, on September 14, 1962, Cage observed a change in the soundscape of Stony Point: "Formerly, going to sleep, I used to hear the sounds of David Tudor playing the piano. They were audible up the hill coming from where he lives down by the stream. Nowadays I hear nothing from his studio."[107]

[105] Mumma quoted in Jonathan Goldman, "The Buttons on Pandora's Box: David Tudor and the Bandoneon," *American Music* 30, no. 1 (Spring 2012), 48.

[106] David Tudor, "Letter to Wolfgang Steinecke (August 16, 1961)," archives of the Internationales Musikinstitut Darmstadt [IMD], Darmstadt; quoted in Goldman, ibid., 42.

[107] Cage, "Remarks before a Visit to Japan (September 14, 1962)," *Selected Letters*, 274. In order to explain this silence, Cage described a distinct nature of electronic instruments that seemed to amplify the indeterminacy of live performances that Wolff had pursued in his works: "particularly with the performance of electronic works, it is useless to practice at home. The characteristics of each electronic system are so unique that one knows little about them until an actual encounter occurs" (ibid.). Ten years later, in 1972, Cage looked back at the time Tudor devoted himself exclusively to the piano, which did not last so long: "When I composed *Music of Changes*, David Tudor applied himself completely to that music. At that time, he was the *Music of Changes*. And then, after a few years, that identification disappeared—because it is in David's nature not to repeat what has been done—because he must always go forward. That's why he no longer plays the piano, except on certain, very rare occasions" (Cage, *For the Birds*, 178).

Chapter 3
Sound Systems

I. Ten Selected Realizations

Improvisation Mnemonic [Realization 10]

1

Tudor's realization of *Variations II* has been regarded as a threshold. It is said that what Tudor did departed so far away from Cage's universe of possibilities that it was not a "realization" anymore. The story goes that having attained this level of independence, it was only natural for Tudor to stop realizing other people's material and start composing his own, thus adding a happy ending to the paternalistic tale of composers giving the performer more freedom because he was capable of being more responsible. In any case, they say, the transition did not take long.[1] And this is evidenced negatively by the fact that after 1961, according to Martin Iddon, "the archival trail largely goes cold."[2]

Despite the popularity of this story, told in many versions by many people, Tudor actually continued to realize the material of others after *Variations II*, and there is plenty of evidence in the archive to prove this fact—except they do not take the appearance one expects. There are no more pages of calculations translating metrical to clock time, no more measurements of space-time notation, no more listings of time brackets, no more written-out performance scores. This makes it difficult to see what one is looking for or even at. Fortunately, a guide Tudor left behind has been found among his papers.

[1] "There is relatively little overlap in these careers," James Pritchett asserts, "Tudor ceased performing other people's works about the same time in the mid-1960s that he began creating his own" (Pritchett, "David Tudor's realization of John Cage's *Variations II*," accessed December 15, 2019: http://www.rosewhitemusic.com/cage/texts/Var2.html).

[2] "After 1961, Tudor's involvement in new Cage projects became sparser. This is hardly to say that Tudor ceased to work with Cage. This is, in truth, far from the case: Cage and Tudor toured together widely and regularly with the Merce Cunningham Dance Company, and Tudor continued to perform many of the Cage scores that he had worked on in the 1950s in just this context. Few new items were added to the store of Cage pieces written for Tudor after this point however. That is hardly to say that there were none, but it is also the case that it is after *Variations II* that the archival trail largely goes cold" (Iddon, *John Cage and David Tudor*, 196).

Reminded by the Instruments. You Nakai, Oxford University Press (2021). © Oxford University Press.
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2

On December 11, 1970, the composer Raymond Wilding-White wrote a letter to Tudor about his plans to include a "David Tudor Album" for a book he was writing on "20th Century Techniques" of music.[3] It would cover "all (?—reasonable approximation) of the pieces you have done," he explained, and asked his correspondent to "talk into a tape and I'll take it from there."[4] Tudor agreed to collaborate, but it took him forever to prepare the necessary material. So Wilding-White wrote another letter on June 23, 1972, to remind him of the project: "I am now in the real assembly part of the job and am badly in need of it. [. . .] please—could I have it sometime this summer?"[5] His desperate plea fell short. In the end, he had Tudor fly to Chicago on November 27, 1973, and engaged in a six-hour discussion at his own home that evening. Based on this conversation, he prepared a draft with the title "10 Selected Realizations of Graphic Scores and Related Performances."[6] On July 7 of the following year, he sent a copy of the almost completed manuscript to Stony Point, urging Tudor to check the article for errors before mid-August.[7] For some reason, in spite of the long and hard work, the book appears to have never been published.

But the material Wilding-White put together remained in Tudor's possession and ended up among his papers now archived at the Getty Research Institute.[8] Covering realizations from 1959 to 1966, the manuscript reveals not only the details of how Tudor worked during those seven years, but also which "realizations" he regarded significant in retrospect:

[Realization 2] *Music for Piano #4 for David Tudor* (1960) by Toshi Ichiyanagi
[Realization 3] *Book for 3* (1962) by Michael von Biel
[Realization 4] *Theatre Piece* (1960) by Cage

[3] "Here is an odd request. I am writing a book on 20th Century Techniques and when I get to theater pieces, I would like to list a whole variety of works in summary form: i.e. composer, title, description of basic devices used. Since you have probably done more of this than anybody around except possibly John, I thought I could put in a 'David Tudor Album' with all (?—reasonable approximation) of the pieces you have done in the manner described. Are you interested?" (Ray Wilding-White, "Letter to David Tudor [December 11, 1970]," Box 60, Folder 5, David Tudor Papers, GRI).

[4] Ibid.

[5] "I wrote to you last December, asking about the chapter you agree to write for my book. I am sorry to press you, but I am now in the real assembly part of the job and am badly in need of it. As I said to you, the work would be incomplete without such an item, and I would like it to come from someone who, like you, has done major work in the field. So please—could I have it sometime this summer?" (Ray Wilding-White, "Letter to David Tudor [June 23, 1972]," Box 60, Folder 5, David Tudor Papers, GRI).

[6] "This analysis was contributed by David Tudor in the form of a six-hour discussion at the author's home on 27 November 1973. By prior agreement, the works were selected by him and concentrated primarily on the realization of graphic scores and related problems, and thus this analysis does not cover the entire range of his performance procedures" (Wilding-White, "David Tudor: 10 Selected Realizations of Graphic Scores and Related Performances [1974]," Box 19, Folder 2, David Tudor Papers, GRI). Tudor left the next morning for Buffalo, as his flight ticket reveals ("American Airlines, Ticket [Chicago-Buffalo, November 28, 1973]," Box 130, Folder 11, David Tudor Papers, GRI).

[7] Ray Wilding-White, "Letter to David Tudor (July 7, 1974)," Box 19, Folder 2, David Tudor Papers, GRI.

[8] Wilding-White, "10 Selected Realizations."

[Realization 5] *Light Piece for Piano for David Tudor* (1965) by Pauline Oliveros and Anthony Martin
[Realization 6] *Bandoneon!* (1966) by Tudor
[Realization 7] *Variations II* (1961) by Cage
[Realization 8] *Variations V* (1965) by Cage
[Realization 9] *Five Piano Pieces for David Tudor* (1959) by Sylvano Bussotti[9]
[Realization 10] *Duo for Accordion and Bandoneon with Possible Mynah Bird Obbligato* (1964) by Oliveros

One realization [1] is missing from the extant copy.[10] Understandably, Tudor chose three materials by Cage, and one of his own. Of the remaining five realizations, two were by the same composer.

3

In the summer of 1963, a few months after his appearance on "Musik im technischen Zeitalter," Tudor was in San Francisco and sought out a thirty-one-year-old composer named Pauline Oliveros.[11] He was interested in her music. Oliveros was an accordionist but composed for various other instruments. Two years before, she had processed the sound of small objects using wooden apple crates as resonators, cardboard tubes as filters, and her bathtub as a reverberation chamber, to create a four-channel tape piece called *Time Perspectives*.[12] This unplugged electronic music was premiered on December 18, 1961, at the very first concert of the San Francisco Tape Music Center, which Oliveros had set up with fellow composers Ramon Sender and Morton Subotnick.[13]

9 The copy of this section is found in Box 26, Folder 11.

10 This may have been Cage's *Cartridge Music* (1960) since a sketch of the sound system for that piece has been found among sketches of sound systems for several other works on the list (Tudor, "Sketch diagram of *Cartridge Music*," Box 39, Folder 8, David Tudor Papers, GRI).

11 The exact date of this encounter is unknown. According to receipts and airplane tickets, Tudor was in the Bay Area twice in 1963, once from July 27 to August 9, and then from September 11 to October 6.

12 David W. Bernstein, ed., *The San Francisco Tape Music Center: 1960s Counterculture and the Avant-garde* (Berkeley: University of California Press, 2008), 101.

13 Oliveros's letter to her mother written on December 24, 1961, a week after the premiere, reports the frenzy leading up to December 18: "Now I shall try to give you a birds eye view of one of the wildest weeks of my life: Ramon Sender (who is in the enclosed news photo) started building an electronic laboratory at the [San Francisco] Conservatory just 8 weeks ago, and scheduled the opening for Dec 18 with tape pieces by him, me, Terry Riley + Phil Winsor. Now just building the lab took considerable doing not to mention a maze of wiring running from the Auditorium down several halls and up into this mad little attic lab! About 10 days before the 18th there was enough equipment assembled to start work on the pieces. But the whole time we were working on the tapes other people were very busy testing the equipment and buzzing speakers etc. so that I never heard my piece until the day of the concert without much extraneous noise!" (Oliveros, "Letter to Edith Gutierrez [December 24, 1961]," Oliveros Archive, Houston Public Library; quoted in Martha Mockus, *Sounding Out: Pauline Oliveros and Lesbian Musicality* [New York, NY: Routledge, 2008], 17).

Meanwhile, as he reported to Wolfgang Steinecke around the same time, Tudor was learning the bandoneon. This new instrument appears to have been the primary reason he became interested in the San Francisco composer, who played a similar free-reed instrument. It was certainly what he wanted to talk about when he met her that summer at the house of Olive Cowell—the aunt of composer Henry Cowell—as Oliveros reminisced thirty-five years later in 1998: "David was learning to play the Bandoneon at the time and expressed an interest in performing with me."[14]

Oliveros proceeded to compose a duo piece for Tudor and herself to perform. By October 3, she had finished the first seven pages of material, which she sent to Stony Point with a progress report: "I'll send more soon. I'm about 3/4 done about 6 or 7 min. more. Should run about 20–25 min. In big section now with vocal + whistle lines added."[15] By the end of the month, a thirteen-page score for Tudor's bandoneon and her accordion had been completed, though the composer later replaced the last page with three new ones to make a total of fifteen.[16] Each page had two systems, each of which notated the bandoneon part and the accordion part in parallel. The notation is a mixture of notes on staves and graphics that indicate action. From page seven, instructions for making various vocal sounds appear: whistling and singing, *bocca chiusa* (humming), fluttering lips and tongue, clenching teeth. From page twelve onward, the instructions become more linguistic (e.g., "as many different vocal sounds as fast as possible"), thus making the score increasingly more indeterminate with respect to its performance.

When Tudor chose the work as [Realization 10] in 1973, he told Wilding-White that Oliveros should write the description from what she remembered after ten years. "It was something in between improvisation and written materials," Oliveros thus proceeded to recall. "Pitch was no longer tightly controlled. I was notating certain kinds of rhythms and pitch outlines, but heading towards notating overall shapes within which the performers could intuitively produce the details which contributed to the design."[17] The duration of each bar was, however, precisely assigned in seconds, the opening and closing of the bellows denoted throughout. When Tudor set out to learn the material, he followed his habits and wrote down on his copy of the score the numbers or symbols designating specific buttons on the bandoneon corresponding to Oliveros's notes, as well as duration in seconds for bars where these were lacking.

[14] Pauline Oliveros, "Still Listening: Reflections on the Life and Music of David Tudor," in Oliveros, *Sounding the Margins: Collected Writings 1992–2009* (New York, NY: Deep Listening Publications, 2010), 11.

[15] Pauline Oliveros, "Letter to David Tudor (October 3, 1963)," Box 57, Folder 8, David Tudor Papers, GRI.

[16] Pauline Oliveros, "*Duo for Accordion and Bandoneon* (original score)," Box 11, Folder 9, David Tudor Papers, GRI.

[17] Oliveros, "*Duo for Accordion and Bandoneon with Possible Mynah Bird Obbligato*," in "10 Selected Realizations."

4

But the progress report of October 3 also reported a slight change in the instrumentation. For there was another creature who, like Tudor, had begun to learn the material:

> *Our duo will be a* trio for Accordion, Bandoneon and Mynah Bird *as Ahmed has made a definite bid to be a member of this performance. Everytime I pick up the squeeze box or play the tape he joins very positively (I thought it would be appropriate to have a CAGE on stage even if it wasn't John.) Also he is producing fantastic combination tones now.*[18]

The third performer, who was owned by Oliveros's roommate and partner Laurel Johnson, had an uncanny ability to modulate his throat muscles and membranes to synthesize the likeness of a wide variety of sounds with his voice. Without even looking at the score, he would continue to memorize the music when the rehearsals started,[19] interrupting the two human performers with the simulation of sounds they were playing:

> *I tried covering Ahmed's cage to quiet him. Nothing worked. Ahmed insisted on joining our rehearsal. I realized that the bird was picking up on the sounds we were making. So I thought, "Why not include the bird?"*[20]

So they did, putting his cage on stage and letting him improvise from memory. Accordingly, the full title of the piece became *Duo for Accordion and Bandoneon with Possible Mynah Bird Obbligato*.

But Ahmed was not the only addition to the original instrumentation. The choreographer and designer Elizabeth Harris, whom Oliveros had asked to "do the staging,"[21] constructed a rotating see-saw apparatus on which the two performers could sit and play their instruments while going up and down, as well as around. "David and I clambered onto this glorious instrument," was how Oliveros put it in her 1974 reminiscence.[22] Once on the instrument, they followed the choreography made by Harris upon Oliveros's request, also depicted in the same recollection:

> *we were to begin slowly, just balancing up and down, then slowly setting the mobile in motion, revolve the see saw to the left, to the right, then patterns of revolving with up and*

18 Oliveros, "Letter to David Tudor (October 3, 1963)," Box 57, Folder 8, David Tudor Papers, GRI.

19 Oliveros's reminiscence ten years later described a slightly different sequence of events: "David and I began to rehearse the *Duo* at my home where Ahmed the mynah bird … lived too. As we rehearsed we were constantly interrupted by the enthusiastic Ahmed's loud and cheerful bursts of high level sounds. As we continued to rehearse, Ahmed insisted on joining in, often with fragments of what we were playing. Finally, I decided that Ahmed must be included in the piece …" (Oliveros in "10 Selected Realizations").

20 Pauline Oliveros, "Memoir of a Community Enterprise," in David W. Bernstein, ed., *The San Francisco Tape Music Center: 1960s Counterculture and the Avant-garde* (Berkeley: University of California Press, 2008), 86.

21 Ibid., 87.

22 Oliveros, in "10 Selected Realizations."

> *down motions, balanced, fast, revolving with the mobile still turning, finally adding the spinning chairs during a fast balanced revolve and onto patterns with all elements.*[23]

In other words, over the course of performance, rotation increased both in variety and scale, until the performers rotated by the see-saw also began rotating themselves. More recently, in 2008, Oliveros recalled that the rotation of instruments even caused a Doppler effect, modifying the perceived sound's frequency in relation to the changing distance between the listener and the sound source.[24]

5

In his 2012 examination of the *Duo*, Jonathan Goldman observed how the configuration of two performers on each side of the rotating see-saw simulated one of the most distinct natures of both Oliveros's and Tudor's instruments: the ability to produce two different sounds from each side of the bellows. Harris's instrument, however, not only enlarged this nature shared between the two squeeze boxes; it also used them, along with the humans performing them, as materials to do so. The giant bandoneon-like see-saw thus contained the bandoneon as its component. Goldman likened this peculiar form of nesting to a figure of speech:

> *The stereophony of the instrument is in the* Duo *transposed to a higher level of structure—another instance of mirroring that might be likened to the rhetorical figure of synecdoche—since two stereophonic ("bi-instrumental") instruments are themselves separated in space.*[25]

Synecdoche, which literally means "understanding together" in Greek (*sunekdokhê*), is a particular usage of language that sets a polarity between the whole and a part—genus and species, composition and component, general and actual, a chapter and its sections—only to cancel the same polarity by taking one to represent the other, much like equating the entire piano with the escapement mechanism. It is a linguistic feedback looping across logical scales (or types), so to speak, which requires one to

23 Ibid.

24 "according to Oliveros the rotation was fast enough to provoke a Doppler effect, the downward glissandi familiar from the sound of sirens on a moving ambulance" (Jonathan Goldman, "The Buttons on Pandora's Box: David Tudor and the Bandoneon," *American Music* 30, no. 1 [Spring 2012], 44). In other words, similar to Oliveros's previous use of "mechanical devices to simulate [electronic] filters and reverberation" in *Time Perspectives*, the mechanical device in the *Duo* simulated another electronic instrument: rotary speakers invented by Donald Leslie in 1937 by rotating horns and cylinders in front of loudspeakers to itself simulate the resonance of pipe organs in big churches using a Hammond electric organ.

25 Goldman, ibid., 44. The term "stereophony," however, usually applies to the distribution of electronically reproduced sound to two or more outputs—loudspeakers or headphones—to create the illusion of an enwrapping sound field. For this reason, I will use Goldman's own paraphrase "bi-instrumental" to describe the double-sided nature of the bandoneon.

first observe the difference, and then to coordinate across that difference. In logic, such identification between the microcosm and macrocosm is often criticized as the "fallacy of composition." In anthroposophy, as in most forms of occult and esoteric philosophy, the seeming "fallacy" is indeed how the world is actually composed.[26]

The separation of separated sound sources was a materialized synecdoche. But the coordination of instruments in the *Duo* also materialized a second form of synecdoche concerning rotation of rotation. There may have been a source to this idea. In *Pandorasbox, bandoneonpiece*, the first work written for Tudor's bandoneon two years before in 1960, Mauricio Kagel, who had first introduced the instrument popular in his home country of Argentina to his friend, had also introduced another auxiliary material: the performer sat on a rotating stool and from time to time spun around so that the two sides of the instrument, along with the sound, could be reversed. Goldman suspected an influence on Harris, who very likely knew about this effect of rotation to explore the nature of bi-instrumentality in Kagel's piece.[27]

Be that as it may, the specifics of the actual see-saw Harris composed also mattered of course, for its physical nature biased the coordination with other components on board. As she recalled in her memoir for "10 Realizations," Oliveros learned this the hard way when she climbed onto the giant instrument:

> *I promptly fell forward, crushing the grill of my accordion since the weight of it changed asymmetrically with the manipulation of the bellows. I had to be strapped into my chair with a safety belt, while David sat centered and free with his well balanced Bandoneon. Because of its free bellows, the weight can be equally distributed from the center of the body during performance.*[28]

6

But Harris's instrument also created a more serious problem for the composer: "how were we to read my score?"[29] Oliveros solved this issue in a very simple way—she discarded the written material altogether. Instead of following the fifteen pages, the performance was now composed of whatever Oliveros and Tudor *remembered* from their rehearsals. In the malfunction of external mnemonic device, recollection was

[26] For instance, see Rudolf Steiner, *Macrocosm and Microcosm* (London, UK: Rudolf Steiner Press, 1968).

[27] "It is unclear whether Harris's staging was itself inspired by Kagel's rotating stool in *Pandorasbox*, which Tudor would likely have discussed with her in the weeks leading up to the performance. Alternatively, it is possible that Harris would have seen a performance of *Pandorasbox* performed by Kagel himself, since Kagel had been invited to Mills College in Oakland, California, in 1963. In either case, the staging can be considered an extension of Kagel's stereophonic experiments" (Goldman, "The Buttons on Pandora's Box: David Tudor and the Bandoneon," 44).

[28] Oliveros, in "10 Selected Realizations." The same incident is recounted forty years later in her 2008 memoir: "I had to employ a safety belt to negotiate the swivel chair because of the imbalance of the motion of my accordion bellows. David could center on the seat with the bandoneon without a safety belt since the bellows were bidirectional" ("Memoir of a Community Enterprise," 87).

[29] Oliveros, in "10 Selected Realizations."

coordinated to the specific physical movement they had been choreographed to perform on the see-saw at any given moment. Again, as Oliveros retrieved from her memory ten years later:

> *Long held tone clusters were modulated by the turning motions. Smooth motions of the see saw were contrasted with jagged, disjunct pitch and rhythm relationships. During each section of movement we concentrated on an overall feeling, either pitch, rhythm, texture or quality. The original notated score remained as an influence or reference point.*[30]

Oliveros called this an "improvisation mnemonic."[31] Just like Ahmed, the two human performers performed from memory while reacting to actual happenstances in the real time of performance. In addition to Harris's see-saw and her choreography, the music was biased by the fading recollection of the bygone score.[32]

[30] Ibid.

[31] Ibid.

[32] In fact, mnemonics was a prevailing concern in Oliveros's approach to electronic music, as revealed in the title of her first series of works for the medium, which was precisely that: *Mnemonics*. She had started composing them in the same year that *Duo* was premiered at the San Francisco Tape Music Center, using the equipment of the same institution. In an article written in May 2008, Oliveros recalled the process of composition from forty-four years before. Back then, she had not been interested in adding sine waves to synthesize sounds or splicing tape to make sound collages. Instead, what she wanted to do was perform "music in real time," which she described as being a matter of (indeterminate) coordination: "to map my 'human motoric input' onto the machine and 'feel my corporeal fallibility and virtuosity' in the process" (Pauline Oliveros, "From Outside the Window: Electronic Sound Performance," in Roger T. Dean, ed., *The Oxford Handbook of Computer Music* [New York, NY: Oxford University Press, 2009], 468). To realize this, Oliveros reminisced, she observed the electronic instruments in the studio until they not so much revealed their nature, but reminded her of something she had learned a while ago:

> *After staring for a long time at the large Hewlett-Packard war surplus test oscillators and wondering how I could make any music with them, an idea popped into mind: my accordion teacher Willard Palmer had taught me to listen to difference tones. If I played an interval in the high register of my instrument and pulled hard on the bellows, I could hear the difference tones. I had always wondered how it would be to hear just the difference tones without the generating tones* (Oliveros, "From Outside the Window: Electronic Sound Performance," 469).

What Oliveros recalled as "difference tones" was the psychoacoustic phenomenon that also went by the name of "phantom tones": two tones sounded simultaneously generate a third tone in the listener's perception whose frequency corresponds to the difference between the first two tones. More than half a century later, this phantom still eludes scholars, with ongoing debates about what causes the phenomenon, which is largely divided between two theories: one posits that the third tone is actually a physical sound created by the mechanics of the ear, while the other posits that it is a psychological effect created in the brain (see, for instance, Eric J. Heller, *Why You Hear What You Hear: An Experiential Approach to Sound, Music, and Psychoacoustics* [Princeton, NJ: Princeton University, 2013], 496–498).

But the exact nature of the apparition was not Oliveros's concern in 1964—it was rather to stage the phantom on its own by turning things inside out, and making instead the two generating sounds into a phantom-like presence that could not be perceived as such. As she stared at the three *Hewlett-Packard HP200C Wide Range Precision Audio Oscillators,* she realized that the frequency range of these instruments was wide enough to surpass that of human audibility (20 Hz to 20,000 Hz). So she set one to 40,000 Hz and the other to 39,950 Hz, and from these two inaudible tones managed to produce—or *heterodyne,* as the process is called—a low audible tone of 50 Hz. She then used this tone as input to a system of connected tape machines where the distance between playback heads enabled long time delays. Listening thus to the layered echoes of past phantoms, Oliveros manipulated the dials of the oscillator to produce more phantoms in real time from sounds that could not be heard by themselves. Coordination with the instrument was gradually established:

Fifty years later, on May 29, 2012, Oliveros tried to recall what she had meant by the word "improvisation." She drew a comparison with the composers Tudor had associated with in New York before she met him:

> *I think he might not have done any improvisation until he started working with me—probably not. But I had been. I had been improvising quite a bit all along. But the interesting thing to think about is that composers like Cage, and Wolff, and Earle Brown, all of that New York School, they had what I would say performer's choice; but they all maintained control over how the choices were used. So they were still composers of the piece. So David was certainly very busy with performer's choice, indeterminacy and so on. But it was a step before improvisation—improvisation being that for which there is no direction given.*[33]

That would only come with Tudor's connection to San Francisco, where things were different, and more specifically with the abandoning of *Duo*'s textual material in favor of other physical materials:

> *And then gradually we abandoned notation because when we got working with the see-saw, it really wasn't feasible to read the score. That's when David sort of got kicked into improvisation, I think.*[34]

The difference Oliveros sets between "performer's choice" and "improvisation" depends on whether or not there is a given "direction." But even though performers in her improvisation may have lacked forward clairvoyance—which is itself arguable—they also consistently looked backward to know where they were. In other words, the specific kind of improvisation Tudor "got kicked into" mattered.

"Improvisation Mnemonic" took recourse to memory, the very trait in improvisation that Cage often complained about, as he did in 1984:

> *Soon, through improvisation I was creating my first electronic music. In creating my electronic instrument with the oscillators, the huge dials that had seemed so unfriendly to performance now became receivers for the musical knowledge embodied in my hands and fingers.* […] *I had created a very unstable nonlinear music-making system: difference tones from tones set above the range of hearing manipulated by the bias frequency of the electromagnetic tape recording, feedback from a second tape machine in parallel with newly generated difference tones as I responded instantaneously with my hands on those dials to what I was hearing from the delays and as the sounds were all being recorded on magnetic tape. I had created a new musical instrument that included my "human motoric input" mapped onto the machine for analog output to speakers. This means that I could play my electronic music in real time without editing or overdubbing* (Oliveros, "From Outside the Window: Electronic Sound Performance," 469).

But the tape machines also responded, leaving their tones scattered all over the music that was played on them: "The bias frequencies of the tape machines also modulated the sounds I was getting from heterodyning of the oscillators" (ibid.).

33 Pauline Oliveros, "Interview by You Nakai," Skype, May 29, 2012.
34 Ibid.

> *It is at the point of spontaneity that the performer is most apt to have recourse to his memory. He is not apt to make a discovery spontaneously. I want to find ways of discovering something you don't know at the time that you improvise—that is to say, the same time you're doing something that's not written down, or decided upon ahead of time.*[35]

But Oliveros's recourse to memory was not a mere return to what one knew: it concerned something that was written down, decided upon ahead of time, but then suddenly abandoned, only to exert its influence through whatever the performers had internalized in the meantime. For Ahmed these would be the sounds of the first rehearsals when the music was still following the score, some of which may have stayed in his memory. Recollection was in this way highly specific to both the individual and occasion, impossible to generalize as something one either knew or did not. In other words, each reminiscence is a live performance.

7

In addition to this imperfection of the mind, "improvisation" in the *Duo* was conditioned by all the other components involved: the see-saw, the bandoneon, the accordion, the choreographed bodies, and Ahmed. Freedom from textual bias did not lead to loss of direction, but to a redirection of focus to non-textual biases. This was how Tudor reasoned much later on November 24, 1988:

> *I do not think of improvisation as a starting point because it is as if the music was already there, and you have to discover it. . . . You know, it is as if the world was already there. . . . It's hard for people to understand this, that the pieces are already formed by the situation, the environment, the particular sound equipment you use. This forms a whole, you know . . . what I mean is that if you started from an improvisation, it's as if you never knew what you were doing, but if you have a whole concept, then, the composition becomes an issue of revealing all the parameters, all the possibilities.*[36]

Parameters were "there" in their entirety because they were one and the same with physical materials. But precisely because they were materialized, and especially because there was more than one material involved, the real-time process of revealing "all the parameters, all the possibilities" became an indeterminate affair. As in Wolff's cue pieces, causal relationships could only be traced and enacted upon locally and partially. In the same way that Tudor talked about the nature of the amplified piano in *Variations II*, one instrument "could only hope to influence" the others. But by the same token, one could also influence other instruments beyond what one had hoped for.

Even after Oliveros and Tudor reduced what was written to what remained in their memory, there was another score that stayed in the work. In May 2012, Oliveros

[35] Bill Shoemaker, "The Age of Cage," *Down Beat* 51, no. 12 (December 1984), 29; also in Richard Kostelanetz, ed., *Conversing with Cage* (2nd edition), 236.
[36] Tudor, "Interview," *Revue et Corrigée* 2 (Spring 1989), 9 (Box 65, Folder 7, David Tudor Papers, GRI.)

reminisced about asking her friend and visual artist Tony Martin to provide lighting for the piece, who "assembled some visuals that used his overhead projection. He used inks and oils, and I think there might have been some slides."[37] Martin created what he called a "light score" for his part. Oliveros clarified what he meant by that: "he had made notations for himself as for what he was going to do next; that kind of score."[38] All the same, Martin's lighting had an unexpected influence on another component in the instrumental complex at the premiere, which is to say his score ended up remotely controlling sound as well:

> *Ahmed became quiet though when the lights went out at the beginning of the piece. It was dark and Tony's lighting was minimal at first. It took a while for Ahmed to make a sound in this new strange environment. The critics on the first night claimed that Ahmed was "mum," even though Ahmed had joined in the music. The second night, we decided to let Ahmed make the first sound.*[39]

Parametric Objects [Realizations 2, 5, and 7]

1

The first and second performances of the *Duo for Accordion and Bandoneon with Possibly Mynah Bird Obbligato* were presented a week apart at the San Francisco Tape Music Center on March 30 and April 6, 1964. It was part of a two-week-long series of concerts that Oliveros invited Tudor to curate, which became known as the "Tudorfest." The namesake composed three programs to be performed twice, once per week.

On both days, after they got off Harris's rotating see-saw, Tudor and Oliveros had another duo to perform: Toshi Ichiyanagi's *Music for Piano No. 4 for David Tudor*, which would be selected ten years later as [Realization 2]. Since its premiere on January 7, 1961, at the studio on Chambers Street in New York co-owned by Ichiyanagi with his then-partner Yoko Ono, Tudor kept this piece in his repertoire for six years until February 6, 1967. The reason for his liking is not difficult to understand. Ichiyanagi's score consisted simply of three short instructions:

> No attack should be made
> Use sustaining sounds and silence(s) only
> The piece may be played with any number of players on any number of pianos

In the 1974 manuscript, Tudor's solution to this puzzle is presented as "constructional sounds"—sounds made by rubbing the body of the piano.[40] These had to be realized

[37] Oliveros, "Interview by Nakai."
[38] Ibid.
[39] Oliveros, "Memoir of a Community Enterprise," 87.
[40] Wilding-White, "10 Selected Realizations."

with minimal dynamics, blurring the beginning and the end of each sound so that no attack would be perceived. Duration, in this case, was determined by the "physical restriction" of the piano surface itself: Tudor would start each sound at the left end of the keyboard, rubbing around the instrument until he hit the keyboard again on its right end. In other words, Ichiyanagi's material was also something Tudor could use to explore the nature of piano as a resonance chamber, this time without making any recourse to the keyboard or even the strings.

After performing the piece for three years, Tudor created a solo electronic version which he premiered at the *Tudorfest*, two days after performing the non-electronic duo version with Oliveros. The details of his realization are given in the 1974 manuscript. Tudor attached contact microphones with separate volume controls to twelve different objects that he used to rub the piano, whose sounds were sent to a four-channel mixer in groups of three:

Channel 1: sponge glove, flat sink stopper, large cork
Channel 2: soft sponge, small sink stopper, thick plastic rod
Channel 3: heavy metal weight, flat square of dense rubber, bamboo claves
Channel 4: double-sided sponge, round wooden claves, flat cork coaster.

Tudor added that performing this electronic version was no less difficult than the non-electronic version, "since at transition points, two objects and two mixers had to be manipulated simultaneously without creating an attack."[41] In contrast to *Variations II*, the lack of parameters assigned by the composer had enabled Tudor to select and treat the objects (including the piano) as materialized parameters from the start. The physical bias of each of the twelve chosen objects in coordination with the physical bias of the piano, now amplified with electronics, composed the entire universe of possibilities that Tudor aimed to reveal in performance.

2

One year after the *Tudorfest*, Oliveros collaborated with Tudor and Martin again for a second work, focusing on the piano as a physical object. The title also put a spotlight on Martin's contribution: *Light Piece for David Tudor.* Ten years later, Tudor would select this piece as [Realization 5] which was categorized as a "triptyc" [*sic*] and described as a "cooperative project with each of the three people contributing one part of the whole."[42]

This time Oliveros did not even bother to write a score. She instead determined the "basic theme" of the work as the pitch D3♭, and created many recordings of that pitch repeated on the piano. Her idea was to play these tapes back together to fortify the harmonics of the basic theme through "a kind of additive synthesis"[43]—another kind, that is, of

41 Ibid.
42 Oliveros, in "10 Selected Realizations."
43 Pauline Oliveros, "Interview with Pauline Oliveros," in *San Francisco Tape Music Center*, 106.

unplugged electronic music where what usually happens electronically inside machines is realized acoustically outside the box.[44] However, when she actually tried this using the twenty-four loop machines of the Tape Music Center,[45] Oliveros discovered that all of them ran at different speeds producing microtonal deviations from the theme pitch rather than fortifying its harmonics.[46] "My ideas [*sic*] was ideal," she looked back in 2008.[47] Yet again, the physical bias of the instrument had brought about an unforeseen situation.

"After driving the technician up the wall, demanding that machines be precise," the composer calmed herself down and, following her usual mode of operation, incorporated this accident into the work, just as she had done with Ahmed: "I turned the misfortune to good use."[48] She let go of the ideal harmonics and fortified instead the deviating inharmonics with sine tones and mixed everything down to four channels, which at the performance were played out from the front and rear of the theater space. She would call it her "drone piece."[49] To determine duration, Oliveros, like Tudor in performing *Music for Piano No. 4*, used the physical nature of the piano as a scale: "The tape length of 34 minutes was taken from the length of the D♭ string, and was the length of the performance."[50]

Martin composed light beams by placing cardboards with a pinhole in front of lamps. Two of these beams hit two six-sided prisms hanging from the piano lid and a stand, rotating throughout the performance, refracting and dispersing the light into the space (Figure 3.1). He calculated the number of times the prisms had to be twisted before the start of the performance so that it would stop simultaneously with the tape—it turned out to be eleven—thus coordinating the rotation of light with the rotation of the tape, itself corresponding to the physical length of the piano string.

3

Oliveros gave only one instruction to Tudor: "play D3♭." For Tudor this meant physical restriction of his coordination with the piano to the three strings used to produce that specific pitch. So he decided to focus on devising as many ways to perform those three strings as possible. Although no amplification was specified, Tudor resorted to electronics to increase the diversity. He placed three magnetic pickups, one phono cartridge, and one contact microphone on the strings and one loudspeaker under the soundboard to produce feedback.[51] None of the pickups was attached to the strings so that different feedback pitches could be produced when Tudor moved them up and

[44] This is one significant precursor to Tudor's later method of taking various forms of electronic processing out of the box and realizing them as giant instruments.
[45] In my interview and elsewhere, she mentions there being twenty-four loop machines: "But what I found out was that the twenty-four loop machines I was using wouldn't play at the same speed" (Oliveros, "Interview by Nakai").
[46] Oliveros, "Interview with Pauline Oliveros," in *San Francisco Tape Music Center*, 106.
[47] Ibid.
[48] Oliveros, in "10 Selected Realizations."
[49] Oliveros, "Interview with Pauline Oliveros," in *San Francisco Tape Music Center*, 107.
[50] Ibid.
[51] Ibid.

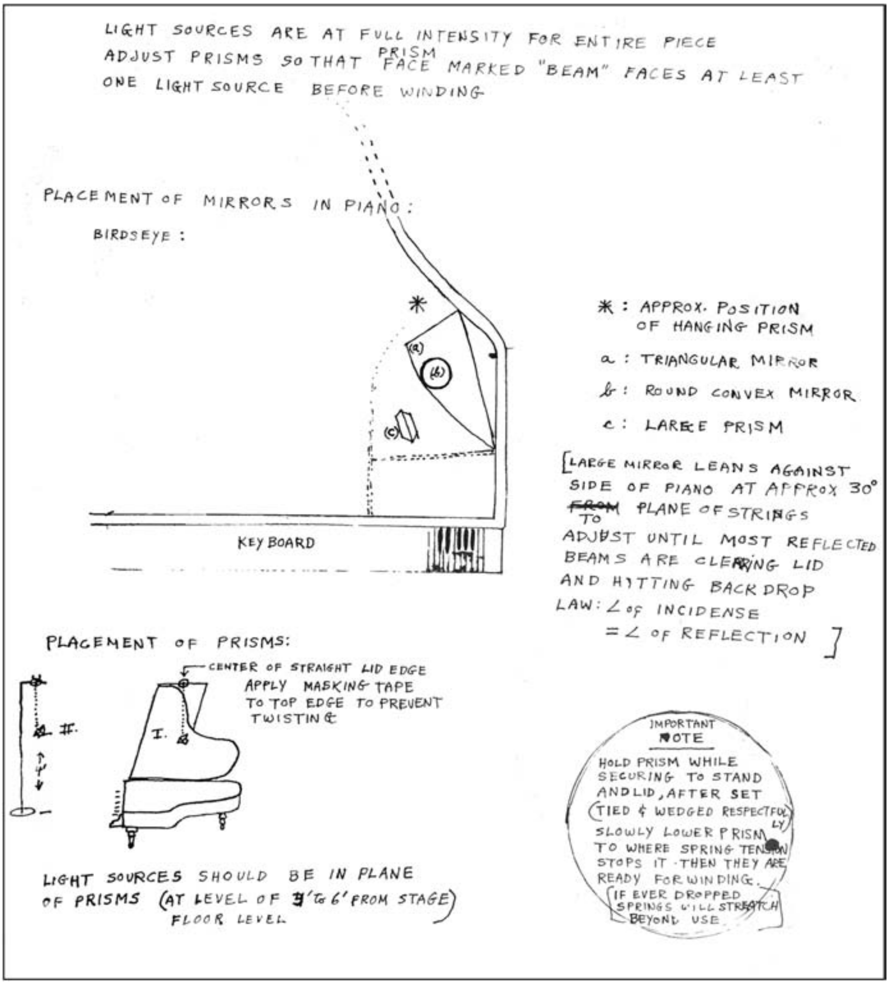


Figure 3.1 Tony Martin | Instructions for *Light Piece for David Tudor* | 1965
DTC | World Instrument Collection, Wesleyan University | Courtesy of Tony Martin

down. Two contact microphones were further attached to the soundboard, and two wires inserted into cartridges were placed under the D3♭ strings. All the picked-up signals went into a two-channel sound system through three small mixers, plus an extra feed to the loudspeaker beneath the piano. After he composed the instrument, Tudor proceeded to perform the three strings with a variety of materials, including a vibrator, an induction coil, and various mallets and sticks.[52] When she was asked to

[52] Oliveros, "Still Listening," 12.

describe Tudor's approach to improvisation fifty years later, it was the diverse selection of parametric objects that Oliveros recalled most vividly:

> *His choice of objects . . .* [. . .] *the only instruction I gave him was to play a D flat. It was wide open. But he devised so many different means for playing that note; it was really amazing. He used all kinds of tools and things.* [. . .] *And indeed when the piece was over the D flat key on that piano was different!*[53]

4

Light Piece for David Tudor was premiered on November 8, 1965, once again at the San Francisco Tape Music Center.[54] Three days later, on November 11, when the piece was performed for the second time at the San Francisco State College, Oliveros and Tudor premiered yet another collaborative "improvisation" in the same program. It was presented as *Duo for Amplified Appleboxes* that day, but would become known as *Applebox Double*. The title referred to the principal instrument: the wooden apple crate that had appeared in *Time Perspectives* four years earlier: "The apple box had solid panels on all sides except the bottom. So the box was ideal as a resonator."[55] Much later, in 1988, Oliveros reminisced about the object with tender affection, itself reminiscent of Tudor's care for his instruments:

> *I had an old apple box I liked and I knew. It was like an old friend as well, because an apple box that has seasoned wood is a very resonant box. I used to amplify the box and put all kinds of things on the box to play: curb scrapers from automobiles, little implements from the kitchen—anything, small little things—and then amplify them, do things with them, make sounds.*[56]

After performing it solo as *Applebox*, she invited Tudor to join her on a second apple box. It was again her collaborator's meticulous preparation of objects that stayed in Oliveros's memory almost half a century later, as she remembered on May 29, 2012: "He really liked it a lot, you know, gathering objects for his part. [. . .] David was

[53] Oliveros, "Interview by Nakai."

[54] The concert was called "An Afternoon with Pauline Oliveros & Friends." The program note lists the piece as "Light Piece for Piano." The third performance took place on May 6, 1966, at the Third Annual Presentation of Experimental Music at the Case Institute of Technology, where *Light Piece for David Tudor* was billed together with David Behrman's *Wave Train*, Alvin Lucier's *Music for Solo Performer* performed by Lucier and Tudor, and Cage's *(3) Solos for Voice 2* performed by Oliveros, Tudor, and Lucier. This was also the first time Oliveros met Behrman (though she misdates the Case Institute concert as taking place in 1965) (Oliveros, "David Behrman and His Home-grown Music," in *Sounding the Margins*, 61). *Light Piece* was subsequently performed at the Isaacs Gallery in Toronto on April 15, 1967. *Applebox Double* was performed for the second time at the ONCE Festival (ONCE Recording Concerts) on March 28, 1966.

[55] Oliveros, "Memoir of a Community Enterprise," 89–90.

[56] Peggyann Wachtel, "Meet the Composer: Pauline Oliveros Interview," *EAR (Magazine of New Music)* 12, no. 9 (December–January 1988), 26.

always very meticulous. And his choice of objects . . . he organized the way the objects were on the box so that he could approach and play them."[57] These, she recalled on another occasion, included "springs, metal tongues, 'Halloween crickets.'"[58]

In 2008, Oliveros described the performance as "a just play and listen improvisation"[59] since "there was no score for the piece."[60] But Tudor's selection of objects certainly biased the performance, just as the resonant characteristics of the specific apple box in the title to which those parametric objects were coordinated. As Gordon Mumma exclaimed in November 2011: "This is three years before *Rainforest*, which uses all the principles of *Rainforest*!"[61] Indeed, in the latter piece from 1968, Tudor would attach transducers to various objects to turn them into "instrumental loudspeakers" with distinct resonant characteristics.

5

But Oliveros's apple boxes not only projected into the future, for they were also grounded in her experiments in the past. And as far as the amplification of small objects was concerned in 1961, Cage and Tudor had been performing *Cartridge Music* from the previous year. Despite their likeness, however, there was a difference between Oliveros and Cage in their approach to amplification. It was not so much a matter of improvisation as instrumentation: the primary amplifier was non-electronic in Oliveros's case. But this is not to say that the materials of *Cartridge Music* could not be used in a similar way. In fact, Tudor had already done so, just around the time Oliveros was experimenting with her apple boxes. According to what Wolff remembered in 1996:

> *In a class in Darmstadt in the early sixties David had suggested some of us prepare a performance of John Cage's* Cartridge Music*, even though the necessary phonograph cartridges were not available, nor in fact any means of electric amplification. We worked up something with objects that would serve as resonating chambers and did a performance for the rest of the class.*[62]

This was in early September 1961, when Tudor participated for the last time in the Summer Courses. Earlier that same summer, on June 20, Tudor had also presented an

[57] Oliveros, "Interview by Nakai." She could not recall the specific materials he used anymore but said that her personal favorite was a 'curb scraper'—a piece of vibrating metal for "automobiles that had big tail fans" that helped the driver to park by touching the sidewalk before the car.
[58] Leta E. Miller, "ONCE and Again: The Evolution of a Legendary Festival (Liner Notes)," *Music from the ONCE Festival 1961–1966*, New World Records 80567-2, 2003, 5 CDs.
[59] Oliveros, "Interview," in *The San Francisco Tape Music Center*, 89–90.
[60] Oliveros, "Memoir of a Community Enterprise," 90.
[61] Mumma, "Interview by Nakai," November 11, 2011.
[62] Christian Wolff, "'. . . how he made all the difference': Thinking of David Tudor," in *Cues*, 380. Wolff continued: "That day Theodor W. Adorno had come to the class. After our performance he got up and spoke at considerable length, and complexly, about what he considered the implications of this music to be. When he finished, David looked at him and said, 'you haven't understood a thing'" (ibid).

unusual realization of *Variations II* in Paris,[63] which the 1974 manuscript described in detail as [Realization 7]:

> *A version using an unamplified piano and the following catalogue of props: Portable radio (inside piano), Wind-up buzzer, "Munyo" rubber whistles, "Audubon" hand bird whistles (inside piano), Non-flexible beater made from wooden crutch with rubber tip, 50-foot rope, Fard hand whistle, Metal-tipped beater, Gyroscope, Large plastic rods, 1" diameter, Triangular ruler, Flat ruler, Pieces of thick tire rubber, Large dust cloth, Sheet and blanket, Thick flat plastic, Plastic syphon flowers*.[64]

Around the same time in San Francisco, Oliveros, who similarly faced the lack of electronic equipment, was also endeavoring to simulate the latter with unplugged materials—"objects that would serve as resonating chambers"—to compose as well as improvise a new four-channel tape music she would call *Time Perspectives*. Yet again, her "improvisation" was biased by the materials she used. For instance, the nature of the *Sears Silvertone Tape Recorder*, which permitted the switching between two speeds of 7½ and 3¾ inches per second, coordinated with Oliveros's own unamplified mind, which could imagine sounds that are not here and now—just as an improvisation mnemonic, except projected forward in time:

> *I was improvising with sounds and with the uses of the recorder. I imagined how an improvised passage recorded at high speed would sound at low speed and vice versa. Thus my real-time improvisation added a new layer that involved projecting future modification and manipulation of the tape recorder as an instrument. Since I had no other electronic equipment I recorded through cardboard tubes for filters, put the microphone in the bathtub for reverberation and amplified small vibrating objects on an apple box with a contact microphone.*[65]

Points of Departure [Realization 3]

1

One participant in the 1961 International Summer Courses for New Music in Darmstadt, who probably attended Tudor's unplugged *Cartridge Music* session, was a twenty-four-year-old German composer and cellist named Michael von Biel. He had

[63] This was part of an event at the American Embassy in Paris with Jasper Johns, Niki de Saint-Phalle, Robert Rauschenberg, and Jean Tinguely.
[64] Wilding-White, "10 Selected Realizations."
[65] Pauline Oliveros, "Tripping on Wires: The Wireless Body: Who is Improvising?" in *Sounding the Margins*, 124.

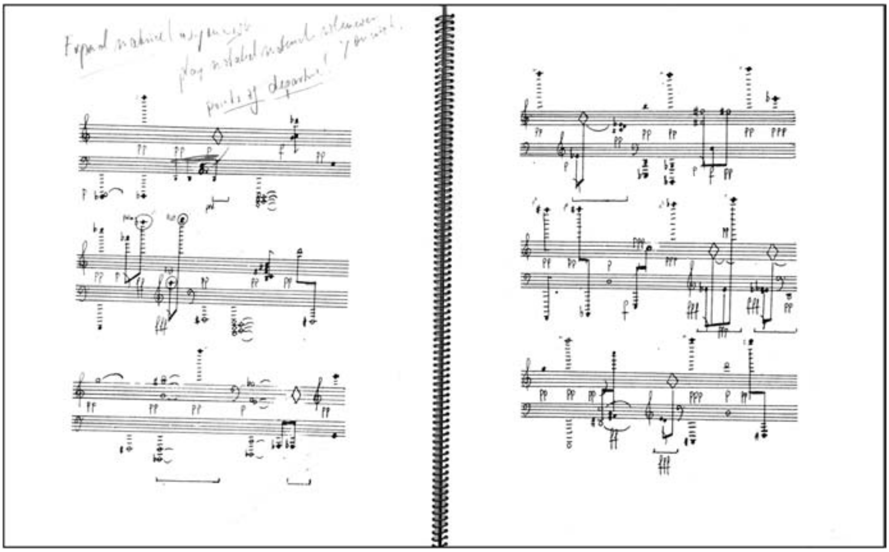


Figure 3.2 Michael von Biel | *Book for 3 (Piano I)*, page 7, with handwritten instructions for Tudor | 1961
DTP, Box 5, Folder 14 | Getty Research Institute, Los Angeles (980039)

recently studied with Morton Feldman for a year in New York, where he must have also met Tudor.[66] In 1961, von Biel was composing a piece called *Book for 3* which he sent to Stony Point on July 2, 1962, with a letter lamenting that "Darmstadt will not be the same without your influence this year."[67] This original composition was dedicated to the violinist Egon Mayer and written for two pianos and one violin, using different kinds of notation for each instrument with instructions on how to read the symbols. The copy Tudor received was for Piano I, with a score written in a relatively conventional manner. It also contained instructions for the two other instruments. Piano II was to use two heavy metal discs with a diameter of approximately six inches (15 cm), wire brushes, and four sharpened eraser-pencils against the piano strings. No amplification was instructed for either of the pianos, although the most suitable discs for Piano II were assigned as "microphone-bases manufactured at present by Electro-Voice of Buchanan, Michigan."[68]

[66] "Since he himself is a cellist, he has been able to demand unprecedented effects from this instrument, involving sawing, scraping, whining, many kinds of harmonics, and the use of the tail-piece and finger-board for various aspects of the sound production. These sonic discoveries are, of course, transferred to the three other instruments as well" (Norbert Linke and Elaine Barkin, "Darmstadt: The Younger German Composers," *Perspectives of New Music* 2, no. 2 (Spring–Summer 1964), 163).

[67] Michael von Biel, "Letter to David Tudor (July 2, 1962)," Box 51, Folder 7, David Tudor Papers, GRI.

[68] Michael von Biel, "*Book for 3* (Two Pianos and One Violin version), 11," Box 5, Folder 14, David Tudor Papers, GRI.

But Tudor's copy also had two personal addenda handwritten in pencil by the composer. On the very first page, von Biel instructed the pianist to "Read Violin Instructions." Starting from page 7, the instructions for violin explained the symbols for different ways of bowing the instrument, but the first thing it presented were five general points about how to approach the material. On Tudor's copy, these points are bracketed in pencil to indicate which part of the "Violin Instructions" the composer wanted him to read. Among other things, such as imagining the various possibilities of ordering the musical material, or realizing that pitch is only a component of the total acoustical spectrum, von Biel advised not treating the score in the traditional way, but to "visualize the given symbols as points of departure through which all combinations and sequences are realized."[69] On the top of the first page of the score for Piano I (Figure 3.2) was another handwritten instruction which repeated this last point: "Expand material as you wish. play notated materials whenever you wish. points of departure!"[70] The composer obviously expected Tudor to take things far. But the only markings Tudor made on his copy of the score were the pitch names of high notes for Piano I—nothing reveals how he expanded the material for the New York premiere at the New School for Social Research on March 15, 1963, with von Biel himself on the other piano, and the dedicatee Mayer on violin.

2

It appears that von Biel himself took his own addendum on Tudor's score seriously, for he decided to expand the first material by transforming it into a piece for three pianos, which he now dedicated to Tudor. Two months after the premiere, *Book for 3* was performed again in Vienna on May 2, 1963. The program lists von Biel, Tudor, and Kurt Schwertsik all playing the piano.[71] In this new version, parts were now called "materials," with the first two shared by two pianists and the third for the third pianist only. Material A expanded the Piano I score by superimposing notes, which together with the unusual length of note-flags extending across the staves made reading indeterminate. Material B expanded the Piano II score by adding more discs of different sizes, as well as metal and wooden mallets to strike the instrument. The different ways the discs could be maneuvered on piano strings were also categorized: oscillation (by which von Biel meant rocking the discs), rotation, vertical sliding, and so on. Material C expanded the Violin score by placing a gong, a cymbal, and a thin metal sheet on the piano strings, along with one or two electric motors on the bass strings. Sounds were to be produced by bowing, rotating, or

69 Ibid., 7.
70 Ibid., 3.
71 Konzertbüro der Wiener Konzerthausgesellschaft, "Program, Musik der Gegenwart: Mozart-Saal (May 2, 1963)," Box 74, Folder 1, David Tudor Papers, GRI.

striking these materials. The new score mentioned amplification, but only briefly.[72] The general theme of *Book for 3* was formulated as follows: "This piece is involved with the maximum articulation and stirring up of the given materials under a certain local performance situation."[73]

3

After two performances, the piece dropped out of Tudor's repertoire. It was picked up again only two years later, in December 1965, for a concert at the Center of the Creative and Performing Arts in the State University of New York at Buffalo.[74] The reason for the revival appears to have been circumstantial: Tudor was in a residency there and so was von Biel. But on this occasion, Tudor did something unprecedented with the material: he discarded it almost completely, along with the original instrumentation, which was switched to a peculiar instrument of his own design: *Amplified Barbecue Grills*.[75]

The instructions for the three piano version had clarified what von Biel had meant in his handwritten addendum to Tudor in the first version: "view each symbol as a point of departure. It is, however, necessary to have interpreted the point in order to depart from it. The material used in the departure must also be in some way related to the point of departure."[76] In the 1974 manuscript, where *Book for 3* was chosen as [Realization 3] Tudor justified the transformation he applied using a peculiar logic, which happened to be quite similar to von Biel's own reasoning when the latter transformed the original Violin score to Material C. Tudor claimed that despite all the changes, the new version still connected to the written score in two ways:

> *two ideas were preserved in the following versions and the score was discarded. These idea are: a. Rotation (as in the microphone bases) b. Bowing (as in the gong and bass bow)* [...] *Rotation is clearly represented by the grill and* [...] *since the rungs of the grill suggest piano strings, the rotation of the inverted microphone stand bases could be transferred to it.*[77]

Tudor's new version thus related to the three piano version only through the constancy of two "ideas" about how materials should physically coordinate with one another. Yet he had actually followed the composer's instruction to interpret the point

[72] "When it is felt necessary a contact-microphone may be employed to project the sounds of very low amplitude, no sounds resulting directly from this apparatus may be used. (feedback, etc.)" (von Biel, "*Book for 3* [Three Piano version], 6," Box 5, Folder 14, David Tudor Papers, GRI).

[73] Ibid., 1.

[74] Renee Levine Packer, *This Life of Sounds: Evenings for New Music in Buffalo* (New York, NY: Oxford University Press, 2010), 47.

[75] As he documented via Wilding-White in the 1974 manuscript: "Starting with a version performed in Buffalo, the pianos were replaced by the round three-legged barbecue grills, which are the standby of every American backyard" (Wilding-White, "10 Selected Realizations," 9).

[76] Von Biel, "*Book for 3* (Three Piano version)," 2.

[77] Wilding-White, "10 Selected Realizations," 8.

he was departing from. On two pages of notes, Tudor wrote down significant passages from the entire score of the three piano version, starting with the general theme, and moving through particular instructions:

> *"involvement with particular material [more, less]"*
> *"repetition, periodically"*
> *"design structured time by creating regions of maximum & minimum activity & regions which integrate & disintegrate both"*
> *"bowing: vary pitch by pressure"*
> *"rotation: slow; long unbroken sounds sometimes fast"*
> *"involvement with more than one activity."*[78]

These were all instructions general enough to be applicable to other instruments as far as they could be bowed or rotated. The "composer" appears to have welcomed this departure: he not only performed the new version with Tudor in Buffalo, but also went on to compose a new piece for brass, contrabass, tape, and amplified barbecue grills called *Jagdstück* the following year.[79]

4

Two years later, on April 16, 1968, Tudor performed *Book for 3* at Mills College, where the San Francisco Tape Music Center had recently relocated. He was teaching there as a guest lecturer that month and worked on the piece with the students of his seminar. For this occasion, Tudor moved further away from von Biel's point of departure, creating a "version" he dubbed "theater." A diagram of the instrumental setup was later drawn for Wilding-White's book project (Figure 3.3).

Four rotating barbecue grills operating on electric motors were placed around the space, with one performer assigned to each. Two contact microphones were attached to each grill cart, and two more were available for amplifying other objects. The input signals were split in two: one went directly to one of the four loudspeakers through a power amplifier, while the other was modulated with signals from a sine-square wave oscillator using an amplitude modulator. The modulated signal was distributed to the four power amplifiers using a *Photocell Stirrer* manipulated by a fifth performer.

The last instrument was itself a "version" of the *Stirrer*, an audio-panning device Lowell Cross designed, and Tudor often used around this time.[80] Alden Jenks, who

[78] Tudor, "Notes on *Book for 3*," Box 5, Folder 14, David Tudor Papers, GRI.

[79] "*Jagdstück (Hunting Piece)*, premiered in February 1968, involved a screeching, electronically amplified barbecue grill, plus electric guitar and double bass, threaded among the more conventional sonorities of a brass ensemble playing hunting tunes. Following the premiere von Biel turned away from music to study drawing with Joseph Beuys at the Dusseldorf Academy of Art" (Rob Young and Irmin Schmidt, *All Gates Open: The Story of Can* (London, UK: Faber & Faber, 2018), 41–42).

[80] The *Stirrer* was originally a four-channel sound motion instrument created by Cross. By using custom-built 360 continuous rotation controls, this instrument could rotate sound in various forms—clockwise,

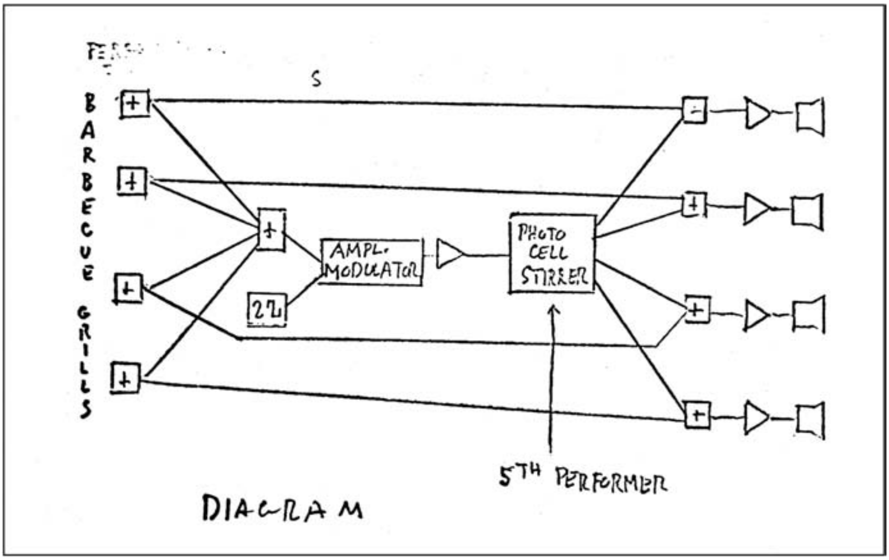


Figure 3.3 Tudor | *Book for 3 (Theater Version),* diagram | Undated
DTP, Box 5, Folder 14 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

took Tudor's seminar at Mills College, recalled forty-seven years later that it was something they made in class:

> *He taught us all how to put together a "sound stirrer" made out of a soup can and four light-dependent resistors arranged in a square on the bottom of the can. I suppose*

counterclockwise, figure-eight—and sequences. The four pointer knobs connected to the four potentiometer (variable resistor) shafts allowed the performer to move four sound-sources, either blended or separately, across the loudspeakers (Lowell Cross, "The Stirrer," *Source: Music of the Avant Garde* 4 [1968], 25–28). Upon the request of Tudor, Cross built him a set of two simplified *Stirrer Jr.* with just one input and four outputs in the summer of 1966. This instrument was put to heavy use in the realizations of Ichiyanagi's *Music for Piano No. 4*, Cage's *Music for Amplified Toy Pianos* and *Fontana Mix* (ibid.; also see Lowell Cross, "Remembering David Tudor: A 75th Anniversary Memoir: 1966," lowelcross.com, accessed December 15, 2018: http://www.lowellcross.com/articles/tudor/1966.html). One *Stirrer Jr.* and one *Stirrer* are found in the Wesleyan collection (Instruments 0012 [*Stirrer*] and 0184 [*Stirrer Jr*]); corresponding schematics as well as a drawing of the *Stirrer* box have been found among Tudor's papers (Box 52, Folder 7). The diagram for *Book for 3* specifies, however, a *Photocell Stirrer*. And no *Photocell Stirrer* made out of a soup can is found among Tudor's instruments. But Instrument 0008 has an equivalent function: a simple device with one input and four outputs, connected via four photocells exposed on the top panels. The amount of light on each photocell controls the signal routing to the four outputs, labeled "W," "S," "E," "N" to indicate the placement of respective loudspeakers in space (West, South, East, North), and thus enabling a movement of sounds similar to that produced by Cross's *Stirrer*. But Tudor appears to have used a different source for composing this instrument: the circuit turns out to be an exact copy of the one Fredrick Rzewski described in his article "A Photoresistor Mixer for Live Performance" (*Electronic Music Review* 4 [October 1967], 33–34). David Behrman also made a copy of the same circuit, which was actually built with soup cans,

> *Mills supplied the materials. I was delighted by this hands-on approach; the design was so simple that even one as clumsy as I could assemble it successfully.*[81]

In the 1974 manuscript, Tudor described the workings of the *Photocell Stirrer* as representing the "theme" of rotation in von Biel's composition, along with the grill and the motor: "The use of the stirrer is another example of the *rotation* theme used in this realization."[82] But the name of the instrument also fit perfectly to the general theme of "*stirring* up of the given materials." The theme of bowing, on the other hand, was preserved in the use of cello or bass bows on different parts of the grill carts or scraping with other miscellaneous objects like a drumstick. The two themes could even be expressed simultaneously in cases where the performer held a bow still and rotated the grill against it, or by using various battery-operated vibrators, including "vibrating hairbrush, comb, or back scratcher."[83]

Since the "theme" was now materialized in the instrumentation, performers had no need to concern themselves with the text. Jenks, who also participated in the performance, remembered the instrumental setup but nothing about a score:

> *Equally tangible were the Weber cookers. There were many more than 3, with two people on a grill. There were contact microphones on them, the outputs of which went to our "stirrers" at the front of the room. David Tudor and either Tony Gnazzo or Lowell Cross "stirred" the sounds around the space. Our only instruction was to make sounds on the Webers. No precompositional boundaries were set. Of course it was pandemonium.*[84]

Reducing von Biel's text material to the constancy of two "ideas" or "themes" allowed Tudor to compose an instrument through which he could explore other interests under the guise of "version"—the selection of specific parametric objects, the process of modulation, the spatial rotation of sound. In the preface to the manuscript of "10 Selected Realizations," Wilding-White singled out this realization and emphasized its extraordinary nature, presumably reflecting what Tudor had told him during their six-hour discussion:

> *Michael van* [sic] *Biel's* Book for 3 [. . .] *is not in fact a work but rather a name for a series of individual and very different performances related by the fact that some feature of one performance would be taken as the basis for the next performance; the art*

and used for his piece *Runthrough* (1967–1968). All this suggests that Tudor's soup can *Photocell Stirrer* at Mills College was very likely based on Rzewski's *Photocell Mixer* as well. Behrman's instruments are now archived alongside Tudor's at Wesleyan University.

81 Alden Jenks, "Email to You Nakai," March 13, 2015.
82 Wilding-White, "10 Selected Realizations," 9.
83 David Tudor, "Note and Diagram for the Theater Version of *Book for 3* by Michael von Biel," Box 5, Folder 14, David Tudor Papers, GRI.
84 Jenks, "Email to You Nakai."

of performance as an evolving chain of events, rather than as a number of repetitions of a prescribed event.[85]

As von Biel himself repeatedly emphasized, the composed material was a mere point of departure that could even be discarded. Tudor had indeed taken the material far. So much so that Jenks, who performed the piece, "had no idea Michael von Biel had anything to do with it."[86]

Sound Systems [Realization 8]

1

At one point during the broadcast of "Musik im technischen Zeitalter" on January 21, 1963, Cage used an amplified typewriter to write out a statement concerning the nature of amplified activities that defied parameters. He then proceeded to read what he wrote aloud wearing a throat microphone around his neck:

For many years now, we have been thinking of composition in terms of sounds which are made up of their parameters: frequency, duration, amplitude, overtone structure, and whatever else one can think of. Now we have nothing to do with the parameters. We produce sounds without giving parameters a thought. That means, let me suggest, that we are giving up thinking of composition, and in return we are getting composition itself.[87]

Even then, Cage resisted the term "improvisation" for reasons other than Tudor's: it was not that the music was already present in the materials; it was that the performers would not be present in the music.[88] In a letter to Leonard Bernstein written nine

85 Wilding-White, "10 Selected Realizations," 2.
86 Jenks, "Email to You Nakai."
87 Cage, in *Musik im technischen Zeitalter: John Cage mit David Tudor*, Sender Freies Berlin, ZKM, 1963.
88 *Conversing with Cage* (2nd edition), 238. For an important study that touches on the racial and political biases that sustained Cage's narrow conception of "improvisation," see George E. Lewis, "Improvised Music after 1950: Afrological and Eurological Perspectives," *Black Music Research Journal*, Vol. 16, No. 1 (Spring 1996), 91–122. Following Lewis's argument, Rebecca Y. Kim devotes a chapter of her dissertation to a detailed analysis of Cage's efforts to distinguish his practice of indeterminacy from improvisation. Kim traces how Cage's opinions changed from an early admiration for jazz to a later dislike of the musical form after his own turn to "non-intention" (Rebecca Y. Kim, "In No Uncertain Musical Terms: The Cultural Politics of John Cage's Indeterminacy," PhD dissertation, Columbia University, 2008, 208–317). Aside from a brief adoption of the term in the mid-1960s to make sense of what Tudor was doing, Cage made peace with his hatred of improvisation only late in his life, when he began engaging in a series of compositions to which he gave the very word that had long troubled him. These pieces, the composer explained, avoided the general danger that lurks in improvisation—that of falling back on one's habits and memories—by taking recourse to either of the following two tactics: (a) the use of indeterminate instruments in which the causal relationship between their manipulation and the resultant sound is unknown and thus uncontrollable; (b) the use of "variable" time brackets which are flexible in terms of their beginnings and endings, as well as the exact timing for the occurrence of sounds inside them. The former approach, which is clearly reminiscent of what Tudor was doing from early on, was used to compose pieces such as *Child of*

months after "Musik im technischen Zeitalter," Cage criticized the conductor's plan to improvise with the orchestra when performing the music of Feldman, Brown, and his own: "Improvisation is not related to what the three of us are doing in our works," he clarified. "It gives free play to the exercise of taste and memory, and it is exactly this that we, in differing ways, are not doing in our music."[89] What he was doing, as far as he was concerned, was something that liberated one from one's own biases.

But what actually liberated the composer from the habitual exercise of taste and memory was not composition. It was the bias of materials. And the most significant material of all was *David Tudor*, who was by then engaging with improvisation mnemonic and using the composed material as a mere point of departure. Within a year from his letter to Bernstein, Cage appeared to have caught up. In the program note for the concert at Sogetsu Art Center in Tokyo on November 27, 1964, the composer used the term he had no taste for to describe the abandoning of parameters and measurements in the two works Tudor was performing that evening:

> Electronic Music for Piano *and* Duet for Cymbal *are not what one would call compositions. They are performances (in other words, improvisations) using electronic equipment (created by David Tudor and Junosuke Okuyama). Measurement of time and parameters of sound are not used. Therefore, notation is unnecessary. Their titles and the fact that I signed them as a composer might be misleading, or might not.*[90]

Cage's reasoning proceeded through a series of negations: there were no more measurements and parameters, which meant no notation, which meant no composition, which meant "improvisation"—for lack of a better word. The important thing was what they were not, rather than what they were.

The polarity between notation/composition and improvisation had a source which Cage had revealed earlier in the same program note. "My recent works have shifted from indeterminacy to one where notation is not used. This tendency has been encouraged by Busoni's *Sketches for A New Esthetic of Music*, and several recent experiences."[91] This was a book that Tudor was particularly fond of since his days with Stefan Wolpe, who had known the Italian composer in Berlin.[92] Cage may have

Tree (Improvisation 1) (1975) performed with amplified plant materials (cacti), and *Inlets (Improvisation 2)* (1977) performed with water-filled conch shells. The latter approach resulted in a series of works collectively entitled *c Composed Improvisation* (1987–1990) toward the end of the following decade (and actually all the so-called *Number Pieces* as well, though these were never referred to as "improvisation").

[89] Cage, "Letter to Leonard Bernstein (October 17, 1963)," *Selected Letters*, 289.

[90] Cage, "Program Note for Sogetsu Art Center concert (November 27, 1964)," Box 75, Folder 1, David Tudor Papers, GRI (translated from Japanese by You Nakai). An entry in Cage's *Diary: How to Improve the World (You Will Only Make Matters Worse)* from 1965 reflects on this program note as follows: "Non-measurement. [. . .] I'd quoted Busoni: Standing between musician and music is notation. Before I'd given the history: chance operations, indeterminacy. I'd cited the musics of India: notation of them's [*sic*] after the fact. I'd spoken of direct musical action (since it's ears, not interposing eyes)" (Cage, "Diary 1965," in *A Year from Monday*, 3).

[91] Cage, "Program Note for Sogetsu Art Center concert."

[92] Tamara Levitz's research suggests that Wolpe did not actually "study" with Busoni in the strict sense, but simply interacted with him on more casual terms. Tamara Levitz, "The Would-Be Master

indeed discovered Busoni through Tudor's influence. In any case, they appear to have been inspired by the same section of the book, as Tudor reminisced to Schonfield in May 1972: "there is a paragraph in Busoni which speaks of notation as an evil separating musicians from music, and I feel everyone should know that this is true."[93] In his 1907 treatise, Busoni did not so much demonize the writing down of music as emphasize its secondary status in relation to improvisation: "notation is to improvisation as the portrait to the living model."[94]

2

Within a couple of months, however, Cage came up with a better term for what Tudor was doing that was not so opposed in his mind to "composition" as was "improvisation," while still acknowledging the absence of notation. As it is unlikely that Cage should decide on his own what to call what Tudor was doing, at one point they probably discussed the issue together, arriving at the agreement that whatever it was, it was composed but not notated. On July 30, 1965, the composition of instrumental complexes received a new name in the program note of the Sundance Festival of the Chamber Art Forms in Upper Black Eddy, Pennsylvania (Figure 3.4), where Tudor performed *Variations II*, Cage performed *0'00"*, and together they gave a performance of *Variations IV*: "*Sound System* by David Tudor."[95]

The new name appears to have been a side effect of another *Variations* which had been premiered just a week before at Philharmonic Hall in the Lincoln Center of Performing Arts in New York: *Variations V*, performed on July 23 with the Merce Cunningham Dance Company, listed as [Realization 8] in the 1974 manuscript. Cage did not write any scores this time.[96] Instead, he conceived of the basic idea—to make the movement of the seven dancers activate and articulate sound—and asked other people to compose the necessary materials for its realization. According to James Tenney, who operated tape machines and radios, the composer did not even give any instructions to the performers: "By the time of *Variations V* [. . .] Cage had come to terms with free improvisation (though he didn't like that word) as long as it was done by people sympathetic to his aesthetic aims."[97] But it was not only the good intention of assembled personnel that subverted the issues of taste and memory. It was also their sheer number, as Leta E. Miller described the situation in 2001, using a familiar wording:

Student: Stefan Wolpe and Ferruccio Busoni, in Austin Clarkson, ed., *On the Music of Stefan Wolpe* (Hillsdale, NY: Pendragon Press, 2002), 31–40.

93 Tudor, "From Piano to Electronics," 24.

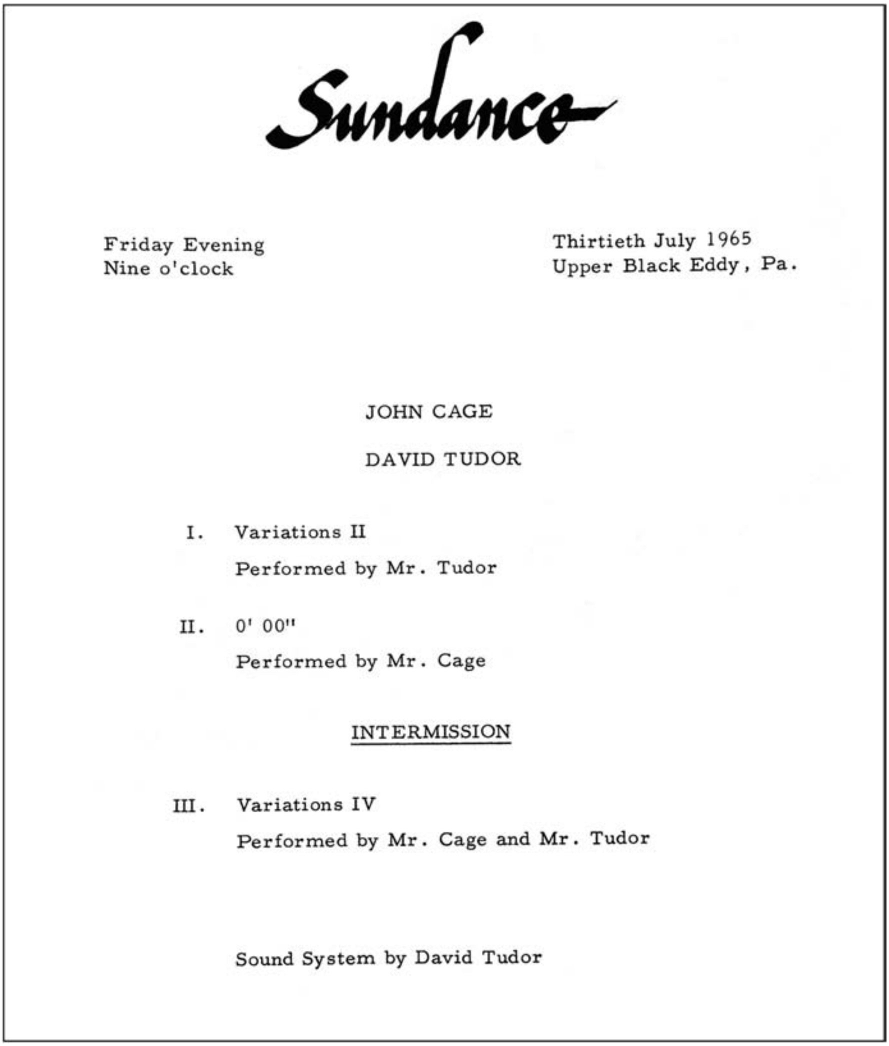
94 Ferruccio Busoni, *Sketches for a New Esthetic of Music*, translated by Theodore Baker (New York, NY: G. Schirmer, 1911), 15.

95 Tudor and Cage, "Program, Sundance Festival (July 30, 1965)," Box 74, Folder 7, David Tudor Papers, GRI.

96 This was also true with *Rozart Mix*, Cage's only other "composition" from 1965, premiered on May 5 of that year.

97 Quoted in Leta E. Miller, "Cage, Cunningham, and Collaborators: The Odyssey of *Variations V*," *Music Quarterly* 85, no. 3 (2001), 553.

> *By superimposing the inputs of an increasingly large number of imaginative personalities, Cage and his colleagues created a work with so many collaborators and such intricate linkages that each participant could* influence *the sound, but none could control it. The greater the number of participants, the more unpredictable the result. Thus Cage increasingly buried his own intentions under the weight of those of his artistic partners.*[98]



Sundance

Friday Evening
Nine o'clock

Thirtieth July 1965
Upper Black Eddy, Pa.

JOHN CAGE

DAVID TUDOR

I. Variations II
Performed by Mr. Tudor

II. 0' 00"
Performed by Mr. Cage

INTERMISSION

III. Variations IV
Performed by Mr. Cage and Mr. Tudor

Sound System by David Tudor

Figure 3.4 Concert program, Sundance Festival | July 30, 1965
DTP, Box 74, Folder 7 | Getty Research Institute, Los Angeles (980039)

[98] Ibid., 562; emphasis added.

However, these "participants" were of course not only people, imaginative or otherwise; they were also, and more significantly, instruments. The multiplicity of electronic equipment and their coordination made it certain that no single intention could take over the entire situation. All one could do was hope to "influence" it. On August 19, shortly after the premiere of *Variations V,* Cage made the following entry to his "Diary: Emma Lake Music Workshop 1965":

> *examining the fact of musical composition in the light of* Variations V*, seeing composition as activity of a* sound system*, whether made up of electronic components or of comparable "components" (scale, intervallic controls, etc.) in the mind of a man.*[99]

But there was one crucial difference between sound systems made up of electronic components and that of comparable "components" in the mind of a man: Cage could compose the latter but not the former. That was somebody else's role, as specified clearly in the thirty-seven remarks on *Variations V*, a score that Cage, in the end, could not help but write even if he had to fabricate the oxymoronic form of "*a posteriori* score"[100]—a score written after the fact:

> Sound System [. . .] Designed by David Tudor

If composition was now seen as the activity of a sound system, the role of a composer who could not participate in its composition had to change. Cage reserved himself a modest task: "Changed function of composer: to telephone, to raise money."[101]

3

Starting from the show at the Long Island Festival on August 20, 1965, when *Variations V* was performed for the second time, Tudor's credit in the program notes of MCDC also turned into "Piano and Sound System," while Cage's remained as

[99] John Cage, "Diary: Emma Lake Music Workshop 1965," in *A Year from Monday*, 22; emphasis added.

[100] In the 1989 panel discussion at UC Berkeley, Cage and Mumma had an interesting exchange about the status of these "a posteriori scores" after the moderator Amirkhanian confirmed to Cage that *Variations V* had "no overall controlling composer mind that was saying this is the way this piece is going to sound." When Cage responded, "No, No, No," Mumma sharply intervened:

> MUMMA: *There is a score for the work that is published.*
> CAGE: *But it's remarks following the performance . . .*
> MUMMA: *But to which you receive royalties!* [laughter]
> CAGE: *Right . . .* [laughter]
> MUMMA: *Music's come a long way!* [laughter]

("A Kind of Anarchy: Merce Cunningham and Music [September 19, 1989]," Merce Cunningham archives, New York Public Library).

[101] John Cage, *Variations V: Thirty-seven Remarks re Audio-Visual Performance* (New York, NY: Peters Edition, 1965).

"Musical Director."[102] This title would be used over the next three years, after which both became equally billed as "musicians."[103]

A more peculiar situation arose with the next entry in the *Variations* series. Composed in March 1966, *Variations VI* was a piece conceived specifically "for plurality of sound-systems (any sources, components and loud-speakers)"—now that what Tudor was doing had been given a name. The materials consisted of a huge number of transparencies: 12 with short straight lines, 38 with triangles, 57 with short bisected lines, and 114 with half-circles.[104] Triangles represented loudspeakers, bisected lines represented available components (amplifiers, preamplifiers, modulators, filters, and so on), and half-circles represented sound sources. As many of these as necessary could be used to compose a sound system whose spatial placement was determined by dropping the transparencies onto a sheet with a long straight line. The short straight lines would tell where one sound system ended and another began. Cage's materials thus constrained the number of components along with their position in space, without determining what they actually were.

When the piece was premiered on March 26, 1966, at the Fine Arts Foundation in Hartford, Connecticut, the duality of composition was expressed in the program note as a double feature of sorts:

> John Cage: Composition (indeterminate) / David Tudor: Sound System[105]

Cage and Tudor performed *Variations VI* together at least two more times that year.[106] As William Fetterman noted in his 1996 study of Cagean theater pieces, the two collaborators held contrary opinions about the sixth piece in the *Variations* series. The composer of indeterminate scores was not impressed: "I was not very happy with our performances, but he [Tudor] was pleased. They didn't seem to me to be any more complicated than with one sound system."[107] The composer of sound systems was indeed very pleased: "*Variations VI* was one of the most enjoyable pieces to perform. It's interesting because if you're in a controlled situation it's very, very beautiful, it turned out to be very theatrical."[108]

[102] MCDC, "Program, A Modern Dance Concert, Long Island Festival (August 20, 1965)," Box 75, Folder 7, David Tudor Papers, GRI.

[103] After joining the Merce Cunningham Dance Company in the summer of 1966, Mumma was also described as being in charge of the "Sound System." This went on until the performance at UCLA on November 15, 1968, after which Cage, Tudor, and Mumma were all equally billed as "Musicians."

[104] Cage, *Variations VI* (New York, NY: Peters Edition, 1966).

[105] Tudor and Cage, "Program, Fine Arts Foundation concert (March 26, 1966)," Box 76, Folder 1, David Tudor Papers, GRI. The concert included two pieces by Cage: *Variations VI* and *(2) Solo(s) for Voice II* [*sic*]. William Fetterman's account that *Variations VI* was first performed on May 13, 1966, in the Sculpture Court of the Art Gallery of Toronto appears to be mistaken (Fetterman, *John Cage's Theatre Pieces* [New York: New York University, 1992], 135).

[106] On April 27 at the Pan American Union Auditorium in Washington, DC, and on May 13 at the Art Gallery of Toronto, also with Lowell Cross and Anthony Gnazzo.

[107] Cage, quoted in Fetterman, *John Cage's Theatre Pieces*, 135.

[108] Tudor, quoted in ibid., 135.

When the piece was performed for the second time on April 27, at the Pan American Union Auditorium in Washington, DC, the program misspelled Cage's role—by sheer chance, yet quite appropriately (Figure 3.):

John Cage: Composition (intermediate) / David Tudor: Sound System[109]

4

This duality of composition influenced how Cage talked about sound systems: with an utter lack of specificity. As he wrote in December 1964, what electronics brought about was a general situation, where anything could be transformed into music:

> *One of the things we nowadays know is that something that happens (anything) can be experienced by means of technique (electronic) as some other (any other) thing (happening). For instance, people getting in and out of elevators and the elevators moving from one floor to another: this "information" can activate circuits that bring to our ears a concatenation of sounds (music).*[110]

Sound systems not only made measurements and parameters useless; they also neutralized the physical difference between materials. Everything was brought together under the singular rubric of "electronics," which named a general universe of possibilities for turning one thing into another. In another text printed on the concert program at the premiere of *Variations VI* in March 1966, Cage went even further, claiming that sound systems also did away with objects:

> *(Composition) is involved with process and not with object … the difference, say, between an ash tray and the whole room. An ash tray can be seen as having beginning and end, and you can concentrate on it. But when you begin to experience the whole room, then where is the beginning? Where is the middle? Where is the end?*[111]

Composition might be an activity of a sound system, but the sound system itself, as a complex of parametric objects localized in time and space, biased the universal nature of electronics. So it was not enough that instruments became neutral by becoming tools; they ultimately needed to become wireless and invisible. "At present," Cage wrote in a different text in the same month of March 1966, "it appears to be a series of components—a sound system—but it is a series of *components*, not a *series* of components. Soon 'twill be done wirelessly; then it won't appear to be different than what it already essentially is: *not* a series of components."[112]

[109] Tudor and Cage, "Program, Pan American Union Auditorium concert (April 27, 1966)," Box 76, Folder 1, David Tudor Papers, GRI.
[110] Cage, *A Year from Monday*, 33.
[111] Tudor and Cage, "Program, Fine Arts Foundation Concert (March 26, 1966)."
[112] Cage, "Seriously Comma (March 1966)," in *A Year from Monday*, 29.

PROGRAM

April 27

Music

John Cage: Composition (intermediate)

David Tudor: Sound System

Variations VI

We wish to extend special thanks to the Secretary General Dr. Jose A. Mora for the use of the Pan American Union Auditorium and to Mr. Guillermo Espinosa, Director of the Music Department.

Technical Assistant: George Ritscher

Chairman

Royce Dendler

Figure 3.5 Concert program, the Pan American Union Auditorium | April 27, 1966
DTP, Box 76, Folder 1 | Getty Research Institute, Los Angeles (980039)

5

During the panel discussion at UC Berkeley in September 1989, Cage tried to recall the sound system of *Variations V* from twenty-four years before: "we had a delay system arranged so that one wouldn't get a Mickey Mouse impression from the dance to the sound."[113] When the moderator Amirkhanian asked for more details—"Was it a fixed delay? It was always the same?"—Cage simply passed the question over to the composer of the sound system who was sitting next to him: "No it was different. Was there many, David?"[114] Tudor's reply negated the premise of the question:

> *Tudor: Umm . . . it didn't use anything which you would call a delay.* [laughter]
> *Cage: But the sound came later, didn't they?*
> *Tudor: It was built into the wiring.* [laughter] *There were miles of wiring involved and believe it or not, that's one of the ways to accomplish delay.* [laughter][115]

Cage had perceived an effect but the mechanism was not what he imagined—even the wire coordinating the components into a series left its material traces scattered all over the music. And since wireless systems are simply yet another way to accomplish delay (as any Wi-Fi user knows very well today), Cage's hope for immaterializing sound systems never really stood a chance. Instead of realizing the transparent neutrality of the transformation process, sound systems actually amplified the dirty materiality of objects involved. The composer of such systems not only had to deal with instruments rather than tools, but also with measurements and parameters—though measurements were now those of impedance, capacitor values, time constants, or cut-off frequencies, and parameters those of gain, voltage, or resistance.

113 "A Kind of Anarchy: Merce Cunningham and Music (September 19, 1989)."
114 Ibid.
115 Tudor went on to describe the sound system from a quarter-century before in detail: "Basically, the materials were simple enough. It was the implementation of it which makes it appear to be extraordinarily complex. And also what happens in a performance was that John tried to make sure that there was enough material so it would be extraordinarily varied. I recall that sources were . . . John had made some recordings. One of his next-door neighbors had a drain which was completely out of order. So he made some very significant recordings of those drains. [*laughter*] The other source was shortwave radios, and we had a kind that you won't find today—unless I guess if you go down Highway 1 you might find some—but they are the kind that the Navy and the Army used to use. So you have a receiver which goes maximum 3 megacycles with ultimate control so that you get the wildest possible kinds of sounds. Like the whistling sounds and all that that you heard. [. . .] Those were shortwave signals, but they were very powerful. If you look at a contemporary shortwave radio, you won't get it, you won't get it, because you won't have the signal amplitude—the receiver doesn't have the strength. Well, okay, and then a third source was contact microphones. The dancers had some objects which they themselves could activate. Merce Cunningham had a bicycle which was rigged up so that there was a contact microphone which was receiving the impulses of the wheel spokes, which was wired into an amplifier and a loudspeaker which the bicycle itself was carrying. So that was whirling around the stage. Then the whole thing was turned on and off, so one never knew what was going to happen. The musicians' job was to keep this material going, so that there was a constant supply of sound and the whole thing was triggered by the dancers—what position they were in, and it was never the same. I mean six things could be triggered at once, and sometimes nothing was happening though you heard a dancer moving a plant which was miked. It was a lovely situation once it got organized. Before that, it was absolute chaos" (ibid.).

When Cage set the throat microphone during the broadcast of "Musik im technischen Zeitalter" and started reading the text he had written on the liberation from parameters, the level of amplification was not adjusted properly and distorted his voice. Needing to convey the words in a clear manner, Cage stopped, went back to the amplifier to adjust the dials. When he could not do this on his own, he called a "Mr. Krauss" to help him. Mr. Krauss indeed appeared and adjusted the parameters of the amplifier accordingly. Only then was Cage ready again to "produce sounds without giving parameters a thought." Meanwhile, Tudor next to him continued to perform *Variations II*, busy scraping the strings of the amplified piano with a triangular ruler while manipulating the dials of the amplifier.[116]

In other words, the way electronics actually worked in a sound system was quite the opposite of how the "intermediate" composer thought about them. For one thing, the bias of materials was simply too large to allow for an utterly contingent connection between them. This meant that chance operations could not be used properly. Once the materials of composition shifted from parameters of sound within a textual universe of possibilities ("in the mind of a man") to parametric objects that extended themselves physically, Cage's method of composition reached a halt. Two notes coordinated via chance were performable, and definitely so if the task was taken up by a *David Tudor*, but an amplifier and a loudspeaker connected according to an ancient form of divination might simply kill the output. The specific nature of each parametric object biases the possibilities of coordination. So not everything is equally possible in equal ways.

6

In addition to this general condition of electronic instruments, there was also a specific nature of Tudor's approach, which further amplified the bias of materials. As Mumma jokingly revealed on November 11, 2011, the Second World War not only helped Tudor's early engagement with the organ by sending older organists to the battlefield, but also his later engagement with electronics by making cheaper components available back home:

> *[Tudor] spent a whole lot of time in the military surplus places getting these weird transistors, capacitors, or whatever.* [. . .] *He'd put them together, and you would have a unique circuit—some kind of an oscillator, some kind of a modulator, some kind of an envelope follower, whatever the hell they were. But they were essentially unique; you couldn't duplicate them. If you replaced one of those transistors with another one, it wasn't the same. So you have unique personalities, in the way they responded.*[117]

[116] *Musik im technischen Zeitalter*, Sender Freies Berlin, ZKM, 1963.
[117] Mumma, "Interview by You Nakai," November 11, 2011.

Specific components composed specific instruments, which in turn composed specific sound systems—so it was bias all the way down. But if that is the case, instead of trying to generalize what people wrote or recalled, it would suit the nature of sound systems to go in the other direction and focus on very specific instruments used in very specific realizations.[118] This involves a switch in the scale of observation.

II. Fontana Mix (Version for Bass Drum and Electronics)

April 15, 1967

1

Box 4 of the David Tudor Papers at the Getty Research Institute is a repository of unidentified materials. Folder 1 contains approximately 60 sheets of block diagrams, sketches of schematics, circuit layouts, and notes of electronic components. Among the miscellany, there are eight block diagrams in which what looks like the same collection of instruments—each designated with unknown symbols and letters—appear in similar configurations. Four of them appear to be fragmentary sketches. On the back of one, Tudor wrote a date: "Mar. 30 1967."[119]

The other four are more complete diagrams where all the components are connected in an almost identical manner. Again, there are dates written on each: "April 1, 1967" (on two) (Figure 3.6), "April 15–16, 1967" (Figure 3.7), and "May 11, 1967" (Figure 3.8)[120] The proximity of dates and likeness of content suggest the connection to the same work.

The dates can be matched with other materials in other parts of the archive. Box 76 contains Tudor's programs for concerts held between 1966 and 1968. Folder 4 of this box includes programs of three concerts that took place on exactly the same dates: on April 1, 1967, Tudor performed at the Rose Art Museum in Brandeis University, in Waltham, Massachusetts; on April 15 and 16, at the two-day Mixed Media Concerts held at Isaacs Gallery in Toronto (Figure 3.9); and on the evening of May 11, at Hope College in Holland, Michigan (Figure 3.10).

[118] Talking to Bruce Duffie on April 7, 1988, Tudor reflected on the manuscript from fourteen years before: "I once gave some notes and materials to Raymond Wilding-White, who wrote a book about electronic music, and he published some of it, but the detail isn't really there" (Tudor, "Presenting David Tudor: A Conversation with Bruce Duffie [April 7, 1988, Chicago]," bruceduffie.com, accessed December 15, 2018: http://www.bruceduffie.com/tudor3.html).

[119] Tudor, "Sketch (March 30, 1967)," Box 4, Folder 1, David Tudor Papers, GRI.

[120] Tudor, "Diagram (April 1, 1967)," "Diagram (April 15–16, 1967)," "Diagram (May 11, 1967)," Box 4, Folder 1, David Tudor Papers, GRI.

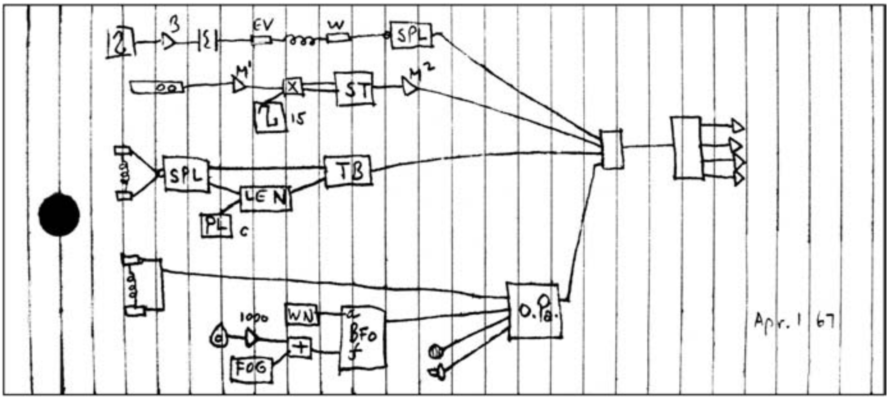


Figure 3.6 Tudor | "April 1, 1967" diagram
DTP, Box 4, Folder 1 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

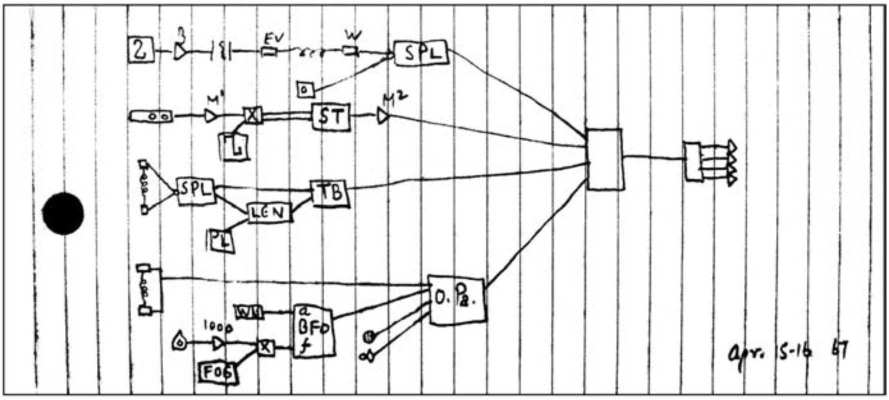


Figure 3.7 Tudor | "April 15–16, 1967" diagram
DTP, Box 4, Folder 1 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

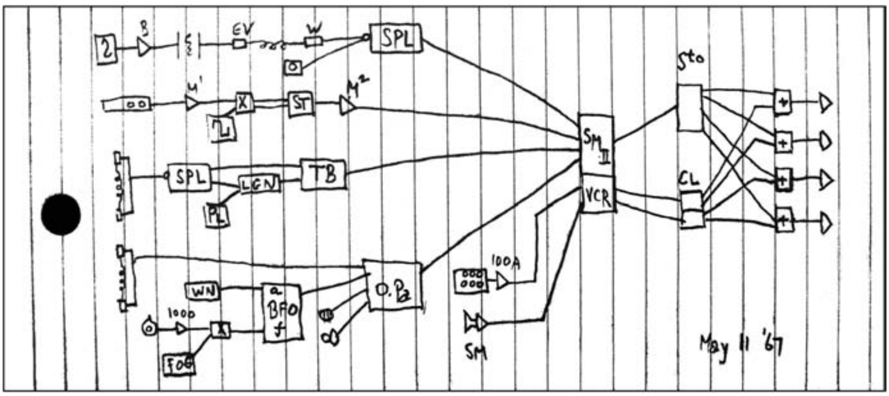


Figure 3.8 Tudor | "May 11, 1967" diagram
DTP, Box 4, Folder 1 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

THE ISAACS GALLERY

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   A D E                                    
 M I X E D     N  O  S T R E    M E D I A   
  X I M X A   C O N C E R T S    X A X I M  
 E D A M I     S T R E C N O C  I D E M X   
              E R T S   O  N          A D E 
```

directed by udo kasemets

Saturday, April 15, 1967
8.30 p.m.

Sunday, April 16, 1967
3.30 p.m.

Sunday, April 16, 1967
8.30 p.m.

M U S I C M C M L X V I I

DAVID TUDOR: performer

assistant: LOWELL CROSS

PROGRAMME

PAULINE OLIVEROS	Light Piece for David Tudor
MAURICIO KAGEL	pandorasbox, bandoneonpiece
JOHN CAGE	Solo for Voice 2 with Fontana Mix (realization for piano and electronic circuits)

****

PAULINE OLIVEROS is one of the founders of San Francisco Tape Music Center, and was appointed director of this studio when last year its sponsorship was taken over by Mills College, Oakland, Calif. Her compositions include instrumental and electronic music and audio-visual performance pieces which all have had numerous performances at major new music festivals and concerts all over the continent. The projections for Light Piece were prepared by Anthony Martin.

MAURICIO KAGEL was born in Buenos Aires in 1931 and is essentially selftaught. Between 1947 and 1957 he was active in the musical life of Argentina as pianist, conductor and writer. Since 1957 he has lived mostly in Europe, working at the Studio for Electronic Music of the West German Radio in Cologne, and conducting numerous concerts of new music throughout Europe.

JOHN CAGE: Solo for Voice 2 is a composition indeterminate of its performance. The performer prepares a program of desired time-length using the material provided. This material is various, some sheets on transparent plastic. Superimposition of these permits the performer to determine many of the details of a vocalise, including the vowels and consonants to be used.

Figure 3.9 Program for Isaacs Gallery Concert | April 15–16, 1967

DTP, Box 76, Folder 4 | Getty Research Institute, Los Angeles (980039)

HOPE COLLEGE

presents

JOHN CAGE,
LOWELL CROSS, TOSHI ICHIYANAGI,
and DAVID TUDOR

Thursday evening, May 11, 1967 at 8:15 o'clock

DIMNENT MEMORIAL CHAPEL
HOLLAND, MICHIGAN

PROGRAM

"APPEARANCE" (1967) . . . . *Toshi Ichiyanagi*
for three instruments, two oscillators, two ring modulators

Mr. Cage, Mr. Cross, Mr. Ichiyanagi, and Mr. Tudor
assisted by David Tubergen, violinist
and Bruce Formsma, trumpeter

MUSIC FOR A SOLO PERFORMER 1965 . . . *Alvin Lucier*
(Edmund Dewan, technical consultant)

Mr. Tudor assisted by Mr. Ichiyanagi and Mr. Cross

Intermission

MUSICA INSTRUMENTALIS (1966) . . . . . *Lowell Cross*
for performer and television oscilloscopes

Mr. Tudor, bandoneón and Mr. Cross, electronic equipment

FONTANA MIX [version for bass drum and electronic circuits (1967)
with by *David Tudor*]
0′00″ (1962) . . . . *John Cage*

Mr. Tudor and Mr. Cage

Figure 3.10 Program of Hope College Concert | May 11, 1967
DTP, Box 76, Folder 4 | Getty Research Institute, Los Angeles (980039)

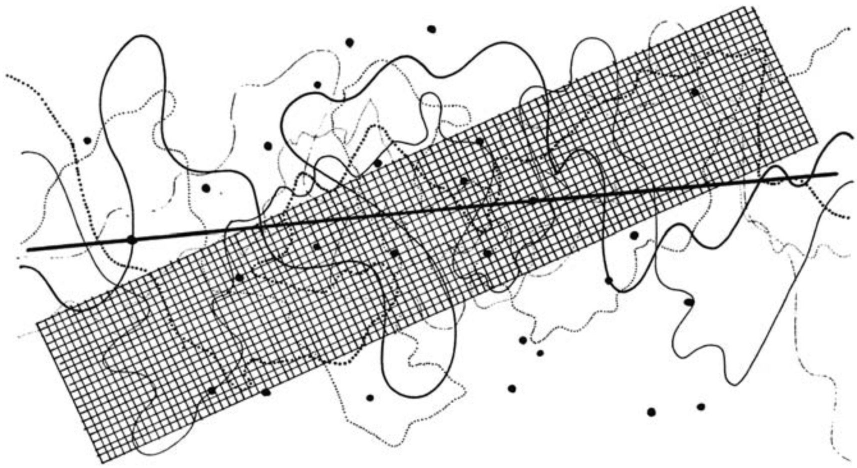


Figure 3.11 John Cage | *Fontana Mix*, possible superimposition of transparency materials | 1958

Only one piece was performed on all three occasions: *Fontana Mix*. The Hope College concert program adds a subtitle describing the instrumentation: "version for bass drum and electronic circuits by David Tudor." The unidentified diagrams from the spring of 1967 are thus revealed to have been Tudor's realization notes for a set of transparency materials Cage had composed nine years before.[121]

The first in Tudor's list of works that freed him from the evil of notation, the extreme flexibility of *Fontana Mix* allowed it to be realized with almost any kind of instrument. The only requirement was to coordinate any six parameters with the six different curved lines on the transparencies (Figure 3.11). The reading of superimposed sheets then determined a particular value for each parameter, along with the time bracket in which the composed event was to occur. Since the composer left the parameters unspecified, the material of *Fontana Mix* was actually even more flexible than that of *Variations II*. Cage used it to compose other materials, such as *Theatre Piece* in 1960. Tudor had used it as a pre-text for performing the amplified piano in January 1963 during the broadcast of "Musik im

[121] In most cases, Tudor wrote these diagrams *after* the performance. They were, in other words, "*a posteriori* scores," like the ones Cage wrote for *Variations V* and other works from the same period. Mumma confirmed this view in 2016: "a large part of his note taking was his memory about what he did. Not necessarily what he would be doing next" (Mumma "Interview by Nakai," November 4, 2016). Obviously, the function of Tudor's diagrams was different from Cage's scores, as they were intended neither for publication nor even to present the minimum requirements for re-enactment (as his own "generalized diagrams" would later do); rather, they were Tudor's personal notes to remind himself of what he had done. Nevertheless, these *a posteriori* diagrams are interesting in the way they bridge the gap between the idea of "work" with a recurring identity and the singularity of live performances in Tudor's music.

technischen Zeitalter." Throughout the decade, he continued to use the same material to perform other instruments.

2

The programs reveal the identity of the work, though not much about the actual instruments except that a bass drum was used with electronic circuits. But another piece of the puzzle is found in yet another part of the archive. Box 64 assembles articles and reviews of Tudor's concerts between 1966 and 1975. Folder 2 in this box contains a clipping of a review published in the *Toronto Daily Star* on April 17, 1967, written by staff writer William Littler, who had just seen Tudor's performance at the Mixed Media Concerts over the weekend. The headline "It didn't add up to much" sums up how unfortunately little Littler thought of what he had witnessed, although his brief recollection is quite telling in its own right:

> Solo for Voice Two *with* Fontana Mix*, by John Cage—one of the loudest, most cacophonous compositions to assault my eardrums in years. Actually, though, the composition was two compositions, played in combination by David Tudor and Toronto's Lowell Cross, sitting at separate control tables in different areas of the gallery. Cross supplied the voice, via microphones strapped to his throat. He also played around with gadgets. Tudor occupied himself with tape manipulations and a specially wired bass drum. Together they worked from programs notated on transparent sheets, superimposed on one another. I tried to stay interested. Walking around the gallery with fellow listeners. I gazed at one speaker, then another, hearing bits of pop music, machine-gun bursts of static and great gobs of crashing sounds.*[122]

Among other details, Littler reveals that Tudor was performing directly from Cage's transparencies, reading the superimposed curves and lines and points in real time. Instead of composing a realization score, he had composed a sound system. Cage's materials served as a mere point of departure—like Tudor's own nomographs from four years before, they were only one material among many to be attended in the real time of performance. No wonder the archival trail appears to go cold.

Littler's description does not tell much about the instruments except that a tape input and an amplified bass drum were involved. But the article contains more than just words. Illustrating the review is a photograph of Tudor sitting at an office desk full of equipment, manipulating an electric head massager on the head of a bass drum covered with other objects (Figure 3.12). The caption reads, "Avant-garde musician David Tudor in concert: 'Bits of pop music, machine-gun bursts or static and gobs of sounds.'" There is thus a photograph, a diagram, and a lot of instruments as pieces of puzzle that await to be coordinated.

[122] William Littler, "It didn't add up to much," *Toronto Daily Star*, April 17, 1967 (Box 64, Folder 2, David Tudor Papers, GRI).

22 TORONTO DAILY STAR, Mon., April 17, 1967

Music 1967

It didn't add up to much

By WILLIAM LITTLER
Star staff writer

Just as one man's meat is another man's poison, one man's music is another man's noise. It's as simple as that, really.

And that's why I'm not going to attempt anything more than a subjective assessment of what took place at the Isaacs Gallery on Saturday night.

To Udo Kasemets, who organized the event, it was obviously music, or he wouldn't have called it Music 1967. To David Tudor, who functioned as principal performer, it must have been music too, or he wouldn't have allowed the term to be used.

SINGLE NOTE

So who am I to disagree with these gentlemen even though my ears often identified just noise?

Noise, after all, is nothing more or less than unwanted sound. Tudor and Kasemets presumably wanted the sounds they produced. Therefore, the sounds were not noise—to them. My responses were less clear-cut, that's all.

Then what about those sounds?

Well, they began in darkness as Tudor, one of today's foremost avant-gardists, started manipulating a single note.

On the one hand he controlled the note as recorded from a piano on tape and at the same time he played it on a live, specially wired piano.

While this was going on, producing a series of swelling, gong-like hums of different pitches, light was being bounced off mirrors and revolving prisms.

This continued for more than a half hour with slight variations, and despite a certain crudity in technical performance (the lighting effects were primitively handled), succeeded in producing a hypnotic effect.

Composer Pauline Oliveros called the totality Light Piece for David Tudor. On this occasion it was also Light Piece for William Littler.

SIMPLICITY

The simplicity of Oliveros' Light Piece accounted in large measure, I think, for its effectiveness. It was a study in the subtle relationships of light and sound rather than a tour de force of electronic gadgetry.

The latter phrase more accurately describes Solo for Voice Two with Fontana Mix, by John Cage—one of the loudest, most cacophonous compositions to assault my eardrums in years.

Actually, though, the composition was two compositions, played in combination by David Tudor and Toronto's Lowell Cross, sitting at separate control tables in different areas of the gallery.

GADGETS

Cross supplied the voice, via microphones strapped to his throat. He also played around with gadgets. Tudor occupied himself with tape manipulations and a specially wired bass drum.

Together they worked from programs notated on transparent sheets, superimposed on one another.

I tried to stay interested. Walking around the gallery with fellow listeners, I gazed at one speaker, than another, hearing bits of pop music, machine-gun bursts of static and great gobs of crashing sounds.

But after conceding the intricacy of the technology employed, the involvement of the performers and the possibility of going deaf, I couldn't find enough to sustain a half hour's listening interest.

Mauricio Kagel's Pandora's Box at least taxed the ears less, being shorter and written for something readily identifiable as a musical instrument.

AVANT-GARDE MUSICIAN DAVID TUDOR IN CONCERT
'Bits of pop music, machine-gun bursts or static and gobs of sounds'

The instrument, the bandonean, resembled an outsized concertina. As Tudor played it, though, it seemed much more versatile.

Spinning himself around on a stool and reading a set of diagrams on the floor, Tudor shook the instrument on his lap, blew into it, pushed its buttons, sustained notes for long intervals and stretched its pleating to exceptional lengths.

The effect bulged the eye and sometimes teased the ear. Unfortunately, the Argentinian composer's music didn't seem to add up to much.

And ultimately, neither did this mixed media concert as a whole. Ideas there were. Sounds too. But musical satisfaction? Well, as I said before, one man's meat. . . .

Lord Thomson empire threatened

LONDON—A powerful group of Scottish financial, political and entertainment interests has entered a formal bid to take over commercial television rights in central Scotland from Lord Thompson.

The group, Central Scotland Television Ltd., is backed by Sir Hugh Fraser's Scottish and Universal Investments Ltd. and has as its chairman Jo Grimond who resigned earlier this year as leader of the Liberal party. Backers also include The Observer Sunday newspaper and the weekly Economist magazine.

The Grimond-Fraser line-up is one of about 50 applicants bidding for program rights in 15 regions of Britain when current licences expire in July, 1968. The group announced it had applied to the Independent Television Authority after the six-week application period closed Saturday. Thomson is bidding to retain the Scottish rights.

Scottish TV, which Thomson established in 1957 almost without opposition, has been a lucrative enterprise for the Toronto-born publisher and broadcaster. His Scottish franchise, which Thomson once described as "a licence to print money," was renewed for three years in 1964 and again for one year.

Figure 3.12 William Littler | "It didn't add up to much" | *Toronto Daily Star* | April 17, 1967

DTP, Box 64, Folder 2 | Reproduced by permission from Toronto Star Newspapers Limited

3

The signs Tudor used to notate his instruments can be sorted out into three types: (a) ***icons***, based on how an instrument *looks*; (b) ***symbols***, based on what an instrument *does* (although in many cases these are based on iconic likeness);[123] and (c) ***abbreviations***, based on what an instrument is *called* (often an "acronym," which takes the initial[s] of the name).

[123] For an inspiring study on the relationship between symbols and icons, see Terrence Deacon's analysis of Peircean semiotics in *The Symbolic Species: The Co-evolution of Language and the Brain* (New York, NY: W. W. Norton, 1997) and its imaginative application in Eduardo Kohn, *How Forests Think: Toward an Anthropology beyond the Human* (Berkeley: University of California Press, 2013).

(a) ***Icons*** are easy to identify if the instruments can be seen. For instance, a quick glance at the *Toronto Daily Star* (TDS) photograph reveals what the three spiraling figures in the diagram are: three *Slinkys*—one of which had already appeared in "Musik im technischen Zeitalter"—laid across the bass-drum head.

(b) ***Symbols*** are usually not that difficult either, if the function of the instrument or the convention of notation is known: a right-sided triangle stands for an amplifier; an S-shape in reverse for a sine-wave oscillator; a Z-shape for a square-wave oscillator; an "×" for a multiplier; a "+" for a mixer; and so on. Tudor did invent several strange symbols of his own, but these will appear only later.

(c) ***Abbreviations*** can be tricky since what one needs to know is neither the appearance nor the function of the instrument, but its name. And names can be a problem in Tudor's case.[124] Instruments made by other people often have names written on them. For instance, among the Wesleyan collection there are two *Olson RA-637 Preamplifier Mixers*, which as commercial products proudly wear their names on their sleeves, and are often abbreviated as "OP" or "O.Pa." Even non-commercial instruments such as the *Beat Frequency Oscillator*, made very likely by Gordon Mumma, has its acronym "BFO" inscribed on a Dymo label. The instruments composed by Tudor, on the other hand, almost never have such convenient name tags or friendly labels explaining the function of this or that switch.

There are a number of ways to proceed:

(a) Consult the equipment lists that Merce Cunningham Dance Company prepared for customs declaration when touring abroad. For the sake of the border control officer, these documents wrote out the name of an instrument unknown anywhere else. They were like passports for instruments, although Tudor's own instruments were born nameless, so they were often described generically as "homemade electronic components."

(b) Compare multiple sketches since the different ways Tudor abbreviated the same name sometimes gives a clue to the original name (for instance, "OP" or "O.Pa").

(c) Examine the instrument's placement within the larger sound system, or analyze its internal circuitry, to detect its function and thereby its name. For instance, "WN" in the diagram which receives no input and whose single output is used as the program signal ("PG") of the *BFO* must be a signal generator of some kind—from there, it is not so hard to imagine that the two letters probably stand for *White Noise Generator*.

Using these methods, Tudor's diagram for the realization of *Fontana Mix* on April 15–16, 1967, has been almost completely deciphered (Figures 3.13 and 3.14).

[124] Chapter 7 will focus on the problem of names in Tudor's music.

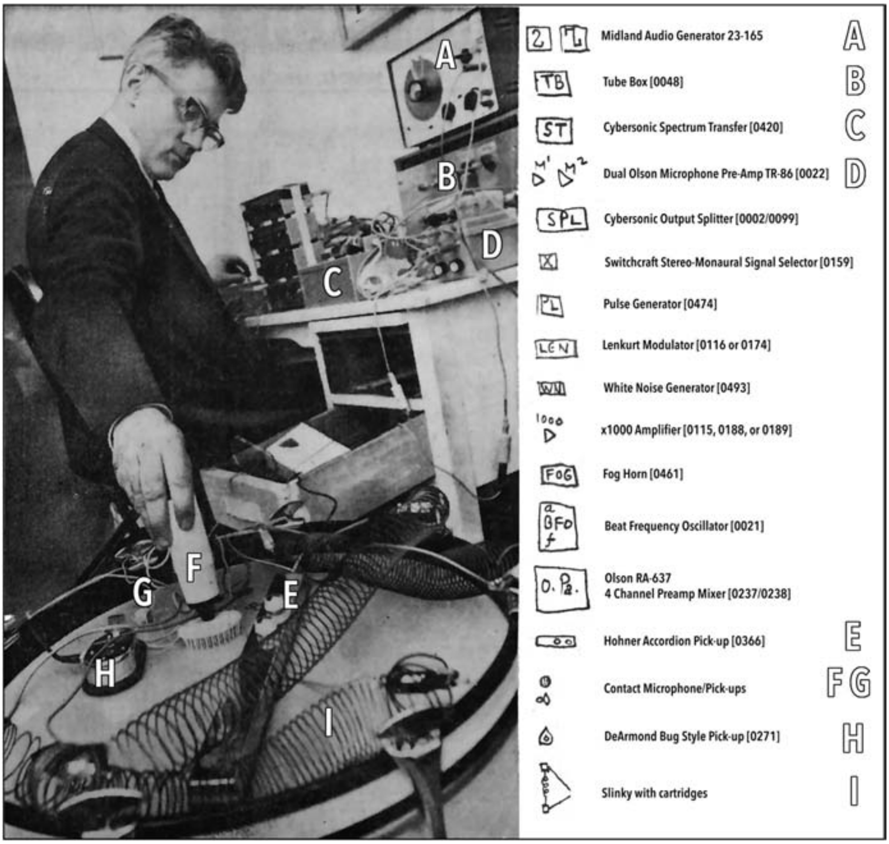


Figure 3.13 Tudor | TDS photo with identification of instruments and corresponding symbols, icons, and acronyms

Created by You Nakai | Reproduced by permission from Toronto Star Newspapers Limited

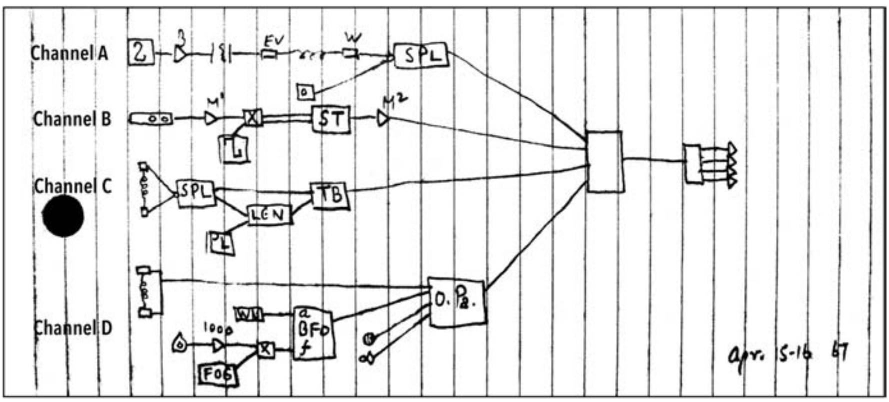


Figure 3.14 Tudor | *Fontana Mix*, realization diagram with channel names added | April 15–16, 1967

DTP, Box 4, Folder 1 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

4

Some general observations can be made just by looking at the placement of instruments in the diagram.

(a) *The channels are composed systematically*. The top one starts from a *Sine-Wave Generator*, whose electronic signal is modified acoustically by a *Slinky* acting as a reverb (Channel A). The other three channels instead start from the bass drum, whose acoustic sound is modulated electronically by three different modulators. A different signal generator is coupled with each modulator, providing the second signal with which the bass-drum signal interacts to produce the modulated signal: the *Spectrum Transfer* ("ST") with a *Square-Wave Generator* (Channel B); the *Lenkurt Modulator* ("LEN") with a *Pulse Generator* ("PL") (Channel C); and the *Beat Frequency Oscillator* ("BFO") with a *White Noise Generator* ("WN") (Channel D). Since the three *Slinkys* are spread on top of one another over the bass-drum head, the channels are not as independent as they may appear on paper.

(b) *Appearances matter, especially for input*. Tudor drew all the input transducers that convert physical vibration into electronic signal—various microphones and *Slinkys*—as icons. So they can be matched with actual instruments based on how they look. Thankfully, the bass drum has been captured quite clearly by the TDS photograph, which shows most of the transducers attached. Four of them have thus been identified, out of which two still survive in the instrument collection at Wesleyan.

Hohner Bar Pick-up for Accordion (Instrument 0366)

The elongated instrument lying on top of the bass-drum head resembles the rectangular-shaped box with two circles inside at the start of Channel B (Figure 3.15). This is a golden *Hohner Bar Pick-up for Accordion* with three air microphones on the back, and a volume and tone control on the front (Figure 3.16). According to a receipt excavated in another obscure corner of the archive, Tudor had purchased this instrument on August 18, 1966, a year before the Toronto concert, when he was in Hamburg filming *Variations V* for the North German Television (NDR).[125]

DeArmond Bug-Style Pick-up (Instrument 0271)

A second instrument that is visible on the bass-drum head looks very much like the input icon drawn as a circle inside an oval with a pointy top in Channel D (Figure 3.17). This is a *DeArmond Bug-style Pick-up* originally made in the mid-1950s by Harry DeArmond to be used on archtop guitars. A copy of this pick-up also made its way into the Wesleyan collection (Figure 3.18).

[125] Musikhaus Detmering Hamburg, "Receipt for *Hohner Microphone* (August 18, 1966)," Box 123, Folder 2, David Tudor Papers, GRI.

Figure 3.15 Tudor | *Hohner Bar Pick-up*, icon
Courtesy of David Tudor Trust

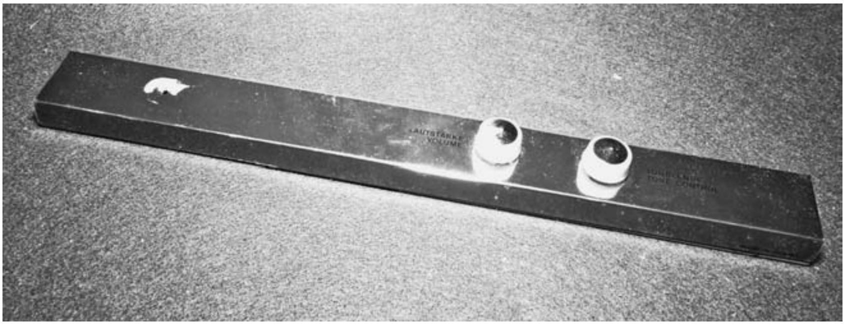


Figure 3.16 Hohner | *Bar Pick-up for Accordion*
DTC, Instrument 0366 | World Instrument Collection, Wesleyan University

Figure 3.17 Tudor | *DeArmond Bug-style Pick-up*, icon
Courtesy of David Tudor Trust

Similarly, the icon in the same channel with a circular tip sticking out of a circular base looks very much like the electric head massager that Tudor is holding in the TDS photograph, and the striped circle icon above it probably stands for the small contact microphone lying between the head massager and the bug-style pickup. Although there is nothing resembling the square icon with a circle inside that shows up midway in Channel A, it is most likely another microphone of some kind. All in all, Tudor appears to have derived all the acoustic input to this sound system solely from the bass drum. Which is also to say that the central instrument has been left out of the diagram.

Figure 3.18 DeArmond | *Bug-style Pick-up*
DTC, Instrument 0271 | World Instrument Collection, Wesleyan University

5

Many of the instruments in this sound system also make an appearance in other realizations featured in subsequent chapters. It would therefore be best to do an introduction of these *dramatis personae,* so to speak, taking a close look at them one by one while tracking the flow of signals throughout the four channels.

Although the nature of the diagram occults this fact, Channels A and B actually share an instrument, so it makes sense to discuss them together (Figure 3.19).

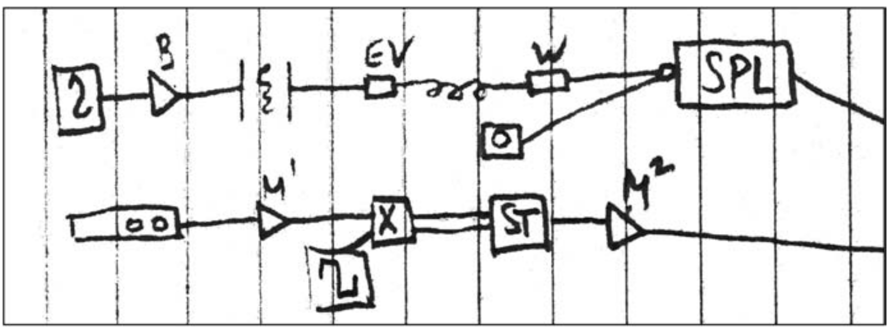


Figure 3.19 Tudor | *Fontana Mix*, realization diagram, channels A and B (close-up)
Courtesy of David Tudor Trust

Midland Audio Generator Model 23-165

The sine wave generator in Channel A and the square wave generator in Channel B were a single instrument which appears in the TDS photograph as a large box stacked on top of another larger box facing Tudor on the table. This was *Midland Audio Generator Model 23-165*, capable of producing sine and square waves ranging from 1 Hz to 110 kHz. Although it is no longer to be found among the instruments in the Wesleyan collection, the same name appears frequently in equipment lists of MCDC from this period. Rogalsky has indeed spotted the same box in a photograph taken by Mumma in Bloomington, Indiana, showing Tudor's setup for *Rainforest* on April 15, 1971 (which happens to be exactly four years after the Toronto concert).[126] A close observation of the TDS photograph reveals there are two cables plugged into this generator, which suggests that the particular one Tudor owned had been modified to output both sine and square waves simultaneously. The equipment lists support this view by always attaching a simple addendum to the name of the instrument: "altered."[127]

Olson Microphone Preamplifier TR-86 (Instrument 0022)

Proceeding on Channel B, the square wave generated by the dual *Midland Audio Generator* is modulated by the sound of the bass-drum which has been picked up by the *Hohner Bar Microphone* and boosted by an amplifier labeled "M1." This letter stands for *Olson Microphone Preamplifier TR-86*, and the number stands for one of the two copies of the same kit that Tudor housed together in a plastic card file box—another dual instrument that is visible in the TDS photograph, sitting at the edge of the office desk (Figures 3.20 and 3.21). The second kit preamplifier in the same box ("M2") appears later in the same Channel B to amplify the signals after they are modulated by a box labeled "ST".

Switchcraft Stereo-Monaural Signal Selector with Reverse (Instrument 0159)

But first, they go through another box with an x-symbol (Figure 3.22), which represents the *Switchcraft Stereo-Monaural Signal Selector with Reverse* (Figure 3.23). This instrument could take two inputs and select between three different kinds of output: either one of the inputs (monaural), both inputs (stereo), or both inputs but channel reversed. So it gave Tudor the option to switch between using the square wave or the bass-drum signal as the "carrier signal," the generally periodic waveform whose regularity is modulated by the other signal; or as the "program signal," the other signal which modulates the carrier which derives its name from having been the program content of the radio show in the realm in which this technology first developed. This switch therefore makes it difficult to tell which one is which from the diagram alone.

[126] Matt Rogalsky, "Idea and Community: The Growth of David Tudor's *Rainforest*, 1965–2006," PhD dissertation, City University London, 2006, 127–129.

[127] For example: MCDC, "Manifest for Customs Clearance and Air Freight for Rome, Italy (April 1969)," Box 29, Folder 10, David Tudor Papers, GRI.

Figure 3.20 Olson Electronics | *Microphone Preamplifier TR-86*
DTC, Instrument 0022 | World Instrument Collection, Wesleyan University

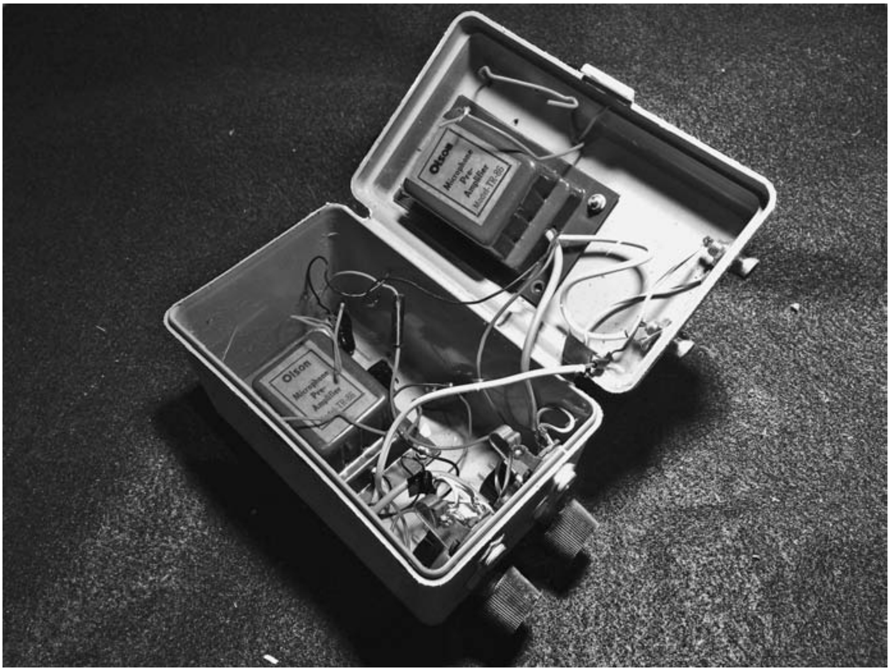


Figure 3.21 Olson Electronics | *Dual Microphone Preamplifier TR-86* (interior)
DTC, Instrument 0022 | World Instrument Collection, Wesleyan University

Figure 3.22 Tudor | *Switchcraft Stereo-Monaural Signal Selector with Reverse*, icon
Courtesy of David Tudor Trust

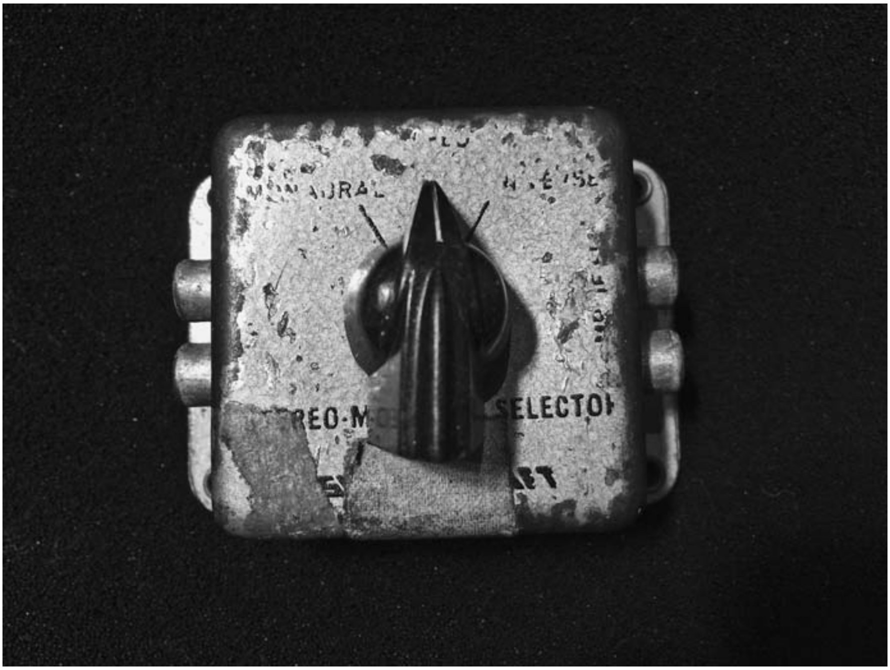


Figure 3.23 Switchcraft | *Stereo-Monaural Signal Selector with Reverse*
DTC, Instrument 0159 | World Instrument Collection, Wesleyan University

Cybersonic Spectrum Transfer (Instrument 0450)

The modulator's acronym "ST" stood for the *Cybersonic Spectrum Transfer*, another extant instrument which can be seen sitting next to the *Olson Microphone Preamplifier* in the TDS photograph (Figure 3.24).[128] Tudor had a special fondness for this box. He had first come across it by chance when he performed with Cage at Antioch College in Yellow

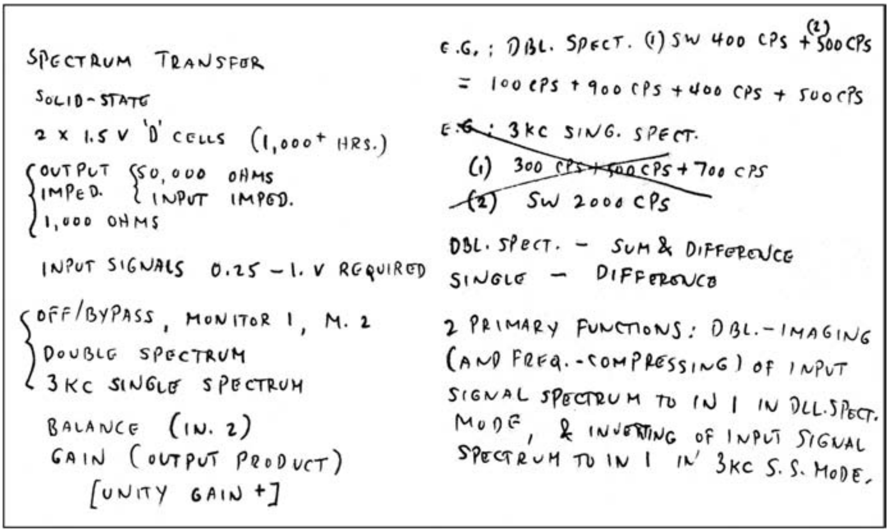
[128] See Chapter 4 for a detailed discussion on Cybersonics.

Figure 3.24 Gordon Mumma | *Cybersonic Spectrum Transfer*
DTC, Instrument 0450 | World Instrument Collection, Wesleyan University

Springs, Ohio, on May 22 and 23, 1965. It was among the equipment he borrowed from the school, but he grew very attached to it after using it in the performance. So when the same tour subsequently stopped by Ann Arbor, Michigan, just a couple of hours drive north, Tudor located the builder of this instrument, who happened to live there, and asked for a copy of the same instrument. On September 8 of that same year, that builder, who turned out to be Gordon Mumma, wrote to his new client: "I've set to work at the *Spectrum Transfer* […] since you used the one at Antioch you are familiar with its musical (and otherwise) talents."[129] Two weeks later, the finished product was handed over to Tudor, who was back in Ann Arbor with Cage, this time to perform at the ONCE AGAIN Festival co-curated by Mumma.

Cybersonic Spectrum Transfer became one of the most frequently used boxes in Tudor's entire collection of instruments, appearing in diagrams and photographs throughout the years until the end of his life. The extant instrument at Wesleyan reveals it was basically a ring modulator: using the principle of heterodyning, the instrument multiplied the two input signals, producing a new spectrum consisting of sums and differences of their frequency components (f1+f2 and f1−f2). A notable feature of Mumma's design was that it allowed a switching between two functions: "double-spectrum," which

[129] Mumma, "Letter to Tudor (September 8, 1965)," Box 57, Folder 3, David Tudor Papers, GRI.



SPECTRUM TRANSFER
SOLID-STATE
2 x 1.5 V 'D' CELLS (1,000+ HRS.)
OUTPUT IMPED. 1,000 OHMS
50,000 OHMS INPUT IMPED.
INPUT SIGNALS 0.25 – 1. V REQUIRED
OFF/BYPASS, MONITOR 1, M. 2
DOUBLE SPECTRUM
3KC SINGLE SPECTRUM
BALANCE (IN. 2)
GAIN (OUTPUT PRODUCT)
[UNITY GAIN +]

E.G.: DBL. SPECT. (1) SW 400 CPS + (2) 500 CPS
= 100 CPS + 900 CPS + 400 CPS + 500 CPS
~~E.G.~~: 3KC SING. SPECT.
(1) 300 ~~CPS + 500~~ CPS + 700 CPS
~~(2)~~ SW 2000 CPS
DBL. SPECT. – SUM & DIFFERENCE
SINGLE – DIFFERENCE
2 PRIMARY FUNCTIONS: DBL.-IMAGING (AND FREQ.-COMPRESSING) OF INPUT SIGNAL SPECTRUM TO IN 1 IN DBL. SPECT. MODE, & INVERTING OF INPUT SIGNAL SPECTRUM TO IN 1 IN 3KC S.S. MODE.

Figure 3.25 Tudor | *Spectrum Transfer,* notes copied from the Cybersonics Catalog
DTP, Box 44, Folder 8 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

did what regular ring modulators do, and "single-spectrum," which sent the modulated signal through a low-pass filter with multiple stages to remove the frequencies above the designated cut-off frequency (3 kHz) and output only the difference between the signals (f1– f2)—a technique known as single-sideband modulation (Figure 3.25). Switching the input channels with the signal selector, like Tudor did in Toronto, changed the order of subtraction and the resulting difference.

6

In Channel C, the signal from the *Slinky* is split in two, one of which gets modulated before merging with the other unmodulated signal (Figure 3.26).

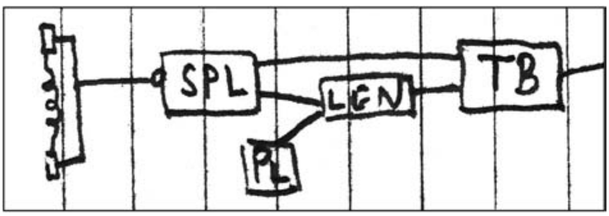


Figure 3.26 Tudor | *Fontana Mix*, realization diagram, channel C (close-up)
Courtesy of David Tudor Trust

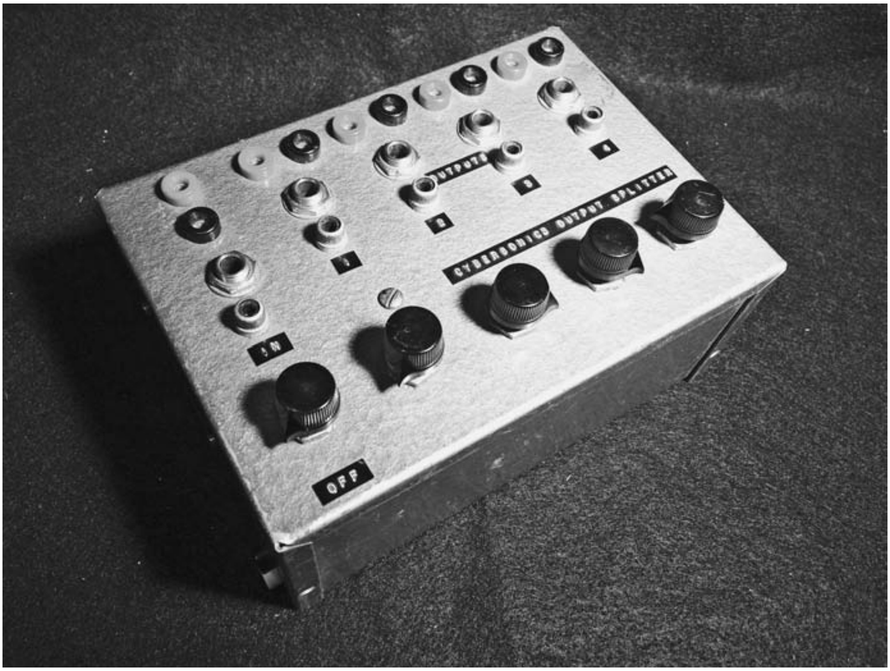


Figure 3.27 Mumma | *Cybersonic Output Splitter*
DTC, Instrument 0002/0099 | World Instrument Collection, Wesleyan University

Cybersonic Output Splitter (Instrument 0002/0099)

The instrument that splits the *Slinky* input in two was another instrument made by Mumma: *Cybersonic Output Splitter* (Figure 3.27). As the name suggests, this box took one input signal, adjusted its gain, and split it into four separate outputs each with additional gain control. Another splitter ("SPL") appears at the end of Channel A. Tudor indeed owned two copies of the same instrument.

But there is something strange about how he uses them in this particular sound system. The two identical *Output Splitters* were both sent to Tudor on October 4, 1966. An accompanying letter from Mumma informed the new owner of their basic specs: maximum gain was 10 (or 10 dB); input impedance was "minimum about 100 K [Ω (ohms)], maximum about 1.1 Meg [Ω]"; maximum output impedance was 1 kΩ.[130] Here as well as in all other correspondence about these instruments, Mumma kept bringing up one particular topic: *impedance*, the overall opposition that a circuit shows to the flow of alternating current (AC) which reverses its direction periodically over time. This opposition does not

[130] Mumma, "Letter to Tudor (October 4, 1966)," Box 57, Folder 3, David Tudor Papers, GRI.

appear for direct current (DC) because it is determined by two kinds of electronic components whose degree of resistance changes according to the frequency of the signal: capacitors and inductors. In both of them, the source of resistance is not the physical friction of conducting material as in resistors, but the temporal charge of electric field (for capacitors) or magnetic field (for inductors). Therefore, these materials work as frequency-dependent resistors that change their value over time according to the ebb and flow of the alternating current. So this fluctuating value, called *reactance*, must be added to the sum of resistance whenever an AC signal is involved. The resulting impedance has a directional nature following the directional nature of alternating current, which is reflected in the fact that its calculation differs according to the direction a given circuit is viewed from: input impedance differs from output impedance.

On September 9, 1966, Mumma reported that the "Output-splitter is all mocked up, and works very well. It was from an idea I got during the last part of the trip."[131] He was referring to a month-long European tour he had just done with the Merce Cunningham Dance Company in August, his first trip after joining the troupe in the spring of that year at Tudor's request. They had apparently discussed the new instrument while on the road.[132] The impedance of the mock-up was slightly less than the final version for both input—"50K minimum, to 1 Meg depending on gain"—and output—"less than 500 ohms." Having high input impedance and low output impedance is a norm in the coordination of audio equipment for several reasons, one of them being that cables connected to an instrument with high output impedance would also have high impedance, which is more vulnerable to noise than low impedance cables.[133] This becomes a problem for long-distance connections—something that appears to have been on Tudor's mind when he commissioned the *Output Splitters* to Mumma.[134]

131 Mumma, "Letter to Tudor (September 9, 1966)," Box 57, Folder 3, David Tudor Papers, GRI.

132 On August 27, Mumma wrote: "In a few more days I'll have this moving event completed, and will get to the special output-splitter we have discussed. It has become important to me also, because of a modification I'll be making of *Mesa*, and Behrman is interested in the device for one of his ideas" (Mumma, "Letter to Tudor [August 27, 1966]," Box 57, Folder 3, David Tudor Papers, GRI).

133 The output impedance of the first instrument coordinated to the input impedance of the second instrument is equivalent to two resistors connected in series. As such, the connection works as a virtual voltage divider, converting voltage (the amount of pressure pushing the current) into a fraction of its original according to the ratio of impedance between the two instruments. Having higher impedance on the output side will therefore prevent loss of voltage when the signal is passed on from one instrument to the next.

134 In an earlier letter sent on September 4, Mumma had revealed one reason why the issue of low output impedance mattered to Tudor, referring to another instrument which they had just used in the performance of Cage's *Variations V* filmed by the Northern German Television (NDR) in Hamburg: "I can also give you an extra output of about 10 ohms, like in my 'Zamp' which we used for the big studio amplifiers at NDR. It enables you to run long lines without shielding" (Mumma, "Letter to Tudor [September 4, 1966]," Box 57, Folder 3, David Tudor Papers, GRI). In the September 9 letter, sent five days later, Mumma wrote about "another procedure" which was "less expensive to build, but lacks several sophistications." The biggest problem was an increase in the output impedance to 50 kΩ, "much higher than other," as the composer noted (the input impedance was 100 kΩ). Thus, the principal drawback was: "No extremely low output impedance for the 'long-line' configuration" (Mumma, "Letter to Tudor [September 9, 1966]," Box 57, Folder 3, David Tudor Papers, GRI).

In the October 4 letter, Mumma assured him that the completed instrument, in spite of its higher output impedance, would still allow coordination over long distances if the instrument on the receiving end had a high input impedance:

> *Long shielded lines of hundreds of feet are feasible from any of the outputs if they ultimately go into a Hi-impedance (100k or better) input.*[135]

Tudor's concern for long-distance coordination suggests the use of the *Output Splitters* that he initially had in mind: performance in a very large space. Indeed, on October 14, just ten days after Mumma shipped the two *Splitters* to Stony Point, Tudor performed *Bandoneon!* (*Bandoneon Factorial*), the first work in which he credited himself as a "composer," at the huge 69th Regiment Armory in New York City.

For the performance of *Fontana Mix* six months later, however, Tudor used the same instrument in an unusual manner. In Channel A, "SPL" *receives two signals and outputs one*. This suggests either of the following two possibilities: (a) Tudor combined two signals at the input and took only one output, using Mumma's *Splitter* only for the gain and possible interaction between the two input signals caused by impedance mismatch; or (b) the function of the *Splitter* was reversed, using the single input as output and the four outputs as inputs—something that Mumma recalled Tudor doing on a number of occasions.[136] Input impedance thus became output impedance and vice versa.

Pulser (Instrument 0474)

One output of the *Output Splitter* in Channel C is used to modulate the signal coming from a *Pulse Generator* ("PL"). This was one of the very few instruments Tudor owned in the spring of 1967 that was neither a commercial product (like the *Midland Audio Generator*), a re-housed kit (like the dual *Olson Microphone Preamplifier*), nor made by a friend (like the *Cybersonic Spectrum Transfer*). Instead, he had composed this one himself (Figures 3.28 and 3.29).

As with virtually all the instruments that have been identified as being made by him, Tudor had a source for this realization, which he followed with the same meticulous attention to detail that he famously displayed for other composers' scores in the 1950s. This time, the material was an article published in the April 1966

135 Mumma, "Letter to Tudor (October 4, 1966)," Box 57, Folder 3, David Tudor Papers, GRI.

136 For instance, Mumma recalled on November 11, 2011: "There was one occasion when I was at his house at Stony Point—that would have been 1966. We were going to be getting ready for the tour of the company. He brought out one of those earlier things and he said, 'Do you know what this will do?' And I said, 'Oh yeah, I remember that one.' And he said, 'I will show you!' And he had the thing all wired up, upside down, and backwards. And he got sounds out of it that, oh my god, I mean it was spectacular. [. . .] And I said, 'David, what have you done in there?' He said, 'Well things are rearranged.' So I took the screws out, put the box out, and it looked pretty much like what I had wired. Maybe this is like an early circuit bender. He did very little. I can't remember what he did, but it didn't look to me as he did much. I put it back together and I plugged it in the way that I had designed for the thing he asked for, and it came out just the way it was supposed to. He had just found a way of shifting inputs, outputs, okay? And that was fundamental to a lot of the things he did" (Mumma, "Interview by Nakai," November 11, 2011). However, if Mumma's memory of this occasion being before the tour is correct, the instrument he talks about here cannot be the *Output Splitters* that were sent to Tudor only after the 1966 tour.

Figure 3.28 Tudor | *Pulse Generator (Pulser)*
DTC, Instrument 0474 | World Instrument Collection, Wesleyan University

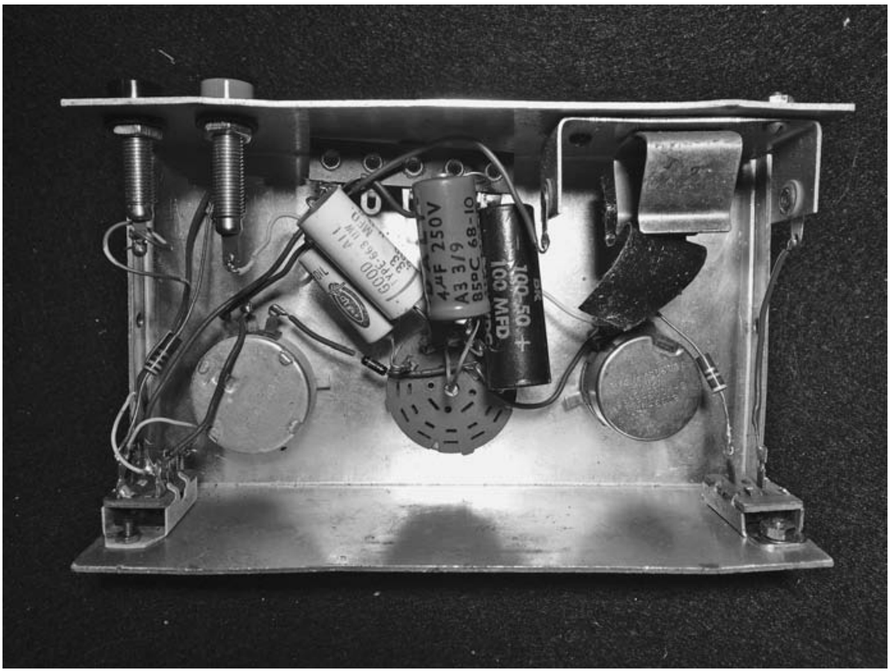
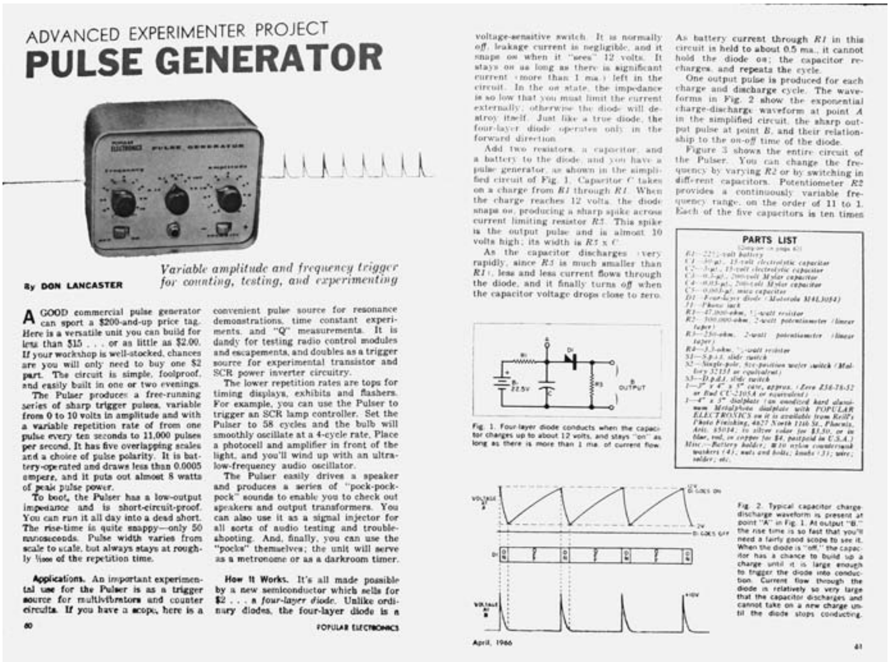


Figure 3.29 Tudor | *Pulse Generator (Pulser)* (interior)
DTC, Instrument 0474 | World Instrument Collection, Wesleyan University



ADVANCED EXPERIMENTER PROJECT

PULSE GENERATOR

Variable amplitude and frequency trigger for counting, testing, and experimenting

By DON LANCASTER

A GOOD commercial pulse generator can sport a $200-and-up price tag. Here is a versatile unit you can build for less than $15 . . . or as little as $2.00. If your workshop is well-stocked, chances are you will only need to buy one $2 part. The circuit is simple, foolproof, and easily built in one or two evenings.

The Pulser produces a free-running series of sharp trigger pulses, variable from 0 to 10 volts in amplitude and with a variable repetition rate of from one pulse every ten seconds to 11,000 pulses per second. It has five overlapping scales and a choice of pulse polarity. It is battery-operated and draws less than 0.0005 ampere, and it puts out almost 8 watts of peak pulse power.

To boot, the Pulser has a low-output impedance and is short-circuit-proof. You can run it all day into a dead short. The rise-time is quite snappy—only 50 nanoseconds. Pulse width varies from scale to scale, but always stays at roughly 1/1000 of the repetition time.

Applications. An important experimental use for the Pulser is as a trigger source for multivibrators and counter circuits. If you have a scope, here is a convenient pulse source for resonance demonstrations, time constant experiments, and "Q" measurements. It is dandy for testing radio control modules and escapements, and doubles as a trigger source for experimental transistor and SCR power inverter circuitry.

The lower repetition rates are tops for timing displays, exhibits and flashers. For example, you can use the Pulser to trigger an SCR lamp controller. Set the Pulser to 58 cycles and the bulb will smoothly oscillate at a 4-cycle rate. Place a photocell and amplifier in front of the light, and you'll wind up with an ultra-low-frequency audio oscillator.

The Pulser easily drives a speaker and produces a series of "pock-pock-pock" sounds to enable you to check out speakers and output transformers. You can also use it as a signal injector for all sorts of audio testing and trouble-shooting. And, finally, you can use the "pocks" themselves; the unit will serve as a metronome or as a darkroom timer.

How It Works. It's all made possible by a new semiconductor which sells for $2 . . . a *four-layer diode*. Unlike ordinary diodes, the four-layer diode is a voltage-sensitive switch. It is normally *off*, leakage current is negligible, and it snaps *on* when it "sees" 12 volts. It stays on as long as there is significant current (more than 1 ma.) left in the circuit. In the on state, the impedance is so low that you must limit the current externally; otherwise the diode will destroy itself. Just like a true diode, the four-layer diode operates only in the forward direction.

Add two resistors, a capacitor, and a battery to the diode, and you have a pulse generator, as shown in the simplified circuit of Fig. 1. Capacitor *C* takes on a charge from *B1* through *R1*. When the charge reaches 12 volts, the diode snaps on, producing a sharp spike across current limiting resistor *R3*. This spike is the output pulse and is almost 10 volts high; its width is *R3* x *C*.

As the capacitor discharges (very rapidly, since *R3* is much smaller than *R1*), less and less current flows through the diode, and it finally turns *off* when the capacitor voltage drops close to zero. As battery current through *R1* in this circuit is held to about 0.5 ma., it cannot hold the diode on; the capacitor recharges, and repeats the cycle.

One output pulse is produced for each charge and discharge cycle. The waveforms in Fig. 2 show the exponential charge-discharge waveform at point *A* in the simplified circuit, the sharp output pulse at point *B*, and their relationship to the on-off time of the diode.

Figure 3 shows the entire circuit of the Pulser. You can change the frequency by varying *R2* or by switching in different capacitors. Potentiometer *R2* provides a continuously variable frequency range, on the order of 11 to 1. Each of the five capacitors is ten times

Fig. 1. Four-layer diode conducts when the capacitor charges up to about 12 volts, and stays "on" as long as there is more than 1 ma. of current flow.

PARTS LIST

B1—22½-volt battery
C1—50-µf., 15-volt electrolytic capacitor
C2—5-µf., 15-volt electrolytic capacitor
C3—0.5-µf., 200-volt Mylar capacitor
C4—0.05-µf., 200-volt Mylar capacitor
C5—0.005-µf. mica capacitor
D1—Four-layer diode (Motorola M4L3054)
J1—Phono jack
R1—47,000-ohm, ½-watt resistor
R2—500,000-ohm, 2-watt potentiometer (linear taper)
R3—250-ohm, 2-watt potentiometer (linear taper)
R4—3.3-ohm, ½-watt resistor
S1—S.p.s.t. slide switch
S2—Single-pole, six-position wafer switch (Mallory 32151 or equivalent)
S3—D.p.d.t. slide switch
1—3" x 4" x 5" case, approx. (Zero 256-78-52 or Bud CU-2105A or equivalent)
1—4" x 3" dialplate (an anodized hard aluminum Metalphoto dialplate with POPULAR ELECTRONICS on it is available from Reill's Photo Finishing, 4627 North 11th St., Phoenix, Ariz. 85014, in silver color for $1.50, or in blue, red, or copper for $4, postpaid in U.S.A.)
Misc.—Battery holder; #10 nylon countersunk washers (4), nuts and bolts; knobs (3); wire; solder; etc.

Fig. 2. Typical capacitor charge-discharge waveform is present at point "A" in Fig. 1. At output "B," the rise time is so fast that you'll need a fairly good scope to see it. When the diode is "off," the capacitor has a chance to build up a charge until it is large enough to trigger the diode into conduction. Current flow through the diode is relatively so very large that the capacitor discharges and cannot take on a new charge until the diode stops conducting.

60 POPULAR ELECTRONICS

April, 1966 61

Figure 3.30 Don Lancaster | "Pulse Generator" | *Popular Electronics* (August 1966)

issue of *Popular Electronics* whose clipping survives among his papers: "Advanced Experimenter Project: Pulse Generator," written by Don Lancaster (Figure 3.30).[137]

The circuit for the instrument Lancaster nicknamed "Pulser" had a simple mechanism centering around a four-layer diode (Motorola M4L3054). A diode is a component usually composed of two asymmetrical layers (the positive and negative side) that serves to conduct electricity in only one direction and is often used to convert a fluctuating AC into a straightforward DC. But four-layers versions (PNPN) also only conducted when the signal voltage exceeds a certain threshold and thus behaved like a voltage-controlled switch. Lancaster's circuit was based on coordinating this nature of four-layered diodes with the nature of capacitors to store electrical energy. The 22.5-volt battery first charged a capacitor through a 47 kΩ resistor. Once the charge reached a threshold of 12 volts the diode snapped on, producing a sharp pulse, which then turned off when the capacitor was discharged. Switching between the five different capacitor values changed the rate of the charge-discharge cycle and, as a corollary, the rate of the pulse cycle. The total cycle range covered a wide spectrum, from one pulse every ten seconds to 11,000 pulses per second. Aside from the central knob for switching between capacitors,

[137] Don Lancaster, "Advanced Experimenter Project: Pulse Generator," *Popular Electronics* (April 1966), 60–62, Box 39, Folder 4, David Tudor Papers, GRI.

there were two other controls: a 500 kΩ variable resistor inserted between the 47 kΩ resistor and the capacitors to allow a continuous change of frequency within the range established by the chosen capacitor; and a 250 Ω variable resistor following the diode which varied the pulse amplitude.[138]

Lenkurt Modulator (Instrument 0116/0174)

The modulator used to modulate the pulses coming out of the *Pulser* with the bass-drum signals coming out of the *Output Splitter* is designated as "LEN" in the diagram. The abbreviation was very likely that of "Lenkurt Electronics," a telephone electronics manufacturer who made the *MB1110 Mixer Stage Transformer* which Tudor re-housed in a black phenolic box to create at least two passive diode modulators.[139]

Tube Box (Instrument 0448)

The modulated signal from the *Lenkurt Modulator* meets an unmodulated signal from the *Output Splitter* at a box labeled "TB," also written as "T-Box" in other diagrams. These were all shorthands for "Tube Box," a dry name for what appears to have been the only vacuum tube device in a box that Tudor owned (at least the only one that remains in the Wesleyan collection) (Figure 3.31). This instrument modified a signal in a series of different ways: low-pass and high-pass filter, frequency doubler, clipper, and center clipper. Although it remains uncertain who built it, it was certainly not Tudor. A complete schematics of the interior circuitry in somebody else's hand has been found among his papers, but the function of each stage is also written out on the front panel of the actual box.[140] This instrument appears in the TDS photograph, placed beneath the *Midland Audio Generator*, as well as in photographs of other performances from the same period, including *Variations V* and *Bandoneon!*.

7

The remaining Channel D is composed of four parallel signals from the bass drum, three of which go directly into a mixer, and one which is mixed and modulated with signals from generators before arriving to the same mixer (Figure 3.32).

Beat Frequency Oscillator (Instrument 0021)

There is yet another instrument that was very likely composed by Mumma, who upon seeing the photograph of the surviving box fifty-five years later, commented, "I can't swear in a court of law, but that's the way I worked with stuff!"[141] The green Dymo label

[138] Rogalsky also identified the same instrument in Mumma's photograph of Tudor's 1971 *Rainforest* setup and analyzed its mechanism, although he did not manage to identify the source material (Rogalsky, "Idea and Community," 133–134).

[139] Instrument 0233 is another device that uses the same MB1110 in a peculiar manner: the transformer is attached to a screw-terminal strip on a wooden ruler.

[140] Anonymous, "Schematics for *Tube Box*," Box 40, Folder 7, David Tudor Papers, GRI.

[141] Mumma, "Interview by Nakai," November 4, 2016. There is also a possibility that this instrument was built by William Ribbens, the engineer who co-founded Cybersonics with Mumma. Michael Johnsen has

Figure 3.31 Anonymous | *Tube-Box*
DTC, Instrument 0448 | World Instrument Collection, Wesleyan University

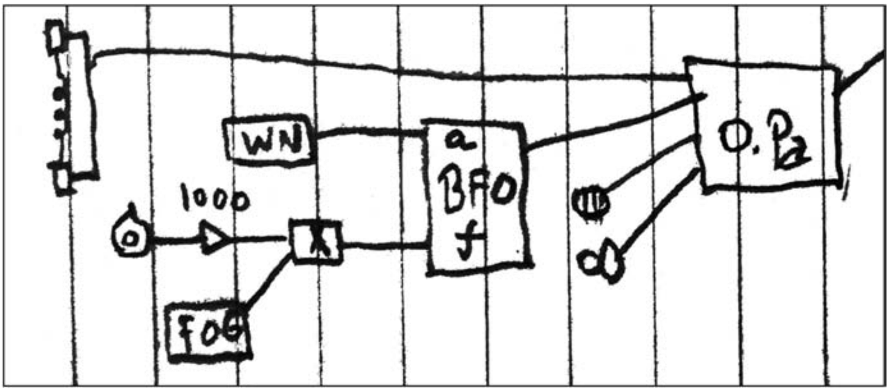


Figure 3.32 Tudor | *Fontana Mix,* realization diagram, channel D (close-up)
Courtesy of David Tudor Trust

on it spells out its name and birth date: "AUDIO BFO BUILT 1961"—this is the *Beat Frequency Oscillator* (Figures 3.33 and 3.34), which, similar to the *Spectrum Transfer*, modulated the signals of an internal oscillator with another signal to heterodyne their sum and difference frequencies. The general use for this type of equipment is to bring

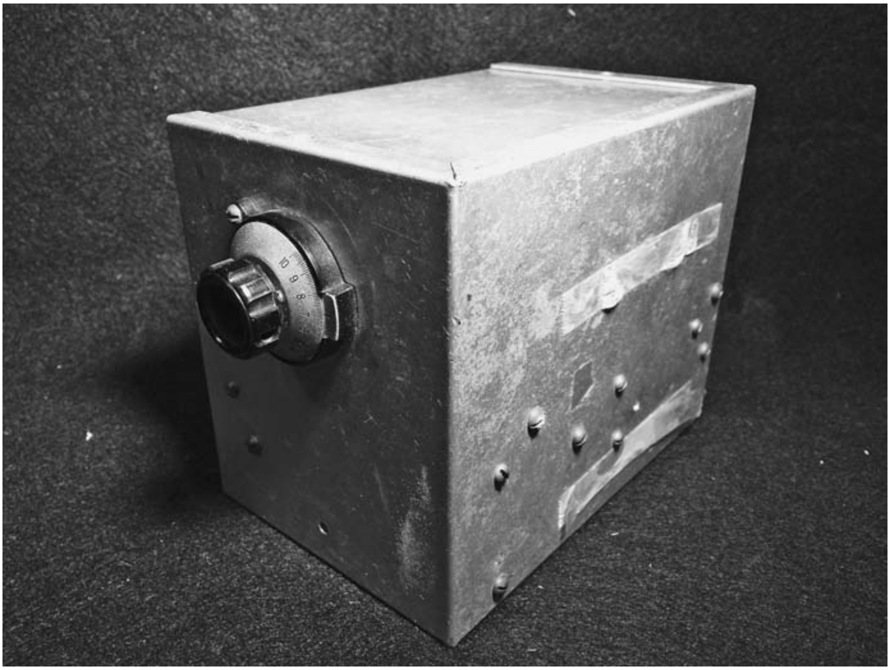


Figure 3.33 Mumma | *Beat Frequency Oscillator*
DTC, Instrument 0021 | World Instrument Collection, Wesleyan University

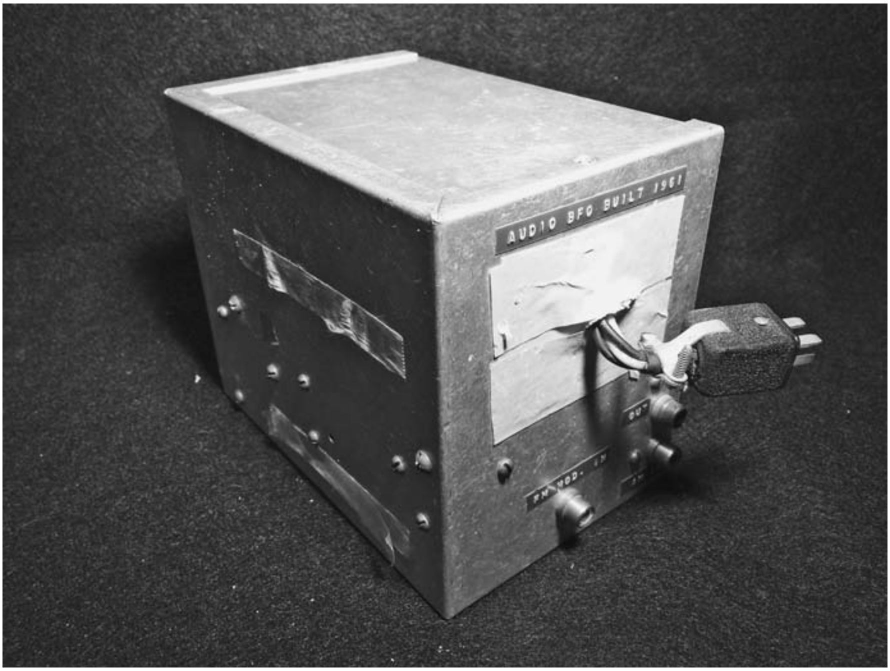


Figure 3.34 Mumma | *Beat Frequency Oscillator*
DTC, Instrument 0021 | World Instrument Collection, Wesleyan University

already modulated signals in the radio-frequency range (20,000 Hz–300 GHz), too high for humans to hear, down to the audible range (20–20,000 Hz). This is done by setting the frequency of the oscillator in close proximity with the incoming signal, so that their difference frequency, or "beat frequency," becomes small—low enough to hear.[142] The *BFO* is thus often found in radio receivers to demodulate transmitted signals.

In the particular instrument that Tudor owned, however, the second ultrasonic signal was also produced inside the instrument using a second internal oscillator. One oscillator was fixed, the other was variable using a knob. And as with the "single-spectrum" mode of the *Spectrum Transfer*, the sum part of the heterodyne process was filtered out, leaving only the subtracted low signals in the audible range. The two inputs designated as "a" and "f" on the diagram, and "AM IN" and "FM MOD. INPUT" on the instrument, allowed the use of external signals to modulate the amplitude and frequency of the output.

×1000 Amplifier (Instrument 0189/0188)

The "AM" input of the *Beat Frequency Oscillator* received a signal from the *White Noise Generator*. For the other "FM" input, a second *Signal Selector*, used in monaural mode, offered one of the next two choices: the bass-drum signal coming from the *DeArmond Bug-style Pickup* and boosted by an amplifier labeled "1000," or signals from a generator labeled "FOG." The amplifier was another kit originally designed for an infrared detector with a high gain of 1000 (60 dB) that Tudor re-housed in a box.[143] Tudor made at least three instruments using the same kit, one of which was a dual device housing two of them (Instrument 0189). It is not clear which of the three he used for this performance of *Fontana Mix*, although Instrument 0188, housed in a transparent plastic case, is a good candidate (Figures 3.35 and 3.36). The use of cheap plastic enclosure was characteristic of Tudor's early efforts to make his own instruments, as already seen in the dual *Olson Microphone Preamplifier* that made a plastic card file box its home.

Fog Horn (Instrument 0461)

In fact, the "FOG" was yet another kit, this time a commercial oscillator, housed in a plastic case—a red soapbox, of all things (Figure 3.37). Inside the soapbox is another plastic case enclosing the circuit. When observed very carefully, the words "FOG HORN," inscribed on it in tiny, fading letters, can be read (Figure 3.38). The name of the manufacturer is too distorted to make any sense, but there is a catalog from Olson Electronics titled "Magic with Electronics" among Tudor's papers which includes the same module.[144] The instrument still works. It is an astable multivibrator

noted the resemblance of building style with the *Spectrum Processor*, another Cybersonics instrument that Tudor owned (Instrument 0135), which was definitely made by Ribbens.

[142] One may recall that this is the same mechanism that Oliveros used to produce her difference tones from two inaudible generating tones in *Mnemonics*.

[143] A page of description with a schematic diagram and circuit board layout has been found among his papers: "Spec Sheet of × *1000 Amplifier*," Box 47, Folder 6, David Tudor Papers, GRI.

[144] Olson Electronics, "Magic with Electronics," Box 42, Folder 5, David Tudor Papers, GRI. This was discovered by Michael Johnsen.

Figure 3.35 Tudor | *X1000 Amplifier*
DTC, Instrument 0188 | World Instrument Collection, Wesleyan University

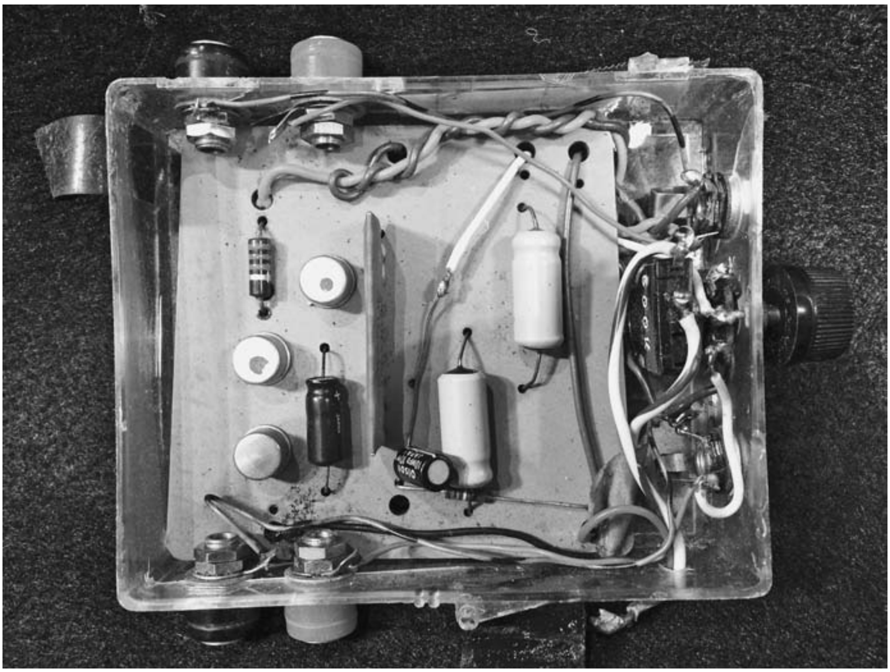


Figure 3.36 Tudor | *X1000 Amplifier* (interior)
DTC, Instrument 0188 | World Instrument Collection, Wesleyan University

Figure 3.37 Olson Electronics | *Fog Horn*
DTC, Instrument 0461 | World Instrument Collection, Wesleyan University

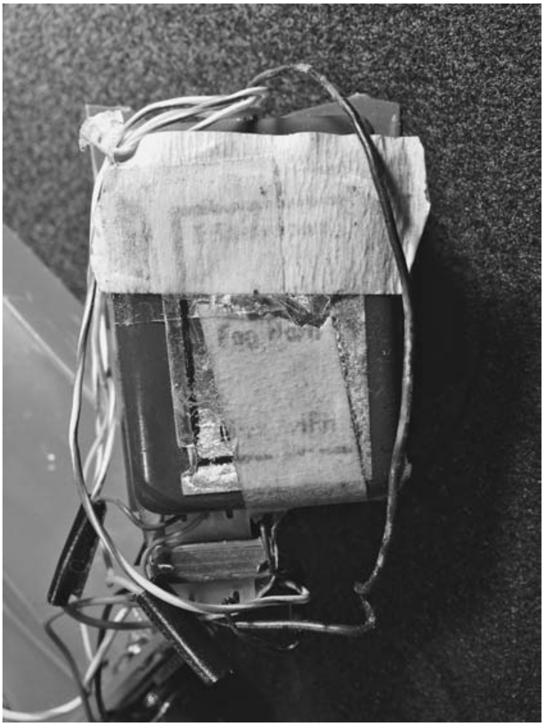


Figure 3.38 Olson Electronics | *Fog Horn* (internal oscillator)
DTC, Instrument 0461 | World Instrument Collection, Wesleyan University

circuit often used to simulate fog horns, outputting a square wave that can be narrowly swept (from approximately 270 to 1000 Hz) using the dial on the front. The catalog describes the purpose of this product as creating "a loud attention-getting audible signal which can be heard and identified over long distances on land or sea."[145] It also makes a brief cameo in the 1967 NDR film of *Variations V*.

Tudor uses amplified fluctuating signals from the bass-drum for the "AM" input to the *Beat Frequency Oscillator* in Channel D, as well as for the carrier signal for the *Spectrum Transfer* in Channel B. It appears Mumma passed on to his friend not only instruments, but how to use them: this technique of using a variable waveform for the usually periodic carrier function of a modulator is also featured prominently in his music of this period. When asked on November 4, 2016, Mumma looked back on what he did as one of the many ways to realize "those interplays of indeterminacy."[146] Perhaps because of this chain of influence, the two Mumma modulators were almost always used as a pair in Tudor's sound systems of this period.

Olson RA-637 4-Channel Preamplifier Mixer (Instrument 0237/0238)

All the sub-channels of Channel D go into the *Olson RA-637 4-Channel Preamplifier Mixer* ("O.Pa") (Figure 3.39). Sold since 1965 by the same company that also made the *Fog Horn* and the *Microphone Preamplifier TR-86,* this was a more versatile instrument than the *Lafayette PA-292 Microphone Mixer* that Tudor already owned and had used for *Variations II*.[147] In addition to volume controls for each channel, it had a master gain control, bass and treble tone controls, as well as a volume unit (VU) meter to monitor the signal level. As a preamplifier, each input had a switch to select between two signal levels which changed the amount of gain to 1778 (65 db) on the high-level position and 31.6 (30 db) on the low-level position. Tudor owned two copies of the same instrument, which began to make frequent appearances in diagrams and photographs from around this time. He had bought the first one on April 29, 1966, while he was in a residency at the Center of Creative and Performing Arts in the State University of New York at Buffalo. The second copy was purchased two years later, on March 9, 1968, when he was again in Buffalo, this time with MCDC to premiere *Rainforest*.[148]

8

There are three components that do not appear anywhere in the diagram, although they together occupied the center stage of Littler's recollection: the tape input playing fragmented pop music, the bass-drum head serving as a primary

[145] Ibid.

[146] Mumma, "Interview by Nakai," November 4, 2016.

[147] An early advertisement for the instrument appears in the "New Products" section of the January 1965 issue of *Radio-Electronics* ("4-Channel Preamp/Mixer," *Radio-Electronics*, January 1965, 86).

[148] Olson Electronics, "Receipt (April 29, 1966)," Box 123, Folder 2, David Tudor Papers, GRI; Olson Electronics, "Receipt (March 9, 1966)," Box 124, Folder 6, David Tudor Papers, GRI.

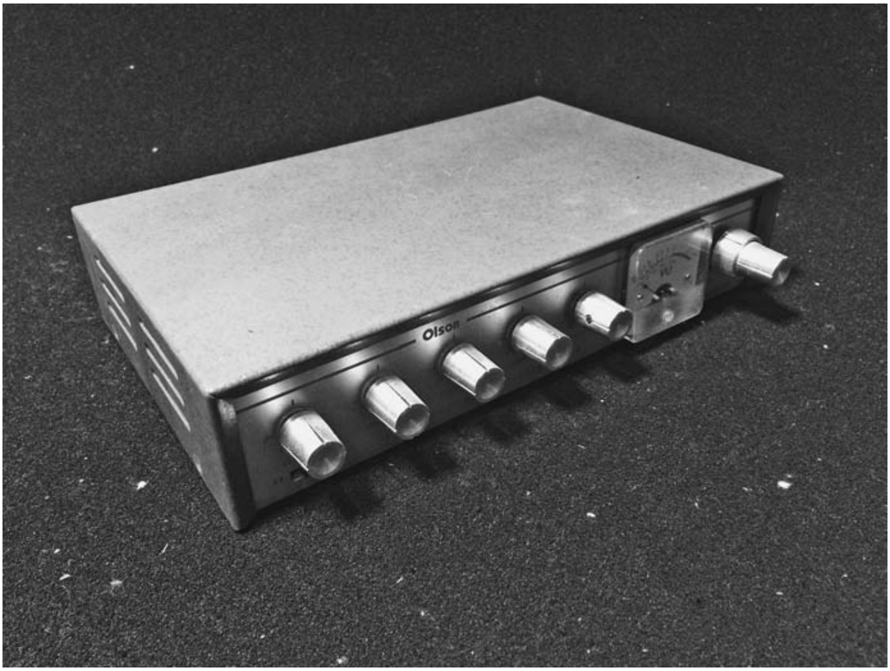


Figure 3.39 Olson Electronics | *RA-637 4-Channel Preamp Mixer*
DTC, Instrument 0237/0238 | World Instrument Collection, Wesleyan University

interface and resonance chamber, and the multiple loudspeakers that this reviewer gazed at one by one as he walked around the gallery space. The absence of tape is most puzzling since the review reported Tudor being occupied with its manipulation; the absence of bass drum and loudspeakers is more understandable, yet it certainly makes it difficult to understand how things might have actually played out in performance.

The overall focus of the sound system is clear: the acoustic sound of the bass-drum is picked up with a variety of transducers and used to modulate different kinds of electronic signals in parallel. Just like the amplified piano, amplified apple box, or amplified barbecue grills, the amplified percussion instrument serves both as a source material to be electronically processed as well as a processor of electronic sources. But the relationship between the acoustic resonator and the other materials is more complex than in the previous cases due to the nature of the three *Slinkys*, which could simultaneously pick up sounds and modify them as reverb, as well as generate new signals by vibrating sympathetically against the bass-drum head. Even in the absence of an external tape input, there would be a number of ways to activate the system: a trigger signal from the *Midland Audio Generator* going into the *Slinky* reverb in Channel A, where it is leaked to the other three channels through the bass-drum head; or the head massager or any other activator Tudor may have been using, not drawn in the diagram. The small pick-ups and contact microphones do not appear to be taped down. So if the loudspeakers were positioned close enough, there would have been a recycling of sounds that would have made the skin of the bass drum tremble along with the objects, obviously influencing the three *Slinkys* in turn.[149] An attack on the acoustic instrument would have triggered responses and modulations throughout the chain of components, some of which could return to further activate the bass drum itself. However, neither the TDS photograph nor the diagram reveals how the loudspeakers were arranged, except that there were probably four of them connected to the four output channels. How feedback was implemented in this sound system therefore remains a mystery.

Compositions

1

Tudor's "version" of *Fontana Mix* in the spring of 1967 presents an extreme case of realization in which Cage's material does not appear to provide even a point of departure but merely a pre-text to pursue Tudor's own composition and performance of sound systems. It appears to be a threshold, if ever there was one. But to conclude that he thereby became a composer would still miss the point. For one thing, the nature of "transition" is much more complicated than a simple switch from one place to the next; for another, if there was a crossing of any sort, it had already happened by then.

Like Cage's recollection of the "delay system" in *Variations V*, the story of "transition" from performer to composer sees an effect, but the mechanism it imagines is often the projection of the observer's own biases. Just as there are other ways to cause delay than just "delay systems," so there are other ways to change one's attitudes about written material than just becoming a "composer." Thus, the story is not only incorrect *factually*—Tudor continued to realize other people's materials even after he started composing his own—but also *conceptually*—Tudor did not so much join the ranks of "composers" one day, as he expanded the act of composition through his particular approach to the performance of music. The title of "composer" did not indicate any accomplishment but lack of a better word.

Tudor had studied composition with Stefan Wolpe in the mid-1940s, but as Austin Clarkson observed, "he was evidently keener to practice the *Passacaglia* than to write music."[150] When Clarkson interviewed him on October 4, 1982, Tudor looked back at his earlier difficulty:

[149] As Ron Kuivila suggested, one source of influence here may have been Max Neuhaus's version of *Fontana Mix* (Kuivila, "Personal conversation with You Nakai," Middletown, CT, April 22, 2017). Since 1963, Neuhaus had realized Cage's score by placing contact microphones on percussion instruments and arranging loudspeakers in close proximity. The operation of amplifiers based on the reading of transparencies would generate and modify the feedback loop without any external input. Cage thought this was brilliant. Tudor, who collaborated with Neuhaus from time to time, must have known about this other "version."

[150] Clarkson, "David Tudor's Apprenticeship," 7.

> *I didn't find that my [composing] work was convincing. I think even more fruitful I found [Stefan's] classes in analysis. You see his teaching in composition always had an underlying basis of sort of Beethoven-like continuity, which he himself used or didn't use at will. I think it was an underlying method that he used with students to get them started. When I was doing it myself, I was not inspired. I suppose I don't belong to that stream in composition. And it was years after that I realized that I was doing work that I could call my own.*[151]

But even when compositions based on no-continuity appeared, it did not lead Tudor to compose the materials himself. More revealing than his analysis of why he was not inspired to compose is what inspired him instead: to practice and analyze other people's scores. Tudor was brilliant at using materials given to him, which meant he was more comfortable being in the middle of the chain rather than at the source. As Wolff recalled, Tudor had always asked others for materials that would serve as triggers for his realizations. What happened "years after" was not that he had found a different stream in composition that did not rely on a Beethoven-like continuity. It was that with electronic instruments, Tudor had found a way to produce materials himself that would nonetheless behave as an "other": he could quite literally let the instruments take the lead. Although he joked to Lucier about the benefits of electronics for performing under the influence of alcohol, his basic approach to electronic instruments was in many ways continuous with how Tudor had always approached non-electronic instruments. Hence, the realization that he was "composing," doing something categorically different from before, came only as an afterthought. But as an afterthought it came, and it would be interesting to know where it came from.

2

One day in early September 1964, Tudor was in Stockholm with MCDC, when Robert Rauschenberg, who also toured with the dance company as their stage designer at the time, asked him to provide music for his new performance. The piece was to be called *Elgin Tie,* performed with a Brahma cow, and presented later that month as part of the "Five New York Evenings" organized jointly by the Moderna Museet and Fylkingen, an experimental arts organization based in Stockholm. Tudor has described what he did on a number of occasions, always sticking more or less to the same story. A version told to Teddy Hultberg on May 17, 1988, went like this:

> *I walked around the museum and thought, "what am I going to do?" I noticed that there were—it must have been—a thousand fluorescent light bulbs. One day I was in the room when someone was turning on the fluorescent lights and they didn't know which to turn on and all of a sudden there was the most beautiful music. I thought,*

151 Clarkson, "Composing the Performer," *Musicworks* 73 (Spring 1999), 28.

> *"OK, I'll put some contact microphones up there from the bulbs to see if the sound can be made really audible."*[152]

He then spent "nearly three days" attaching contact microphones to the lights to amplify the already audible sounds of the fluorescent lights. The distinct ping sounds occurred from the starter and ballast circuit that produced short bursts of high voltages to ionize the gas in the glass tube; then, a smaller voltage could produce ultraviolet light which was made visible by the phosphor coating. In 1964, this was a process that could take several seconds.[153] Tudor found out that one switch—a screw-in fuse—controlled three lights, with a total of 50 to 75 fuses for all the available lights.[154] So he performed all these parametric objects, turning the lights on and off remotely from a switching box outside the room where Rauschenberg was performing. Probably because he had to operate the fuses blindly, Tudor created a "score" for himself,[155] although this material has not been found.

What has been found, however, is another performer of the piece: Sören Brunes, a Swedish scenographer, who back in the late summer of 1964 was a young member of an experimental theater group that often performed at the Moderna Museet. He and his friend had been recruited to help with this and that during the "Five New York Evenings." More than half a century later, on July 1, 2015, Brunes recalled that Tudor placed the two of them in charge of the screw-in fuses without giving them any instructions or scores.[156] So they operated the fuses blindly. Brunes was uncertain, but assumed that Tudor was inside the performance space modulating the sounds of amplified fluorescent lights. However, Brunes also recalled something puzzling: he and his friend not only saw the performance of *Elgin Tie* in its entirety, but also "performed" in it. If this is the case, it would have been impossible for them to perform the fuses in another room.

According to all accounts, there was only one request from Rauschenberg: that the music be quiet or stopped completely when the cow made its entrance in the second

[152] Tudor, "Interview by Hultberg," davidtudor.org.

[153] This nature of fluorescent light has been noted by several people: "Fluorescent lighting circa 1964 depended on a starter circuit which over a period of several seconds provided initial power to the main lamp's filaments, before a surge of power from the ballast (a type of transformer) caused it to light" (Rogalsky, "Idea and Community," 67); "He certainly would have been attracted to the inherent time delay between flipping a switch and the resultant ping—a quite measurable and possibly musically useful fraction of a second it takes for a filament to heat up a little bi-metallic strip in the fluorescent little starter circuit (those little FS2 cans)" (Edelstein, "Email to Julie Martin," October 6, 2014).

[154] Tudor recalled 75 switches on May 17, 1988 (Tudor, "Interview by Hultberg."), but 50 on January 26, 1992 (Tudor, "Interview by Julie Martin," Klüver/Martin archive).

[155] On November 2, 1994, Tudor told Matt Rogalsky that he still had the score back home: "And one reason why I've been thinking about it is because in my archival papers in Stony Point I have the score of it" (Tudor, "Interview by Rogalsky," davidtudor.org). But nothing of the sort has been found among his papers that were sent to GRI that year. A fax sent from the Getty Center for the History of Art and the Humanities to Julie Martin on January 13, 1994, informed the official approval for the purchase of Tudor's materials as "the Center's first major music collection," asking to ship the archive by early June (Getty Center for the History of Art and the Humanities, "Fax to Julie Martin (January 13, 1994)," Box 55, Folder 4, David Tudor Papers, GRI). Tudor's score of *Fluorescent Sound* may have stayed in Stony Point for some reason after the archival papers were shipped to Los Angeles, and subsequently was lost.

[156] Sören Brunes, "Interview by You Nakai and Mats Lindström," Stockholm, Sweden, July 1, 2015.

half of the performance. The artist worried that the sounds of the amplified fluorescent lights might influence the holy creature—Tony Martin's light score had indeed affected Ahmed at the premiere of the *Duo for Accordion and Bandoneon with Possible Mynah Bird Obbligato* just five months before. As Tudor reminisced to Julie Martin on January 26, 1992: "The most notable thing about the performance I guess was the fact that I had to be informed when the cow was in the room because at that point the music had to stop, because Bob was afraid that the cow was going to shit [*laughs*]."[157]

There are no films or recordings of the performance, but Stig T. Karlsson took a series of photographs documenting *Elgin Tie* which reveals the temporal progression of events in a flipbook manner (Figure 3.40). Most importantly, it shows the fluorescent lights flickering on and off throughout the performance.

Judging from these contact sheets, Tudor continued to perform even after the cow entered. Although he recalled the music being "very quiet,"[158] the sound appears to have been enough to trigger what his collaborator feared most: the series of photographs end with two men holding a bucket and cleaning the floor with a broom after the cow defecated. In July 2015, Brunes identified these two men as himself and his friend: "oh, that's me there."[159]

The same photographs are also revealing in what they do not show: any sound system Tudor would have needed if he was processing the sounds in real time. The only visible equipment in the room is a giant horn-loudspeaker in the corner. There is no sign of *David Tudor* himself either. Given all this, the most probable scenario is that Tudor asked Brunes and his friend to control the fuses blindly while he prepared for the performance, since he could not soundcheck otherwise. He must have made a score based on this experience, which he used for the actual performance, operating the fuses without being able to hear the audible results—as a result of which, he could not stop the music when the cow entered the room.

3

In any case, according to all the versions of recollection, Tudor did not realize he had composed a "work" until sometime later. To Martin, he continued his reminiscence in January 1992:

> *And I guess for various reasons I didn't realize that I was actually composing it, but later on I did. A couple of years later I realized that that was actually my first electronic piece, and at that point I gave it a title. Whereas the title doesn't appear anywhere in relationship to Bob's work.*[160]

[157] Tudor, "Interview by Martin."
[158] Tudor, "Interview by Rogalsky."
[159] Brunes, "Interview by Nakai and Lindström."
[160] Tudor, "Interview by Martin."

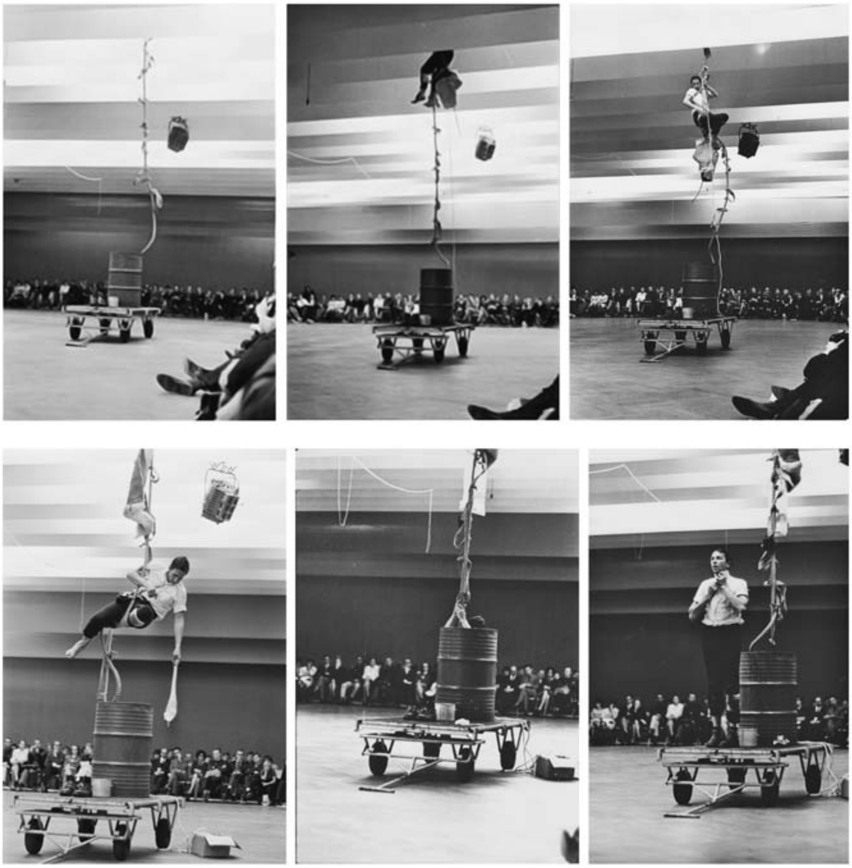


Figure 3.40 *Fluorescent Sound/Elgin Tie*, sequence showing the change of lights | Moderna Museet, Stockholm | September 13, 1964
Photo: Stig T. Karlsson | Klüver/Martin Archive | Courtesy of Moderna Museet

The title Tudor remembers to have given in retrospect was *Fluorescent Sound*. However, there is something very puzzling about this recollection, for the same name already appears in the program note of the performance at the Moderna Museet on September 13, 1964 (Figure 3.41):

> Fluorescent sound: David Tudor

The other credits in the same program using a colon—"Tape: Alex Hay"; "Kostymer: Barbro Ostlihn"; "Arm make up: Oyvind Fahlstrom"[161]—suggest that

[161] "Program of events at Moderna Museet, September 13, 1964," Box 75, Folder 1, David Tudor Papers, GRI.

MODERNA MUSEET och FYLKINGEN

Söndagen den 13 september 1964

COLORADO PLATEAU - ALEX HAY

Tape: Alex Hay

1 2 3 4 5 6

SHOTPUT + ELGIN TIE - ROBERT RAUSCHENBERG

Tape: "Fåglar i Sverige". Poem for radio by Öyvind Fahlström (arranged for this piece by Robert Rauschenberg)

Fluorescent sound: David Tudor

Robert Rauschenberg

30 min.

LEADVILLE DESCRIPTION - ALEX HAY

Tape: Alex Hay

Deborah Hay, Robert Rauschenberg, Barbara Lloyd, Alex Hay

Ur "MELLANÖL" - ÖYVIND FAHLSTRÖM

Mats G. Bengtsson, Öyvind Fahlström, Alex Hay

Bengt Emil Johnson, Sissi Nilson, Ulla Wiggen

10 min.

JAG VILL GÄRNA TELEFONERA - STEVE PAXTON

Robert Rauschenberg, Steve Paxton

Kostymer: Barbro Östlihn

Arm make up: Öyvind Fahlström

ARMSTRONG - DEBORAH HAY

Pullers: Lars Martin, Christer Östberg, Michael Amundin, Rolf Stenberg, Rolf Olle Nilson, Carlo Derkert Paul Siegal, Fred Salmson

Musicians: Lars-Gunnar Bodin, Leo Nilson, Sissi Nilson, Åke Karlung Barbro Östlihn, Eric Luttropp, Bengt Emil Johnson, Åke Tylöskog

Dancers: Rebecca Weiss, Alex Hay, Barbara Lloyd, Öyvind Fahlström, Robert Rauschenberg, Deborah Hay, Steve Paxton, Sören Brunes.

Animals-courtesy of GÖSTA WIBOM

Figure 3.41 Program of “Five New York Evenings” | Moderna Museet, Stockholm | September 13, 1964

DTP, Box 75, Folder 1 | Getty Research Institute, Los Angeles (980039)

"Fluorescent sound" is written here not as a title of a composition but as a category of component used in the larger work *Elgin Tie*, and that Tudor is listed not as a composer but as the person in charge. Just as he was in charge of sound systems, he was in charge of fluorescent sound. It was a part and not the whole. No wonder Tudor did not think of what he did as his first composition at the time. Only in retrospect did he realize there was something different about "Fluorescent sound" and turned the category into a proper name: *Fluorescent Sound*. In the style of synecdoche, the part had claimed a new whole.

4

On May 29, 1972, Tudor was in Brussels and answered a joint interview with Cage for the KPFA radio based in Berkeley, California, which had frequently broadcast Tudor's material since his involvement with the San Francisco Tape Music Center—the radio station had shared the same building on 321 Divisadero Street with the electronic music studio. At one point the unnamed interviewer brought up the difference between a "performer" and a "composer," suggesting Tudor had made the transition from one to the other some years before: "I think it's only fair to say that in several of the pieces that you played before even on the piano, composed by other people, you were in fact, the true composer." Tudor disagreed:

> *Well, I beg to differ!* [laughs] *Because one person's process is not another person's process. And still, even though one is involved in making precise all the details of an indeterminate composition, still the process is not what one would choose oneself, if one were to choose it. There would surely be a different choice somewhere in the process.*[162]

According to this reasoning, even when the composer's score had become a mere point of departure and Tudor's realization the composition of sound systems, the process still belonged to someone else. The duality of composition always turned what Tudor did into a part of the whole. But there was a small slippage here. As a corollary to his observation while realizing *Variations II* that the instrument did not have to be one but could be many, Tudor's sound systems were *modular* in nature, composed of multiple discrete components. Which meant that a *part of a given whole could also be used as a part of another whole*. Indeed, many instruments that appeared in the 1967 realization of *Fontana Mix* also made an appearance in other works, coordinated to other components in other electronic complexes—just as military surplus items were used to compose those same instruments. In other words, aside from the duality between sound systems and composition, there was another

[162] "Interview with John Cage and David Tudor," May 29, 1972, KPFA, Other Minds Audio Archive, accessed December 15, 2019: http://archive.org/details/am_1972_05_29

duality *within* the sound systems themselves: a gap between the system and individual instruments, as well as between the instruments and their components.

Such constancy of instruments presents a third case against the simple story of transition. Aside from the *factual* case that he never stopped being a performer for others, and the *conceptual* case that he did not become a composer but rather redefined what composition is, there is what might be called the *instrumental* case: what Tudor composed, by definition, could be detached from the composition and cross the boundaries between one work and another, even the boundary between his own and that of others. But interestingly, what Tudor took as a point of departure for his own composition was precisely this modular and partial nature of instruments which resist being contained in the wholeness of compositions: he would find ways to superimpose the workings of an individual instrument onto that of the entire sound system. This involved a synecdochical confusion of scales, just like calling Fluorescent sound, *Fluorescent Sound*.

5

The *White Noise Generator* whose output went into the *Beat Frequency Oscillator* in Tudor's sound system of *Fontana Mix* is another extant box that is now part of the Wesleyan collection (Instrument 0493) (Figures 3.42 and 3.43).

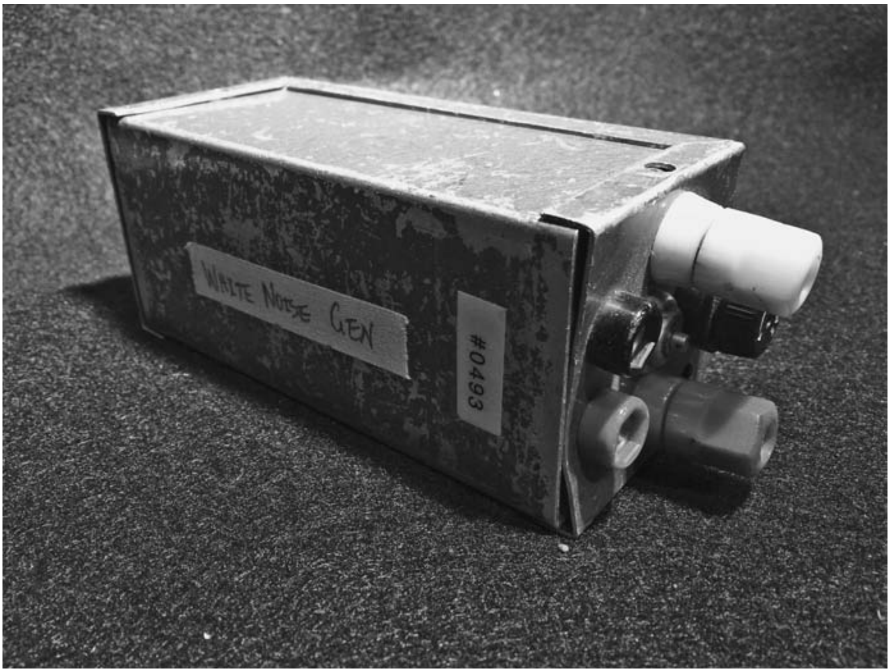


Figure 3.42 *White Noise Generator*
DTC, Instrument 0493 | World Instrument Collection, Wesleyan University

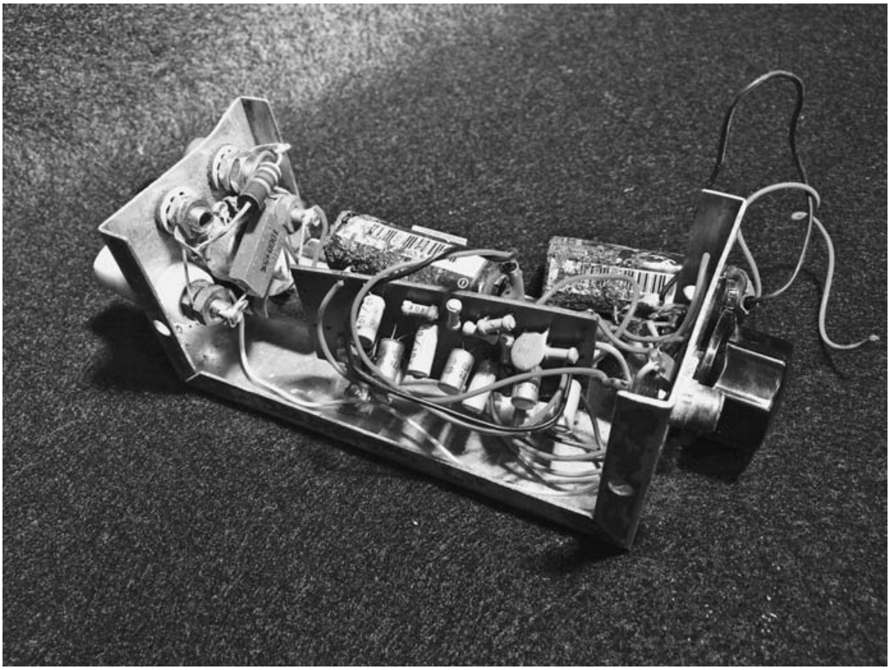


Figure 3.43 *White Noise Generator* (interior)
DTC, Instrument 0493 | World Instrument Collection, Wesleyan University

The internal circuitry follows the standard method of making a noise generator by putting a point-contact diode (1N21B)—stored in a fuse holder—in what is called a "reverse-biased" circuit. Diodes either allow or block current in one direction depending on the polarity of their external voltage source. When the polarity is set so that the diode blocks current, this is called reverse-biasing. However, when enough reverse-bias voltage is applied, the diode goes through a temporary state of breakdown, producing noise which can then be amplified. In Instrument 0493, this process of amplification is done with *Lafayette PK-522*, the three-transistor amplifier that Tudor had purchased on April 24, 1962, at the Lafayette Radio Electronics store in Paramus, New Jersey.[163] The output transformer from the kit was removed. Along with several other modifications, this change is scribbled down in the schematic diagram of the amplifier found among Tudor's papers.[164] The schematics of the noise generator section is, however, nowhere to be found at GRI. Instead, it was discovered in an unexpected location: the private papers of David Behrman, Tudor's friend who collaborated with him

[163] "Lafayette Radio Electronics, PK-522 receipt (April 24, 1962)," Box 120, Folder 1, David Tudor Papers, GRI.
[164] "Diagram of Lafayette PK-522," Box 40, Folder 1, David Tudor Papers, GRI.

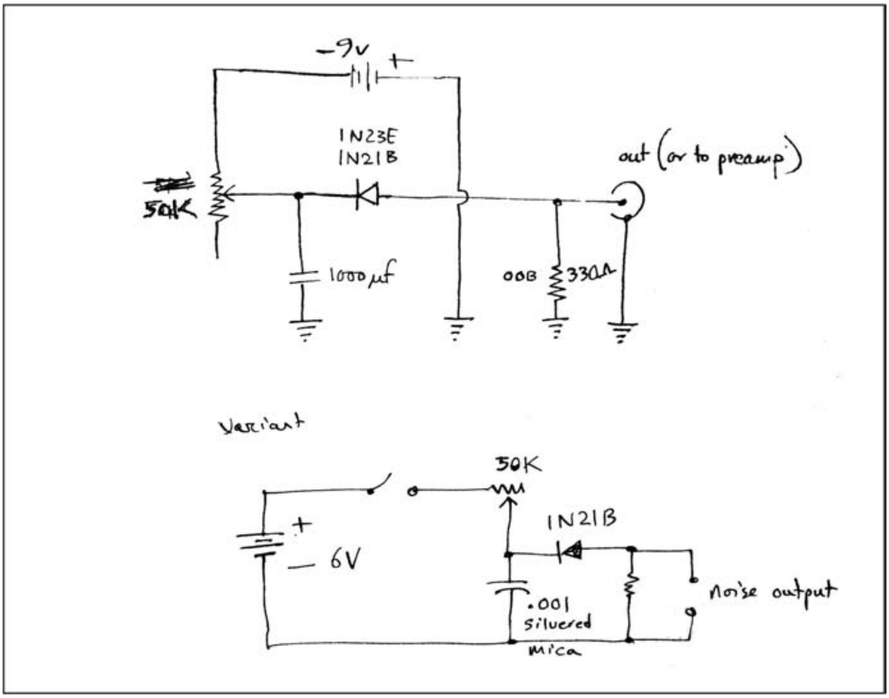


Figure 3.44 David Behrman | *White Noise Generator,* schematics | Undated
Private collection of David Behrman | Courtesy of David Behrman

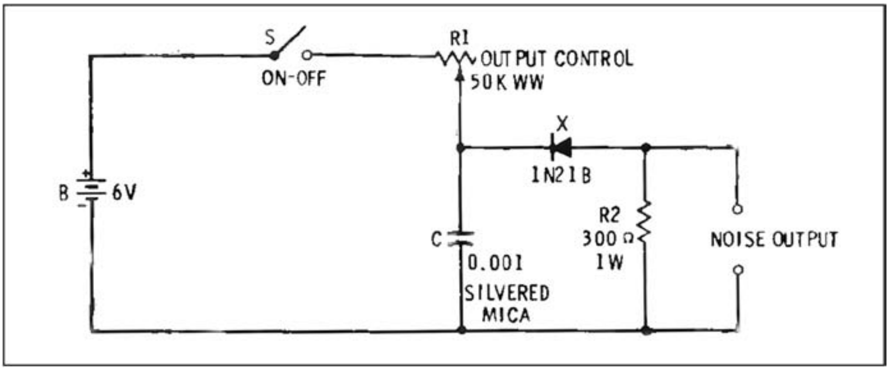


Figure 3.45 Rufus P. Turner | *White Noise Generator*, schematics
Diode Circuits Handbook (1963) |

frequently since the mid-1960s and later became his colleague at MCDC in 1974, as well as his next-door neighbor in Stony Point for some time.

The schematics that perfectly match Instrument 0493 are not in Tudor's hand (Figure 3.44). On May 28, 2015, Behrman could no longer recall how he was involved in the composition of the *White Noise Generator* half a century before.[165] But the source material of another, slightly different circuit labeled "variant" in his drawing—which does not correspond to the extant instrument but uses the same reverse-biased 1N21B diode—has been identified. Behrman had copied it from *Diode Circuits Handbook* written by the prolific author and engineer Rufus P. Turner in 1963 (Figure 3.45).

As described on the cover, this book offered "concise discussion of diode circuits containing nearly 100 diagrams with complete explanation of their operation."[166] According to a receipt of delivery found at GRI, Tudor had purchased this book by mail and received it on April 8, 1966.[167] Whoever its composer may have been, the actual *White Noise Generator* was also in Tudor's possession soon after. Half a year prior to the realization of *Fontana Mix* in Toronto, this particular instrument played a principal role inside another sound system: *Bandoneon!,* Tudor's first conscious attempt to compose his own composition, which the 1974 manuscript had listed as [Realization 6] (Figure 3.46).

Figure 3.46 David Tudor holding the *White Noise Generator* with David Behrman and Fred Waldhauer at the Armory setting up *Bandoneon Factorial* | October 1966
Photo: Peter Moore | © 2019 Barbara Moore / Licensed by VAGA at Artists Rights Society (ARS), NY, Courtesy Paula Cooper Gallery, New York

165 David Behrman, "Interview by You Nakai and John Driscoll," Hudson, NY, May 28, 2015.
166 Rufus P. Turner, *Diode Circuits Handbook* (New York, NY: Howard W. Sams, 1963)
167 Purchase Radio Supply, "Delivery Note, Ann Arbor, Michigan (April 8, 1966)," Box 121, Folder 1, David Tudor Papers, GRI.

Chapter 4
Bandoneon!

I. Instrumentalization of Sound

Cybersonics

1

On April 5, 1965, the *Buffalo Evening News* published a review of a rare concert by a "well-known avant-gardist" that had taken place two nights before at the State University of New York at Buffalo. The reviewer J.D. offered an eloquent description of the physique of the thirty-nine-year-old performer as "slightly graying, trim sack suit, looks like the junior member of an old seed-catalog firm, in repose. In action, he comes closer to a reaper of bedlam."[1] The action in question was then reported:

> *Spreading the music on the floor, Mr. Tudor sat on a revolving stool, revolving now and then. He juggled the Bandoneon with his knees, hummed out of tune as he played out of tune (that makes two out-of-tunes, not one in-tune) and paired up gutteral bass groans with treble squeaks.*[2]

What J.D. had witnessed that evening was the American premiere of *Pandorasbox, bandoneonpiece*, a piece Mauricio Kagel had written for David Tudor five years before. Back in June 1960, when Tudor stopped by Berlin for four days, he had gone out with the Argentinian composer to purchase a bandoneon. Two months later, he was still in Europe carrying the new instrument when he wrote home to M. C. Richards from Venice over the last weekend of August: "I am practicing my Bandoneon (which is basically a big squeezebox) but it will be a year before I can play it! Kagel has already written a piece for me & I hope to present it next year."[3]

But this big squeezebox was a notoriously difficult instrument with a notoriously complex interface. The number of buttons averaged around 71, laid out on both sides of the bellows in what Kagel informed one interviewer in advance of the 1965 concert as a "completely illogical displacement of the pitches in relation to their absolute

[1] J.D., "Rare Bandoneon Features in Kagel's 'Pandora's Box,'" *Buffalo Evening News*, April 5, 1965, Box 63, Folder 8, David Tudor Papers, GRI.
[2] Ibid.
[3] David Tudor, "Letter to M. C. Richards (August 26–29, 1960)," Box 26, Folder 2, Mary Caroline Richards Papers, GRI.

Reminded by the Instruments. You Nakai, Oxford University Press (2021). © Oxford University Press.
DOI: 10.1093/oso/9780190686765.001.0001.

Figure 4.1 Tudor performing the bandoneon | Brooklyn Academy of Music | February 1972
Photo: James Klosty | Courtesy of James Klosty

register."[4] Since it was a bi-sonic instrument where a single button produced one note when the bellows are pushed in and another when they are pulled out, the 71 or so buttons controlled a total of 142 or so notes. The bass range was given to the left hand extending three octaves (from C2 to B4), and the treble range to the right hand also extending three octaves (from A3 to B6).

Despite the enthusiasm of the summer of 1960, it would take Tudor another five years to learn the music—the American premiere was also his. But the avant-garde bandoneonist now had two works in his growing repertoire, following Pauline Oliveros's *Duo for Accordion and Bandoneon with Possible Mynah Bird Obbligato* performed the year before. Although J.D. had emphasized the rarity of the bandoneon in his 1965 review—"it's still a popular instrument in Argentine tango bands. Where else, we wouldn't know"[5]—Tudor's personal dedication would lead to an unexpected resurgence of the big squeezebox in the world of live-electronic music (Figure 4.1).

2

Five months after the Buffalo concert, on September 19, 1965, Tudor and Cage were in Ann Arbor, Michigan, to perform a piece called *Talk 1* at the ONCE AGAIN Festival. During a rehearsal break, Tudor—who had just received his copy of *Cybersonic Spectrum Transfer* from its composer and co-curator of the festival, Gordon Mumma—took out the

[4] Mauricio Kagel, "Kagel on Music," *New Student Review*, no. 12 (1965), 9. (Box 63, Folder 8, David Tudor Papers, GRI).
[5] J.D., "Rare Bandoneon Features in Kagel's 'Pandora's Box.'"

bandoneon and showed it to him, asking if he would write a new piece for the instrument. Mumma asked just one question in response, according to his own recollection forty-six years later: "I said, what do you think is the most amazing thing about this instrument?"[6] Tudor answered by playing the instrument: "[he] just went … [*gesture of pulling the bellows of bandoneon*] and this sound went on for two minutes. At the end of the two minutes, I said I know exactly what I'm going to do. Okay, I've got long wind sounds, right?"[7]

One day in early May of the following year, Mumma received a phone call from Cage asking him to join the Merce Cunningham Dance Company's upcoming summer tour in Europe. Tudor had specifically requested his help.[8] As the new recruit later recounted to Vincent Plush on May 17, 1982, "for some reason that only nutty artists could probably pull together and explain to you," Cunningham and Cage had decided to take *Variations V* on the road.[9] Although the portability of the complex sound system was questionable—"as portable as Napoleon's armies marching through Russia," was Mumma's opinion—the piece had already been touring the United States for eight months following its premiere.[10] But now, MCDC was invited by the North German Television, which wanted to film the work in Hamburg. Tudor, in charge of the electronics, was naturally worried about crossing the Atlantic.[11]

Mumma agreed to join the company and redesign the sound system of *Variations V* into a more tour-friendly version. His solution was simple, as he recalled on November 11, 2011: "I cut down the amount of *Variations V* equipment. We took half of it. Nobody knew the difference!"[12] But the restructuring of an old sound system was only the first task assigned to the new musician, for soon after Cage' s phone call, Cunningham also made a call to Ann Arbor and commissioned the new music for his new choreography to be premiered on the same tour. "This is like spring," he looked back sixteen years later, "and there's a few months to go, and I got other stuff going, and, of course, I still said yes."[13] Because of the shortage of time, Mumma decided to

6 Mumma, "Interview by Nakai," November 11, 2011.

7 Ibid.

8 Although the date of the call is uncertain, it can be deduced through two other dates: the company administrator Lew Lloyd wrote to Tudor on April 22 asking who the new musician will be, so it must have been sometime after that: "John says that you have some good ideas on an assistant for you two. Will you write them to me? If you are sure in your own mind who we should take, just tell me, and I can contact them about the mechanical parts of becoming part of our little troupe" (Lew Lloyd, "Letter to David Tudor [April 22, 1966]," Box 55, Folder 9, David Tudor Papers, GRI). And since Mumma wrote to Tudor about developing the bandoneon piece for Cunningham's dance on May 17, it must have been sometime before that: "The bandoneon piece which we discussed starting back last September is incubating. Merce & John have asked about the possibility of it being done with a new dance that Merce is doing, and that is now a real focus for my completing the piece" (Mumma, "Letter to David Tudor [May 17, 1966]," Box 57, Folder 3, David Tudor Papers, GRI).

9 Gordon Mumma, "Interview with Vincent Plush (May 17, 1982)," *Oral History of American Music*, Yale University Library, 108.

10 "Cunningham archivist David Vaughan has documented twenty-nine additional performances in the following three years. Within a month of the French-American festival, Cage and Cunningham had taken the work to Upper Black Eddy, Pennsylvania, and to C. W. Post College on Long Island. In November they performed it three times at the Harper Theater in Chicago and early the following year gave four performances in a single week on the West Coast (at the Seattle Playhouse, Simon Fraser University in British Columbia, Western Washington State College, and the University of Oregon). Three weeks later they took it to Hartford, Connecticut" (Miller, "Cage, Cunningham, and Collaborators: The Odyssey of *Variations V*," 557).

11 The DVD of this broadcast has been released from Mode Records: Variations V: Cage, Tudor, Mumma, Merce Cunningham Dance Company, 1966, NDR, Mode Records, 2013.

12 Mumma, "Interview by Nakai," November 11, 2011.

13 Mumma, "Interview with Vincent Plush," 109.

merge the two commissions as one: he would focus on finishing the bandoneon piece for Tudor he had already been working on.

3

In 1960 Mumma had started a small company called "Cybersonics" with William Ribbens, a doctoral student of electrical engineering at the University of Michigan, to sell electronic musical instruments they designed together. The company name was a word that the twenty-five-year-old multi-instrumentalist had coined to describe his approach to electronic music as well as electronic instruments.[14] It was a modification of a well-known source: "Cybernetics," a relatively recent term that the mathematician Norbert Wiener had coined some twelve years earlier as the title of a new interdisciplinary study of semi-automatic behavior of systems based on feedback. Generalizing the lessons derived from his war-time effort of developing anti-aircraft guns that automatically adjusted their aim according to whether it had hit the mark or not, Wiener described a mechanism of auto-correction observed in a vast number of phenomena whereby changes produced in the environment by a system are fed back to the same system to change its behavior so that it may better reach a predetermined goal.[15] At a certain level of generalization, a person reaching out to drink a glass of water, a thermostat maintaining the room temperature steady, and a gun trying to shoot a plane down could all be seen as engaging in the same task. To name this circular mode of control through feedback, Wiener used the Greek word κυβερνάω (*kybernao*), meaning "to steer, navigate or govern."

Mumma's "little invention of taking the 'netics' out and putting the 'sonic' in"[16] connected Wiener's theory of self-correcting systems to the performance of music.[17] He knew electronics well enough to compose instruments that adjusted their behavior in reaction to a sound input, which could cybernetically be their own output. But his aim was neither to shoot down fighter planes nor to make instruments play some music correctly; it was instead to use the principle of feedback control for developing new ways to perform live music with electronics. For this reason, cybersonics departed from cybernetics in several significant ways. First of all, the goal-oriented view of systems became itself a means to another end: what mattered was not what the system ultimately accomplished but what it produced in the attempt. The music, in other words, was a side effect. As a corollary, feedback also became something other than a form of interaction between a system and its environment that triggered the former's auto-correction; it was instead a form of interaction between multiple materials, each of which formed a smaller system

[14] Over the next couple of years Mumma experimented with cybersonic procedures, first composing *Medium Size Mograph 1963* for piano and cybersonic console.

[15] Norbert Wiener, *Extrapolation, Interpolation, and Smoothing of Stationary Time Series: With Engineering Applications* (Boston, MA: MIT Press, 1964); Wiener, *Cybernetics: or the Control and Communication in the Animal and the Machine* (Boston, MA: MIT Press, 1965).

[16] Mumma, "Interview by Nakai," November 11, 2011.

[17] The early pioneers of this approach were Bebe and Louis Barron, who used Wiener's 1948 book as source material to build electronic circuits that produced unpredictable sounds semi-automatically before they burned out. The Barrons also provided the tape recorder for a magnetic tape project led by Cage in the early 1950s which gave birth to works like *Williams Mix* (1952).

of its own and together composed what Mumma called the "total configuration" of live performance. This included not only electronics, but also acoustic instruments, human performers, concert space, and even more, as he explained in an article written in 1967:

> *I am concerned primarily with "system concepts"—configurations that include sound sources, electronic modification circuitry, control or logic circuitry, playback apparatus (power amplifiers, loudspeakers, and the auditorium), and even social conditions beyond the confines of technology. I suggest that the most important creative aspect of live-performance electronic music technology is not this or that circuit innovation but rather the total configuration itself.*[18]

Since there was no predetermined goal to attain globally, the components in the total configuration did not have to be tightly coordinated to work together as "one" system. On the contrary, cybersonics focused on the indeterminacy between one component and another, the mismatch between different local goals whose outcome could not be completely foreseen.

When he talked about an actual cybersonic instrument, therefore, Mumma often talked about how it was designed not to be obedient to human command, but to deliberate on its own, so to speak, so that the response was always somewhat unforeseeable—not a reaction but a "decision."[19] Within the boundaries of material bias, coordination was loose as far as cybersonics was concerned. This nature of being unpredictable, despite constancies on a more general level, made electronic instruments appear to have a private interiority, a capacity for reflection. And the constancies were in turn perceived as a matter of "characters," much like letters that can be distinguished despite being written in different hands, or handwriting that reveals the same hand despite writing different letters. Identity became a matter of tendency, which is also to say "personality," to use a word that Mumma often used, for instance in a note written in February 1970:

> *If we admit of musical performance as social intercourse, then we may include the varieties of artificial intelligence in our musical ensembles: not merely for their sophistication and speed, but also for the contribution of their personalities.*[20]

As a corollary, sound input became a matter of perception, something each instrument "listened to" or "heard," as Mumma reflected, this time while talking to Plush on May 17, 1982:

> *The circuit had ears, microphones, and it listened, and then it responded. And, of course, when it responded, it added itself to the ensemble, and it was still making an*

[18] "Creative Aspects of Live-Performance Electronic Music Technology (1967)," in Mumma, *Cybersonic Arts*, 44.

[19] "And the performance space, which now includes another intelligent being, which is the circuitry which makes *decisions*—that's what intelligent beings do." (Mumma, "Interview with Vincent Plush," 102; emphasis added) "It receives and stores information in an analog rather than digital form, making *'decisions'* essential to the composition" ("Two Cybersonic Works: *Horn* and *Hornpipe*," *Cybersonic Arts*, 61; emphasis added).

[20] Mumma, "Notes on Cybersonics: Artificial Intelligence in Live Musical Performance (February 1970)," Box 57, Folder 3, David Tudor Papers, GRI.

> *analysis of what was going on, so it changed what it was doing according to what it was doing as well.*[21]

In short, cybersonics was a method for multiplying the agency involved in the performance of music. What each circuit listened to was not so much its own output returned immediately to itself, but the reflections of its output after being listened to by other components in the total configuration. Not a soliloquy but a social intercourse; a matter of ensemble between modular agents whose insides were occulted from one another, as though they were persons.[22]

4

But Mumma also had another way of explaining cybersonics, one that coordinated better with how cybernetics explained things. Instead of focusing on the instruments with personalities that listen and respond to one another, he would switch the scale of observation to see the total configuration as "one" system, thereby rendering all the interactions between its components into a model case of cybernetic behavior. On this level of generalization, it was no longer the members of the ensemble that mattered but what was passed between them, as Mumma continued his reflection in May 1982:

> *The sound modifies itself. I establish the procedure by which the sound is modified, but the actual modification of the sound is done by the sound itself. And that's hardly a new principle in electronics, but applying the principle in a musical composition—a live performance composition—that may well have been one of the first times that that specifically happened that way.*[23]

What Mumma described here was no longer an instrument that decides for itself, but a sound that modifies itself, probably through some kind of instrument, although he did not mention any in particular.[24] But this shift of focus did not simply reduce the multiplicity of instrumental characters to the singular flow of signals going through them, a process that involves all products without being reduced to any. For with the appearance of instruments that listened and deliberated their responses, sound also gained a new role: it now had the physical capacity to modify other sounds, a role

21 Mumma, "Interview with Vincent Plush," 101.

22 This does not translate immediately into the polarity between "soliloquy" and "communication." For a brief analysis of the complicity between cybernetic closure of feedback and communication as theorized by so-called communication theory, see You Nakai, "Lost Information: Selected Perspectives on 'Experimental Actions' (1948–1972)," *Tacet: Experimental Music Review* 2 (2013), 19–51.

23 Mumma, "Interview with Vincent Plush," 91–92. Another similar explanation from 2005: "Simply, cybersonics is a situation in which the electronic processing of sound activities is determined (or influenced) by the interactions of the sounds with themselves—that interaction itself being 'collaborative'" (Mumma, "Composer's Notes," in Mumma, *Electronic Music of Theatre and Public Activity*, New World Records, 80632-2, 2005, 11–12).

24 In the 1982 interview, Mumma appears to distinguish this as a cybernetic "process" as opposed to "system": "a cybernetic process is something in which some aspect of the process is fed back into the process as a control mechanism, just as the steersman controls the boat" (Mumma, "Interview with Vincent Plush," 91).

long played by musical instruments. That is to say, sound, once turned into electronic signals, turned into a virtual instrument of sorts. In 2004, Ron Kuivila observed this double role of sound, contrasting the opposite reactions of two characters, one who remained indifferent and another who was intrigued:

> *"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.*[25]

As already seen in the sound system of 1967 *Fontana Mix*, it was to Mumma's cybersonic instruments that Tudor turned in order to pursue this potential of electronic sounds that disrupted logical categories. At the same time, both Mumma and Kuivila talked about the instrumentalization of sound as a general possibility brought about by electronics. Indeed, modulation and modularity, the two principles conditioning cybersonics, was also a common ground for other contemporary approaches to electronic music.

Influences

1

From late 1959 through 1960, as Mumma was busy setting up his company in Ann Arbor, a German engineer and electronic instrument builder named Harald Bode who had immigrated to the United States five years earlier, composed, under the influence of Les Paul's earlier endeavors,[26] a collection of instruments he called the *Modular Sound Modification System* or the "system synthesizer." A year later, he wrote an article reflecting on his invention which used "well-known electronic circuits [. . .] in system combinations" to produce unconventional sounds. Bode emphasized the usefulness of modularity in composing, and composing with, electronic instruments:

> *The modern approach of synthesizing intricate electronic systems from modules with a limited number of basic functions has proven successful in the computer field. This approach has now been made in the area of sound synthesis. With means for compiling any desired modular configuration, an audio system synthesizer could become*

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

[26] "His influence in many areas is felt to this day. The author was so impressed by his work that he later developed a sound modification system consisting of a number of electronic modules, assigned to two separate outputs through a multiple-head tape loop device" (Harald Bode, "History of Electronic Sound Modification," *Journal of the Audio Engineering Society* 32, no. 10 (October 1984), 733).

> *a flexible and versatile tool for sound processing and would be suited to meet the ever-growing demand for exploration and production of new sounds.*[27]

Among all the good things, modularity made possible one particular technique that Bode viewed as especially important: voltage-control. Instead of manually controlling the knobs and the switches, an external voltage input could be used to either modify the parameters of signal modification or modify the parameters of a signal directly.[28] Since these instruments worked with signals in audio frequency Bode also called them "audio-controlled" devices—parametric objects that could be performed with instrumentalized sound.[29]

Voltage-control was of course not something Bode invented. Hugh Le Caine had already made the first instrument using that principle, called the *Electronic Sackbut*, back in the 1940s.[30] But it was Bode's paper—which leaves out what Le Caine did from its history—that turned out to be influential, and very soon others followed his steps to build audio-controlled modular instruments. In 1962, shortly before Tudor met Oliveros, two of her colleagues at the San Francisco Tape Music Center, Ramon Sender and Morton Subotnick, began asking a twenty-five-year-old engineer and physicist who lived nearby if he could build several specific electronic instruments for them. This request soon led to the idea of composing a whole system of modular devices that could be flexibly coordinated for various uses. By late 1963, as Oliveros and Tudor worked on the *Duo* with Ahmed, Donald Buchla had installed the first version of his *Modular Electronic Music System* at the Tape Music Center. In the attached manual, a copy of which Tudor owned, Buchla stressed the modular nature of his instrument: "Composed of functional modules, each designed to generate a particular class of signals or perform a specific type of signal processing."[31] Just as in Bode's system, this modularity was coupled with the use of control voltage to perform one sound with another.[32]

Closer to Tudor's home, Robert Moog in Trumansburg, New York, had also begun composing a new electronic instrument around the same time under the influence of

[27] Harald Bode, "Sound Synthesizer Creates New Musical Effects," *Electronics* (December 1, 1961) 37.

[28] Bode's article mentioned two such devices: a "ring-bridge modulator" which takes two input signals and yields their sum and differences while suppressing the original signals—like the *Cybernetic Spectrum Transfer*—, and an "envelope shaper" which shapes the envelope of one input using the voltage of another (ibid., 35).

[29] Ibid, 36–37.

[30] For an excellent study of Le Caine's works, see Gayle Young, *The Sackbut Blues: Hugh Le Caine, Pioneer in Electronic Music* (Ottawa, ON: National Museum of Science and Technology, 1989)

[31] Donald Buchla, "The System," Box 39, Folder 3, David Tudor Papers, GRI.

[32] Buchla, on his part, insisted on a strict separation between audio signals and control voltages. His reasoning revolved around the issue of unwanted noise: (a) compared to audio voltage which usually stayed around one volt, control voltage tended to span a large range of values, so the high gain needed to boost audio signals for use as control voltages would result in relatively high noise level and signal leakage; (b) in order to make control voltages and audio signals interchangeable, all the components had to be "DC-coupled" and allow DC (or very slow DC-like) signals to pass from one module to another—as opposed to "AC-coupling" which filters out DC signals to let only fluctuating AC signals pass—but this would result in the amplification of unwanted offsets (DC components biasing AC signals). Buchla actually materialized this concern on the level of hardware by assigning banana plugs for control voltages and phono plugs for audio signals. The two were not to be mixed.

Bode's article.[33] Working with the composer Herbert Deutsch, Moog completed the *Voltage-Controlled Electronic Music Modules* which he presented at the conference of the Audio Engineering Society on October 16, 1964. As its name reveals, this was yet another new instrument based on modularity and modulation. The paper he read was published in the *Journal of the Audio Engineering Society* nine months later in July 1965; a copy made its way into Tudor's papers.[34] That same month, Moog participated in the production of *Variations V*, building the capacitance antennas that attenuated the sound according to a dancer's proximity to them—one of the things that Mumma, a good friend of Moog, would be hired to restructure in less than a year: "Bob Moog's phallus things that the dancers would run into, cut themselves. . . ."[35]

2

Tudor also knew both Buchla and Moog, as well as their instruments. When the former decided to turn his efforts into a business in 1966, he praised the product which was quoted in the very first catalog of the *Modular Electronic Music System*: "A most remarkable instrument for manipulating sound. As useful in the concert hall as it is in the studio."[36] When he was invited as a guest lecturer to Mills College in the winter of 1967, Tudor occasionally used Buchla's original instrument, which had moved there along with the Tape Music Center that same year. Two years later, in December 1969, he flew to India carrying a whole set of Moog's *Modules*, this time to build the country's first electronic music studio at the National Institute of Design in Ahmedabad.[37] Tudor kept a series of dated schematics that Moog had sent him for this task—twenty-one modules to be exact, many of them voltage-controlled, including Bode's *Ring Modulator* and *Dome Filter*, which had by then also become part of Moog's system.[38]

Yet, Tudor did not hide the fact that he hated these so-called synthesizers. His dislike was mostly due to the inflexibility caused by standardization, which resulted in

[33] "The idea of one oscillator controlled by another came to mind. I knew that such a thing as voltage control was possible and the whole idea of making it modular was in an article by Harald Bode in some issue of *Electronics* magazine in 1961, describing a very simple modular system that he had designed. It had a tape delay module, a reverb, a voltage-controlled amplifier. From that I learned what a modular system was" (Robert Moog, quoted in Joel Chadabe, *Electric Sound: The Past and Promise of Electronic Music* (New York, NY: Prentice Hall, 1997), 141).

[34] Robert Moog, "Voltage-Controlled Electronic Music Modules," *Journal of the Audio Engineering Society* 13, no. 3 (July 1965), 200 (Box 39, Folder 3, David Tudor Papers, GRI).

[35] Mumma, "Interview by Nakai," November 11, 2011.

[36] "Modular Electronic Music System, catalog, 1966," Box 39, Folder 3, David Tudor Papers, GRI.

[37] For a wonderful account of this project, see Alexander Keefe, "Subcontinental Synth: David Tudor and the First Moog in India," east of borneo, accessed December 15, 2019: https://eastofborneo.org/articles/subcontinental-synth-david-tudor-and-the-first-moog-in-india/

[38] These were: *901-A Oscillator Controller* (7-22-66); *901-B Oscillator* (7-25-66); *901-B Voltage Controlled High Pass Filter* (12-12-66); *902 Voltage Controlled Amplifier* (4-19-65); *903 White Sound Source* (7-15-66); *904-C Voltage Controlled Filter Coupler Control Circuitry* (7-14-67); *904-A Voltage Controlled Low Pass Filter* (7-25-67); *905 Reverberation Unit* (7-26-66); *907 Fixed Filter Bank* (7-27-66); *910 Power Supply* (3-8-65); *911 Envelope Generator* (8-14-68); *912 Envelope Follower* (3-10-67); *950 Pitch Control Circuit with Portamento* (3-9-67); *956 Ribbon Controller* (1-22-69); *960 Sequential Controller* (6-19-68); *984 Four Channel Mixer* (5-3-67); *Microphone Preamplifier* (7-12-68); *Frequency Shifter* (Block Diagram); *Console Panel; Bode Ring Modulator; Bode Dome Filter*.

predictability. As he reminisced to John David Fullemann, the former sound engineer of MCDC, on September 3, 1984: "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."[39] Anthony Gnazzo, who was at Mills College when Tudor was there, similarly recalled in March 2015 that despite his comments on the catalog, "[Tudor] lamented that the Buchla, like most other electronic instruments of the time was 'too predictable.'"[40] So the instrumentalization of sound was not enough—the specific nature of instruments that turned sounds into instruments mattered.

In contrast to the all too predictable synthesizers of Buchla and Moog, Tudor's sound systems were characterized by an utter lack of standardization: "a lot of equipment that I built myself where there was no question of a power supply common," he revealed to Fullemann in September 1984, "so the voltages present were constantly unpredictable."[41] As in cybersonics, such mismatch between modular components was a source of indeterminacy that could be carefully composed. The potluck-like character of Tudor's sound system was also reflected in how the instruments were laid out in space, as seen in the *Toronto Daily Star* photograph of *Fontana Mix* at Isaacs Gallery (Figure 3.12): scattered across the desk, flooding the drawers, stacked on top of one another, at times even taped together like the pile of four amplifiers at the end of the desk. Aside from the absence of a common power supply, this ad hoc nature also facilitated the subtle exchange of components from one performance to another as revealed by the series of almost-identical-but-not-quite *Fontana Mix* diagrams—yet another ingredient in the composition of indeterminacy.

So if coordination was too rigidly composed in advance, Tudor could not find contact with the material, even if it was modular and audio-controlled. But unlike the paper scores which he simply stuck in his drawer for years, the modular nature of synthesizers allowed Tudor to use or abuse them whenever he came across one. Talking to Fullemann in September 1983, Tudor reflected on his experience of using Moog's *Modules* he had set up in Ahmedabad fifteen years before: "I had to make a piece, and the only thing available was this synthesizers So I put all my gain stages into a single oscillator [*laughing*] and the poor thing doesn't know what it's doing. It turned out to be fun, eventually."[42] A year after this interview, Tudor recounted a similar story to the participants of a workshop he held at the Mobius Art Center in Boston on September 29, 1985:

[39] Tudor, "Interview by Fullemann," davidtudor.org.

[40] Anthony Gnazzo, "Email to John Bischoff," March 3, 2015 (forwarded by Bischoff to You Nakai on March 5, 2015).

[41] Tudor, "Interview by Fullemann."

[42] Ibid. This performance in early December 1969 was recorded and became the source tape for *Monobird*, which Tudor performed three times in 1972 (August 30 in Munich, September 8 in Shiraz, Iran, and December 10 at SUNY Albany) and once in 1975 (December 17 at SUNY Potsdam), every time in a duet with Cage's *Bird Cage*. The same tape is also audible in the recording of a performance Tudor did at Xenon, a popular disco in New York City, on March 1, 1979. This was one day after Experiments in Art and Technology (E.A.T.) had held *Artists for New York*, a benefit event for the nonprofit artists' organization Institute for Art and Urban Resources, at the same venue, where Tudor was scheduled to perform a laser concert with Lowell Cross. According to Julie Martin who was there, "The evening performance

Every time I've had to use the synthesizer, or a synthesizer component, I had something outboard to it that then would change the way it operates. It's mostly because all the considerations of the voltage, you know, where voltage needs to correspond to what the output signal level is—that's all coordinated. And if you manage to uncoordinate that, then you are in a completely different position.[43]

Sometimes the goal of un-coordination could be achieved without bringing other modules in. Tudor could simply apply the principle of feedback to destabilize the system's operation instead of stabilizing it, or even to halt it completely, like standing cybernetic control on its head. There are testimonies as well as material evidence: a photograph taken during the performance of *Variations VI* at Mills College on January 16, 1968, captures Tudor using the *Buchla Synthesizer* (Figure 4.2).[44] Gnazzo, who performed with him that day, recalled forty-seven years later how Tudor actually treated the instrument during his residency: "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. I don't recall that he ever tried any other patch."[45] Alden Jenks, who would perform *Amplified Barbecue Grills* under Tudor's guidance in April of the same year, similarly recalled in March 2015 how his teacher "killed the Buchla dead"[46] while at Mills College:

I do remember that he sat down in front of the Buchla system one evening. This was informal, only I was present. I suppose I was working with the Buchla at that time. But David proceeded to grab a handful of cords and, with a sort of devilish smile, very rapidly set the lights in motion in a complex pattern until, with one final connection, the whole thing suddenly stopped—he had forced the machine to turn itself off.[47]

was cut short when the dirty New York water clogged the filter on the water supply cooling the laser [. . .] and the laser had to be turned off, and the piece stopped" (Julie Martin, "Email to You Nakai, Jacob Kierkegaard, John Driscoll, and Phil Edelstein," September 9, 2015). The following day, Tudor set up his table on the floor of the disco and performed just for the sake of recording his music, with no laser and no audience. The glittering discotheque had just invested $100,000 in a spectacular sixteen-channel sound system, the most expensive ever installed in a New York club. So it is not at all surprising that Tudor wished to blast his music through the multiple house speakers there. Tudor's tendency to treat live performances as open recording sessions is discussed in Chapter 7.

43 David Tudor, "Workshop at Mobius Art Center, Boston (September 29, 1985)," Box2A, C75, David Tudor Papers, GRI.

44 I first came across this photograph in Thom Holmes, *Electronic and Experimental Music* (2nd edition) (New York, NY: Routledge, 2002), 239). I thank Holmes for responding to my inquiry and putting me in touch with John Bischoff who was credited as the photographer. Bischoff, however, could not have taken this photograph since he was still in high school in January 1968. Seeing this photograph reminded Gnazzo that "[h]e did have the Buchla on one of the tables for the *Variations VI* performance. I'm sure he probably had set up his favorite patch and created a couple of howls with the Buchla" (Gnazzo, "Email to You Nakai," March 11, 2015).

45 Gnazzo, "Email to John Bischoff," March 3, 2015.

46 Ibid.

47 Alden Jenks, "Email to You Nakai," March 13, 2015.

Figure 4.2 Tudor manipulating the *Buchla 100* synthesizer during the performance of *Variations VI* at Mills College Art Gallery | January 16, 1968
Photographer unknown | Courtesy of the Center for Contemporary Music Archive, Mills College

3

One thing Buchla immediately realized when he began making his own voltage-controlled modular synthesizer was that humans didn't have to control the instrument because signals did a much better job. As he recalled circa 1996, "as soon as I added voltage control to the elements of the synthesizer it became a different ball game because you could parametize [*sic*] everything. You weren't limited by how fast you could turn a knob to get between two states of a parameter."[48] In most cases, this potential of instrumentalized sound would be described as an expansion of parametric control beyond the physical bias of a human performer. But it meant something else for cybersonics where music was conceived as a "social intercourse" between different personalities, human and otherwise. For there was no longer a predetermined chain of command from humans to machines where the latter merely enhanced the former's capabilities, a hierarchy that was also inscribed in the language of cybernetics where machines were called "*servo*-mechanisms" with the obvious implication that the "master" they served was a human being. Instead, Mumma saw instruments as collaborators, as he wrote in February 1970 for a manifesto-like "Notes on Cybersonics," a copy of which is found among Tudor's papers: "We may treat the artificial intelligence

[48] Buchla on May 20, 1996, or April 4, 1997, quoted in Trevor Pinch and Frank Trocco, *Analog Days: The Invention and Impact of the Moog Synthesizer* (Cambridge, MA: Harvard University Press, 2002) 39.

not as a slave, but as a collaborative equal in a democratic musical society."[49] By "artificial intelligence," he was of course referring to his cybersonic instruments.

As a corollary, there was one particular term that Mumma returned to again and again when describing the way instrumental personalities interacted within a cybersonic configuration, in an implicit yet obvious opposition to cybernetics and to other modular synthesizers that otherwise similarly modified sounds with sounds. In the "Notes," for instance, he wrote as follows:

> *My personal interest is with matters of* influence *rather than control. In my live/electronic work I explore the* influences *and interactions among myself and other people and the electro-acoustic circuitry that is our "instrument."*[50]

The same polarity appeared again twelve years later when Mumma reflected on the performance of another cybersonic piece, *Hornpipe*, while talking to Plush on May 17, 1982:

> *There wasn't a matter of control anymore, it was a matter of* influence. *I mean, it was—I designed the circuitry, and, in that sense, I exerted control, but in fact, when the whole thing gets going. We were all* influencing *it.*[51]

A matter of influence and not control. Unlike the latter, the former is a kind of coordination that is difficult to perceive immediately or experience directly because it goes beyond the usual scales of observation in size—either too big or too small—or in complexity—either too subtle or too complex; yet it produces an effect that can be felt. Like catching or spreading the flu (or the coronavirus, for that matter), one often exerts and is exerted by influence before realizing so. One could deliberately place oneself "under the influence" of external substances, as Tudor often did during his performances—the secret reason behind his switch from piano to electronics—which is generally believed to have negative effects on the control of vehicles as it uncoordinates the coordination between the body and the larger body encompassing it. In other words, influence is coordination that always leaves a margin of indeterminacy.

The term originally comes from the state of being "in flux," discussed most notably by Neo-Platonist philosophers who believed that the essence or nature of one object flowed invisibly into another object, thereby modifying its nature.[52] At the start of this chain of influences were the stars covering the night sky and shining upon everything in the sub-lunary world. According to a common view long held

49 Gordon Mumma, "Notes on Cybersonics"; emphasis added.
50 Ibid.
51 Mumma, "Interview with Vincent Plush"; emphasis added.
52 Mary Quinlan-McGrath, *Influences: Art, Optics, and Astrology in the Italian Renaissance* (Chicago, IL: University of Chicago Press, 2013). As Quinlan-McGrath explains, the multifold network of influences covering the world centered around the heavenly stars. As a giant, ever-moving "text" that, if read correctly, gave knowledge of what has not yet happened, the celestial bodies exerted huge influence on all things terrestrial. Harold Bloom also summarizes in passing: "The flowing from the stars upon our fates and our

in Europe and popularized in the form of astrology and horoscopes, ethereal fluids emanating from celestial bodies triggered all sorts of effects without themselves being sensed, one among which was the sudden outbreak of malady known as influenza, and another was the modification of individual characters and personalities.[53] When one object influenced or inspired (in-spirited) another, it indeed worked very much like instrumentalized sounds, the nature of one impressing its likeness on the other: "every natural agent sends its powers outward in a line or Ray, and this Ray makes anything that it encounters similar to itself."[54]

4

Influence, by nature, is difficult to determine. Tudor probably knew at least a thing or two about the flow of essences before coming across Mumma's term, since the occult philosophy of Rudolf Steiner was deeply influenced by the lineage of esoteric thought extending from the Neo-Platonists. In fact, "occult" was itself a term that describes the workings of influence hidden to direct observation,[55] which Steiner preached in books and lectures with titles like "Planetary Spheres and Their Influence on Man's Life on Earth and in the Spiritual Worlds."[56] But regardless of where the ethereal fluids that reached Tudor originally emanated from, the effect could be perceived all over. Tudor would explain to Wilding-White on November 27, 1973, that the piano was amplified for *Variations II* in such a way that "you could only hope to *influence*" the instrument.[57] By 1985, Tudor had acknowledged it as his responsibility, as he spoke to his workshop participants at the Mobius Art Center on September 29: "You can't know exactly what's going to happen but my job is to *influence* it so that it does happen."[58] Another decade later, the same verb was used to reflect upon the indirect control of tone via escapement

personalities is the prime meaning of 'influence' " (Bloom, *The Anxiety of Influence: A Theory of Poetry (Second Edition)* [New York, NY: Oxford University Press, 1997], xii).

53 There is an undated recording labeled "Pulsars, Jupiter, Sun" (R197) among Tudor's source tapes, which has been identified as the sounds of a pulsar from the Vela Supernova received and recorded at the National Radio Astronomy Observatory in September 1970 (the same recording can be listened to online at "Vela Pulsar Observations," Hawkesbury Radio Astronomy Observatory, accessed December 15, 2019: http://hawkrao.joataman.net/pulsar/vela_pulsar/audio/vela.wav). The rhythm heard in the recording is strangely reminiscent of Tudor's *Pulsers* from 1975, for which it may have served as a source of inspiration. The narrator explains in the recording: "this remnant from the supernova explosion 11,000 years ago is estimated to be traveling at 1,200 km/s (750 mi/s)." On September 29, 1985, while conversing with audience members after the performance of *Hedgehog*, Tudor was asked "what kinds of things do you want to happen?" to which he answered, perhaps much more literally than it appeared: "I want it to be like stars!" ("*Hedgehog*, Mobius Art Center, Boston [September 29, 1985]," C73, David Tudor Papers, GRI).

54 Quinlan-McGrath, *Influences*, 53.

55 Ibid., 61.

56 Rudolf Steiner, *Planetary Spheres and Their Influence on Man's Life on Earth and in the Spiritual Worlds* (London, UK: Rudolf Steiner Press, 1982)

57 Ray Wilding-White, "David Tudor: 10 Selected Realizations of Graphic Scores and Related Performances (1974)," Box 19, Folder 2, David Tudor Papers, GRI.

58 Tudor, "Workshop with students at Mobius Art Center."

mechanism in the unamplified piano: "if you can find the right point to press into the escapement action you have absolute control of the dynamics and, as a corollary, you have control over the tone—you can *influence* the tone."[59] But influence of course did not only flow in one direction from the human performer to his instruments. When he talked with Schonfield in May 1972, the word was applied to the relationship between mismatched components, perhaps inspired by what Mumma had written two years earlier in his "Notes on Cybersonics": "with a synthesizer you match up each component with the next one, so that each input can handle the previous output. 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."[60]

As far as influence is concerned, however, there was one particular source of inspiration in Tudor's night sky that remained more occult than others, if only because it had turned sound into an instrument without using electronics, or even electricity for that matter. The same source also happen to shine on the music of Mumma, who began "a series of compositions for horn with various accompanying resources, including live cybersonic processing" in 1961, two years *before* completing the first cybersonic work in his catalogue, *Medium Size Mograph 1963*.[61] In *Horn*, for example, premiered in March 1965, the sounds of one hornist and two vocalists modified the sounds of one another using cybersonic circuits.[62] What "inspired" Mumma was music that Tudor was also very familiar with:

> *For several years Robert Ashley and I performed a remarkable work for horn and piano,* Duet II *(1961) by Christian Wolff. This and several of Wolff's other works inspired me to compose for the horn.*[63]

In Wolff's music from this period, coordination between materials was determined by sonic cues that performers heard, which triggered them to do one thing and not the other. This was an audio-influenced system, albeit acoustic—a cybersonics unplugged.[64] Despite all the conditions being thought up in advance and written down on paper, coordination between the cues and their responses always involved the problem

[59] David Tudor, "Interview with David Tudor by Jack Vees and John D. S. Adams (July 19, 1995), 241 a," *Oral History of American Music*, Yale University Library, 5.

[60] Tudor, "From Piano to Electronics," 26.

[61] Mumma, "Two Cybersonic Works: *Horn* and *Hornpipe*," in *Cybersonic Arts*, 54.

[62] "One of its notable performances took place on November 26, 1966, as a last-minute request for London's Saville Theatre during a Cunningham Dance Company residency. John Cage and David Tudor supplied the voice parts of my performance of the horn and cybersonics" (Mumma, ibid., 55)

[63] Ibid., 54.

[64] On October 9, 1966, Alvin Lucier sent a letter to Tudor in which he described an idea for a new organ piece which conceived the organist—*David Tudor*—as an audio-controlled instrument: "You would receive stimuli through a set of stereo headphones. The input to each headphone would be a mixture of signals from at least 4 channels. The signals could be anything from any source—radios, phonographs, tapes and so forth; but I would like at least some of it to be control signals from some daily occupation such as aircraft activity, taxicabs, police radio work and so forth. You would have to determine how to interpret the input. You could take only that material that suits your purpose, or consider that it is all relevant and attempt to deal with as much as you humanly can. You can assemble the material yourself or have assistants to do it so that it is a surprise to you when performing. You can call it *Organ Music for David Tudor*" (Lucier, "Letter to David Tudor [October 9, 1966]," Box 55, Folder 10, David Tudor Papers, GRI). This piece was never completed.

of mismatch because each process of listening was a live performance. Like circuits turned into persons, listeners turned into instruments left a margin of indeterminacy through their private interiority. What was occult was not only the flux of instrumentalized sound but also the instruments which processed them. "Christian Wolff never delineates a universe," Tudor had summarized to Schonfield in May 1972, probably because in his starry network of influences, each of the influenced was also a star.[65]

Musica Instrumentalis

1

On August 6, 1966, approximately a year after Tudor's brief presentation of the bandoneon in Ann Arbor, Mumma's first commissioned music for MCDC, titled *Mesa for Cybersonic Bandoneon*, was premiered at the Fondation Maeght in Saint Paul de Vence in France, together with a choreography named *Place*. The basic idea of the piece was derived from the specific physical bias of the acoustic instrument used. As Tudor once observed, having separate reed systems on the left and right side of the bellows made the bandoneon "one of the very few instruments which are two-sided."[66] Given this bi-instrumental nature, the long wind sounds it produced turned out to be an ideal source for electronic processing for at least three reasons:

(a) the signal was always fluctuating with a complex spectrum and wide dynamic range;
(b) the signal from one side could be used to modulate the other; and,
(c) changes in distance from the microphone created variable phase differences between the two signals.

In *Mesa,* the sustained tones of the bandoneon were modulated using cybersonic modules to create long clusters of sound with complex inharmonic overtones (frequencies stacked over the fundamental tone in non-integer intervals as opposed to integer multiples of harmonic overtones). These long sounds were interrupted by sudden extreme shifts in dynamics at various points. Six microphones were used, three on each side of the instrument, each responding to a different frequency band. After the sound was picked up and transduced to six electronic signals, one signal from each side of the bandoneon was applied to the opposite channel. Then they were all sent into four parallel processing channels which routed signals at various points to modify one sound with another. The four channels were composed in pairs: two primary modulation paths, and two other secondary paths Mumma called "outriggers." In the primary path, the signal was modulated using three modulators (including the *Cybersonic Spectrum Transfer*)

[65] Tudor, "From Piano to Electronics," 26.
[66] David Tudor, in *David Tudor: Bandoneon! (a combine)*, DVD (ArtPix, 2010). Also quoted in Goldman, "The Buttons on Pandora's Box," 50.

to further expand the already complex overtone of the bandoneon sound. The modulated signals were then added together before being split again in two directions: one went through further modulation in the secondary "outrigger" channels, and the other to a voltage-controlled comb-filter which further modified the signal by adding a slightly delayed (phase-shifted) version of itself which fortified some frequencies and attenuated others. At the end of each processing chain, the signals entered a voltage-controlled attenuator (VCA) with a time-delay circuitry which tracked the envelope of the incoming signals and triggered the sudden loud outbursts based on this information. Almost every component in the chain had parameters controlled by instrumentalized sound, either from the bandoneon itself, or from two separate modules that a second human performer operated in performance, which Mumma himself did at the premiere. All in all, the sound of the bandoneon processed the sound of the bandoneon, enhancing the complexity of its overtones, feeding back the multi-layered result to influence various aspects of the same process.

The four signals that came out of the four processing channels were then sent to four loudspeakers. The spatial distribution of inharmonically related and temporary displaced sounds across multiple loudspeakers created the illusion of sound sources moving when they were "mixed" in the two ears of each audience member. Which is to say that the total configuration simulated the slight delay (phase-shift) between sounds that microphones were "listening to" on each side of the bandoneon as Tudor moved its bellows in and out. The bi-instrumentality of the big squeeze box was virtually reproduced within the bi-instrumentality of the listener's ears.[67] As Goldman observed, Mumma's bandoneon music was therefore yet another case of "sonic synecdoche," the coordination of microcosm with macrocosm: "the internal space enclosed by the bandoneon is mirrored in that of the concert hall."[68] It was as if the listeners were listening to a giant version of the instrument from the inside.

2

Mesa thus became the fourth entry in Tudor's growing repertoire. It was not the third, as there was another piece he had already realized by then. A week or two before the American premiere of *Pandorasbox, bandoneonpiece* in April 1965, Tudor visited Toronto, only an hour and a half drive across the border from Buffalo. He was accompanied by Kagel, who probably offered to drive since Tudor always acted as if he could not.[69] They were there to see the electronic instruments of Hugh Le

[67] Mumma, "Creative Aspects of Live-Performance Electronic Music Technology," 46.
[68] Goldman, "The Buttons on Pandora's Box," 51.
[69] On March 25, 2016, during the three-day conference "Over, Under, Around and Through the Music of David Tudor" at Wesleyan University, John Holzaepfel presented a talk titled "David Tudor: into the Fire" which focused on Tudor's early life. Among many interesting details about Tudor's upbringing and childhood, Holzaepfel revealed at one point that Tudor could actually drive, and indeed drove Sigurd Rascher around when the two were touring in the early 1950s. I remember clearly the shock that ran through the room, filled with Tudor's close collaborators such as John Driscoll, Phil Edelstein, and Ralph Jones, who

Caine at the University of Toronto Electronic Music Studio (UTEMS).[70] The visit was arranged by Lowell Cross, a twenty-six-years-old composer Tudor had met in May of the previous year when he and Cage were invited to perform at the Texas Technological College in Lubbock, Texas. Since then Cross had moved to Toronto for his graduate studies.

Several months after Tudor's visit, Cross found himself dissatisfied one evening after a concert of electronic music at the Royal Conservatory of Music, where his *Three Etudes for Magnetic Tape* had just been performed. The problem was that there was nothing interesting for the audience to see.[71] So when he got home, Cross opened up a 17-inch black and white television set and connected the output of his sound system to its deflection yoke, essentially turning his TV into a giant oscilloscope which displayed visual patterns corresponding to the amplitude and phase of stereo music. Under the general title of "Video," Cross began experimenting with different kinds of audio input. According to Gnazzo, who was assisting Cross at the time, the graduate student in musicology considered this as a "great joke" pertaining to his scholarly discipline:

> *When people would come to his apartment he would hook his amplifier into it and he would play music by a composer he didn't particularly like, and who everyone agreed was not a good composer, and the images would not be very exciting, they wouldn't move so much. And then he would play a piece by a composer that he liked, and the images would be really good. So he came up with this musicological theory that this instrument, this tv set, could actually pick out good music from bad music* [laughter].[72]

When Tudor visited Toronto again in early 1966, Cross showed him what he had been up to. As Gnazzo reminisced, Tudor got the joke all too well: "David just thought this was the greatest thing. They would just sit there for hours playing sounds and just roaring in front of this thing, deciding who was good and who wasn't good."[73] But the input they tried did not only come from others. The bandoneon's bi-instrumentality and phase differences that Mumma could replicate in the listener's ears through cybersonic treatment turned out to be an ideal source for the *Video* system as well—the two signals on a single flat axis of left and right could be mapped onto the two perpendicular axes of verticality and horizontality defining the display screen. So Cross proceeded to compose a piece that coordinated Tudor's instrument and his modified TV set. *Musica Instrumentalis* was premiered at the Art Gallery of Toronto on May

not only believed their dear mentor and friend could not drive, but also had driven him around for years based on that belief.

[70] Lowell Cross, *Remembering David Tudor: A 75th Anniversary Memoir,* lowellcross.com, accessed December 15, 2018: http://www.lowellcross.com/articles/tudor/1964-1966.html

[71] Ibid.

[72] Anthony Gnazzo, "Interview by Julie Martin [video recording]," Oakland, CA, March 17, 1999, Klüver/Martin Archive.

[73] Ibid.

13, 1966, with Tudor playing the bandoneon and Cross operating the *Video* system, which now included a color TV. "David would be the sound source so he was guaranteed he was going to have good music this time," Gnazzo explained, "so they were going to have a great display."[74] The joke, quite literally, was now on them.

3

The signals generated from the bandoneon were output in two forms: sound and visual patterns. Accordingly, there were two feedback paths: (a) the audio route, which started from the bandoneon, went through the microphones to the mixing stages, and came out of the loudspeakers to enter Tudor's ears as well as the microphones again; and (b) the video route, which similarly started from the bandoneon but went to the deflection yoke to produce visual figures on the TV screen, which was seen by Tudor and influenced his next move.

Cross had given Tudor some "score materials" in advance. These were first colored drawings and later photographs of Lissajous figures, curved patterns visualizing the phase-relationships between two signals perpendicular to one another, which Tudor was to reproduce during the performance. Among Tudor's papers is a page of "performance instructions" in Cross's hand, listing three rules of coordination between sound and visuals to aid Tudor in re-drawing the score in real time:

(1) The loudness of sound determines the area covered by the images on the screen. Silence will produce a stationary bright dot in the center of the screen;
(2) The complexity of the patterns on the screen is directly proportional to the complexity of the sounds (their partials, etc);
(3) Rotational effects can be produced by slight inaccuracies in the intonation of constant intervals; greater inaccuracy will produce faster rotation.[75]

Since the "score" was a visual image, audio followed video. As Cross formulated concisely in 1971, "The sounds of the piece are a by-product of the visual feedback process."[76] The effort to achieve accurate control in one medium produced unexpected results in the other,[77] similar to the deliberate failure of cybernetic control that

[74] Ibid.
[75] Lowell Cross, "Performance Instructions," Box 36, Folder 2, David Tudor Papers, GRI.
[76] Lowell Cross, "*Musica Instrumentalis, Video II (B), Video II (C), Video II (L),*" *SOURCE: music of the avant garde* 9 (1971), 4.
[77] Cage had also explored ways to produce music as a side effect of another activity, for instance in *Variations III* performed during "Musik im technischen Zeitalter" where the amplified sound was whatever the performer's "disciplined" actions produced, or in *Variations V* where the output of sound was controlled by how dancers moved. The obvious difference, however, was feedback. As Cage was opposed to memory, the notion of an output returning to influence the next operation of the system appears to have never interested him. Control was something that had to be brought in from elsewhere in the form of discipline or choreography. The dual feedback in *Musica Instrumentalis*, on the other hand, generated control from within the system itself.

Mumma pursued in cybersonics. Music was once again created as a side effect of an self-correcting system. In *Musica Instrumentalis*, however, this system had a prominent center, a single component in the configuration that could perceive the difference between what is seen and heard. *David Tudor* constantly compared the score with the rapidly changing patterns on the screen, adjusting his control of the instrument accordingly, much like a pilot trying to navigate an airplane, or the missile operator trying to shoot it down. With a principal agent and a clear target in sight, Cross's system was closer to cybernetics proper than Mumma's cybersonics despite the name or the lack thereof. Sounds, once transduced into signals, could do more than modify other sounds; they could be output as both audio and video, feeding back separately to influence the human performer who, as Cage observed in 1957, had "eyes as well as ears."[78] Tudor was once again turned into an instrument, this time playing the role of a giant phase shifter and comparator of sounds turned into visual images.

In 2001, Cross remembered how he discussed these matters with Tudor when he visited Stony Point in the fall of 1966:

> *I explained to him that he had already experienced himself as a feedback "component" in* Musica Instrumentalis*, during which his physical movement of the bandoneon between the microphones produced audible stereophonic phase-shift effects over the loudspeakers and visible kinetic phase-shift effects on the TV screens.*[79]

Cross had come to help Tudor, who was in the midst of preparing his first composition that took the influx of these two works he had recently been exposed to, and used one to modify the other, as if to instrumentalize not only sound but also influences.

II. Giant White Noise Generator

Möbius-Strip

1

When *Variation V* was premiered on July 23, 1965, two months after the Buffalo performance of *Pandorasbox, bandoneonpiece*, Cage enlisted the help of others to build what he or Tudor could not. Aside from Moog, who delivered twelve phallus-like capacitance antennas that sensed dancers' proximity, there was another engineer named Billy Klüver who was brought in to compose a network of light beams coupled with photocells

[78] Cage, "Experimental Music," in *Silence*, 12.
[79] Lowell Cross, *Remembering David Tudor: A 75th Anniversary Memoir.*

(light-sensitive resistors) that activated sound sources every time dancers interrupted the line of light. A year younger than Tudor, Klüver was born in Monaco, grew up in Sweden, immigrated to the United States in 1954, and had been working for Bell Labs since 1958. He had become active in the art scene of New York starting from 1960, when he assisted Jean Tinguely in making *Homage to New York*, a twenty-three-foot long and twenty-seven-foot high drawing machine that (in)famously destroyed itself during its operation in the garden of the Museum of Modern Art.

On November 17, four months after the premiere of *Variations V*, Klüver met with Knut Wiggen, the director of Fylkingen who was visiting New York, to discuss the participation of American artists in "Visions of the Present," a festival of art and technology planned to take place in Stockholm in September 1966.[80] Both sides were motivated. The previous year's "Five New York Evenings" at the Moderna Museet, where Tudor performed *Fluorescent Sound*, had been successful, and Klüver wanted to drive forward large-scale collaborative projects between New York artists and Bell Labs engineers. So he enlisted a group of more than thirty colleagues from his workplace, and together with Robert Rauschenberg selected ten artists whose work they knew. Among them was David Tudor.

Meetings to talk about individual projects and technical requirements for the festival began on January 14, 1966, and Klüver's diary mentions the participation of Tudor and Cage that day.[81] But it appears that their busy schedule did not permit them to attend subsequent gatherings. The earliest report of a meeting found in Tudor's papers is from February 13, 1966, which only notes his absence as well as Cage's, for both were in Bellingham, Washington, that day setting up the heavy gear of *Variations V*, which was to be performed at Western Washington State College the following day (Valentine's Day). In fact, Tudor's name does not appear in any report of subsequent meetings held between March and May, around the time Mumma was working on *Mesa*, and Cross on *Musica Instrumentalis*.

Meanwhile, negotiations between Klüver's group and Fylkingen had fallen apart by mid-July 1966. In response, the American artists and engineers decided to go ahead with their work and hold the performances in New York. In August, the 69th Regiment Armory on Lexington Avenue between 25th and 26th Streets in Manhattan was selected as the venue to host the festival, now scheduled for mid-October and renamed as "9 Evenings: Theatre & Engineering."

2

In the years following *9 Evenings*, Klüver planned to put together a documentary book on the festival and began to ask for materials from the participants. In 1973, Tudor

80 Julie Martin, "A Fifty-Year Friendship," Klüver/Martin Archive.
81 Billy Klüver, "Diary," Klüver/Martin Archive.

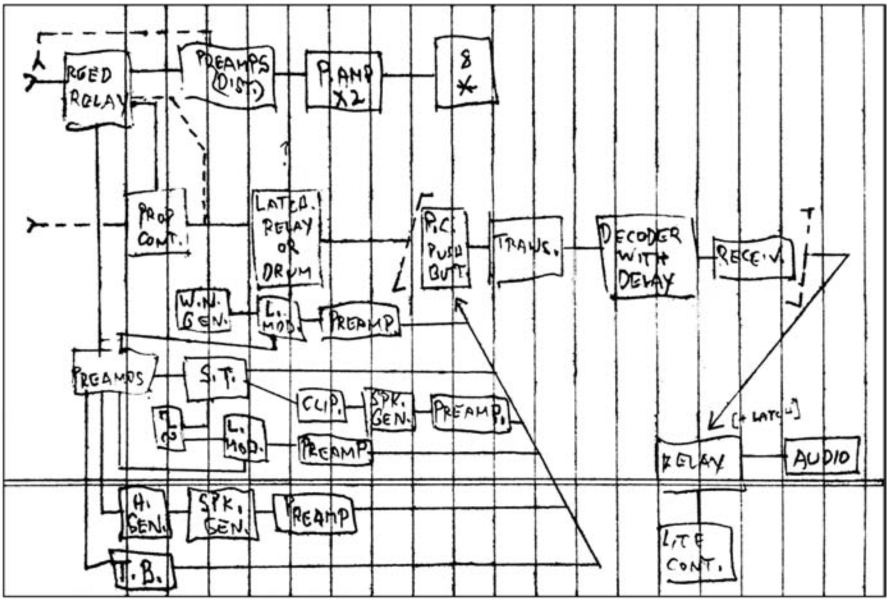


Figure 4.3 Tudor | *Alle Rechte vorbehalten,* early realization diagram | 1966
DTP, Box 3, Folder 2 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

wrote and submitted a short text with the title "Pre & Post-operative Note." Among other things, he reflected on the origins of his contribution seven years earlier:

> *My first plan for the* 9 evenings *was to have been a realization of my friend Mauricio Kagel's Möbius-strip composition, 'Alle Rechte vorbehalten,' using only white noise as a source, gated, triggered, etc. in a complex fashion by some instrument.*[82]

Presenting his own work was not what Tudor initially had in mind. He probably had not yet reconsidered *Fluorescent Sound* from two years before as his first "composition." Kagel's playfully titled *Alle Rechte vorbehalten* [All Rights Reserved] was a flexible material composed in 1965, consisting of a single short strip of tempo markings in Italian and German with several dynamic markings written below them.[83] The paper was to be read as a Möbius-strip loop, aligning its physical form with endless feedback. Kagel did not specify instrumentation—and neither did Tudor. The only mention of "instrument" in the *Pre & Post-operative Note* is that there would be one, whose function was to process white noise in a complex manner.

An undated block diagram matching the description of this first plan is found among Tudor's papers (Figure 4.3). The lower left section of the drawing is crowded

[82] David Tudor, "*Bandoneon!*, Pre & Post-operative Note," Box 16, Folder 6, David Tudor Papers, GRI.
[83] "accellerando [*sic*] / immer ruhiger werden / non accellerare / a Tempo / poco più / molto / rallentando / non rallentare / poco meno (attacca)" (Kagel, *Alle Rechte vorbehalten*, in *Notations,* edited by Cage and Allison Knowles [New York, NY: Something Else Press, 1969], 142).

by a multitude of boxes that actually form six parallel processing channels stemming from a single source labeled "W. N. GEN.": *White Noise Generator* or Instrument 0493. The processing instruments largely overlap with the following year's *Fontana Mix*: two *Lenkurt Modulators* ("L. MOD."), *Cybersonic Spectrum Transfer* ("S.T."), *Midland Audio Generator Model 23-165* (sine and square wave symbols), and *Tube Box* ("T.B."). There are four instruments that appear for the first time (or more accurately, does not appear later): *Clipper* ("CLIP."), *Harmonic Generator* ("H. GEN."), and two *Spike Generators* ("SPK. GEN.").

In another section of the archive where materials related to the preparations for the Stockholm Festival are gathered, there is a note listing the names of all these new instruments along with their components (Figure 4.4).[84] The page number next to each name suggests that the components were copied from some publication. This source material turns out to be *Diode Circuits Handbook*, the very same book by Rufus P. Turner from which the schematics for the *White Noise Generator* were taken. The *Spike Generator* and the *Harmonic Generator* even appear in the same Chapter 6 of the 1963 book dedicated to "Instrument Circuits," under the title "Timing-Marker (Spike) Generator" and "Harmonic Intensifier for Frequency Standards," respectively, immediately preceding the circuit of "Noise Generator" that Behrman had copied out.[85] The *Clipper* appears as "Level Clipper" earlier in Chapter 3 dealing with "Audio Circuits."[86] These were all very simple circuits composed around two diodes in different configurations. The names of the components all match the ones Tudor wrote down in his note.[87] He had bought this book on April 8, 1966, in Buffalo.[88] Other receipts show that one week later, on April 16, he purchased all the necessary components and set out to build the instruments.[89]

All three circuits have been discovered among extant instruments in the Wesleyan collection, encased in plastic containers reminiscent of the rehoused *Fog Horn* or the *Dual Olson Microphone Preamplifer*. The *Spike Generator* and *Harmonic Generator* turn out to be housed in the same green plastic container as two independent circuits indicated with initials on two Dymo labels attached to each pair of input and output: "S" for Spike on the left, and "H" for Harmonic on the right (Instrument 0173) (Figures 4.5 and 4.6).

Turner's book explains how when a square wave is input to "S," the first diode in the way ("X1")—which like all diodes should pass a signal in only one direction, leaving just the positive half-cycle of an AC signal fluctuating back and forth between positive and negative—does not shut off immediately when the negative half-cycle appears,

84 Tudor, "Note with Component Names," Box 16, Folder 1, David Tudor Papers, GRI.

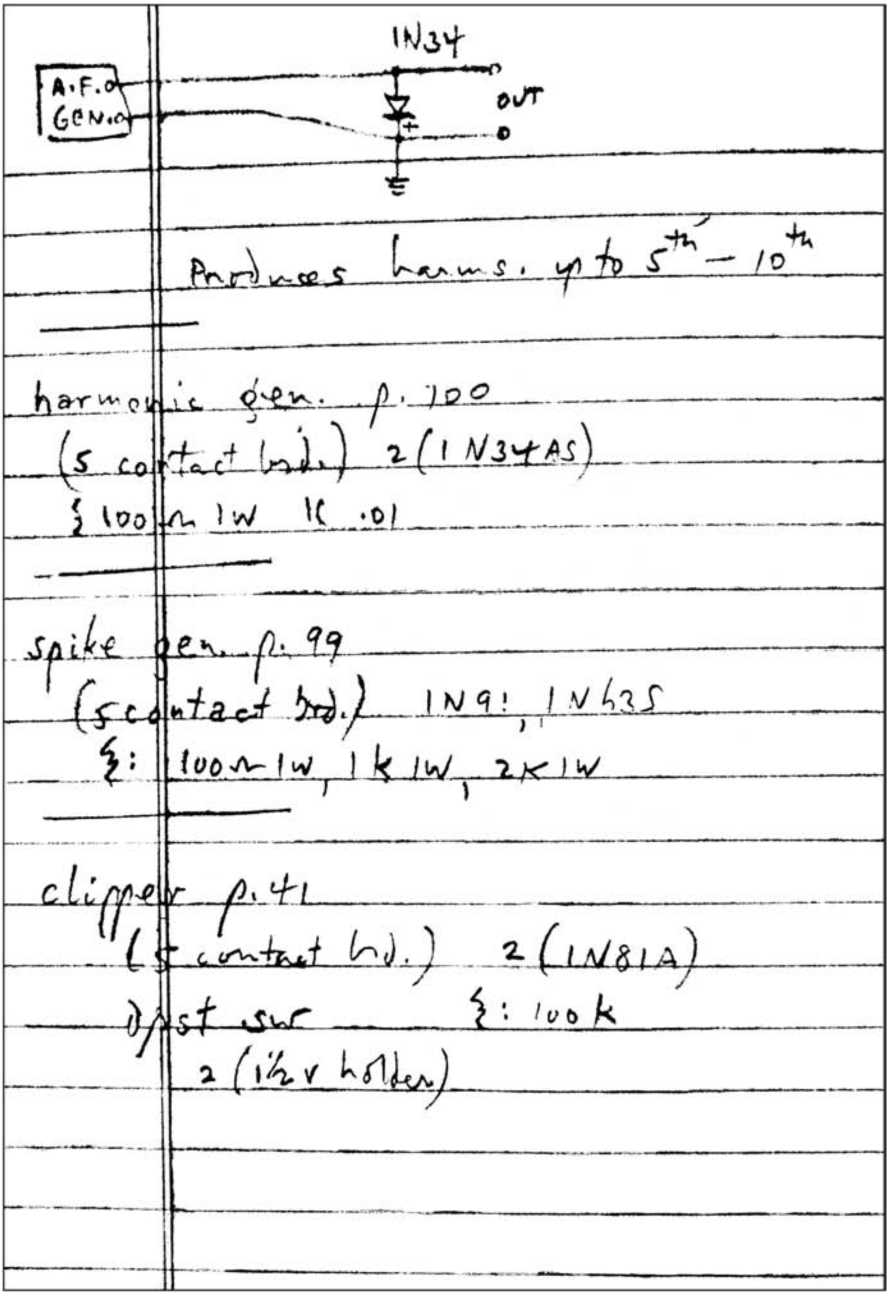
85 Rufus P. Turner, *Diode Circuits Handbook* (New York, NY: Howard W. Sams, 1963), 99–100.

86 Ibid., 41.

87 *Harmonic Generator* is built from two diodes (*1N34*), one resistor (100 Ω), and one capacitor (.01 uF); *Spike Generator* from two diodes (*1N91* and *1N63S*), and three resistors (100 Ω, 1 kΩ, and 2 kΩ); and *Clipper* from two diodes (*1N81A*), one resistor (100 kΩ), and a DPST (double-pole single-throw) switch. At the top of the page is a drawing for using a single *1N34* to generate "harmonics up to 5th–10th" from an audio-frequency input.

88 Purchase Radio Supply, "Delivery Note (April 8, 1966)," Box 121, Folder 1, David Tudor Papers, GRI.

89 Radio Equipment Corp, "Receipt (April 16, 1966)," Box 122, Folder 6, David Tudor Papers, GRI.



1N34

A.F.
GEN.

OUT

Produces harms. up to 5th – 10th

harmonic gen. p. 100
(5 contact bd.) 2 (1N34AS)
{ 100Ω 1W)(.01

spike gen. p. 99
(5 contact brd.) 1N91, 1N635
{: 100Ω 1W, 1K 1W, 2K 1W

clipper p. 41
(5 contact bd.) 2 (1N81A)
DPST sw {: 100k
2 (1½ v holder)

Figure 4.4 Tudor | Note with component names | Undated (presumably 1966)
DTP, Box 16, Folder 1 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

Figure 4.5 Tudor | *Spike Generator* and *Harmonic Generator*
DTC, Instrument 0173 | World Instrument Collection, Wesleyan University

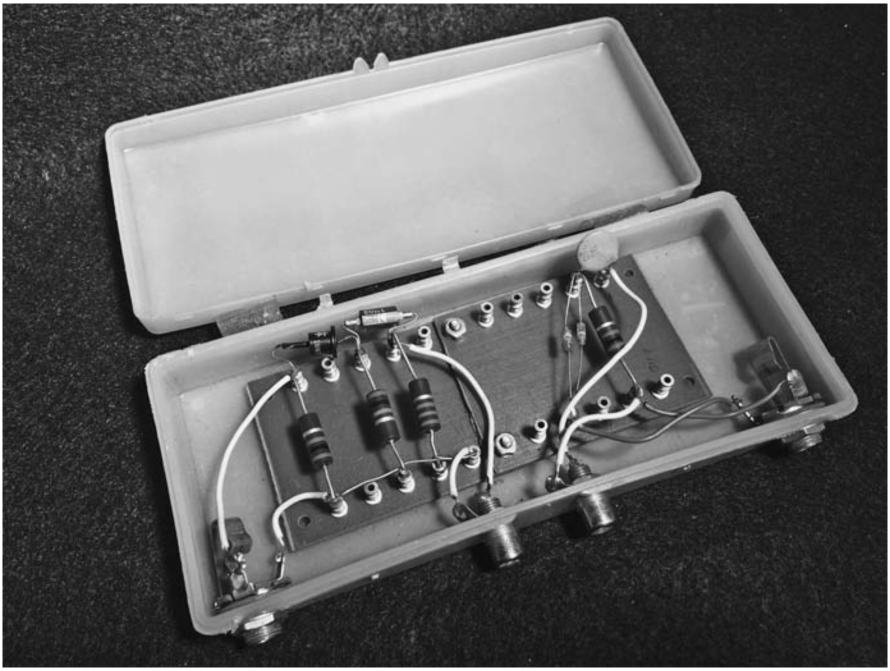


Figure 4.6 Tudor | *Spike Generator* and *Harmonic Generator* (interior)
DTC, Instrument 0173 | World Instrument Collection, Wesleyan University

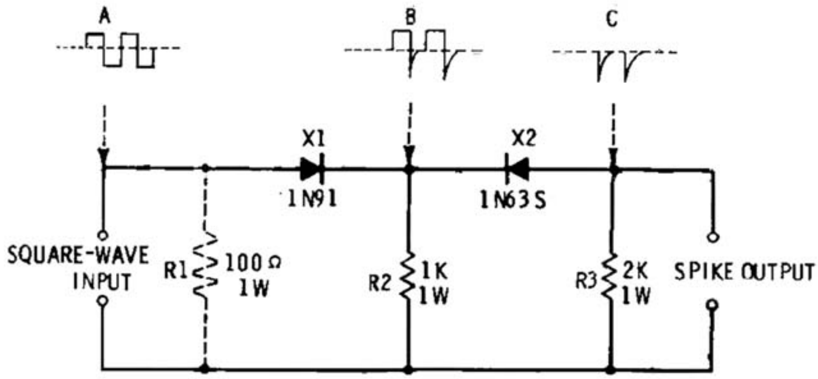


Figure 4.7 Rufus P. Turner | *Spike Generator,* schematics
Diode Circuits Handbook (1963) |

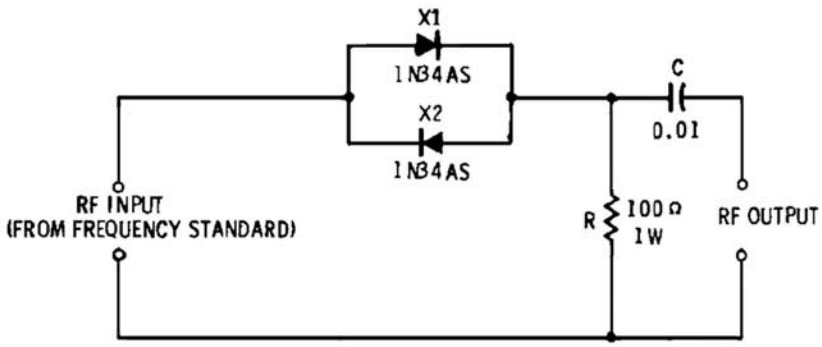


Figure 4.8 Rufus P. Turner | *Harmonics Generator,* schematics
Diode Circuits Handbook (1963) |

producing negative spikes as a result. The remaining positive half-cycle is then taken out by the second diode ("X2"), set in the reverse direction so that only those spikes are output (Figure 4.7). The input to "H," on the other hand, goes through two 1N34 germanium diodes connected back to back to pass forward current for both positive and negative half-cycles, which distorts the signal and intensifies its harmonics (Figure 4.8).

Clipper is encased similarly in a green plastic soapbox (Instrument 0027) (Figures 4.9 and 4.10). Like the *White Noise Generator*, the two diodes in parallel are both reverse-biased, working like a switch that only conducts forward current when the positive and negative half-cycles surpass the threshold set by the 1.5-volt batteries (–1.5 v to +1.5 v). Everything above and below this voltage becomes clipped, thereby squaring the input wave, which also adds distortion with rich harmonics (Figure 4.11).

Figure 4.9 Tudor | *Clipper*
DTC, Instrument 0027 | World Instrument Collection, Wesleyan University

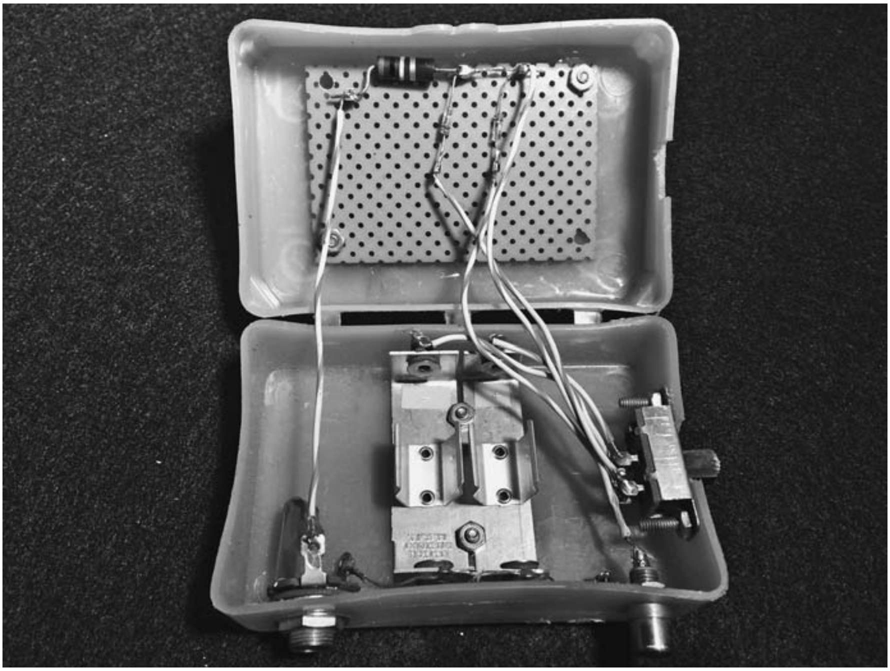


Figure 4.10 Tudor | *Clipper* (interior)
DTC, Instrument 0027 | World Instrument Collection, Wesleyan University

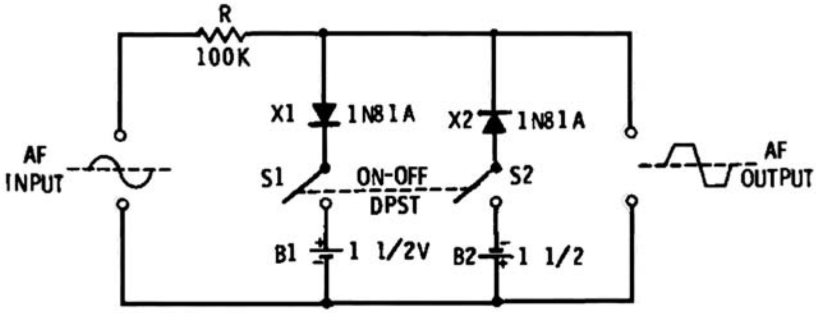


Figure 4.11 Rufus P. Turner | *Clipper,* schematics
Diode Circuits Handbook (1963) |

4

Composed in mid-April 1966, these simple diode circuits in small plastic containers appear to be the first instruments Tudor built for the project when the initial plan for *Alle Rechte vorbehalten* was still alive and well. That is certainly how they are used in the diagram (Figure 4.3), processing white noise in parallel before sending all the results to a box labeled "P.C. PUSH BUTT." Unlike the boxes processing white noise in the lower-left section, this latter instrument, as well as all the remaining boxes in the diagram, were not made by Tudor. Instead, they formed a part of the many components that Bell Labs engineers had begun building for the Stockholm Festival as early as February 22, 1966, when Klüver's colleague Bob Kieronski drafted a series of diagrams titled "Wireless System for Stockholm Festival" (Figure 4.12).[90]

This early proposal centered around multiple pairs of FM transmitters and receivers to send signals across space wirelessly. In addition to continuous analog signals like audio, the system could also send discrete digital information like the turning of switches if the various switch units were paired with what Kieronski called "tone box with 5 subchannels," a digital-to-analog encoder that produced five different tones according to the trigger signal it received. This analog tone could then be sent wirelessly across the air and decoded back to digital switching patterns on the receiving end to control relay switches that then turned things on and off. Kieronski's diagrams depicted these signal routes in different configurations, which amounted to a portable system with no center—only modular components that could be arranged in suggested sequences (or not) primarily to do two things: (a) convert one form of signal to another, and (b) control events from afar.

[90] Bob Kieronski, "Wireless System (draft)," Klüver/Martin Archive.

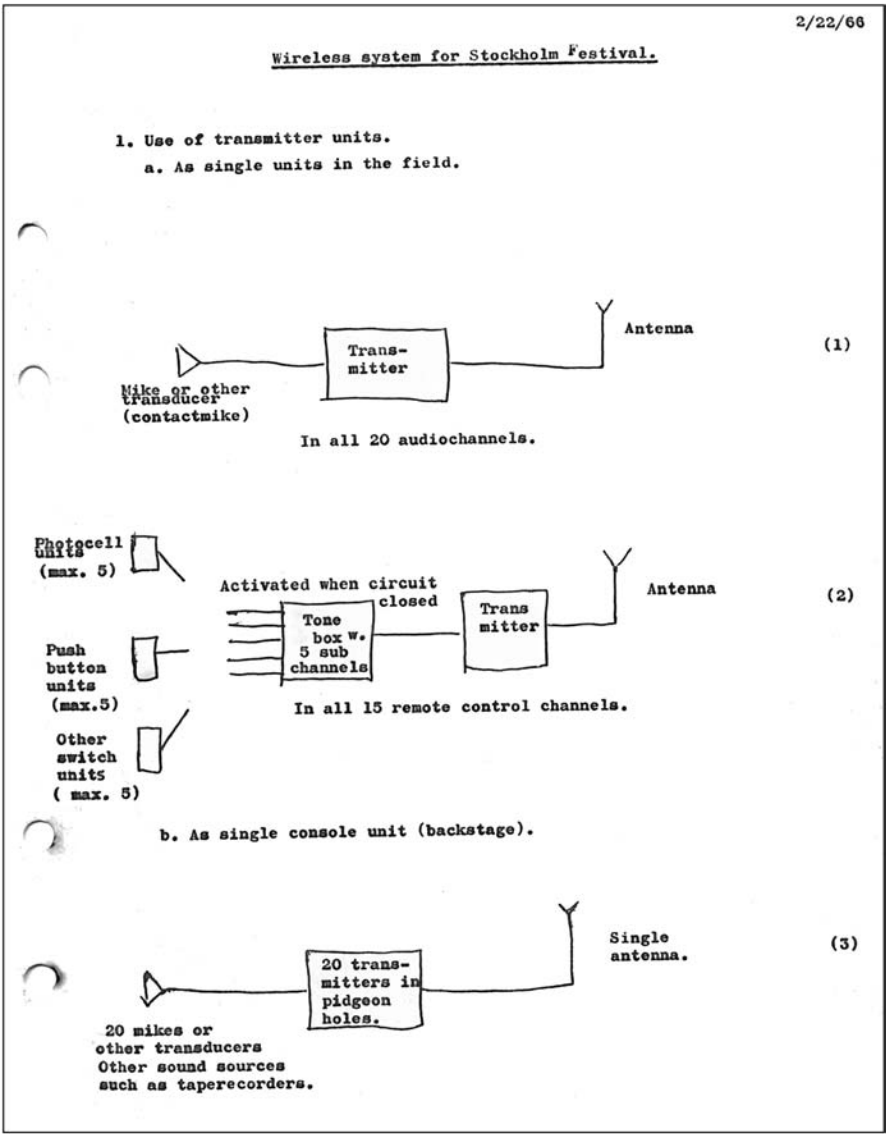


Figure 4.12 Bob Kieronski | Wireless System for *Stockholm Festival* | February 1966
Klüver/Martin Archive | Courtesy of Experiments in Art and Technology

In Tudor's undated diagram, however, the "tone box" does not make an appearance, and "P.C. PUSH BUTT.," now revealed to be a *Photocell—Push Button Unit*, is connected directly to the sequence of "Transmitter," "Decoder with Delay," and "Receiver," in that puzzling order. Tracing the connection backward, "P.C. PUSH BUTT." also receives signals from an external sound source after going through two other components: *Proportional Control* ("PROP. CONT."), an analog-to-analog controller which used continuous audio or visual input to control continuous audio or visual output, and *Latch Relay* or *Drum*, also known as *Program Drum*, a relay switch that could be activated by the incoming signal.[91] No actual instrument is specified as a source, although the two parallel inputs suggest a bi-instrumental output—naturally bringing the bandoneon to mind. Whatever it is, the source instrument would control the *Proportional Control* controlling the *Relay Switch* controlling the *P.C. / Push Button Unit* that somehow "gated or triggered" the transmission of modulated white noise. So if everything worked well, the configuration did what Tudor said he had initially planned to do: modulate a white noise source in various ways and to control its output distribution using the sound of "some instrument."

The actual redundancy of components and their bizarre sequence, which would have made the realization of this plan impossible, appear to reveal Tudor's early struggle to understand the nature of these new instruments brought in by Bell Labs engineers. Aside from being modular, the many relays, encoders, and decoders reflected the daily concerns of the research division of the world's largest telephone and communications company. The choreographer and dancer Alex Hay, one of the selected artists for *9 Evenings*, made an observation about the engineers while he prepared his own piece, which his friend, the choreographer and dancer Simone Forti, later reported in an article she wrote for *Artforum*: "For the most part, what they've been talking about, what seems to be more available are materials and processes and methods in communications."[92] When Forti subsequently interviewed Dick Wolff on November 17, 1966, while *9 Evenings* was going on, the participating engineer confirmed Hay's suspicion: "The fact that so much work went into communications was largely because of the influence of the engineers."[93]

5

But the artists also exerted their influence.[94] In fact, the wireless system itself had evolved from a wish uttered in one of the many meetings between engineers and artists selected for the Stockholm Festival (which was essentially the same group that participated in

[91] "Program Drum: Each time the drum is activated, a relay is engaged and the corresponding action triggered. This type of program drum requires that all relays be wired according to the chronological order of the performance components. Backtracking is not possible" (Fondation Daniel Langlois, "Program Drum," *9 Evenings: Theatre & Engineering*, accessed December 15, 2018. http://www.fondation-langlois.org/flash/e/index.php?NumPage=571).

[92] Alex Hay, quoted in Simone Forti, "Theatre and Engineering: An Experiment: Notes by a Participant," *Artforum* (Feb. 1967), 27.

[93] Ibid.

[94] Among Tudor's papers there is a series of lists compiling ideas proposed in meetings held between February 13 and March 6 which reveal the development of various equipment. Lucinda Childs, who in her piece *Vehicle* would use a Doppler sonar to translate movement into sound so that she could "create her own accompaniment as she danced" (Manfred Schroeder, quoted in "Art and Science: Two Worlds Merge," *Bell Telephone Magazine* 46, no. 6 [November–December, 1967], 15–16), had already requested that technology in the first meeting ("Projects for Stockholm Festival [February 13, 1966]," Box 16, Folder 2, David Tudor Papers, GRI). On the same day, Steve Paxton, who in his *Physical Things* would install wire loops under which the visitor could listen to a certain sound using a telephone pick-up connected to a radio receiver, asked about "Many (50? 100?) speakers of low power placed on walls or around the room, or outside.

9 Evenings, with the exception of Yvonne Rainer who joined after the decision to hold the festival in New York was made).[95] As Wolff continued to explain to Forti:

> *Someone asked if we could turn lights on and off by remote control with no connections. This required a radio transmitter to send signals to a receiver connected to the lights. From that we realized what we had and started describing it to the other artists and they started asking more questions and having other ideas.* [. . .] *Debbie's* [Deborah Hay] *request for remote control of eight platforms gave us the necessity for channels [because this required eight transmitters, each sending stop & go signals to a separate receiver]. So we went ahead and used the channels for other things too. Tudor and Cage used the channels extensively. Cage used them to turn speakers on and off as he walked in front of the lights. Tudor to turn on and off lights* [. . .] *The decoder that Robbie* [L. J. Robinson] *made did something that was never planned or asked for and the artists went and used it. That was the time-stepping that Cage and Tudor used [a delay mechanism by which, for instance, a light might go on a minute after receiving its "on" signal].*[96]

Ideas, once materialized, inspired other ideas. In this way, as far as communication was concerned, it was the presence of actual instruments that provided a common ground for the two parties that otherwise appeared to speak in different tongues. "The amazing thing is that it's possible for artists and scientists to talk together at all," Klüver reminisced to Forti. "It's like a triangle between the scientists and the artists and the hardware. The main thing is to establish a working relationship and the hardware is the basis for this."[97] What conditioned this sequence of ideas that led to materials that led to other ideas was no doubt Klüver's own decision to bring artists and engineers together and let them just "play" "all spring and summer" without imposing exterior control, as a slightly disgruntled colleague later described.[98] In any case, as with the wireless system, the development of equipment proceeded in a modular fashion, with artists and engineers working on different projects in pairs, without a central control

Each speaker giving a different sound" (ibid.). Rauschenberg likewise inquired in the same gathering about infrared TV which he eventually used in *Open Score* (ibid.). During the March 1 meeting, Deborah Hay, who in *Solo* would place her dancers on remote-controlled carts, proposed the idea for "cars controlled at a distance" ("Projects for Stockholm Festival, 3rd List [May 1, 1966]," Box 16, Folder 2, David Tudor Papers, GRI). Robert Whitman, who in *Two Holes of Water—3* would focus on the difference between film and television, projecting both types of images from projectors installed in seven cars, already expressed his interest in investigating home TV projection systems and color TV tape-projection system on March 8 ("2nd Progress Report for Stockholm Festival [March 8, 1966]," Box 16, Folder 2, David Tudor Papers, GRI). Simone Forti relayed Jim McGee's March 9 report that "Harold H. is building [Oyvind] Fahlström's antimissilemissle (a balloon which follows a performer around). He was working hard to make a rectangular balloon. I suggested he make it round. Harold called Fahlström who said that was even better" (Simone Forti, "Notes by a Participant," 27).

[95] The list of "people in connection with Stockholm Festival" dated March 1, 1966, includes only nine artists. Claes Oldenberg was added to a later list. Rainer's name does not appear in a presumably early "Address List" of artists for "Nine Evenings: Theater & Engineering" (Box 16, Folder 2, David Tudor Papers, GRI).

[96] Dick Wolff, commentary from November 17, 1966, quoted in Forti, "Notes by a Participant," 28.

[97] Klüver, quoted in Forti, "Notes by a Participant," 26.

[98] Herb Schneider, "Interview by Julie Martin," Klüver/Martin Archive.

system to coordinate them all. Tudor's assigned partner was Fred Waldhauer, an expert on feedback theory and a later developer of hearing aids, who was a year younger than him, like Klüver, and with whom he would become good friends for the rest of his life. Thus, as Forti summarized in her article, "by June the project had divided into two general sections. One was the individual pieces of equipment that the artists had asked for […] The other section was the wireless system."[99]

6

But by then Tudor had changed his mind. In the original program of *9 Evenings*, a handwritten note, written below a typed description, describes a revised second plan:

> instrumental loud-speakers (sounding physical materials), actuated by material of Mauricio Kagel—"Alle Rechte vorbehalten"—in a self-multiplying audio-visual application (towards "rebirth of white noise"). live signals → becoming electronic → programmed transmission to physical materials.[100]

The reference to Kagel's material remains but there is a notable shift of focus. While not much is said about the input, the output is now specified: "instrumental loudspeakers," physical materials turned into speakers with specific resonant characteristics by attaching transducers to them. Parametric objects could now speak. These would be the central focus of Tudor's next piece, *Rainforest*, premiered a year and a half after *9 Evenings*.[101] When he spoke with Fullemann twenty years later, on September 3, 1984, Tudor traced back the same idea to an unrealized sound installation project from late 1965—which would have in fact made it the very first idea that he consciously framed as his own work:

> *I recall I was asked to make a project for a Washington park, who wanted to have a more or less permanent sound installation. It was an opportunity to make a project, and I didn't know if anything would happen and eventually nothing did happen. But what happened was that my mind started working and I thought that what I would like to do would be to make an orchestra of loudspeakers all having different "voices" which would all receive a common input.*[102]

Contrary to the later approach in *Rainforest,* where each input tended to be chosen in relation to the specific nature of an instrumental loudspeaker, Tudor initially thought of the

[99] Forti, "Notes by a Participant," 27.
[100] Pontus Hultén and Frank Königsberg eds., *9 Evenings: Theatre and Engineering* (New York, NY: Experiments in Art and Technology, The Foundation for Contemporary Performance Arts, 1966), 11.
[101] The premiere of *Rainforest* took place on March 9, 1968, at the State University of New York in Buffalo.
[102] Also, "My piece 'Rainforest IV' was developed from ideas I had as early as 1965 […] that the loudspeaker should have a voice which was unique and not just an instrument of reproduction, but an instrument unto itself" (Tudor, "Interview with Fullemann").

entire orchestra as receiving a single input—a polyphony in disguise, so to speak. Since his plan for *9 Evenings* also revolved around the modulation of a single sound source, it was a good occasion to try out the unrealized idea from less than a year before.[103]

But the very nature of that sound source had changed in the meantime. Although the bandoneon is not yet mentioned, the flow of signals in the second plan no longer starts from "white noise" but from "live signals." Whatever the instrument may be, it had switched from being a control device to a sound source. Accordingly, "white noise" was no longer the singular source material to be modified, but something to be "(re)generated" through the entirety of the self-multiplying processing of voices that are actually one but appear as many. As if proceeding on a Möbius-strip himself, Tudor had turned his approach inside-out.

7

In the final version, Tudor used the sounds of the bandoneon both as signals to be processed and control signals to process them. A tone he played could (a) modify the same tone in various ways to produce dense layers of overtone frequencies that approximated white noise—a noise composed of every frequency in the human audible range sounding with equal intensity—and (b) remote-control the switching and intensity of lights and sounds through a variety of modular instruments.

Some influences are apparent. Between April—when he began making the diode soapbox instruments—and October—when *9 Evenings* was held—Tudor had performed *Musica Instrumentalis* in May and *Mesa* in August. The complex sound spectrum of Mumma's work appears to have inspired the sound world that could be arrived at, and the cybersonic processing the method for arriving there. The use of the bandoneon to perform both sound and video was a second source of inspiration cited in the *Pre & Post-operative Note* of 1973: "The situation obtaining when a performer scans two media simultaneously to which I had been introduced through Lowell Cross's 'Musica Instrumentalis,' contributed the performance method: a single performer feedback, which also obviated the need for any compositional means."[104]

According to what Tudor wrote in the original program notes in 1966, however, there was a third source that biased the process of composition. The initial idea of realizing Kagel's piece "abandoned itself thru the process of my projecting my thoughts into the about-to-become available technology, & its potential for the creation of 'white noise' from scratch."[105] Yet again, what changed Tudor's mind was the nature of actual instruments he engaged with, which is to say the large collection of modular components that

[103] Rogalsky has suggested that Tudor's conception of instrumental loudspeakers could have been inspired by an article from the December 1965 issue of *Popular Mechanics* about "The Fantastic Coneless Loudspeaker," thus providing a possible time frame for the shift of his interest toward the output end in the development of the project (Rogalsky, "Idea and Community," 73; the article is found in Box 46, Folder 9, David Tudor Papers, GRI).

[104] David Tudor, "Bandoneon!, Pre & Post-operative Note," Box 16, Folder 6, David Tudor Papers, GRI.

[105] Hultén and Königsberg, eds., *9 Evenings: Theatre and Engineering*, 11. Also Tudor recalled much later, on September 8, 1993: "I started to accumulate equipment and I saw the possibilities in using the

Bell Labs engineers had built under the influence of their day jobs, in response to artists' collective wishes and needs. As he explained to Bruce Duffie on April 7, 1986:

> *We had to work on the audio systems and the programming of the audio systems. And I had a large part in the basic design parameters, so we decided how to go for clean audio, whether to make it portable. . . . I was working at the electronic end of it, and I noticed that the whole system had been created because each artist wanted certain things to happen but they require different components. Well, I noticed that nobody was really using a lot of the features of the system, so I said, I'll put everything into this* [laughs].[106]

Sometime between July and August, the wireless communication system was expanded—"with strong input from Tudor," Klüver recalled much later, in 1996[107]—and renamed "Theatre Electronic Environmental Modular System," which often went by its acronym TEEM.[108] Although initially promised to be ready by early August,[109] the actual equipment was finally revealed to the artists only over the weekend of September 10 and 11 at the Berkeley School near Bell Labs in Berkeley Heights, New Jersey. On those two days, a press release reported shortly afterward, "artists and engineers alternately conferred and tested the first electronic environmental system ever developed for theater use."[110]

As the name bespeaks, TEEM was also based on the principle of modularity, which among other benefits, allowed Tudor to connect his own modular instruments to the much larger system (Figure 4.13). Its 289 or so components included 10 encoders-decoders each with 5 channels, 50 photocells, 40 power relays, 10 FM transmitters-receivers, 16 silicon control rectifiers, 20 tone control units, 40 power amplifiers, 1 patch panel, 25 preamplifiers, 12 speakers with tweeters, 3 drum switches, and the *Proportional Control* which Tudor had specifically asked Waldhauer to build. Since he had decided to "put everything into this," the nature of his piece would be influenced by that of TEEM, which was in turn influenced by the initial wireless system and its focus on the conversion of signals to control events from afar. Consequently, the description of TEEM in the press release for *9 Evenings* also served as a good description of Tudor's

bandoneon and I completely forgot my connection with Kagel's piece" (David Tudor, "Interviewed by Joel Chadabe (Tomkins Cove, September 8, 1993)," davidtudor.org, accessed December 15, 2019: http://davidtudor.org/Articles/chadabe.html).

106 Tudor, "Presenting Tudor: A Conversation with Bruce Duffie," bruceduffie.com.

107 Billy Klüver and Julie Martin, "Sound into Image: The Collaboration between David Tudor and Sophia Ogielska," in David Tudor and Sophia Ogielska, *Toneburst: Maps and Fragments*, 1996, 8.

108 An article in the August 22 issue of *Electronic News* already describes TEEM in detail: "Nat Snyderman, 'The New IMP Theatre,' *Electronic News*, August 22," Box 16, Folder 2, David Tudor Papers, GRI.

109 During the meeting held on June 15, Paxton asked, "When can we have the wireless to play with?" Klüver replied, "August first. The first week in July will be a time when we'll show as many things as possible. There are a lot of decisions, like amplifiers and the choice of speakers. I have bought about eight or nine different speakers which have all kinds of criteria" (quoted in Forti, "Notes by a Participant," 28).

110 "Technology for Art's Sake, Experiments in Art & Technology press release (September 14, 1966)," Box 16, Folder 2, David Tudor Papers, GRI.

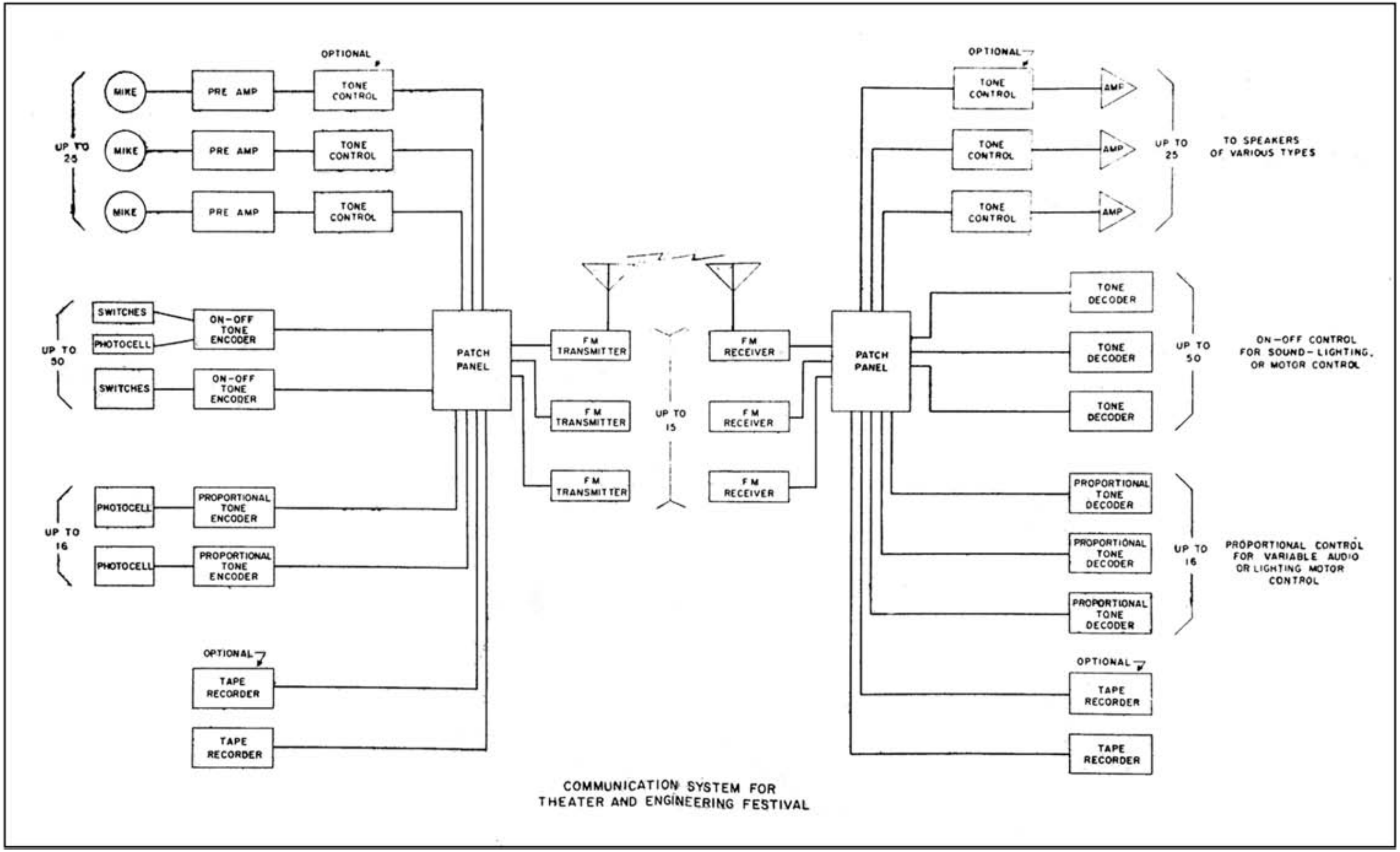


Figure 4.13 TEEM system diagram | 1966

Klüver/Martin Archive | Courtesy of Experiments in Art and Technology composition: "simultaneous remote control of multiple sounds, lights, and movements of objects."

The miscellany of components, however, appears to have reminded Tudor of yet another source of influence. For the subtitle of his contribution he borrowed a term Rauschenberg had been using to call his works that juxtaposed disparate elements to create something that was neither painting nor sculpture but both: "a combine." Now that the circumstances were pushing him to consciously frame what he was doing as a "composition," perhaps Tudor realized after all that it was his painter friend who had commissioned him the very first work he could call his own two years earlier.

Bandoneon!

1

In mathematics, a factorial is the number obtained when one integer is multiplied with all the integers below it down to 1. It is a self-multiplication with an end. The obtained number reveals how many possible ways there are to arrange a given number of things into a sequence.[111] In other words, a factorial calculates permutation, the maximum number of linear order that can be realized from a finite universe of possibilities. The use of the exclamation mark as its symbol was invented by Christian Kramp in 1808 to replace a former symbol that was difficult to print.

Tudor realized *Bandoneon!* or *Bandoneon Factorial (a combine)* on two of the *9 Evenings*: October 14 and 18, 1966. The final description read as follows:

> *Bandoneon ! (Bandoneon Factorial)* is a combine incorporating programmed audio circuits, moving loudspeakers, t.v. images and lighting, instrumentally excited.
>
> The instrument, a bandoneon, will create simultaneously: signals used as material for differentiated audio spectrums (achieved thru modulation means and special loudspeaker construction); signals for the production of visual images; signals for the activation of programming devices controlling the audio-visual environment.[112]

In addition to many sketches, there are two diagrams of the entire system among Tudor's papers. One was drawn by Herb Schneider, a Bell Labs engineer who was called to join the project in September, less than a month before the festival, when finally, he would later explain, "the Swedes had become realistic." (Figure 4.14)[113] Although Schneider would claim in the same interview that nothing was ready when he came in, a photograph from

[111] For example, the factorial of three is six [3 × 2 × 1 = 6] which means there should be six ways of reordering three elements: ABC, ACB, BAC, BCA, CAB, CBA.
[112] Tudor, "*Bandoneon Factorial*, description," Box 3, Folder 2, David Tudor Papers, GRI.
[113] Schneider, "Interview with Martin."

the Berkeley School gathering shows him already holding the diagram of *Bandoneon!* and discussing the work with Tudor and Waldhauer (Figure 4.15).

The other diagram is in Tudor's own hand, probably written later, carrying the adjective "Generalized." (Figure 4.16) The two diagrams largely overlap. However, despite its apparent simplicity, Tudor's is the only one to differentiate between the two roles that sound now played: "signal" and "control."

According to what was written down on paper, the sound of the bandoneon was picked up by eight contact microphones and two air microphones, divided evenly on the two sides of the instrument and distributed to four parallel channels. Three of these channels used instruments made by people other than Tudor:

(A) Proportional Control (Waldhauer)
(B) Audio Processing & Modifying (Tudor)
(C) Vochrome + Program Switching (Kieronski)
(D) TV Image Control (Cross)

Out of the four channels, two (A and C) used the bandoneon sound as control signals to modify the intensity and distribution of sound and light. The other two (B and D) used the same sound as signals to be modified, either through audio processing or by converting them into dancing Lissajous figures projected onto three large screens.

The signals processed by Tudor's instruments were also sent via FM transmitters and receivers to four "instrumental loudspeakers" and one horn speaker Tudor had named "George," to realize the idea of polyphony from a single source. However, now the orchestra—or rather the quintet—was mobile, placed on remote-controlled carts built at the request of Deborah Hay to carry her dancers around. Tudor had bargained their use with the choreographer in exchange for playing the recording of Toshi Ichiyanagi's *Funakakushi* during her performance. These mobile loudspeakers were moved around by Larry Heilos, Per Biorn, Behrman, and Gnazzo during the first evening; for some reason, they remained stationary on the Armory floor for the second performance.[114]

2

The two control channels, owing respectively to Waldhauer (A), who was paired with Tudor, and Kieronski (C), who had drafted the wireless system, were complementary: both used a "frequency selective" instrument which converted the pitch of the bandoneon sound into control signals. The difference was that one created continuous analog signals, whereas the other produced discrete digital triggers.

[114] According to Julie Martin, Deborah Hay did not want Tudor to use the carts the second time, as she wanted them identified only with her work (Martin, "Comment to You Nakai's manuscript," December 20, 2018).

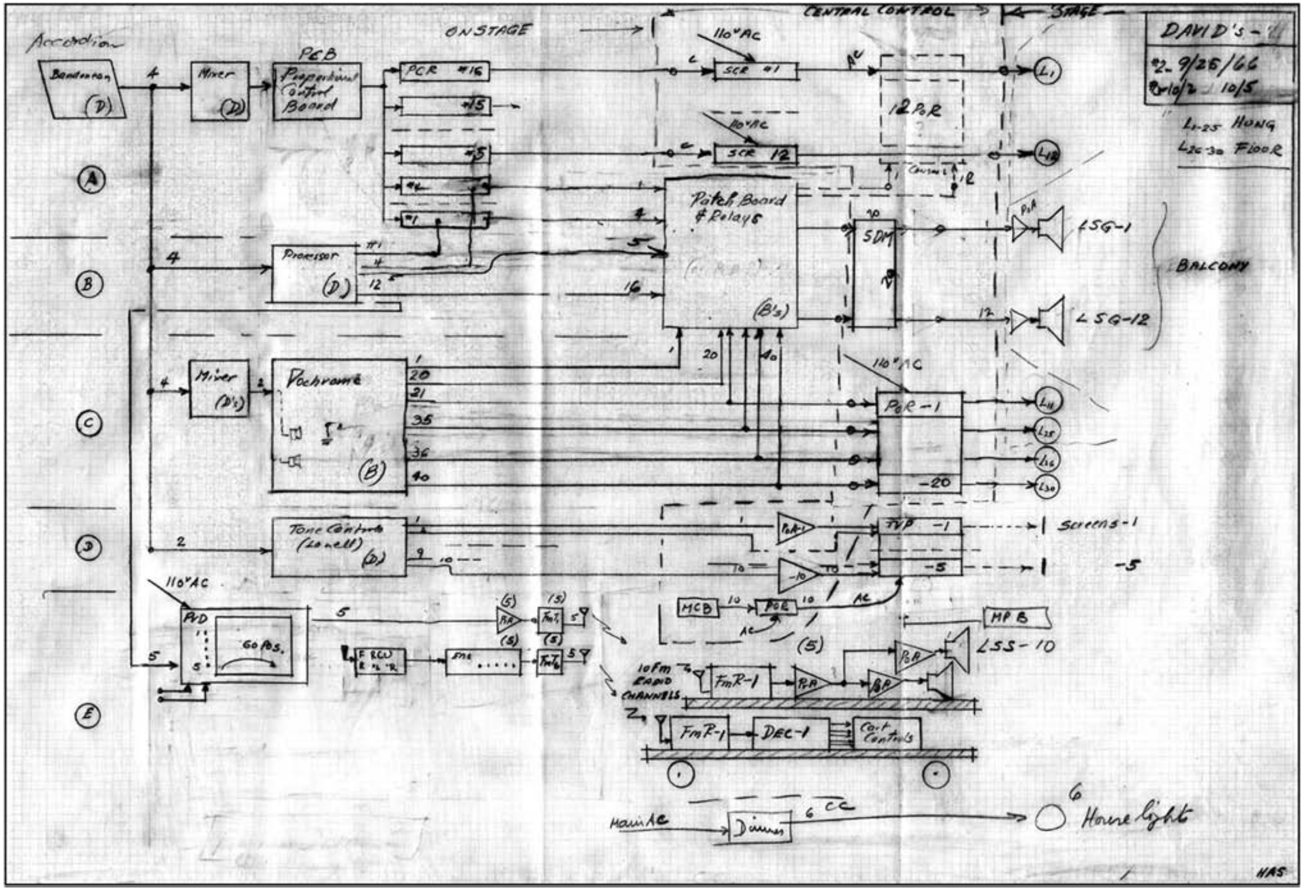


Figure 4.14 Herbert Schneider | *Bandoneon Factorial*, diagram | 1966

Klüver/Martin Archive | Courtesy of Experiments in Art and Technology

Figure 4.15 Tudor, Fred Waldhauer, Herb Schneider, and Bob Kieronski discussing Tudor's setup | Berkeley School | September 10 or 11
Photo: Franny Breer | Klüver/Martin Archive | Courtesy of Experiments in Art and Technology

Proportional Control (Channel A) (Figure 4.17)

Composed by Waldhauer upon Tudor's request, this instrument was a 10" × 14" × 3" box with a white, translucent plastic cover whose surface was divided into sixteen squares in a 4" × 4" grid. Beneath each square was a photocell coupled with an oscillator. By using a light pen, the performer could vary the resistance of each photocell, which varied the amplitude of the oscillator. This meant that up to sixteen variables

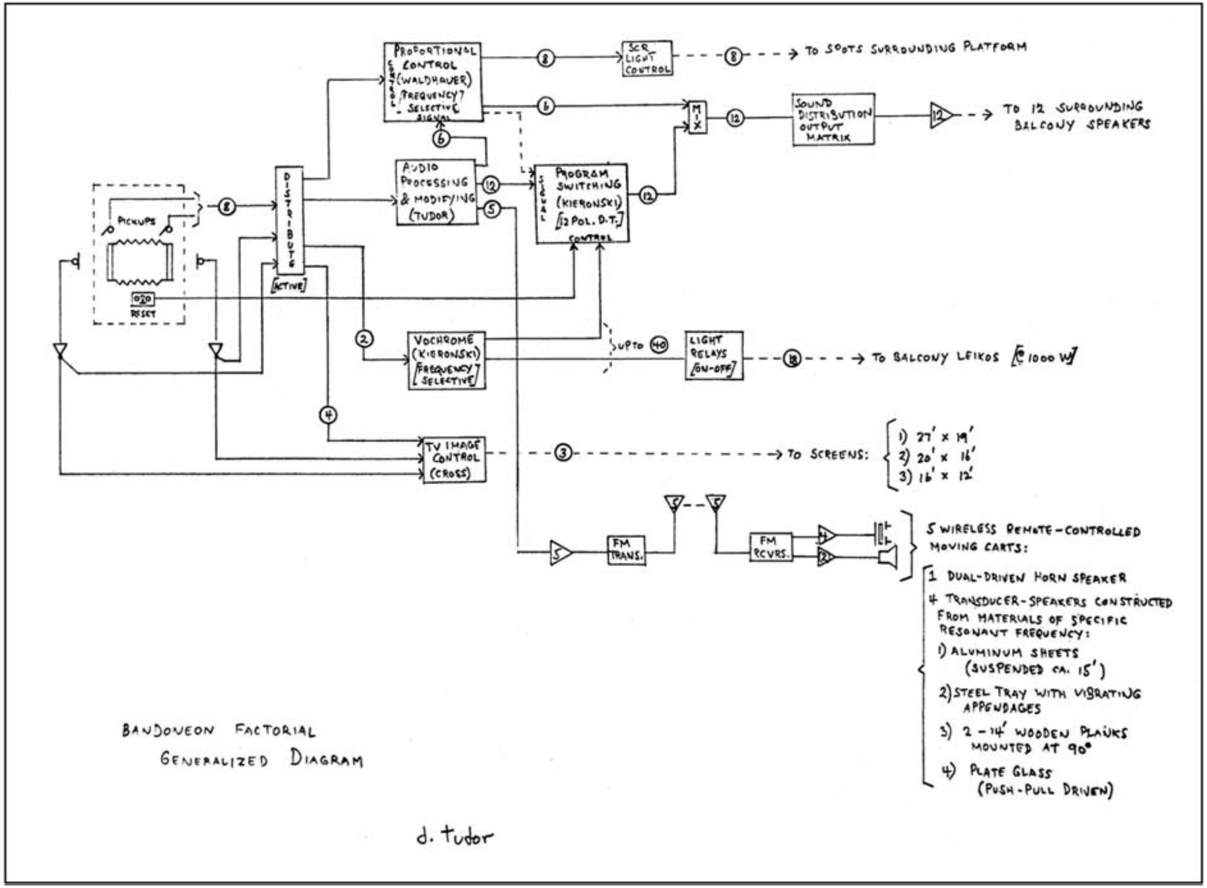


Figure 4.16 Tudor | *Bandoneon Factorial*, Generalized Diagram
Courtesy of David Tudor Trust

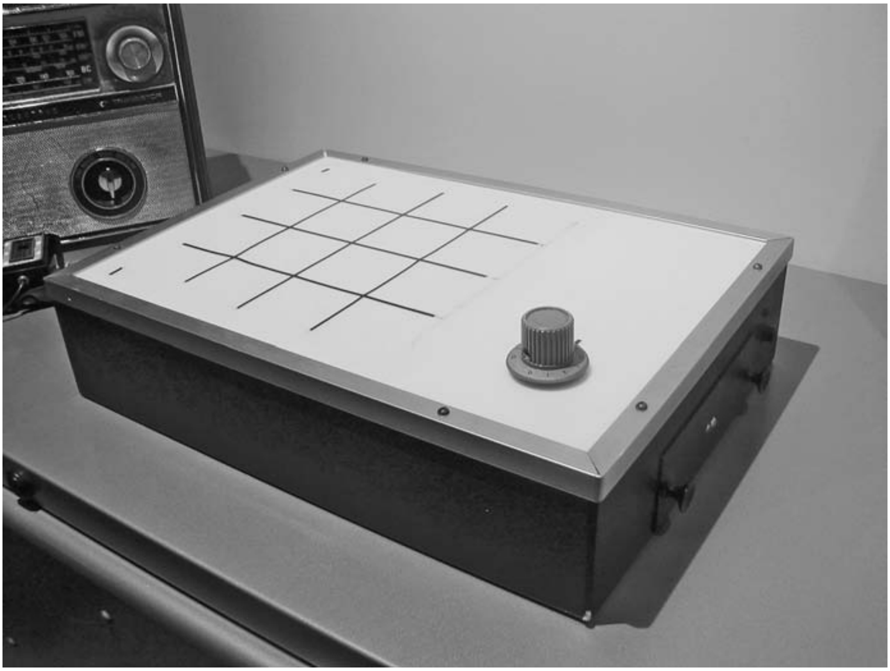


Figure 4.17 Fred Waldhauer | Plotting Board of the *Proportional Control System*
Photo: Éric Legendre | The Daniel Langlois Foundation for Art, Science, and Technology, 9 Evenings: Theatre and Engineering fonds. | Courtesy of Experiments in Art and Technology and the Daniel Langlois Foundation

could be controlled in analogous "proportion" to the amount of light on each square. Since the oscillators were each tuned to a different note in the musical scale, the system could also be controlled with a pitched instrument. In *Bandoneon!*, Tudor used the instrument in the title as input to control two events: (a) the intensity of sound from twelve balcony loudspeakers surrounding the entire space, and (b) the intensity of eight spotlights surrounding the platform where he sat with his instruments.

Vochrome (Channel C-1) (Figure 4.18)

"A complex microphone," in Tudor's own words,[115] this instrument was composed by Kieronski from a set of harmonium reeds covering a range of four octaves (48 reeds), each tuned to a different note and with a sensor to detect its vibration. Thus, when the incoming signal was played from "an array of loudspeakers" inside the acoustic chamber of the instrument, its frequency was sensed through the sympathetic vibration of the corresponding reed, which then activated a corresponding relay switch. In other words, it converted a continuous signal into discrete triggers. Kieronski did not make any effort to suppress resonances or intermodulation products, so a complex signal could activate several reeds at once. This instrument enabled the bandoneon sound to control (a) the switching of eighteen balcony spotlights via light relays, and (b) the switching of audio signals using another device made by Kieronski.

[115] Tudor, "Presenting Tudor: A Conversation with Bruce Duffie."

Figure 4.18 Robert Kieronski | *Vochrome*
Photo: Robert Kieronski (2005) | Courtesy of Experiments in Art and Technology and the Daniel Langlois Foundation

Program Switching Matrix (Channel C-2)

The second Kieronski instrument was a relay switching circuit allowing flexible connections between multiple inputs and multiple outputs. It received twelve channels of audio signals processed by Tudor and determined the spatial arrangement of the output using control signals from the *Vochrome*. This was Tudor's first encounter with a matrix switcher, an instrument that would become central to his sound systems from the late 1970s. But in 1966, the specific nature of the *Program Switching Matrix* created an important side effect, as Tudor told Joel Chadabe on September 8, 1993:

> *[Kieronski] recalled that he had in his basement some old relays and that he could connect them to the* Vochrome*. One day, when we were trying it out, he said that the only problem with the relays was that they're in sequence and you have to start a sequence from the beginning, so would you like it if I put a switch on your bandoneon so that you can reset the relays to zero. That was one of the most important things, because by touching that button I could stop the sound. The silence was deafening, because the sound in the Armory was extraordinary, so reverberant. Once you started something oscillating, it would go on forever.*[116]

[116] Tudor, "Interview by Joel Chadabe."

Contrary to organ keys—or any key on any acoustic instrument for that matter—Kieronski's "reset" button did not start, but stopped the self-multiplication of the bandoneon sound. This was especially effective at the Armory, which had an infamously long reverberation time that Tudor nevertheless wished to make part of his performance. As Klüver reminisced: "I found David one day on the balcony with a signal generator and a microphone. He turned on the signal generator and twisted the microphone 180 degrees back and forth, picking up the signal when it bounced off one wall of the Armory, and coming back again."[117] He found out that the signal took six seconds to decay. The sudden resetting of oscillation thus resulted in making audible the resonant characteristics of the venue itself as the dense noise left a trail of reverberation throughout the 31,000-square-foot space.

3

Since Waldhauer and Kieronski's instruments produced only control signals, and Cross's visualized the raw signals of the bandoneon, the generation of white noise from scratch must have been entirely carried out by Tudor's own sound system. The problem is that in both diagrams the many instruments he used have been all framed in a single box labeled "Audio Processing & Modifying" or "Processor," occulting any detail of what happened inside it. The actual mechanism for creating white noise is blackboxed, as Clarisse Bardiot lamented in 2006:

> *in the diagram for Tudor's* Bandoneon ! (a combine), [. . .] *we know almost nothing about the mixers, not to mention the objects developed by Tudor, which are initialed "D," the first letter of his first name. In other words, it is impossible to precisely describe the operating principle of most of the electronic artifacts used in* 9 Evenings, *and it is therefore impossible to identify the exact technical system specific to each performance.*[118]

However, Tudor had actually drawn another diagram for "Audio Processing & Routing," which has been found among his papers along with many related sketches.[119] This second diagram reveals all the internal circuitry that had been squashed into a single little box in the first (Figure 4.19).

Like turning the dials of a microscope, the scale of observation can now shift from one level to another. The shift, however, is not a smooth transition but an abrupt switching. At the Armory in October 1966, Tudor's modular instruments were certainly not boxed apart from the *Proportional Control* or the *Vochrome* but were spread side by side with them on the performance platform, along with the performer

117 Billy Klüver, comment in *David Tudor: Bandoneon! (a combine)*, DVD (ArtPix, 2010).
118 Clarisse Bardiot, "The Diagrams of 9 Evenings," in *9 Evenings Reconsidered: Art, Theatre, and Engineering* (Boston, MA: MIT List Visual Arts Center, 2006), 47.
119 Tudor, "Audio Processing & Routing diagram," Klüver/Martin Archive.

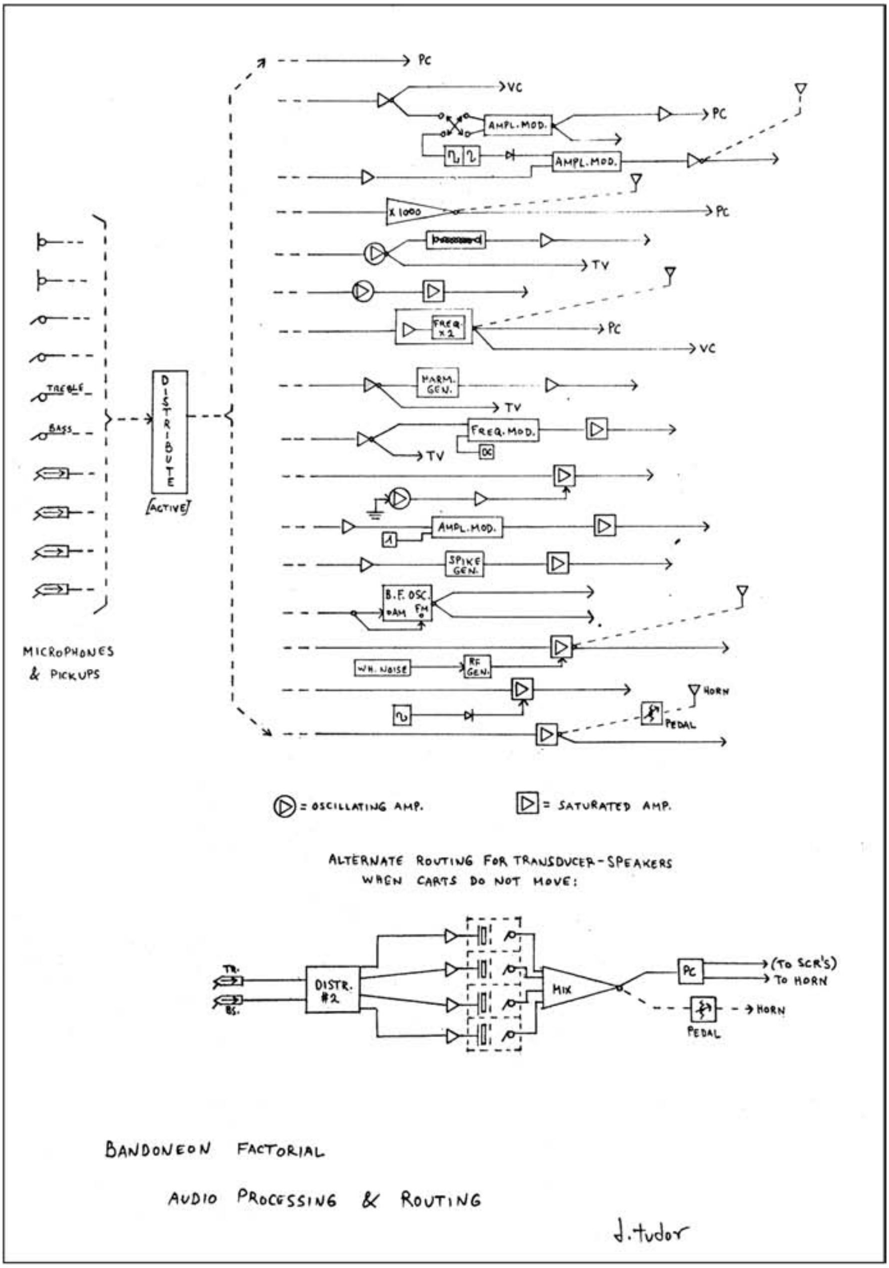


Figure 4.19 Tudor | *Bandoneon Factorial*, "Audio Processing & Routing" diagram
Courtesy of David Tudor Trust

and his bandoneon. The distinction between "Generalized" and "Audio Processing & Routing" diagrams, in other words, is a *conceptual* distinction guided by language that introduces metaphysical leaps into the physical coordination of materials. It first exists only in the mind of the observer for the sake of organizing information; it then becomes materialized on paper to allow the reader of diagrams to think one thing at a time, putting one thing in a box to focus on another. And by analogy, this realization serves as a reminder that each box depicted in the second diagram also occults its own interior circuitry. It is a nesting of scales.

The sounds picked up from the bandoneon were distributed to sixteen parallel channels that modified them in various ways, creating multiple versions of the same signal before sending them off to different parts of the total configuration. Destinations are indicated using three acronyms and one symbol, all easy to decipher: two for the *Vochrome* ("VC"), three for image projection ("TV"), four for the *Proportional Control* ("PC"), and five to FM transmitters represented by a downward triangle at the end of an angled dotted line, looking like a flying kite; the twelve remaining signals all go to the *Program Switching Matrix*.

The constancy of instruments with the realization of *Fontana Mix* six months later is easy to observe: *Midland Audio Generator Model 23-165*, whose dual sine-square wave outputs modulate the bandoneon sound in channels 2 and 3; the ×*1000 Amplifier* in channel 4; *Beat Frequency Oscillator* ("B.F. OSC") with the same sound going into its AM and FM inputs in channel 13; and *White Noise Generator* ("WH. NOISE"), which is now coupled with a *Radio-Frequency Generator* ("RF GEN") in channel 14. The diode soapbox instruments that Tudor had composed when the *White Noise Generator* was still the single source are all here: *Harmonic Generator* in channel 8, *Spike Generator* in channel 12, and two *Clippers* indicated by the diode symbol—a small rightward triangle with a vertical line in front—following a sine-wave oscillator in both channels 3 and 15, where it would have squared the initially curving waveform.

4

About half of the channels have thus been identified. Actually, the constancy of instruments goes on, but the very nature of this diagram prevents reading further. Like the first diagram encompassing the entirety of *Bandoneon!*, this local map has also been "generalized"—abstracted from particulars so that the reader may focus instead on the functions and their relationships, leaving open the possibility for reviving the piece in the future with different instruments. The specifics of what Tudor performed on the two evenings in mid-October 1966 have been occulted by another performance of a more mental nature that took place later on paper.

To "generalize" a sound system, Tudor took an actual instrument, observed its role, and wrote down what it did using symbols or abbreviations. As a result, different instruments with a similar function could end up being notated in the same way, like all the amplifiers that populate the channels of the diagram in the form of the same rightward triangle. In general, generalization sacrifices resolution for adaptability. To "de-generalize" the diagram and arrive at specifics, the process must be tracked in reverse. And the only way to do so is by going through the sketches, of which there are five versions. The order in which they were drawn can be more or less detected from how they are drawn.

The earliest Sketch 1 (Figure 4.20) is on a single page where nine processing channels are listed, each starting from one of the microphones listening to the bandoneon. Many names of instruments are partially written out, and even when they are not, abbreviations can be identified from other diagrams. Five more boxes that will reappear later in *Fontana Mix* make an appearance here: *Cybersonic Spectrum Transfer* ("SPEC. TRANS"), *Tube Box* ("T.B."), *Dual Olson Microphone Preamplifier TR-86* ("mike P.A."), *Fog Horn* ("FOG"), and *Lenkurt Modulator* ("LENKURT").

The first two channels with two modulators sharing the dual *Midland Audio Generator* outputting sine and square waves would become Channels 2 and 3 in the generalized diagram. Their modification throughout the five sketches serves as a good example of Tudor's process of "generalization." Several instruments are added in what appears to be Sketch 2 (Figure 4.21). The *Switchcraft Stereo-Monaural Signal Selector with Reverse* is inserted between the square-wave oscillator and the two microphone inputs now coupled with the *Cybersonic Output Splitter* ("SPL"), so that the roles of the carrier and program signal could be reversed before entering the *Cybersonic Spectrum Transfer*. For the other channel, a *Clipper* is added after the sine-wave oscillator to square the signal before going into "tr. mod.," or "transformer modulator." And two preamplifiers appear after each modulator.

The components largely stay the same in all subsequent sketches, but the way they are identified changes. The difference between "t. preamp" (transistor preamp) and "preamp" is flattened as "PR" in Sketch 3 (Figure 4.22), and further converted into rightward triangle symbols in Sketch 4 (Figure 4.23). *Spectrum Transfer* is abbreviated as "S.T. MOD" in Sketch 4 and generalized as "MOD" in Sketch 5. Similarly, "transformer modulator" is revealed to be *Lenkurt Modulator* in Sketches 3 and 4, only to be generalized as "MOD" in Sketch 5 (Figure 4.24). Both end up being "Amplitude Modulator" in the final diagram.

The *Signal Selector with Reverse*, only designated as "reverse" in Sketch 2, receives a longer name, "SPK. REV.," in Sketch 3, which presumably stands for "Speaker Reverser." Then it becomes a square with a cross that looks more like a modulator than a router in Sketch 4, that is then duly corrected in Sketch 5. In Sketches 3 and 4, a preamplifier labeled "G.PR" appears in between the *Output Splitter* and the *Signal Selector with Reverse*, with one of the split signals now going into the *Proportional Control*. In Sketch 5, the *Output Splitter* disappears, thus creating the solitary Channel 1 connected to "PC" in the generalized diagram.

5

Other components have been identified in the same way, revealing the actual instruments Tudor used at the Armory on October 14 and 18, 1966:

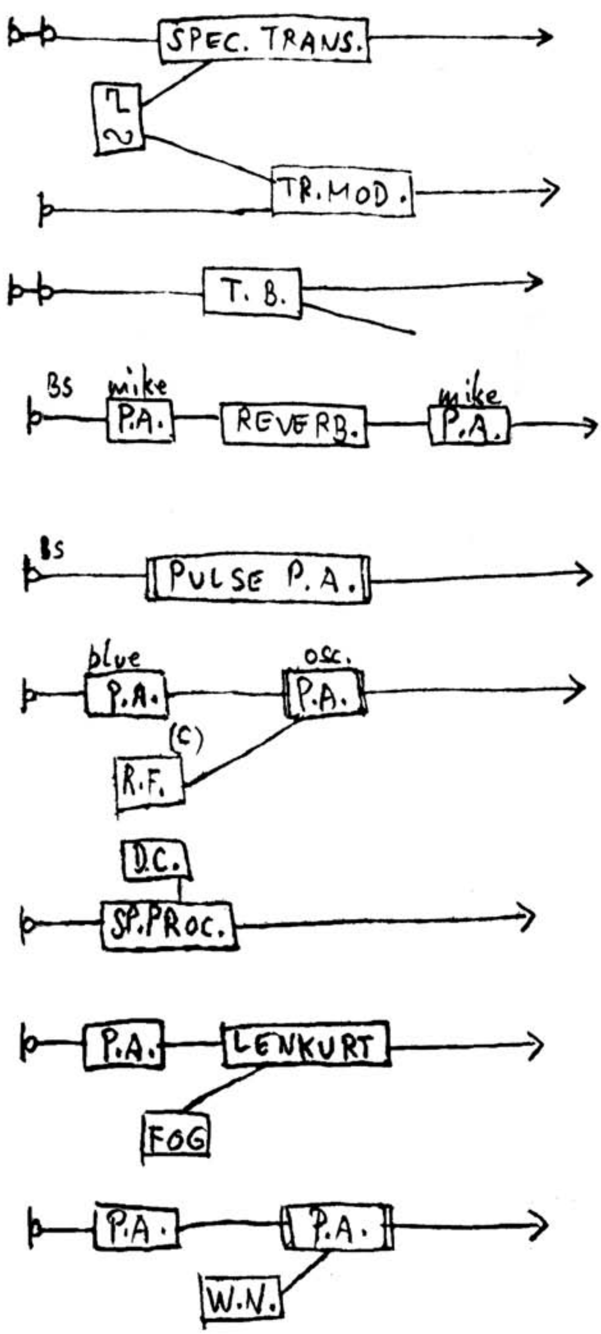


Figure 4.20 Tudor | *Bandoneon Factorial*, “Audio Processing & Routing” diagram, Sketch 1 | 1966

DTP, Box 3, Folder 2 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

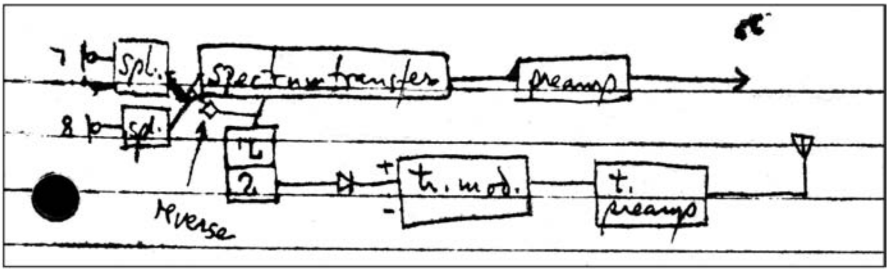


Figure 4.21 Tudor | *Bandoneon Factorial*, “Audio Processing & Routing” diagram, Sketch 2 (channels 2 & 3) | 1966
DTP, Box 3, Folder 2 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

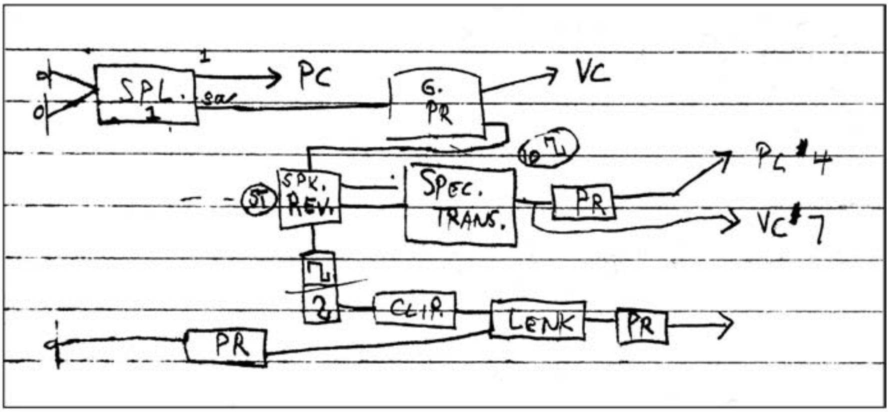


Figure 4.22 Tudor | *Bandoneon Factorial*, “Audio Processing & Routing” diagram, Sketch 3 (channels 2 & 3) | 1966
DTP, Box 3, Folder 2 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

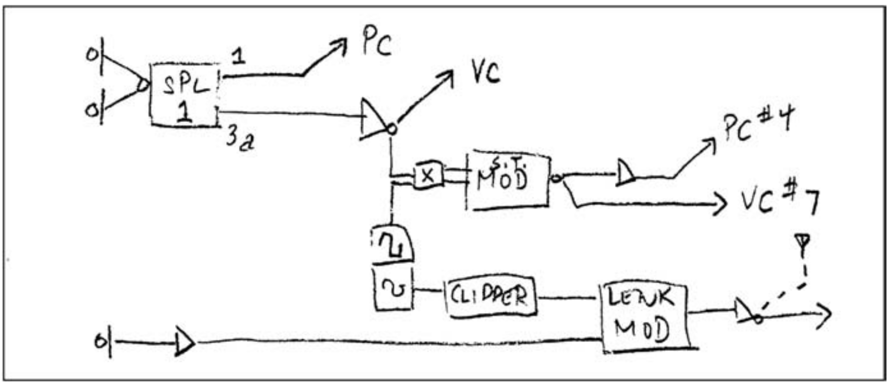


Figure 4.23 Tudor | *Bandoneon Factorial*, “Audio Processing & Routing” diagram, Sketch 4 (channels 2 & 3) | 1966
DTP, Box 3, Folder 2 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

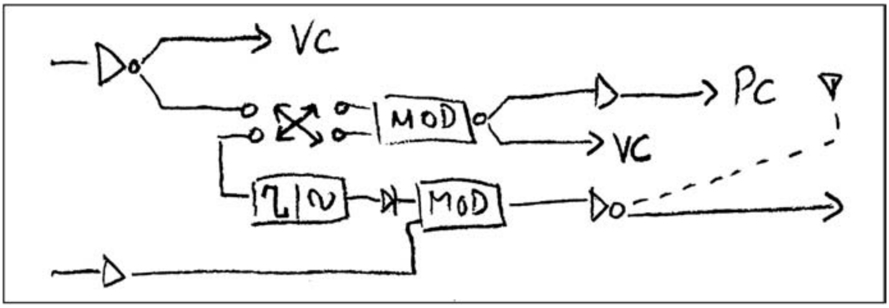


Figure 4.24 Tudor | *Bandoneon Factorial*, “Audio Processing & Routing” diagram, Sketch 5 (channels 2 & 3) | 1966
DTP, Box 3, Folder 2 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

Channel 2: *Cybersonic Spectrum Transfer* (Instrument 0450) with a square wave input
Channel 3: *Lenkurt Modulator* (0116/0174) modulating a sine wave “squared” through a *Clipper* (0027)
Channel 4: ×*1000 Amplifier* (0188)
Channel 5: *Reverb*[120] (0164)
Channel 7: *Tube Box* (Frequency Doubler) (0448)
Channel 8: *Harmonic Generator* (0173)
Channel 9: *Cybersonic Spectrum Processor*[121] (0135)
Channel 11: *Ring Modulator*[122] (0171) modulating input from *Pulse Generator* (0474)
Channel 12: *Spike Generator* (0173)
Channel 13: *Beat Frequency Oscillator* (0021)
Channel 14: *Saturated Amplifier* modulating *White Noise Generator* (0493) going through a *Radio-Frequency Generator*

[120] Although a *Slinky* would be used to achieve the same effect in the realization of *Fontana Mix* six month later, here it is a single box: Instrument 0164, a spring reverb box contained in a white plastic case. Aside from the fact that this is the only instrument in the Wesleyan collection that fits the description, its use in *Bandoneon!* is also suggested by the stylistic correspondence with other instruments similarly housed in plastic cases.

[121] “SP. PROC.” with a DC signal input (of 4.5 volts, as revealed from the other sketches) stood for *Spectrum Processor*, another extant instrument in the Wesleyan collection (Instrument 0135). This was a Cybersonic product made by Mumma and Ribbens, intended as a high-end model of the *Spectrum Transfer*. The focus was similarly in the control of overtone frequencies (sound spectra), but unlike the *Transfer*, whose generation of additional spectra was based on amplitude (ring) modulation that produced the sum and difference of two inputs, the *Processor* employed frequency modulation. The “Operating Instructions” found among Tudor’s papers reveal furthermore that although certain models of the *Spectrum Processor* had an extra input for amplitude modulation, the “70-S” model that Tudor owned was limited to frequency modulation. Hence, in the final diagram this instrument appears as a “Frequency Modulator” in the ninth channel, whereas the *Spectrum Transfer* is designated as an “Amplitude Modulator” in the second channel.

[122] The other “Amplitude Modulator” in Channel 11 with a pulse signal going into one input was a “ring modulator” coupled with the *Pulse Generator* (Instrument 0474). Additionally, Sketch 3 shows a change of plans concerning the dual *Microphone Amplifier* that was connected to the *Reverb* in Sketch 1: it is now connected to the “ring modulator” and the *Spike Generator*. Thus, the two amplifiers at the start of Channels 11 and 12 are very likely the two *Olson Microphone Preamplifier Model TR-86* housed together

Channel 15: *Saturated Amplifier* using a sine wave squared through *Clipper*[123] (0027?), or *Fog Horn* (0461), as control signal.

The instruments all imparted additional harmonics and inharmonics to the original signal in various ways: symmetrical distortion (*Clippers, Harmonic Generator*), intermodulation distortion (*Amplitude Modulators, Spectrum Processor*), frequency doubling (*Tube Box*), and so on. Which is to say that the boxes hidden inside the box assigned to Tudor were precisely aimed at multiplying the density of overall frequency spectrum to create white noise from scratch. The entire sound system indeed approximated a giant white noise generator. The black box housing his instruments in the generalized diagram could have simply been labeled as such. And since that box itself also included a *White Noise Generator*, it was yet another case of instrumental synecdoche, where the part is equated with the whole and the whole with the part—a Möbius-strip of the mind that uses and abuses differences of logical levels such as the one Tudor set as he drew the two diagrams of "Audio Processing & Routing" and "Generalized."[124] The permutations of the bandoneon in the title therefore extended to the nesting of scales that is not only physical and continuous, but also metaphysical and discrete.

For Tudor, such coordination across the part and the whole appears to have carried more meaning than just a useful way to organize things. The five or so instruments he made on his own for this first composition—*Clippers, Harmonic Generator, Spike Modulator, Reverb, Ring Modulator*—were all encased in small plastic cases, as were the ones he did not make but rehoused—*Fog Horn, ×1000 Amplifier*, or *Dual Microphone Preamplifier*. These were all extremely simple devices. The rest of his instruments were almost all made by friends (or by companies made by friends). Mobilizing this potluck to perform the entire Armory entailed a synecdochical inversion of hierarchies in which the periphery took over the whole, as he reminisced to

in Instrument 0022. So far, all the instruments identified share the same characteristic of using a plastic container. Another device found in the Wesleyan collection that is similar in style is Instrument 0171, a simple ring modulator housed inside a green plastic card file box. It also resembles the *Dual Microphone Preamplifier* that was used to amplify the signals going into the "ring modulator" in the diagram. Their likeness suggest that this instrument was made around the same time, and may have indeed been the ring modulator used in Channel 11.

[123] On the back of the note with the three diode instruments from Turner's book, another instrument named "Squarer" is listed, which is made from one transistor (2N107), one resistor (24 kΩ), one potentiometer (10 kΩ), and two capacitors (1 uF). The corresponding instrument has not been found, but a schematic that Tudor copied from some other publication (since the circuit does not use any diodes, it could not have been taken from *Diode Circuits Handbook*) is found in Box 46, Folder 3 (drawn next to a copy of the same drawing for harmonic generation using the 1N34 that had appeared in the other note). Here, the "Squarer" is given a different name of "Sine-wave Clipper," though both terms describe the same function of grossly amplifying the positive and negative peaks of a sine wave to the point of clipping distortion to turn the waveform into a square wave. Thus, this lost instrument may have been the second *Clipper* that appears in the final diagram.

[124] But on the two evenings in October 1966 when the music was actually performed, the generation of white noise also involved the entire space, as Klüver reminisced much later in 2002, "[Tudor] played the armory, the whole hall . . ." (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, 7CDs). So the synecdoche was itself nested: a white noise generator inside a white noise generator inside a white noise generator.

Chadabe on September 8, 1993 "My approach was to make a situation where I controlled the maximum number of tonal variables that I could obtain through the use of peripheral instruments."[125]

However, there was one group of instruments that did not fit neatly into this way of explaining things: the three *Oscillating Amplifiers* (encircled rightward triangle) and eight *Saturated Amplifiers* (squared rightward triangle) that appear all over the "Audio Processing & Modifying" diagram. The processing of signals in Channels 6, 10, 14, 15, and 16 are almost entirely done by these amplifiers, which in Channels 9, 11, and 12 modify the outputs of *Spectrum Processor, Ring Modulator*, and *Spike Generator*. These amplifiers present a peculiar puzzle at the heart of *Bandoneon!*, for in spite of being everywhere in the diagram, they are nowhere to be found as actual instruments.

Saturated Amplifiers

1

On January 26, 1992, Tudor sat down at his home in Stony Point with his longtime friend Julie Martin, who since the late 1960s had worked on many projects with Klüver, whom she married in 1983. Talking about *9 Evenings*, Tudor reflected on what he considered to be the most essential component of his sound system for *Bandoneon!*. It was meant as a warning to a group interested in reviving the piece from a quarter century before:

> *A lot of the sound modification devices had to deal with the home-built equipment that I had built myself, and I had discovered this principle of what is called a saturated amplifier, where you arrange feedback around an amplifier to the point where the circuit oscillates of itself. All you have to do is activate it by putting a signal in, and it can keep oscillating forever and ever, which is one of the features of the piece, and I had to tell the engineer that the piece would not be the same if they did not have that sound.* [. . .] *you are dealing with a particular kind of distortion that comes from saturating an amplifier.*[126]

The principle of transforming an amplifier into an oscillator through feedback is well known. Simply arranging a return path from the output to the input results in positive feedback, an accumulative reinforcement of the signal accompanied by distortion. Therefore, the returning signal must be attenuated to balance out the gain of the amplifier, a procedure known as negative feedback. In other words, the amplifier would oscillate as long as the total gain of the loop wrapped around it is kept at 1 (unity).[127] An

[125] Tudor, "Interview by Joel Chadabe."
[126] Tudor, "Interview by Julie Martin," Klüver/Martin archive.
[127] More accurately, there is a second condition: the net phase shift (the total phase shift in the feedback loop) must be set to zero so that the returned signal is in phase with the incoming signal. These two conditions of zero net phase shift and unity loop gain are usually achieved by setting the specific resonant

oscillating amplifier becomes a saturated amplifier when the loop gain exceeds unity. Then the amplifier hits the limits of power supply and is unable to increase more gain, consequently clipping its sine wave output and producing heavily distorted oscillations of quasi-square waves—the "particular kind of distortion" that Tudor recalled. This difference between the two amplifiers is expressed in the symbols he used: a right-sided triangle encased in a circle for oscillation and a square for saturation.

2

But these instruments that dominated Tudor's diagram in 1966 and his reminiscence in 1992 cannot be found.[128] There are not eleven amplifiers in the extant collection of Tudor's instruments at Wesleyan that can be linked to *Bandoneon!* with any certainty. It looks like they have either disappeared or did not belong to Tudor in the first place. But the majority of instruments from this period have survived, and Tudor did keep several TEEM instruments with him, including three power amplifiers. And given his nature to preserve materials, it would be quite unusual of him not to hold on to the particular group of instruments which he thought was most important for the very first piece he admitted composing under his own name. Which suggests another possibility: it might just be that these instruments are hiding in plain sight.

Among the materials sent to Wesleyan University from Stony Point in 1996 is a black suitcase containing 36 identical metal boxes all housing the same kit circuit: *Lafayette PK-522*, the three-transistor amplifier that was found inside the *White Noise Generator*. The 5" x 6" containers are actually standard telephone junction boxes, whose prefabricated holes are used for an extremely minimal interface of two inputs, one output (wire), and an on/off switch. The instrument runs on a 9-volt battery, and it comes with a trimpot (a preset yet variable resistor which can be adjusted using a screwdriver) sticking its head from the back of the box for gain control. On the cover of each is the name of an acoustic instrument and a number written in an unidentified hand (Figures 4.25 and 4.26).

On the cover of the suitcase is a name which tells where these amplifiers came from: *Atlas Eclipticalis*, an orchestral piece Cage wrote in 1961 by copying a star chart onto musical staves. Influenced by what Tudor had begun doing following Bo Nilsson's bluff, the composer instructed the orchestra to amplify their instruments, which led to a particularly disastrous result on February 9, 1964, when Leonard

frequency of the circuit at which the net phase shift becomes zero, and then setting the gain of the amplifier to match the attenuation necessary to obtain that frequency.

128 In my PhD dissertation I made the wrong assumption that part of these oscillating/saturated amplifiers were three *Roundhill AA-100 Amplifiers* that Tudor had rehoused in black phenolic cases. I had also found diagrams showing how feedback is wrapped around the instrument to make them oscillate. However, receipts discovered later indicate that these amplifiers were all purchased after 1967 for *Rainforest*, where they do make a prominent appearance. See You Nakai, "On the Instrumental Natures of David Tudor's Music," PhD dissertation, New York University, 2016, 218–234; and Appendix B: Rainforest Amplifiers in this volume.

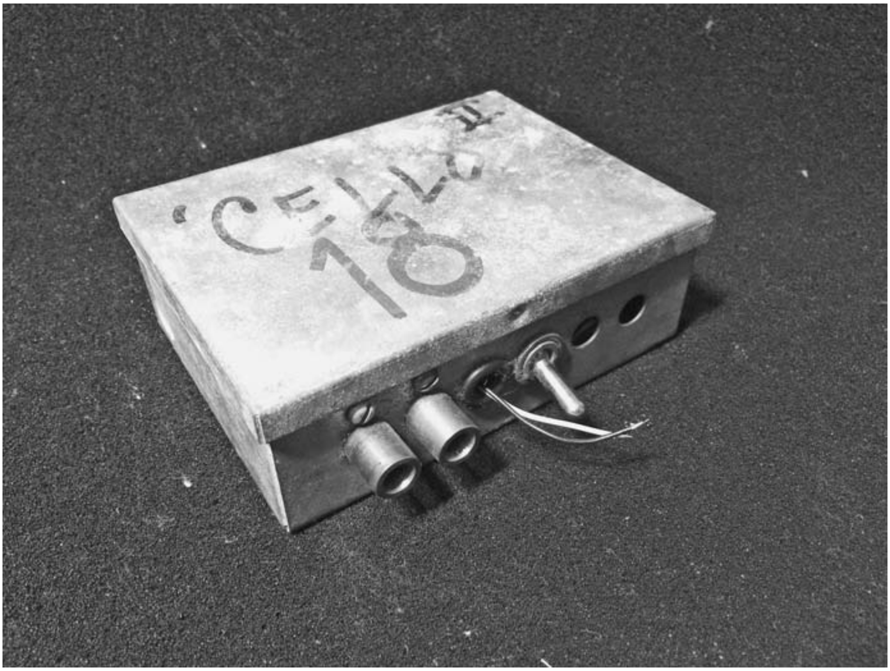


Figure 4.25 Anonymous | *Atlas Eclipticalis* amplifier
DTC, Instrument 0092 | World Instrument Collection, Wesleyan University

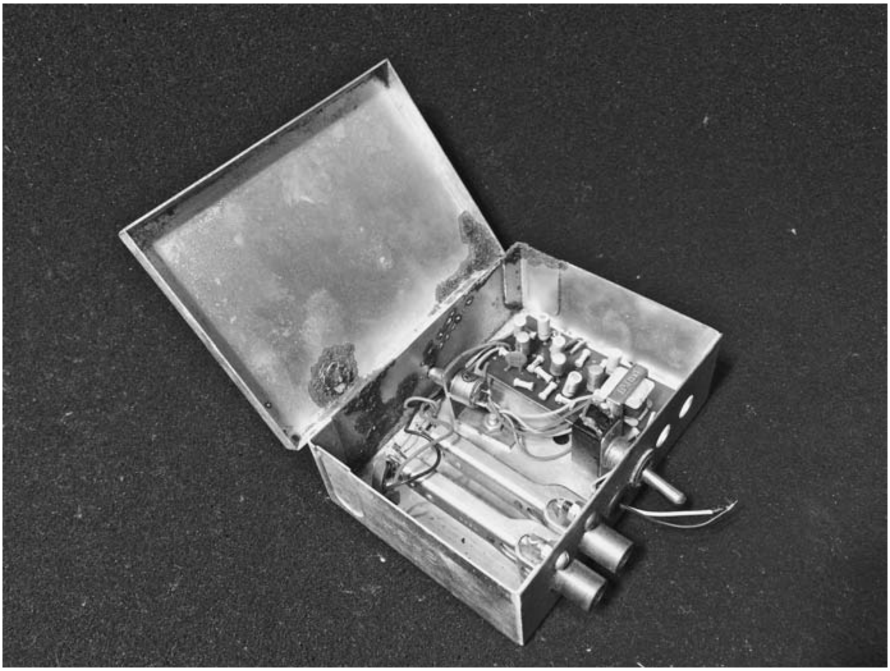


Figure 4.26 Anonymous | *Atlas Eclipticalis* amplifier (interior)
DTC, Instrument 0092 | World Instrument Collection, Wesleyan University

Bernstein conducted the piece with the New York Philharmonic. The story of the musicians sabotaging the performance that day and breaking the Radio Shack contact microphones attached to their instruments is often told. Those who reflect on this notorious event tend to recall the *50-Channel Mixer* that Cage asked Max Matthews at Bell Labs to build so that the 86 instrumental parts could be mixed, usually adding the insight that the parts had to be combined to make the math between the instrumental parts and the mixer channels work.[129] Curiously, however, the amplifiers which must have amplified the signal of the orchestral instruments before they reached the mixer never appear in any of the accounts, not even in firsthand recollections. These instruments always fall through the gaps of the generalized narrative of the piece. Somehow the scale of observation does not meet the necessary resolution to capture their existence.

But when the 36 boxes in the suitcase at Wesleyan are ordered according to their numbers, a pattern emerges. Some numbers are missing, and these gaps serve to organize them into seven groups: 1–6 [~~7, 8~~] 9–14 [~~15, 16~~] 17–23 [~~24~~] 25–30 [~~31, 32~~] 33–38 [~~39, 40~~] 41–42 [~~43~~] 44–45. The name of instruments in each group also reveal a pattern. With the exception of one, all the large groups with six boxes start with a string quartet (actually a double quartet since each box accommodated two instruments): violin, cello, violin, viola. The missing numbers can therefore be understood in two ways: (a) they are structural markers that did not have a corresponding instrument, although in that case the maximum number of amplifiable instruments would be 72 and not 86, so the math doesn't add up; or (b) the corresponding amplifiers are not there because Tudor reused them for other purposes and did not put them back. The number of missing numbers is 10, but since there is no reason to think that the count stopped at 45, the total could very well amount to 11—the exact number of oscillating and saturated amplifiers in the *Bandoneon!* diagram.

Indeed, four of these *Atlas Eclipticalis* amplifiers appear in photographs of Tudor testing his equipment at the Berkeley School gathering over the weekend of September 10 and 11, 1966 (Figures 4.27 and 4.28)[130] , as well as in the filmed footage of *Variations V* performed in Hamburg a month earlier in mid-August.[131] However, only four or six are seen each time, never eleven.

[129] For an insightful analyses of this concert, see the first chapter of Benjamin Piekut, *Experimentalism Otherwise: The New York Avant-Garde and Its Limits* (Berkeley: University of California Press), 2011; as well as Leta E. Miller, "Cage, Cunningham, and Collaborators: The Odyssey of *Variations V*," *The Musical Quarterly* 85, no. 3 (Fall 2001), 545–567.

[130] Three boxes resembling the extant power amplifiers from TEEM in Tudor's instrument collection also appear in the Berkeley School photograph, two placed above the *Spectrum Processor* and one above the *Atlas Eclipticalis* amplifier. However, the holes in their cases, as well as the number of inputs and outputs, do not match Instruments 0031–0033.

[131] Six *Atlas Eclipticalis* amplifiers can be seen in the photograph taken by Herve Gloaguen that captures Tudor, Cage and Mumma performing (four are piled up in between Cage and Tudor, and two others lay near the edge of the table on Mumma's side). I prepared an image indicating their locations in the photograph, but unfortunately the price quote from Getty Images was absurdly expensive to comply. The same image can be easily be searched online and is also featured on the cover of the DVD: *Variations V: Cage, Tudor, Mumma, Merce Cunningham Dance Company*, 1966, NDR, Mode Records, 2013.

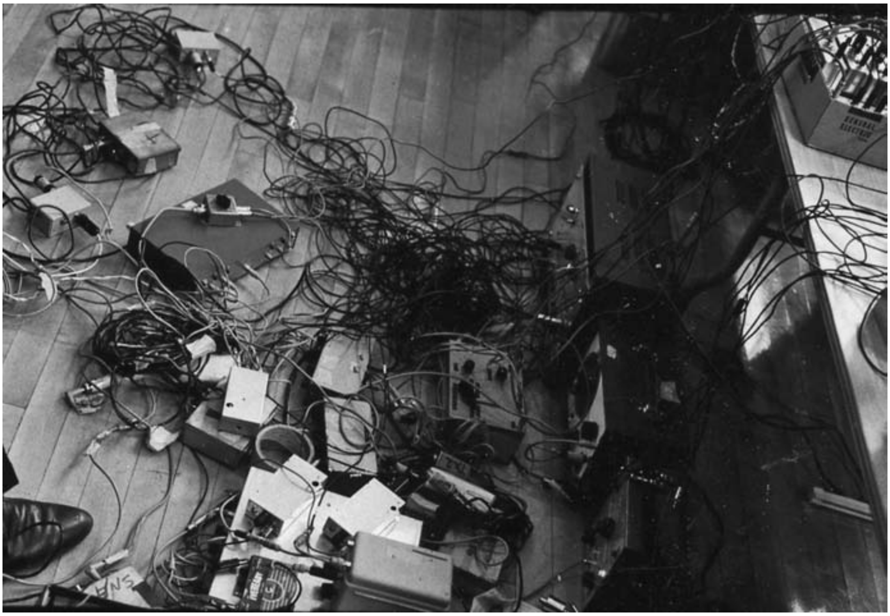


Figure 4.27 Tudor's rehearsal setup at the Berkeley School | September 10–11, 1966
Photo: Franny Breer | Klüver/Martin Archive | Courtesy of Experiments in Art and Technology

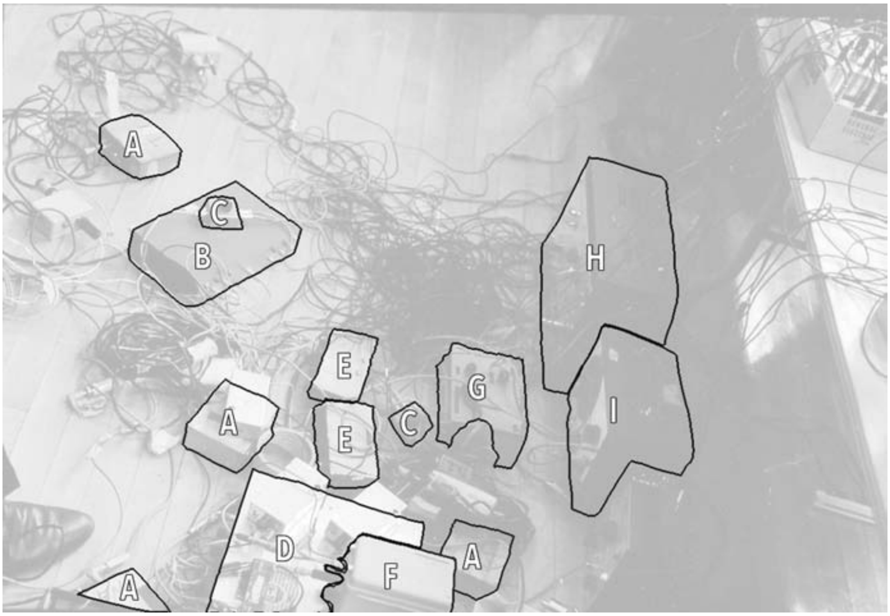


Figure 4.28 Identification of instruments in the Berkeley School photo
A = *Atlas Eclipticalis* amplifiers; B = *Olson RA-637 4-Channel Preamp Mixer*; C = *Switchcraft Signal Selector*; D = *Cybersonic Spectrum Processor*; E = *Lafayette PA-292 Microphone Mixer*; F = *Dual Olson Mic Preamp*; G = *Cybersonic Spectrum Transfer*; H = *Tube Box*; I = *Midland Audio Generator*.

3

There is a particular difficulty that the amplifiers turned into oscillators present to the effort to de-generalize their existence from Tudor's generalized diagram. Since neither the diagram nor Tudor explains how the feedback around the amplifier was actually established, it is possible that the return path ran *outside* each box. Indeed, some circumstantial evidence suggests that it was quite likely so. Not only the proximity between input and output in the telephone junction boxes would have made it easy to connect the two externally, but the second input jack could have been used as output after patching feedback across the other two. More significantly, a second series of oscillating and saturated amplifiers that Tudor began composing for *Rainforest* shortly after *9 Evenings* all patched feedback outside the box housing a kit amplifier, which allowed Tudor to insert capacitor substitution boxes and other instruments in the loop.[132] In other words, the most important instrument in Tudor's sound system of *Bandoneon!* may have been *not one but several instruments*. Each "saturated amplifier" may have already been a combine.

But in the process of composing the diagram, Tudor reduced the multiplicity of instruments into one symbol, creating a threshold of resolution beyond which correspondence with actual devices became occulted. Again, the *Atlas Eclipticalis* amplifiers fall through the gaps of generalization, this time not as an effect of storytelling, but of diagramming. The number of boxes on paper may not match the number of actual instruments—something that was already apparent, albeit in the opposite direction, with instruments like the *Dual Olson Microphone Preamplifier* or the *Harmonic Generator* and *Spike Generator* housed in one container, which nonetheless appeared in diagrams as two separate boxes. Which is also to say that the composition of a unit that houses multiple components is not only carried out conceptually by symbols and words. The engineers at Bell Labs also composed a unit by putting the *PK-522 Amplifier*, along with the power switch, the input and output jacks, and the wires connecting them, inside the telephone junction box. So there are textual units and physical units whose counts do not match, and the oscillating amplifiers go missing somewhere in between.

One obvious difference between composing instruments and composing symbols for instruments is that the latter is relatively unconstrained by physical scale. In the "Audio Processing & Modifying" diagram, the saturated amplifier is drawn in about the same size as all the other instruments. And as far as the "Generalized" diagram is concerned, all those instruments could be housed inside the box of "Audio Processing & Modifying" that is about the same size as the box of "Proportional Control" on paper, even though the actual instrument made by Waldhauer was even smaller than the single *Tube Box*. The size of boxes on diagrams only partially corresponds to the actual size of the boxes. The nesting of scales takes place both physically and textually, but the two often do not meet on the same level.

[132] See Appendix B: Rainforest Amplifiers for a more detailed analysis.

4

According to Tudor's reminiscence on January 26, 1992, the nature of the saturated and oscillating amplifiers was such that they did not require much from the human performer:

> *All you have to do is activate it by putting a signal in, and it can keep oscillating forever and ever.*[133]

But twenty-six years before, he had used the same expression to describe the nature of the whole piece in the original program note:

> *Bandoneon!* uses no composing means; when activated it composes itself out of its own composite instrumental nature.[134]

The instruments that were apparently everywhere back then and nowhere to be found now defined not only how the music sounded but also how the total configuration worked. The giant white noise generator was also a giant saturated and oscillating amplifier, which may be a matter of course considering that both instruments were built around the same *PK-522 Amplifier*. Yet, Tudor titled his piece *Bandoneon!* and not *White Noise Generator!* or *Saturated Amplifiers!* or *PK-522!* The name does not appear to reflect the nature of the material. But combined instruments like the saturated amplifier are difficult to count, and when they are, it is usually their name and corresponding symbol—the textual units—that are counted. *Combine!* would not have worked either because the unit at the basis of operation similarly knows no physical scale. Like the oscillation of feedback amplifiers, the metaphysical nesting of categories inside categories could have gone on and on forever.

Instead, the bandoneon was a physical unit that not only triggered but also limited the never-ending self-multiplication. And, unlike the *PK-522 Amplifier* that was always housed in larger boxes for the sake of performance, this was an acoustic instrument whose scale was designed to match that of the human performer. In other words, it was the coordination between Tudor's body and the bandoneon that set the ground level where feedback returned to, thereby turning the potentially infinite process of self-multiplication into factorialization, an operation with an end. As Tudor reflected in his *Pre & Post-operative Note*, what "obviated the need for any compositional means"[135] was not simply feedback wrapped around the *PK-522 Amplifier*, but the performance method of single-performer feedback he had learned through *Musica Instrumentalis*. All one needed was a trigger, but the specific material bias of that trigger mattered:

> *So there I had one trigger device which could trigger lots of things.* [. . .] *All I had to do was play this instrument and all things were set in motion.*[136]

[133] Tudor, "Interview by Martin."
[134] Tudor, "*Bandoneon!* description," *9 Evenings* program note.
[135] Tudor, "*Bandoneon!*, Pre & Post-operative Note," Box 16, Folder 6, David Tudor Papers, GRI.
[136] Tudor, "Presenting Tudor: A Conversation with Bruce Duffie."

5

But precisely for this reason, making things larger physically was different from accumulating logical levels metaphysically. Materialized synecdoche brought all kinds of distortions into the attempt at sorting things out through concepts and categories, all kinds of complications that fell through the gaps of language and symbols. For one thing, Schneider, who was asked by Klüver to organize matters at the last minute, had decided to compose a second system on top of TEEM in a desperate effort to actually realize *9 Evenings* in a timely manner. Drawing the diagrams for each piece which showed the necessary instruments and their interconnections had given him an overview of the entire *9 Evenings* for the first time.[137] This allowed the engineer to make two observations: on the one hand, there were many overlaps of equipment between the works; on the other, there was not enough overlap, so that switching from one setting to another presented a problem. "Just looking at the 10 diagrams made it clear that shifts between artists once each night might take hours," he later recalled.[138] Being in charge of switching research at Bell Labs for his day job, Schneider's solution was to centralize matters. The constancy of instruments between the diagrams suggested that the problem of switching could be solved by coordinating everything on switchboards.[139] "The idea was simple," he wrote in retrospect, four months after *9 Evenings*, "to make as much of the TEEM gear available as possible on patchboards. Descendants of switchboards, the patchboards allowed each artist access to all the equipment and each piece to be pre-programmed and repeated at will."[140]

A central control room was thus set in the Armory, in whose center a series of switching plugboards, made by Automotive Marine Products, were installed.[141] Like the commercial synthesizers based on the same principle of patching fixed consoles, the portable modularity of TEEM was suddenly tethered and standardized. Or an attempt in that direction was made, at least. For the process of organization was utterly unorganized. Most critically,

[137] From this perspective, it is significant that the cover of the *9 Evenings* program was the superimposition of the 10 diagrams. But Schneider's own recollection about the sequence of events meandered. On November 1, 1966, he described the process as follows: "we talked […] with each of the artists and then made up the drawings" (quoted in Forti, "Notes by a Participant," 29). However, he also explained that, at least on one occasion, the diagram was drawn *during* the interviews with artists: "David Tudor was asking for functions I couldn't visualize. Then I made the drawing. We talked back and forth making corrections till we finally beat it into shape. I couldn't understand what he wanted until I could visualize it and he couldn't communicate it to me in those terms because he's not used to visualizing functions" (ibid.). In the same way, Schneider tended to explain the use of *AMP Switching Plugboards* as an outcome of these interviews and diagrams, which does not coordinate well with the nature of the diagrams.

[138] Herbert A. Schneider, "A glimpse or more at some technical aspects not seen by the third partner of Nine Evenings—the public," Box 2, Folder 3, Experiments in Art and Technology, Records, 1966–1993, GRI.

[139] "Very early I recognized that there were 10 people with 10 different ideas or maybe 20, and there was a time, way back when I was in a department called 'switching research.' So switching things, or information was part of the game" (Schneider, "Interview by Martin").

[140] Herbert A. Schneider, "A Systems Approach (February 1967)," Klüver/Martin archive.

[141] "It was my idea to set up a central control area, where the engineers could work during the performance. […] The control area was mostly comprised of the wired plug boards we made up for each performance" (Bardot and Morris, "Interview with Herb Schneider," 57).

the *AMP Switching Plugboards* required that the wireless system now be all wired up. So in the final days leading up to *9 Evenings*, all available personnel were recruited to crimp wires. In her October 8 journal entry, five days before the first show, Forti wrote: "One of the engineers said, 'What we need is a lot of unskilled labor.' And there were two dancers and a composer—Cindy, Yvonne, and Cage—stripping wires."[142] Cage, a major proponent of wireless systems that would have realized his dream of making electronics immaterial, commented that although he was told everything would be wireless, he had never seen so many wires in his life. It was also around this time that Waldhauer reported Tudor was "running into the limits of wiring"[143]—although in this particular case, the physical breaking point may have been Tudor's own doing, judging from the photograph of his setup at the Berkeley School, showing heaps of wires even before the *AMP Switching Plugboards* were introduced (Figure 4.29).

In any case, the time artists spent immersed in the world of wires was time taken away from rehearsals. Klüver looked back with some regret shortly afterwards:

> *I didn't have the presence of mind to put a stop to what I saw happening with the AMP equipment and start the engineers working on a simpler system. What they had set out to do was a three month job. And they would have had to do it in three days. So the week that should have gone into rehearsals was spent in wiring the patchboard.*[144]

In the end, the material chaos of wiring that appeared only on the periphery of the generalized diagrams could not be solved in time. When Tudor activated the system in the evening of October 14, not much happened. The trigger that was supposed to set things in motion did not work because some people had mistaken the front of the *AMP Switching Plugboards* for the back and had wired everything in reverse:

> *The first time it didn't work, and that was one of the biggest fuckups of the century. But nobody knew about it until after it happened. My piece was on the second night. The first night there were two pieces performed and certain things were not working in the audio programming and nobody knew why, so we did it by hand. The second night my piece was involved where the whole thing was involved, which meant it was a test of the whole system, and it was obvious that there was something really radically wrong. It turned out to be a very simple mistake. It was the fact that many circuit boards had to be made to put into the programmer, and there was one engineer who was in charge of doing that. But there were so many to be made that people who had come there to observe or to help as they could, set to work soldering these circuit boards, and nobody told them the back of a circuit board is the reverse image of the front. So the whole wiring was done backwards, and that was only discovered because my piece was on the second day.*[145]

142 Forti, "Notes by a Participant," 29.
143 Ibid.
144 Quoted in Ibid., 30.
145 Tudor, "Presenting Tudor: A Conversation with Bruce Duffie."

Figure 4.29 Tudor rehearsing *Bandoneon Factorial* at the Berkeley School | September 10–11, 1966
Photo: Franny Breer | Klüver/Martin Archive | Courtesy of Experiments in Art and Technology

Because he had meticulously attempted to "put everything" TEEM had to offer, Tudor's work served as a perfect test-run of the system and it failed miserably. One of the engineers, L. J. Robinson, recalled looking at his watch as they worked to fix the problem, already 45 minutes into the intermission: "It was 10:50. This was incredible. The show should have been over ten minutes ago, and the end of intermission wasn't in sight yet. […] At exactly one hour of the intermission, David gave Judith the cue to go. I knew, and all the engineers surmised, that David Tudor was being a very brave performer."[146] Gnazzo, who sat on the platform with Tudor to operate the remote-controlled loudspeaker carts had a slightly different recollection:

> *Everybody was going crazy about this except for David who knew it didn't make any difference because he knew he could do a performance. And it was absolutely spectacular: people had been planning this thing for months and months, and there were tens of thousands, if not hundreds of thousands of dollars worth of stuff all tied up and nothing was going to work. And yet, David being the ultimate performer, just knew that it was up to the performer to save the day, and he just hooked up what he had and just got out there and made it work, even though I doubt it was factorial for the first half an hour but once he got it going it was working just fine.*[147]

In any case, after the first two evenings, which is to say immediately following the first performance of *Bandoneon!*, a decision was made by the engineers to start on time instead of making the audience wait until setup was complete. Schneider gave a peculiar pretext concerning this shift: "Up to that time we were purists. Initially, all the artists had encouraged us in this. No artist said, 'Let's fake it, let's do it by hand.' "[148] In other words, solutions had to be composed on spot. Just as the dancers and composers became impromptu engineers crimping wires, the engineers were forced to become improvisers. In spite of how Tudor explained it in words, the music did not compose itself out of its own composite instrumental nature—it needed to be performed.

6

Or perhaps Tudor was simply counting himself, along with the engineers who ran around the Armory to fix problems here and there, as part of that composite instrumental nature. As a result of his Möbius-strip-like inversion of approach, white noise had ceased to be a source to be processed, becoming instead something to be approximated using all available resources: "*Bandoneon!*'s sound image is a tending toward total oscillation (approaching white noise), with the differentiation discoverable therein," he later wrote in his *Pre & Post-operative Note*.[149] So over the course of forty

[146] L. J. Robinson, "At the Armory," Box 1, Folder 41, Experiments in Art and Technology, Records, 1966–1993, GRI.

[147] Gnazzo, "Interview by Martin." He also recalled how the remote-controlled carts, which appeared to be safe as they were not wired to the *AMP Switching Plugboards*, nevertheless ran into a major problem during performance: "Apparently with all the design that had gone into these things they had forgotten to include a reverse gear and I remember that David Behrman and I got a couple of these carts going—and this was a huge hall so there was no problem of having enough room to maneuver—but […] we somehow got into an area, a corner, and the two carts were nosed in like this and they had to spend the rest of the performance just at the corner because we couldn't back them out. [*laughter*] So it sort of removed yet another dimension from the 12-channel sound system since we placed two of them right at the corner" (ibid.).

[148] Quoted in Forti, "Notes by a Participant," 30.

[149] Tudor, "*Bandoneon!*, Pre & Post-operative Note," Box 16, Folder 6, David Tudor Papers, GRI.

minutes in the second evening, when things worked better—with the exception of the carts, which remained stationary this time—Tudor focused on accumulating the complexity and density of the sound spectrum to simulate white noise, while articulating subtle differences of color by manipulating the bandoneon:

> *So if you imagine a scale where pure tone is at one end and white noise is at the other end, and* […] *if I pressed more than three tones simultaneously I had white noise, and I could add to it to change its color or I could diminish it by releasing some of the buttons.*[150]

Setting a polarity between "pure tone" and "white noise" to orient himself through the performance, Tudor nevertheless imagined the scale to be continuous and not as discrete as when he was composing the diagrams or thought up the title of the piece. He was a component in the feedback process, continuously processing sounds, no longer trying to organize matters on paper. That phase had already passed or had not yet come, and now even the engineers had to improvise. Instrumentalized sounds would enter his ears, influencing the way he modified other components from afar, which in response changed their behaviors and influenced others in turn, saturating the entire Armory and composing a giant white noise generator from the inside out (Figure 4.30).

Figure 4.30 *Bandoneon Factorial* | October 18, 1966
Photo: Peter Moore | © 2019 Barbara Moore / Licensed by VAGA at Artists Rights Society (ARS), NY, Courtesy Paula Cooper Gallery, New York.

[150] Billy Klüver, Barbro Schultz Lundestam, "Interview with David Tudor, 1996," The Daniel Langlois Foundation for Art, Science, and Technology, 9 Evenings: Theatre & Engineering fonds.

Chapter 5
Pepsi Pavilion

Pepsi Pavilion

1

In the spring of 1970, David Tudor composed a musical instrument. Approximately 45 meters wide and 23 meters high, this giant composition was housed in a dome-shaped pavilion at the southern end of the World's Fair site in Osaka, Japan (Figure 5.1). The temporary architecture, which existed only during the six months of the Expo, was funded by Pepsi-Cola and developed by Experiments in Art and Technology (E.A.T.)—a group co-founded by Billy Klüver, Robert Rauschenberg, Fred Waldhauer, and Robert Whitman in the days leading up to *9 Evenings,* to support the collaboration between engineers and artists.

The unusual alliance between a nonprofit experimental organization and a profit-based beverage corporation had started two years before, when the filmmaker Robert Breer was asked by a neighbor to help him with a new project he had recently been assigned at work. This acquaintance happened to be the vice president of Pepsi-Cola International, and his company had happened to decide to take part in the first World's Fair in Japan, hoping to expand its influence in the Far East. Excited about the possibilities this offer opened up but worried about working with corporate people, Breer called up another friend who had some experience in coordinating large-scale projects at the intersection of business and art: Billy Klüver. The two of them then selected four core artists for the project. Whitman, who made theatrical happenings and environmental works, would design the inner space of the pavilion; Forrest Myers, who made giant light-beam sculptures, would illuminate the exterior space; Breer himself wanted to place mobile sculptures called *Floats* outside the pavilion—these would move so slowly that they looked stationary until one sneaked up right behind you. When they began discussing the sound system, Klüver immediately thought of Tudor, whose astonishing use of the entire 69th Regiment Armory during *9 Evenings* was still fresh in his memory.

What Tudor set out to make is well known. In the introduction of *The Pavilion*, a book Klüver edited two years later in 1972 with Julie Martin and art critic Barbara Rose to document the project from the E.A.T. side, Nilo Lindgren wrote, "[he] 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."[1] As Klüver reminisced

[1] Nilo Lindgren, "Into the Collaboration," in Billy Klüver, Julie Martin, Barbara Rose, eds., *The Pavilion: Experiments in Art and Technology* (New York, NY: E. P. Dutton, 1972), 15.

Reminded by the Instruments. You Nakai, Oxford University Press (2021). © Oxford University Press.
DOI: 10.1093/oso/9780190686765.001.0001.

Figure 5.1 *Pepsi Pavilion* with Nakaya's fog, Breer's *Floats*, and Myers's light beam towers
Photo: Shunk-Kender © J. Paul Getty Trust. Getty Research Institute, Los Angeles (2014.R.20)

much later on May 8, 2002, Tudor had "played the armory, the whole hall" as an instrument in *Bandoneon!*;[2] now he would compose the whole pavilion as an instrument. But although this "fact" has been mentioned again and again in the writings about the *Pepsi Pavilion* that have piled up since then, the extraordinary nature of Tudor's idea appears to have been completely ignored. It is as if the common conception people hold about "musical instruments" has biased their gaze into not seeing what otherwise lies in plain sight. Yet again, it might do well to take what Tudor said quite literally and observe the specifics accordingly.

For one thing, the conditions differed greatly between New York and Osaka. The audience at the Armory mostly sat on chairs and watched the performance as well as the haywire of cables and equipment from a distance.[3] But as part of the World's Fair, the *Pepsi Pavilion* expected an average of 350,000 visitors per day who would be free to move around the space. This meant that the sound system had to be fixed in advance and rigidly installed into the architecture of the free-standing dome. The centralization of control Herb Schneider had devised belatedly for *9 Evenings* was the starting point this time around. In addition, the difference between the TEEM equipment shared by all the artists and Tudor's own peripheral modules did not exist anymore. There would be just one sound system used by everyone involved. This required the instrument to be flexible and versatile—*generalized*, in other words.

[2] Billy Klüver, "Interview by 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.
[3] The two exceptions were Cage's *Variations VII* and Steve Paxton's *Physical Things* in which the audience was free to walk around the performance area.

These new conditions also gave birth to a new category of output. The *Pepsi Pavilion* opened its doors on March 15, 1970; shortly after a month, on April 25, E.A.T. was forced out of its premises by Pepsi, which had come to its corporate senses and realized it was spending too much money on a futile experiment, one which promised no return as far as drinking carbonated soda was concerned. By then, however, Tudor had already performed nine or ten "programs" with his giant instrument. In other words, "instrument" was not the only thing he composed. The nature of these "programs" complicates the usual claim in electronic music that the instrument is the composition. Tudor's music could not have simply composed itself out of its instrumental nature this time, since the instrument was one but the programs were many. A puzzling gap is thus revealed between the *Pepsi Pavilion* and the so-called *Pepsi Pieces*.

2

When Tudor joined the project, Pepsi had already drafted a plan for what should happen inside their so-called Youth Pavilion to attract their potential customer base: they wanted to organize a big rock concert in the giant venue.[4] So Tudor's ideas had to initially revolve around this condition, which presented an odd puzzle for the "well-known avant-gardist"[5]: "I tried to imagine what I would consider an interesting environment if I were a rock performer."[6] One of the earliest proposals, which indeed carried the title of "Rock Environment," described a "constantly changing light-sound space, activated by any signals filtered from a live or taped rock-performance."[7] The list of items to be performed with instrumentalized sound included sounding sculptures, various light installations, a closed-circuit TV system, and an audio system covering the entire space (Figure 5.2). The likeness to *Bandoneon!* is easy to see—Tudor had simply taken the basic format of his work from four years before and replaced the big squeezebox with a rock performance.

This seemingly subtle switching of source material nevertheless turns out to be another Möbius-strip-like inversion when Tudor's own position in relation to the so-called environment is taken into account. For this time, thanks to Pepsi, *he no longer had any control over input*. The instrumental trigger that activated the process of factorialization and even lent its name to the title of the 1966 piece had now turned into a mere given. Tudor had no choice but to shift his focus. Consequently, the role of input was minimized in his sketches for the *Pepsi Pavilion*; what is amplified instead was a concern for the rest of the sound system. But Tudor could neither focus on the instrumentalization of sound or the method of single-performer feedback unless he was willing to let rock-'n'-roll impose its mighty influence on the process of modification as well. The only place to start, therefore, was from the opposite end—output.

[4] Lowell Cross, "Letter to Vernon J. Fowler (March 13, 1969)," Box 17, Folder 5, David Tudor Papers, GRI.

[5] J.D., "Rare Bandoneon Features in Kagel's 'Pandora's Box,'" *Buffalo Evening News*, April 5, 1965 (Box 63, Folder 8, David Tudor Papers, GRI.)

[6] Lindgren, "Into the Collaboration," 17.

[7] Tudor, "Rock Environment (First Draft)," Box 17, Folder 3, David Tudor Papers, GRI.

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 5.2 Tudor | Rock Environment (First Draft) | Undated (presumably 1969)
DTP, Box 17, Folder 3 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

As Tudor tried hard to imagine himself as a rock star, he began to think that it might be interesting for the band to move its sound across multiple loudspeakers at extreme speed, so that their music would be distorted 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.*[8]

[8] Lindgren, "Into the Collaboration," 18.

This idea actually had its roots at the Armory as well, except it concerned neither the bandoneon nor the various channels used to create white noise from scratch. It was instead an issue of output, an aerial development of the mobile loudspeakers that ran around on remote-controlled carts: "the listener would have the impression that the sound was somehow embodied in a vehicle that was flying around him at varying speeds."[9]

3

As preparations for the *Pepsi Pavilion* developed, the artists reached an agreement that the idea of holding a rock concert was ridiculous. In his usual way, Tudor described it as a decision guided by the nature of the instrument: "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."[10] But like a curse, the original "Rock Environment" would continue to exert its influence even after it was gone, biasing Tudor's focus without making itself explicitly known. For one thing, he now appeared to think of input only as something given. This was quite literally so: Tudor asked the geographer Peter Poole, working with E.A.T., to collect a large number of sound materials from biomedical laboratories and field recordings all over the world to use as input source for his giant instrument. Toward the end of 1969, the filmmaker Ritty Burchfield was hired for the project in the role of "software librarian." Forty-five years later, on September 8, 2014, she reminisced about the task assigned to her under that attractive title: "my job was cataloging the recordings and putting them in some kind of workable form. And then, as it had turned out, we'd make a lot of loops of sounds and things like that."[11]

By February 1970, they had gathered more than 500 recordings of different sounds, out of which Tudor and Burchfield began editing a library of 45-minute tapes. Some of the recordings were modified electronically in the process, although many of the modifications consisted of no more than changing the tape speed. The work of the software librarian continued after she and Tudor arrived in Osaka.[12] An "earphone time" was set every day at the basement of the *Pepsi Pavilion* for the two to listen to the tapes and decide which ones to use (Figure 5.3). There were some personal favorites:

> *We always liked the* Longhorn Beetle. *It was one of our favorites, because it says, "here's the sound of a longhorn beetle walking" and "ti ti ti ti . . . ," and then, "here's the sound of a longhorn beetle eating a leaf . . . crunch! crunch! crunch!" And that*

[9] Ibid., 54.

[10] Ibid., 18.

[11] Ritty Burchfield, "Interview by You Nakai and John Driscoll," New York, NY, September 8, 2014. Birchfield recalled that Takehisa Kosugi, who later became a colleague musician of Tudor and Cage in MCDC, was visiting New York at the time and also helped: "Kosugi made the famous *Mosquitoes in the Water Jar* tape which is one of our favorite sounds which involved dropping a microphone into . . . catching mosquitoes and putting them into a jar [*laughter*]" (ibid.).

[12] A plane ticket reveals that Tudor's arrival was on February 18: "Pan American World Airways (February 18, 1970)," Box 125, Folder 6, David Tudor Papers, GRI.

Figure 5.3 Tudor and Ritty Burchfield during "earphone time"| March 1970
Photo: Shunk-Kender © J. Paul Getty Trust. Getty Research Institute, Los Angeles (2014.R.20)

would just break us up every time and any time we were upset we would put on the Longhorn Beetle *recording.*[13]

The *Longhorn Beetle* tape that survived among Tudor's collection of tapes does not have narration, so that must have been edited out when the loop was made.[14] "I didn't really transform it," Tudor explained to Bruce Duffie later, on April 7, 1986, "I sort of trimmed it to a useful material for me."[15] By then some of the surviving "Pepsi Tapes" had made their way into other works. But in spite of all the laughter they had during earphone time, Tudor put on a mask of indifference when he went on record with Duffie—while also revealing that, even after all those years, he still returned to them: "I find that I'm still using that, because that's *only an input*. It depends on what kind of device is meeting it at the other end."[16]

[13] Burchfield, "Interview by Nakai and Driscoll."
[14] "Longhorn Beetle Walking," R129, David Tudor Papers, GRI.
[15] Tudor, "Presenting Tudor: A Conversation with Bruce Duffie," bruceduffie.com.
[16] Ibid.

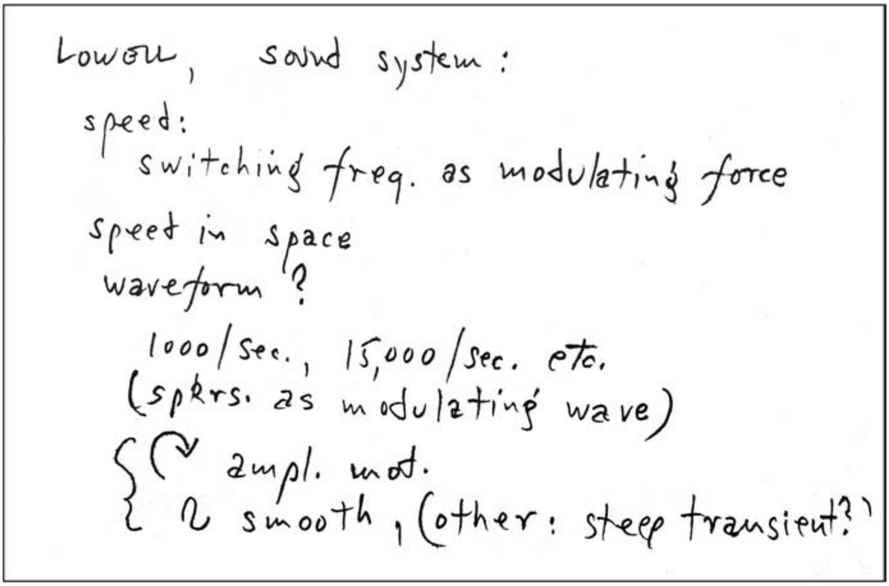

Lowell, sound system:
speed:
switching freq. as modulating force
speed in space
waveform ?
1000/sec., 15,000/sec. etc.
(spkrs. as modulating wave)
ampl. mod.
smooth, (other: steep transient?)

Figure 5.4 Tudor | Note on sound modulation using rapid switching of loudspeakers | Undated (presumably 1970)
DTP, Box 17, Folder 7 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

4

Back in 1970, it was indeed the "other end" that continued to occupy Tudor's mind: "I kept the sound movement because the idea was still in my head."[17] If anything, he decided to increase the speed to see what would happen:

> *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 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.*[18]

The unusualness of this idea concerns *where* the modification of sound takes place: neither at the input nor in the electronic circuitry, but at the loudspeakers—or more accurately, *in between* one loudspeaker and another (Figure 5.4). In other words, Tudor conceived of the interior of the *Pepsi Pavilion* as a giant modifier and a potential generator of sound. In the absence of the single instrument serving as

[17] Lindgren, "Into the Collaboration," 18.
[18] Ibid.

the generator, modulator, and trigger for the self-multiplying accumulation of audiovisual events, the whole space—"with its own characteristics"—took on that role. Input remained only an input, while the other end became everything.

But what Tudor called the "sound space" was not one and the same with the architecture of the dome.[19] In fact, the artists on the E.A.T. side had no say in the construction of the building, which was undertaken by the Japanese construction firm Takenaka Koumuten. Just as much as the rock groups it was planning to host, the pavilion was itself a given. If anything, the artists took great pains to erase its physical presence, which appeared ugly to their eyes. This was achieved by using an artificial fog to obscure its exterior, a task assigned to Fujiko Nakaya, and setting a mirror dome held by negative pressure for its interior.

These efforts to occult the architecture, like the architecture itself, certainly influenced the characteristics of the "sound space." The aluminized mylar diaphragm used for the mirror dome, for instance, functioned as a low-pass filter for any sound coming out of the loudspeakers installed behind it.[20] In the 1972 *Pavilion* book, the physicist Elsa Garmire, who was in charge of designing the mirror structure, also reported one distinct characteristic of the interior space: "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."[21] This naturally made things catastrophic for Pepsi's original plan: "the Pavilion […] was acoustically the worst design imaginable for a live rock group because they would not be able to hear themselves playing."[22] As far as Tudor was concerned, however, this was simply the nature of the materials he was given. And if sound as an instrument had its own physicality, so did the space *it* created: "You see, for me, sound space is more physical: I can almost touch it."[23] As if to prove this point, Klüver recalled in 2001, Tudor even brought the entire mirror dome into sympathetic vibration with his sound space:

> *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.*[24]

[19] Ibid. Others have called this sound space "aural architecture": Barry Blesser and Linda-Ruth Salter, *Spaces Speak, Are You Listening?: Experiencing Aural Architecture* (Cambridge, MA: MIT Press, 2007).

[20] According to Larry Owens's report, "We can consider the air structure surface as a porous diaphragm which is placed in front of the speaker. This diaphragm acts as a filter to all sound passing from the speaker to the inside of the dome. The filter has a low frequency cutoff due to the mechanical properties of a diaphragm and a high frequency cutoff dependent on the material used in the diaphragm. It is felt that the diaphragm will be so flexible as to pass all sound in the lower end of the audio spectrum. Under the worst case of ideal speaker cone-diaphragm coupling, the diaphragm should vibrate no more than ⅛ inch, causing no damage to the diaphragm material. The high frequency cutoff of such a system however is well within the audio spectrum. A typical cutoff frequency for the material is about 4 kHz" (Owens, "Feasibility Study on the Incorporation of the E.A.T.-Designed Sound System with an Air Structure," Box 17, Folder 2, David Tudor Papers, GRI).

[21] Elsa Garmire, "An Overview," in *The Pavilion*, 190.

[22] Ibid.

[23] Lindgren, "Into the Collaboration," 18.

[24] Billy Klüver, "Talk on David Tudor, Getty Center (May 17, 2001)," Klüver/Martin archive.

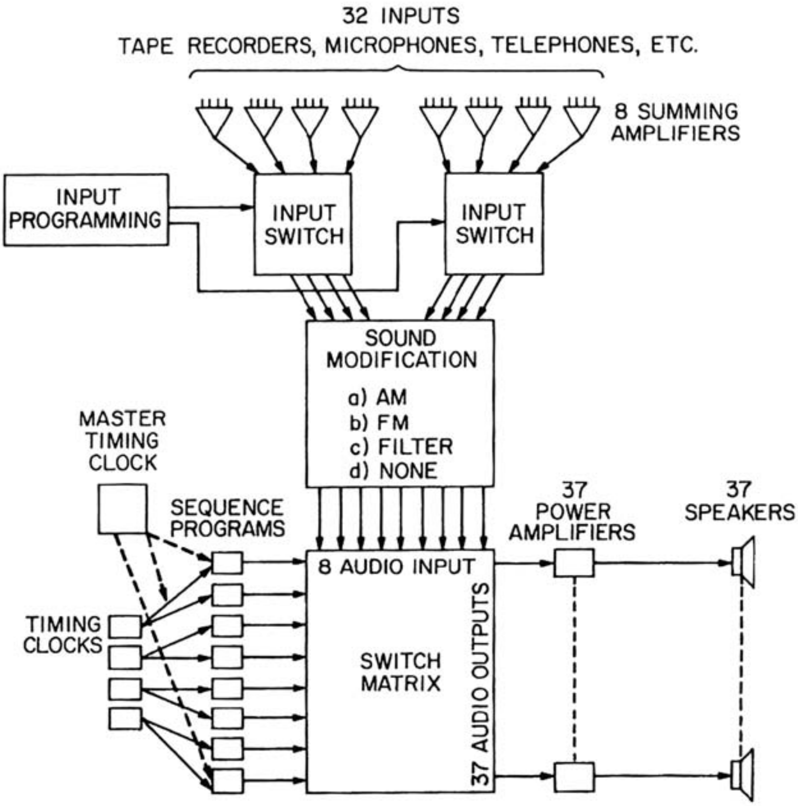


Figure 5.5 E.A.T | Diagram of the *Pepsi Pavilion* Sound System | 1970
Klüver/Martin archive | Courtesy of Experiments in Art and Technology

5

The sound system of the *Pepsi Pavilion* can be thought of as being composed of three relatively distinct levels: input, modification, and output (Figure 5.5). For input, the assembled *Pepsi Tapes* could be played from sixteen quarter-track monaural tape recorders, with the extra option of microphones, audio generators, and telephones. For output, Tudor wanted to move twenty channels independently across multiple loudspeakers at different speeds and patterns. A Bell Labs engineer named Larry Owens was invited for this job and designed a digital switching system that could individually activate each of the loudspeakers installed in a rhombic grid pattern behind the mirror dome (Figure 5.6).[25] To control

[25] Owens had then recently assisted Steve Reich on composing an instrument called the *Phase Shifting Pulse Gate*, which was used in pieces like *Pulse Music* from 1969 (Norma Loewen, *Experiments in Art and Technology: A Descriptive History of the Organization*, PhD dissertation, New York University, 1975, 284).

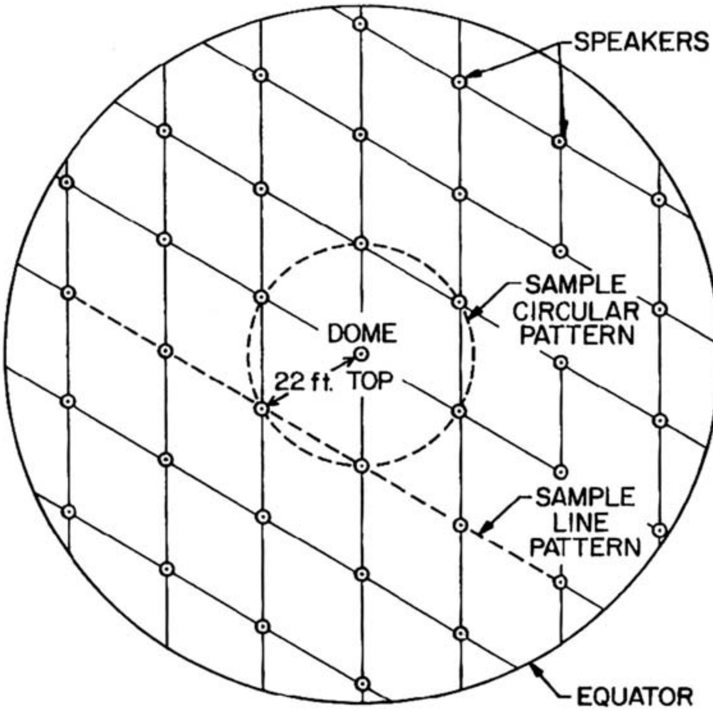


Figure 5.6 E.A.T | Diagram of loudspeakers in rhombic grid pattern | 1970
Klüver/Martin archive | Courtesy of Experiments in Art and Technology

the movement of sound, two types of program cards were used: (a) “Sequence Card,” to switch the order and pattern of activation; and (b) “Clock Card,” to switch the speed. The number of activated loudspeakers, along with the parameters of their movement, could thus be changed flexibly. Garmire further categorized the resulting sound experience into three basic types: (a) “Line sound,” a rapid switching of speakers in different patterns; (b) “Point sound,” with only one activated speaker at a time; and, (c) “Immersion or environmental sound,” in which sounds came from all around.[26]

But this flexible system came with a price. To realize the whole thing in time, Owens reduced the number of modulation channels from the requested twenty to a mere eight, and the number of loudspeakers from sixty to thirty-seven. Talking to Lindgren for the 1972 book, Tudor reflected on this problem as a difference in how numbers were conceived:

> *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*

[26] Garmire, “An Overview,” 190.

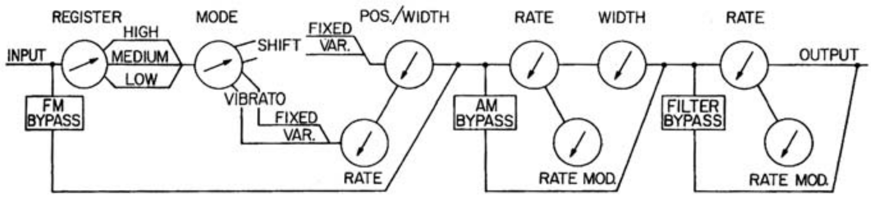


Figure 5.7 Gordon Mumma | Sound Modifier Console | 1970
Courtesy of Gordon Mumma

> *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.*[27]

For the engineer, the number of channels and loudspeakers was 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. But despite the impossibility of translation, he had no choice but to make do with what he was given: "I knew if I only got a part of what I asked for I could recreate my vision of what it would sound like."[28] Between the input that had been taken up by the rock group from the start, and the output that was beginning to take the engineer's shape, Tudor proposed to add a separate modification unit. For this, he turned to someone he knew well and trusted.

6

Upon Tudor's request, Gordon Mumma designed and built the eight-channel *Pepsi Modifier* which could take in as many as thirty-two inputs summed in groups of four, and process them through three stages, any of which could be bypassed: (a) frequency modulation, (b) amplitude modulation, and (c) high-pass filter (Figure 5.7). The first two stages were each built around the same *Motorola MC1545 Wideband Amplifier IC* chip and shifted the pitch or modified the loudness of the input signal with variable controls for the rate and width of modulation. The first stage also had a selection of pitch register as well as mode between vibrato and pitch shift.[29] The last high-pass filter was added at a late stage to compensate for the effect of the mirror

[27] Lindgren, "Into the Collaboration," 58.
[28] Ibid.
[29] Mumma had also made a *Prototype Pepsi Modifier* which he later passed on to Tudor, who used it extensively throughout the 1970s. Michael Johnsen, who studied the extant instrument at Wesleyan (Instrument 0130), observed some discrepancies between the names Mumma gave to each modulation

dome mylar acting as a low-pass filter,[30] as well as to enhance the beam-like quality of sounds coming out of the loudspeakers since higher frequencies are more directional.[31] The outputs from the eight channels were sent to an audio switching matrix which distributed them across the thirty-seven loudspeakers. In addition, each channel had an envelope follower in the sidechain that extracted the varying amplitude of the input signal which could then be used as a control voltage for modulation rates in all the three stages. In this way, instrumentalized sound was brought back into the *Pepsi Pavilion*.

But Mumma had also smuggled in something else. Although the conditions at the World's Fair required the instrument to be generalized, each channel was deliberately made somewhat different from every other to increase variability behind the apparent uniformity. As he recalled on November 4, 2016:

> *I used slightly different resistor amounts and capacitor amounts so that this was not a mass-produced thing. It was like a piano from Italy as opposed to a piano from England. I liked the differences so that whatever you did in channel one with exactly*

stage and the actual workings of the circuitry: "the 'FM' stage is simply a double balanced modulator. 'pitch shift' implies a sense of pitch while a BM creates inharmonic partials at sum and diff frequencies quite destroying a pitch feeling. BM sounds are often called clangorous, sort of the opposite of pitched. the 'AM' stage doesn't change amplitude fast enough to create partials—the lfo is too slow. it should just be described as simple tremolo. sure tremolo is technically a degenerate, very slow AM, but AM really implies that sidebands are created" (Johnsen, "Comment on the Manuscript of *Reminded by the Instruments*," January 12, 2019). Since the actual console installed in the *Pepsi Pavilion* has been lost for good, however, it is not possible to verify how much of the specifics found in the *Prototype* were shared with the finalized version.

[30] On October 29, 1969, Mumma wrote to Larry Owens: "Distressed, I am, to learn of our high-frequency attenuation for the Pepsi Pavilion [. . .] If the problem can be solved by holes cut in the dome, that's fine. Otherwise, I think we should put in active, not passive, equalization to compensate for the problem. Unless you've got enough gain in the power amps to make up for the loss in the passive units. Perhaps upgrading the output of the power amps would not cost very much? If there is a separate power amp for each of the 37 loudspeakers it might cost a bit. [. . .] May I suggest that you only need eight equalizers, at the input to the 8 x 37 switching matrix. I'm sure they could fit even into the Sound Modifier Console itself. I'm using that HH Smith panel holder for my eight modifier boards, and there's room in the holder for several more boards. I don't think I've got time to design the equalizers myself, if that is the procedure that proves to be most feasible, but there is room in the Modifier to mount them. They could be wired directly from the Modifier outputs, which would not be a problem for unmodified sounds since they would be after the bypass switching functions. It might be a disadvantage to have them in the Modifier console if the panel-mounted bypass jacks are used. We'd have to take that into account, so that any external patching always put the audio into an equalizer before the switching matrix. Surely it's not a problem to make eight op-amps to incorporate with an equalizer, in order to get the gain back where it belongs. But I think we must have that high-frequency response, no matter how it's achieved. 4khz isn't even AM broadcast standards. Scratchy old optical film tracks give us 8khz. The world craves that two octaves from 4khz to 16khz. How's Pepsi going to like it, not being able to hear the fizz?" (Mumma, "Letter to Larry Owens [October 29, 1969]," Box 46, Folder 12, Experiments in Art and Technology records, GRI).

[31] According to Mumma's recollection on November 4, 2016, this concern for directional sounds was inspired by the exploration of visual reflections: "And the concept early on—I'm speaking about the Pavilion itself—had to do with what happens to light reflections and image reflections. But they extended beyond the visual to the acoustical, so in the test, things were made here and in California way in advance. There was a situation where we could speak to each other very quietly and the loudest place was way over there, somewhere where you heard the sound, right? That spooky acoustics, but also spooky image echoes. And they worked it out to get those reflective characteristics very carefully" (Mumma, "Interview by Nakai," November 4, 2016). The role of visual reflection implemented in the *Pepsi Pavilion* by Tony Martin is discussed in Chapter 6.

the same settings as on channel three, they were always different—they were different instruments. So in a sense, I made a collection of period instruments.[32]

In particular, an undated note in Tudor's hand reveals that the high-pass filters all had the same fixed cut-off rate (attenuation of around 12 dB per octave[33]) but different cut-off frequency ranges for each channel.[34] The diversity was carefully composed:

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.*[35]

None of these variations was visible on the front panel of the console. On that side, however, Mumma had devised yet another coordination with Tudor's music, although this one concerned not the particular channels but the modifier in its entirety. Since each channel had twelve knobs, the total number of controls in all the eight channels added up to ninety-six. Mumma saw a special significance in this number. Ninety-six, he later explained to Lindgren, was "the same order of magnitude of combinations as one has with a large organ."[36] Knowing very well about Tudor's early connection to that instrument, he 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] In other words, his conception of numbers was also real. After all, it wasn't for nothing that the interface of the organ and the *Pepsi Modifier* both shared the same name of "console" (Figure 5.8).

But Mumma's arithmetic of magnitude contained a small error he could not have anticipated.[38] A review of all the problems encountered in the sound system, written

32 Mumma, ibid.

33 12db/oct would have required two resistor/capacitor stages. Johnsen, however, noted that the filter section of the *Prototype Pepsi Modifier* contains only one resistor/capacitor stage (followed by a fixed series capacitors). As a result, the actual attenuation is less sharp in the *Prototype*.

34 Tudor, "Note on the *Pepsi Modifier*," Box 17, Folder 3, David Tudor Papers, GRI.

35 Mumma, "Interview by Nakai," November 4, 2016. Also see Maggi Payne, "The System Is the Composition Itself," in *Music with Roots in the Aether,* edited by Robert Ashley (Cologne, Germany: Musiktexte, 2000), 118–119.

36 Mumma, quoted in Lindgren, "Into the Collaboration," 19.

37 Ibid.

38 Mumma's speculation forty-six years later suggests the similarity of the problem with *9 Evenings*—mis-wiring due to shortage of time: "You know, it's so far away that I can't speculate how that is, except that there are two aspects which may contribute to the possibilities of what that situation was. One is that when I completed this thing in New York City, which was to go out three days later—they were flying it over to Tokyo—I had made very careful schematic diagrams because I knew they had to do some engineering stuff. And I was very specific about the power connections, which were DC connections, and I was very specific about the color lines that defined the difference between negative and positive. *Very* specific. And I had instructions, and I had a thing glued onto the thing that you could take off because that is so commonplace. Well the thing ended up there, [. . .] and when they were installing the whole thing [. . .] they mis-wired the electrical power. [. . .] And then Fred Waldhauer called me—he was still here in the San Francisco area—and he told me what had happened, and I said, "oh, Jesus." The best he understood was that they mis-wired the power thing. Now they were having trouble with this all along because the power situation there is in anyways different. So that was my first assumption" (Mumma, "Interview by Nakai," November 4, 2016).

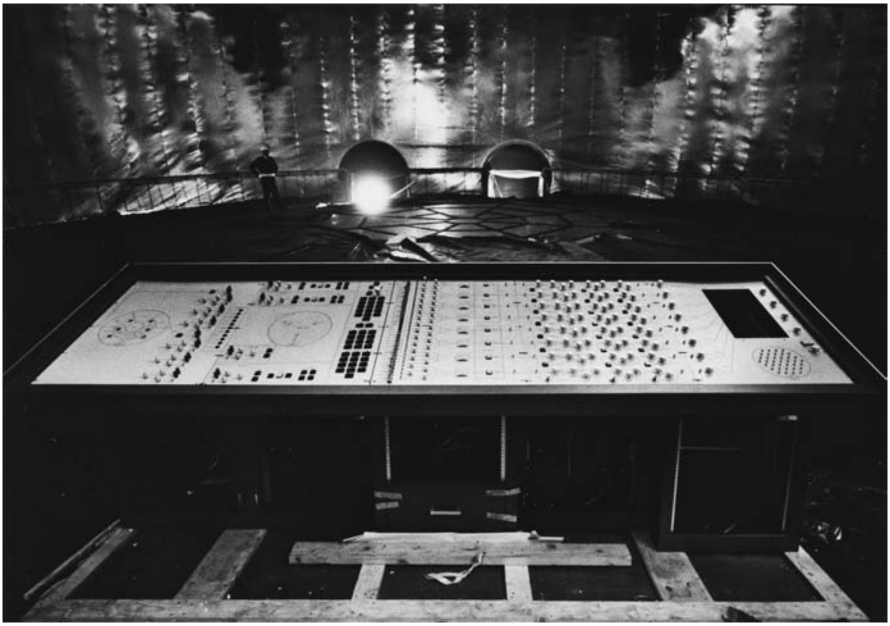


Figure 5.8 *Pepsi Pavilion Sound Modifier Console* | 1970
Photo: Shunk-Kender © J. Paul Getty Trust. Getty Research Institute, Los Angeles (2014.R.20)

by Tudor, Waldhauer, and Martin on April 22, 1970—just over a month after the *Pepsi Pavilion* had opened its doors and only three days before they were dismissed by Pepsi—reported an issue in the console: "Sound modification board for channel eight not installed."[39]

Pepsi Pieces

1

The former software librarian Burchfield recalled in September 2014 the daily routines at the *Pepsi Pavilion* in the one month of preparation before its opening on March 15:

> *We would work and work and work, and in the afternoon Billy [Klüver] would call us all in to play in the space, and we would do things, we would try different things, we would literally spend couple of hours in the afternoon playing in the space. It was like a big instrument! The whole place was a big instrument.*[40]

[39] Tudor, Fred Waldhauer, Julie Martin, "Quick Review of Problems Encountered in Sound System (April 22, 1970)," Box 17, Folder 7, David Tudor Papers, GRI.
[40] Burchfield, "Interview by Nakai and Driscoll."

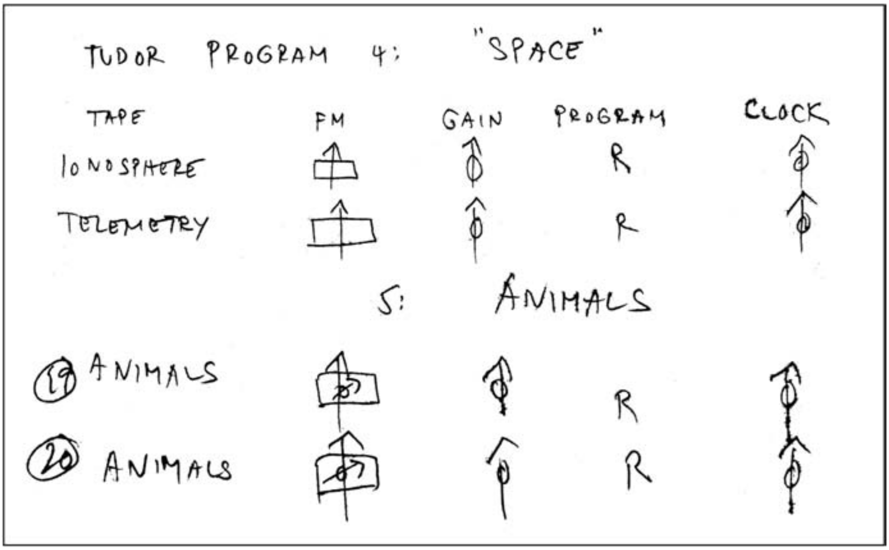


Figure 5.9 Tudor | Program 4, *Space*/Program 5, *Animals*, setting diagram | 1970
DTP, Box 17, Folder 2 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

Through these afternoon sessions, Tudor began creating nine or ten "programs" for his giant instrument. At least that was the number he gave Lindgren soon after his return from Osaka, and to Teddy Hultberg eighteen years later, although only four of them were grouped together and became known as the *Pepsi Pieces*.[41] In the sketched diagrams, each program received a number:

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

Two more diagrams have been found among Tudor's papers, corresponding to two more programs that fill in the gap between *Anima Pepsi* and *Microphone* (Figure 5.9):

Program 4 = *Space*
Program 5 = *Animals*

Out of these six programs, *Pepsibird, Anima Pepsi, Space*, and *Animals* made use of the *Pepsi Tapes*, processing selected sources through the *Pepsi Modifier* and

[41] Based on Tudor's account, Lindgren wrote that he "created *nine* programs for the Pavilion" (Lindgren, "Into the Collaboration," 58). In May 1988, Tudor similarly claimed, "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" (Tudor, "Interview by Teddy Hultberg," davidtudor.org).

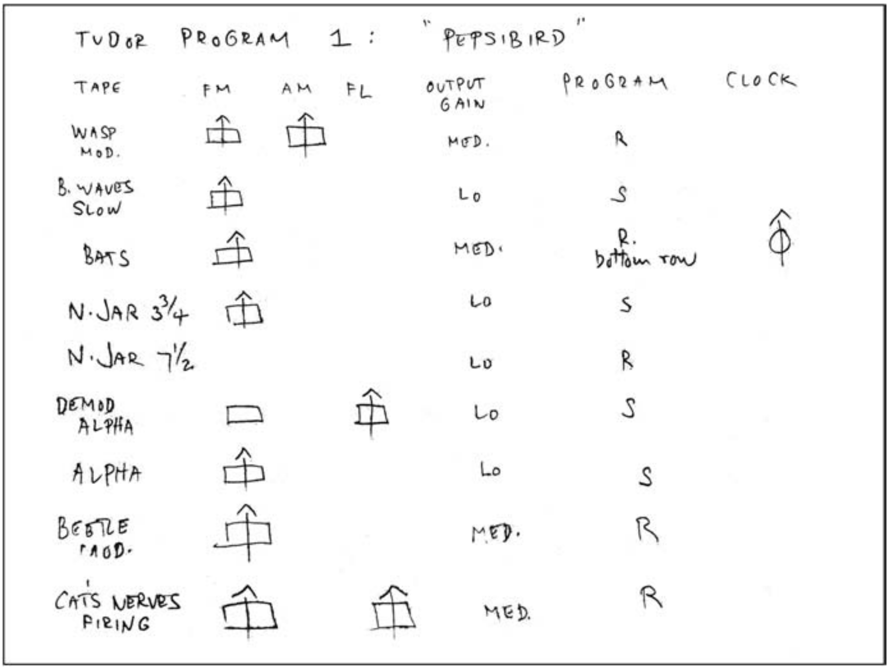


Figure 5.10 Tudor | Program 1, *Pepsibird*, setting diagram | 1970
DTP, Box 3, Folder 10 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

distributing them across the thirty-seven loudspeakers. Burchfield remembered the care they took to choose the specific tapes that would be sent to the console:

> *When we were selecting sounds, we were looking for—much like you do in* Rainforest*—you look for different textures of sounds, dynamics and things like that.* [. . .] *The selection of sounds, it's not random. You know if you have a repeating sound in it, or a crashy other kind of sound up against and it's really the crux of what the music is.*[42]

Two types of materials are found for these programs using tape input: (a) handwritten diagrams that list the names of source tapes, type of modulation, gain settings, speaker patterns ("R" for "Rotating," and "S" for "Stationary"), and switching speed controlled by clock cards; and (b) a typed description, which does not include *Space* and *Animals*, similarly listing the source tapes but numbering them, and with an additional text describing the method of performance.

The diagrams and the descriptions do not match completely. For instance, Program 1 is a "live mix of ten source tapes" according to the latter, although the former only

[42] Burchfield, "Interview by Nakai and Driscoll."

lists nine sources (Figure 5.10). The sources themselves also differ. The description for the same program lacks two tapes that appear in the diagram but adds three others. All in all, the typed description labeled "Four Pepsi Pieces" gives a more organized and systematic presentation of the programs, and was probably written later. The diagram, in comparison, appears more like a shorthand of the settings that were tried out at the *Pavilion*.

2

Despite its title, the ten source tapes for Program 1 *Pepsibird* did not include any birds other than the two *Nightjars* in different speeds, and no other flying creature except for *Bats*. Instead, most were recordings of neural activity—which may have sounded like birds to Tudor, or may have connected to the theme of "flight," albeit on a miniature scale: *Cat's Eye, Nerves Firing, Bats, Brainwaves Slow, Brainwaves Regular, E.E.G.* (electroencephalography—the brain's spontaneous electrical activity), *Alpha Waves AM-FM, Modified Nightjar Slow, Modified Nightjar Regular*, and *Demodulated Alpha [Waves]*. The instruction reads as follows:

> 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 [sic] 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.[43]

Tudor's focus here is clearly on setting a relationship between the source tapes and the loudspeaker patterns. For this reason, the use of the *Pepsi Modifier* is kept at a minimum, even allowing for the possibility to bypass it entirely (the conditional "if modified through the console," along with the addendum "[five source tapes] may be modified through the console channels," obviously implies that they may *not* be

[43] David Tudor, "*Pepsibird*, Typed Description," Box 3, Folder 10, David Tudor Papers, GRI.

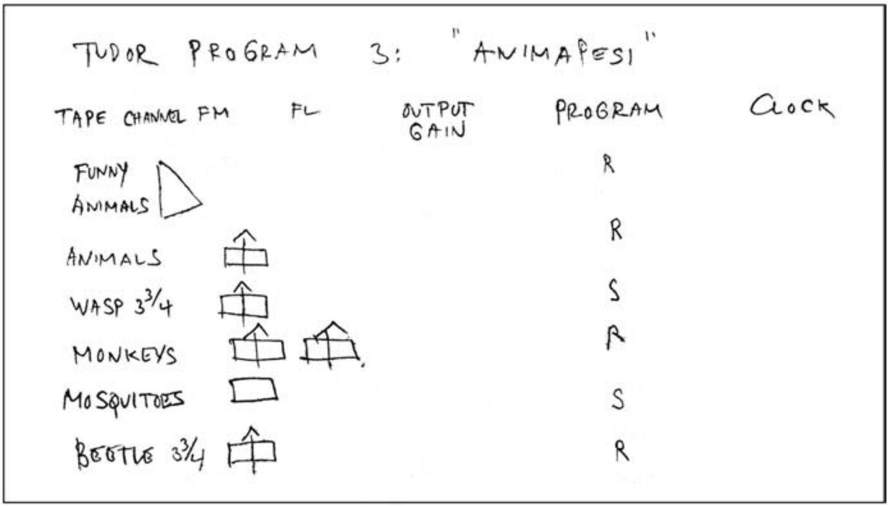


Figure 5.11 Tudor | Program 3, *Anima Pepsi*, setting diagram | 1970
DTP, Box 3, Folder 10 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

modified at all). The distinct identity of sources achieved by limiting the number of simultaneously played tapes was necessary in order to clarify the changes occurring at the output end. In other words, Tudor's first program for the *Pepsi Pavilion* did what he had been planning all along: to move sounds across multiple loudspeakers in different patterns and speeds in order to define the interior space of his instrument. The source tapes can indeed be identified quite easily in the extant eighteen-minute recording which starts with the chirping melodies of *Bats* captured by ultrasonic receivers, which are soon joined by rapid machine-gun-like clatter of *Modified Nightjar Regular*, and later with more watery and bubbly sounds of *Demodulated Alpha* and *E.E.G.*[44]

3

This focus was turned inside out in Program 3 *Anima Pepsi* (Figure 5.11). The source tapes consisted of animal and insect sounds with no overlap with *Pepsibird*. The typed description adds two sources not found in the diagram, making a total of nine: *Mosquitoes, Monkeys*, *Insects*, two *Animals, Fly on Flypaper Modified, Wasp Chewing Modified, Beetle Walking Modified*, and *Funny Tape*. The instruction reads as follows:

[44] There are two identical recordings of *Pepsibird* among Tudor's collection at GRI (C88 side A and R19), which are also the same as the one in *The Art of David Tudor: 1963–1992* (disc 2), New World Records (80737), 2013, 7 CD. The same CD set includes recordings of *Anima Pepsi* and *Pepscillator* as well.

> 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.[45]

Contrary to the first program, Tudor's focus here was in exploring the nature of Mumma's *Pepsi Modifier*. This also explains the fact that no mention is made of the speaker patterns, except that they and their speed should be changed. The simplicity of instruction connects to an interesting detail about this program. Burchfield recalled performing it several times when Tudor could not: "The one I did myself, that he actually let me play, was *Anima Pepsi*."[46]

When Matt Rogalsky analyzed the difference between these two programs in 2013, he focused on the nature of the source tapes to be modified: "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."[47] This polarity between "interior" and "exterior," however, is itself turned inside out when the nature of modification is considered. For Tudor used the 'interior' sounds of *Pepsibird* to define the entire space of the pavilion *exterior* to Mumma's modifier, and the 'exterior' sounds of *Anima Pepsi* to explore the *interior* operations of the same modifier. The polarity of "inside" and "outside" is relative to the focus of the program, each directed to a different scale of the instrument, one housed inside the other—a simplified version of the multiple nesting of physical and metaphysical levels in *Bandoneon!*. The two remaining programs bring this point home.

4

If the first program, *Pepsibird*, realized what Tudor had been planning to do all along, the second program, *Pepscillator*, developed out of his initial engagement with the actual *Pepsi Modifier*.[48] "[Mumma] made eight channels of modification," he reminisced to John David Fullemann on September 3, 1982. "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."[49] Following what had by then become his customary method, Tudor wrapped feedback across the multiple channels, connecting the output of one to the input of another. As is obvious from the title, Tudor had modeled this no-input configuration on an oscillator,

[45] Tudor, "*Anima Pepsi*, Typed Description," Box 3, Folder 10, David Tudor Papers, GRI.

[46] Burchfield, "Interview by Nakai and Driscoll."

[47] Matt Rogalsky, "Liner Notes," in *The Art of David Tudor* (New World Records, 2013).

[48] Tudor drew a sketch of *Pepscillator* on the back of an envelope with the date stamp of March 19, four days after the *Pepsi Pavilion* opened. It therefore appears he started working on the second program in the second week of the Expo (Tudor, "Sketch of *Pepscillator*," Box 108, Folder 8, David Tudor Papers, GRI).

[49] Tudor, "Interview by Fullemann," davidtudor.org.

returning once again to his discovery of saturated amplifiers in *Bandoneon!*: "Seven channels of sound modification hooked up together to form a complex oscillator, without using external input material of any kind."[50]

The diagram shows the seven channels—seven, since the eighth channel was never installed—divided into three main oscillator sections, each framed by a yellow square (Figure 5.12). The only section that would actually oscillate is formed by the top three channels, where the output of channel 2 is returned to its own input through channels 5 and 7. The other four channels below are dedicated to output processing, connected in chains without forming a loop. Naturally, therefore, the sensitive control points concentrated in the first three channels. Tudor wrote down a specific procedure for activating this giant oscillator: the process starts from channel 2 with its frequency modulation stage set to high register and in variable pitch shift mode, which makes it controllable by the amplitude of the incoming signal; all the controls in the amplitude modulation stage are variable. Oscillation is obtained by gradually opening the gain for channels 5 and 7, and adjusting the width control for their amplitude modulation.[51]

Mumma's *Pepsi Modifier* contained four oscillator sections to be used as internal control signals for the three stages of processing. Which is to say that *Pepscillator* formed yet another case of instrumental synecdoche. These oscillators, used for something other than generating audible sound, nonetheless influenced the audible sound generated by the "complex oscillator" housing them.[52] In one sketch, the same feedback configuration that became known as *Pepscillator* received another name which was more about the character of sound than the instrument which produced it: "Rhythms."[53] As Tudor later reminisced to Hultberg in May 1988, when he patched *Pepscillator* together and gradually opened the gains, "rhythms began to appear and the degree of their variability was really extraordinary. [*laughter*] When I was performing this at the pavilion, people started to dance on the floor. [*laughter*]"[54] The appearance of rhythm was due to the fact that three out of four internal oscillators were set in frequency too low for humans to hear. Instead of producing audible pitch, the shifting subaudible tones articulated the signal, impressing a repetitive pattern that gradually transformed itself as it progressed. Oscillators thus functioned as modifiers in the feedback path.[55]

50 Tudor, "Four Pepsi Pieces," Box 3, Folder 10, David Tudor Papers, GRI.

51 In general, what triggers oscillation in a feedback setting is thermal noise generated by powering the device on, which then becomes smoothed into a sine wave as the signal goes around the loop through a filter (or any modifier which is bound to have a filter-like quality). Therefore, as Tudor happened to be describing quite literally, all one needs to start the process is to "activate" the instrument. In other words, there appears to be no input because the physical operation of turning the switch on becomes the input.

52 In a later note for *Untitled*, another no-input feedback music composed two years after the *Pepsi Pavilion*, Tudor employed a more straightforward description: "the configuration of devices & their interconnections, was conceived of as a 'Giant Oscillator'" (Tudor, "*Untitled*, Description," Box 3e, Folder 3, David Tudor Papers, GRI). *Untitled* is discussed in Chapter 7.

53 Tudor, "Sketch for Rhythms," Box 18, Folder 2, David Tudor Papers, GRI.

54 Tudor, "Interview with Teddy Hultberg." A recording of *Pepscillator* is included in *The Art of David Tudor* (disc 2) (New World Records, 2013).

55 Furthermore, Johnsen has revealed that, as far as the *Prototype Pepsi Modifier* is concerned, these internal oscillators also conditioned the very generation of no-input feedback. Their leaky nature caused

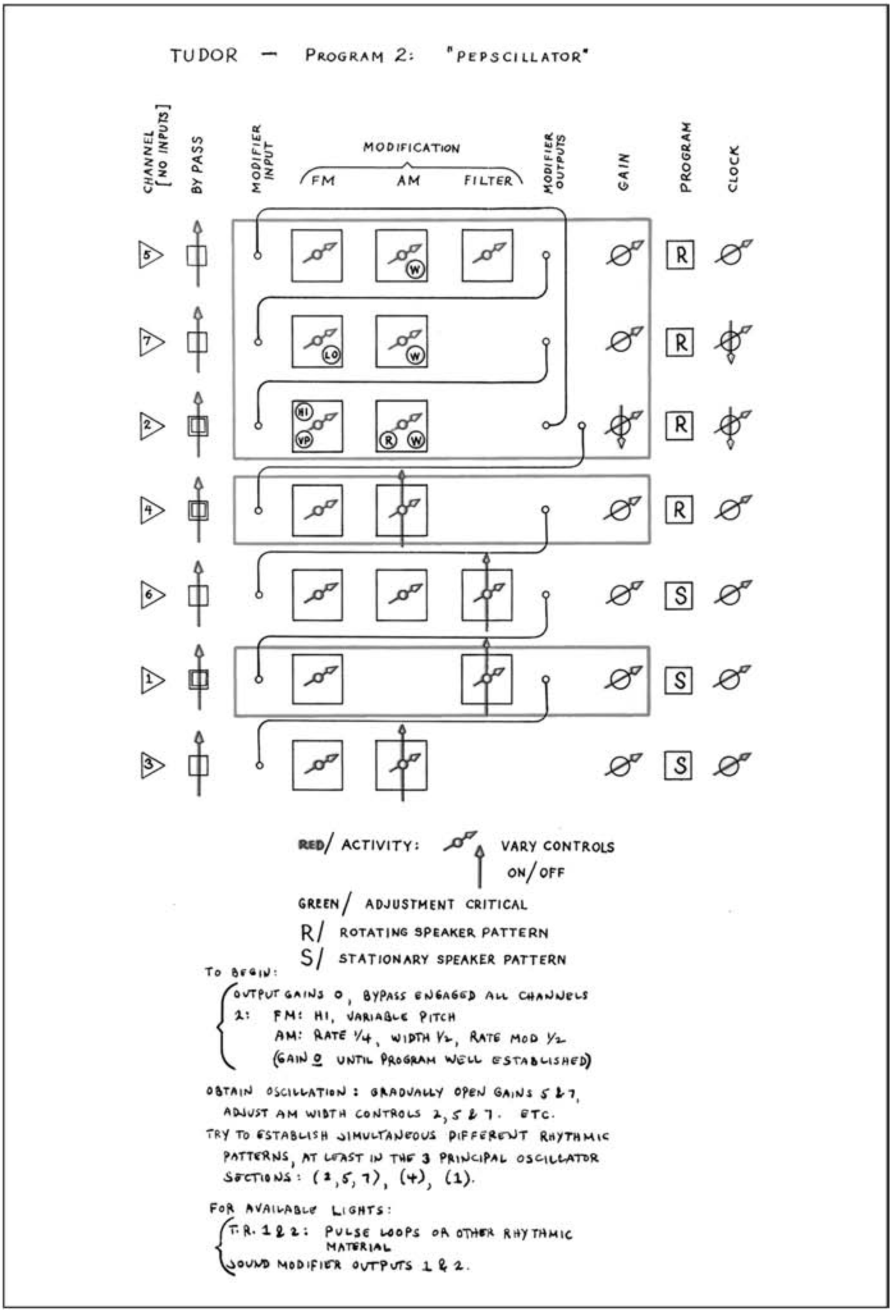


Figure 5.12 Tudor | Program 2, *Pepscillator*, diagram

Klüver/Martin Archive | Courtesy of David Tudor Trust | Undated (presumably 1970)

Under the occult influence of the "Rock Environment," Tudor's approach to feedback had shifted: he no longer started from the start but from the middle point. After all, not having to squeeze the bandoneon during the performance set his hands free and allowed him to manipulate the modulation channels instead. In this way, what lay in the periphery in *Bandoneon!* now became the center. The rhythmic articulation of low-frequency oscillators was also a way out of the continuous tone that had always been associated with feedback since *Variations II*. Tudor could now generate a constant supply of *non-continuous* sound modified with inaudible sounds.

5

But it was not only hands that were set free at the *Pepsi Pavilion*. Another benefit of not having to play the bandoneon was that Tudor could now walk around the space. This ability was put to good use in the last program, *Microphone*, which also explored feedback oscillation but turned the focus inside out to the interior space of the *Pepsi Pavilion*. Taking a stroll away from the console, Tudor used two shotgun microphones, one directed at the loudspeakers behind the mirror dome and the other at some random space, to create discrete bursts of feedback that were regulated by the slow rotating pattern of activated speakers (Figure 5.13).

The primary input from the microphone pointed toward the loudspeakers was processed through amplitude modulation, while the secondary input from the other microphone went through the other two stages of frequency modulation and high-pass filtering. The two microphones thus transformed the entire *Pepsi Pavilion* into a giant oscillating echo chamber which accumulated and reinforced its own resonant characteristics as acoustic feedback was gated intermittently by the programmed movement of activated loudspeakers, again converting the otherwise continuous tone into rhythm—albeit at a much slower rate. Fourteen years later, Tudor recounted the experience to Fullemann:

> *So one day I got up there and I was performing . . . I took the two shotgun microphones and aimed them at random into the space. And then I used the slowest clock patterns amongst the speakers. And it worked like a charm. I mean, you could never tell when there was going to be a sound. And of course they were modified through the modification capability, so it was very beautiful.* [. . .] *Eventually you felt like you were on a barren seashore, listening to birds coming and going occasionally and there'd be a silence for a long period, then all of a sudden . . .*[56]

bleed into the main signal path, which assured that "there's always enough rumble in the signal floor to get an oscillation going once you add some gain" (Johnsen, "Comment on the Manuscript").

[56] Tudor, "Interview by Fullemann."

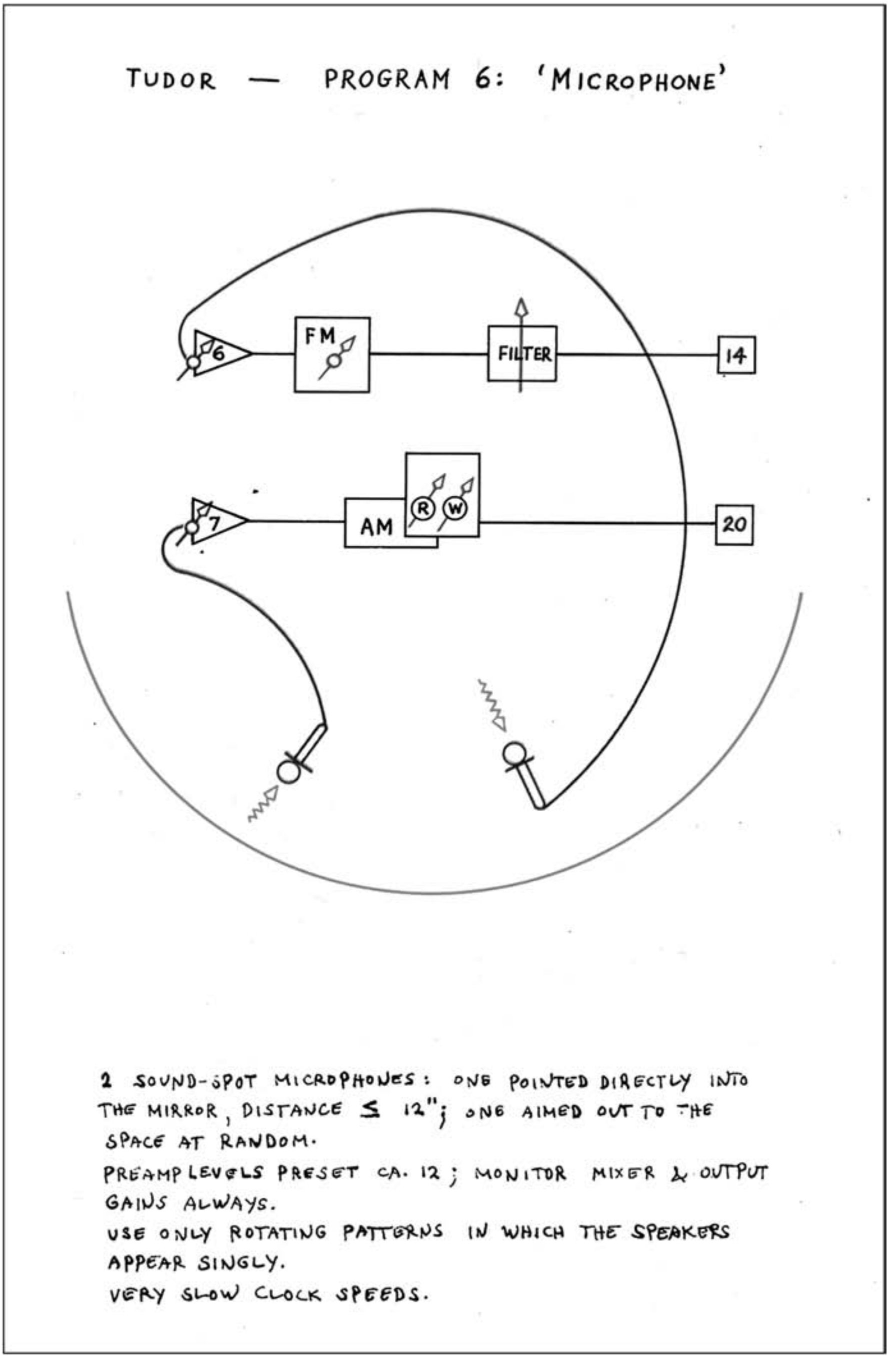


Figure 5.13 Tudor | Program 6, *Microphone*, diagram | Undated (presumably 1970)
Klüver/Martin Archive | Courtesy of David Tudor Trust

6

With these two no-input feedback programs Tudor dissolved the polarity between generation and modification of sound that had haunted him since the start of the project. For the very difference between generating and modifying sound ceases to exist in a system that generates sound from within the process of modification. If there is no input, there is no problem of input. The method of "single performer feedback" at the Armory revolved around Tudor himself influencing the regeneration of white noise from scratch. If the self-multiplication process was taking over, he could simply use Kieronski's "reset button" to cut off everything. At the *Pepsi Pavilion*, where he had to start from the modifier, Tudor turned the modifier into a generator and discarded external input completely.

But when he later selected the four *Pepsi Pieces* out of the nine or ten programs he made, Tudor coupled the two no-input feedback programs with two other programs that were based on the processing of input. So there must have been something they did that he thought the other two did not. Indeed, the four programs can be seen as neatly complementing one another, exploring the two scales of Tudor's instrument in two different ways:

Anima Pepsi: input processing, focusing on the *Pepsi Modifier*
Pepscillator: no-input feedback, focusing on the *Pepsi Modifier*
Pepsibird: input processing, focusing on the *Pepsi Pavilion* as a modifier
Microphone: no-input feedback, focusing on the *Pepsi Pavilion* as a modifier.

Each program discovered one instrument inside or outside another. The puzzling gap between the composition of a single *Pepsi Pavilion* and that of many *Pepsi Pieces* is thus turned inside out to reveal the multiplicity of the instrument itself.

The View from Inside

1

On July 12, 1995, Tudor looked back at his life and admitted to Jack Vees: "Well, I admired the organ music a great deal. You could say that my sound imagination was controlled by it. And even to this day, you could see the traces in my own music."[57] Like the haunting effect of the abandoned "Rock Environment" at the *Pepsi Pavilion*, Tudor's earlier engagement with the so-called king of instruments

[57] Tudor, "Interview by Jack Vees (July 12, 1995), 241 r," *Oral History of American Music*, Yale University Library, 3.

continued to exert its influence long after the explicit coordination was gone. This source of inspiration has been observed by Mumma, who likened the magnitude of his own *Pepsi Modifier* console to that of Tudor's beloved instrument. One reason he knew this was because he had often accompanied his friend on excursions to churches with historic organs in European towns as they toured with MCDC. Whenever he was allowed, Tudor 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."[58] These techniques are all present in Tudor's electronic music. Furthermore, the unique character of each organ, never quite the same from one church to the next, is reflected in the miscellaneous nature of his sound systems—something Mumma also simulated when he designed the channels of the *Pepsi Modifier* as a collection of period instruments.

But aside from all these correspondences, the exposure to the largest of all musical instruments whose body extends to the interior space of the church it is installed in appears to have also inspired in Tudor an extraordinary idea about the *physical scale* of instruments. That is to say, the likeness between the *Pepsi Pavilion* and the organ went beyond the mere number of controls on the console. It was not only the scale of interface that they shared, but also the scale of what that interface controlled and how it did so: both instruments processed a constant supply of potential sound source, which was output as sound through the pipes or the loudspeakers, letting it reverberate throughout the entire architecture which housed them.[59]

In electronic music, it is common to call an electronic device, or even a configuration of multiple devices, an "instrument." But Tudor's conception of the *Pepsi Pavilion* as a musical instrument does more than just expand the term to include many objects. For if the oscillating dome in its entirety is a musical instrument, then the musical instrument is obviously *larger than a human being*—as with the organ, listeners and performers alike are now housed inside the instrument. Tudor consequently becomes not only a composer of the *Pepsi Pavilion*, but also its component, and quite literally so.

[58] Mumma, "With Tudor the Organist," in *Cybersonic Arts*, 145.

[59] Blesser and Salter also explain how the sound-generation mechanism of the organ based on gating requires the instrument to encompass the entirety of the architecture housing it: "Reverberation is even more critical to organ music, which, because an organ pipe's valve is an on-off device with no intermediate intensity, sounds dreadful without it. Unlike pianists, organists cannot produce gradual changes in loudness by varying the velocity or pressure on the keys, and they have no equivalent of the sustain pedal. They must therefore rely on reverberation to produce smooth decay and mixing. The famous organist E. Power Biggs, wrote that 'an organist will take all the reverberation time that he is given, and then ask for a bit more, for ample reverberation is part of organ music itself. . . . Certain French music depends so completely on long periods of reverberation that, no matter how well played, in acoustically dead surroundings it falls apart into disconnected fragments' " (Blesser and Salter, *Spaces Speak, Are You Listening?*, 102–103).

2

Composing giant instruments by enlarging the "unique character" of a specific electronic component would become a method of sorts for Tudor. Following the description of *Pepscillator* as a "complex oscillator," *Untitled*, another no-input feedback piece from 1972, would be described as a "giant oscillator." During an interview on November 24, 1988, Tudor revealed that "I don't use electronic reverb," and proceeded to explain what he did instead: "You can have a single sound which is processed through many devices without the listeners knowing that it's actually just one sound. In this way, I have a natural reverb, because if I make eight variations from the same sound, it becomes like a reverb"—a giant reverb, so to speak.[60] John D. S. Adams, who worked as the sound engineer for MCDC in the early 1990s, described Tudor's treatment of loudspeakers in a similar way:

> *Tudor* [. . .] *used his acoustic environment as a big EQ. 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.*[61]

Tudor had referred to his instrumental loudspeakers with individual frequency responses as mechanical filters, which had always been larger than normal electronic ones since they first appeared on moving carts in *Bandoneon!*. Seven years later, during a two-week workshop in the New Music in New Hampshire festival held in the early summer of 1973, *Rainforest* was expanded into a group piece, and the sizes of the objects to which transducers were attached grew larger through the initiative of younger participants like John Driscoll, whose background was in sculpture.[62] At the presentation on July 7, the last evening of the festival, a forest of nineteen giant parametric objects were hung inside a huge barn and performed by Tudor and nine or so workshop participants as audience members walked around and listened for five and a half hours.

This experience led to the creation of a new group composed of workshop participants and Tudor to perform *Rainforest*. When they were invited for a week-long residency at the Festival d'Automne à Paris in October 1976, it became necessary to decide what the collective should be called. Through discussion with Driscoll, who by then had moved to Stony Point, Tudor came up with the name "Composers Inside Electronics" (CIE). When Fullemann asked him how the phrase came about eight years later, he explained: "Well, I tried to think of what we were doing, that other people don't do, and the thing is that we . . . first of all . . . that we built equipment but also that we think about what's inside."[63]

[60] Tudor, "Interview," *Revue et Corrigee* 2 (Spring 1989), 10. (Box 65, Folder 7, David Tudor Papers, GRI.)
[61] John D. S. Adams, "Equalization a la Tudor," davidtudor.org, accessed December 15, 2019. https://davidtudor.org/Electronics/eq.html
[62] Rogalsky has surveyed in detail the process through which *Rainforest* grew in scale: "Idea and Community," 213–246.
[63] Tudor, "Interview by Fullemann."

For the program note of their performance series at the Palais Galliera in Paris, Tudor wrote a manifesto-like text with the title "The View from Inside," which revolved around the topological polarity that gave the group its name:

> 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 their own musical ideas, arriving at that point of discovery, always incredible, where music is revealed from "inside," rather than from "outside."[64]

Reminiscent of Mumma's "Notes on Cybersonics" written six years earlier, Tudor opposed the cybernetic control of servomechanisms—servant machines—and called instead for a personification of non-human instruments. The result was music that revealed itself from within the nature of electronic components. But what "inside" means naturally changes according to what is viewed as an instrument. The very idea of enlarging electronic components beyond human size to compose giant instruments, which happened to be the other underlying principle in Tudor's music—*Rainforest* certainly being no exception—multiplies the view from inside. The human arranging a feedback path around an amplifier to make it oscillate could be said to be "inside" electronics, but so might a human walking around with a shotgun microphone inside an oscillating echo chamber. The nesting of instruments across scales relativizes the polarity between inside and outside.

Out of the four *Pepsi Pieces*, two of them processed selected *Pepsi Tapes* with the *Pepsi Modifier*. They can therefore be categorized differently from the other two programs, using yet another polarity: input versus no-input. This difference has indeed been used to make sense of Tudor's subsequent works.[65] But as far as the *Pepsi Pieces* are concerned, the polarity of input and no-input is coordinated to the view from inside a particular location: the main mirror dome. All that one sees in that space is the modifier console; even the loudspeakers are set behind the mylar. The tapes exist, but down in the control room, hidden from sight. As a corollary, one obvious fact is always overlooked: if the *Pepsi Pavilion* in its entirety is thought of as an electronic instrument, then the use of tape is something that happens *inside* it—which is to say, even *Anima Pepsi* and *Pepsibird* can be thought as having "no-input." From this point of view, the source tapes become analogous to the random thermal noise in the circuit that activates feedback, just on a much bigger scale. Tudor had indeed stressed the role of the *Pepsi Tapes* as being "only" an input in 1986. More recently, Driscoll recalled a rare public talk his friend gave on December 3, 1978, when CIE was in residency at Media/Study Buffalo, in which Tudor claimed that when using tape materials, "I really don't care about where it starts. All I care is what I end up with."[66]

[64] Tudor, "The View from Inside (1976)," Box 19, Folder 12, David Tudor Papers, GRI.

[65] For instance, D'arcy Philip Gray, "David Tudor in the Late 1980s: Understanding a Secret Voice," *Leonardo Music Journal* 14 (2004), 41–47.

[66] John Driscoll, "Interview by You Nakai," Long Island City, NY, November 19, 2011.

3

On October 9, 1958, Tudor visited the World's Fair at Brussels with Cage to give a piano concert inside the German Pavilion. They performed again the following day, this time in the French Pavilion. Standing nearby was the Philips Pavilion, the famous collaboration between Le Corbusier, Iannis Xenakis, and Edgard Varèse, housing 350 loudspeakers controlled by a switching system. Yet Tudor wrote nothing about it in the postcard he sent home to M. C. Richards. The only pavilion he mentioned was the Dutch one, which had an artificial wave built inside. "It makes a beautiful sound," he reported.[67]

This indifference may have been insignificant in 1958, but it extended all the way to 1970. The Osaka World's Fair alone included several well-known musical pavilions with multiple loudspeakers dedicated to complex spatialization of sound, most notably the West German Pavilion which housed a spherical concert hall designed by Karlheinz Stockhausen, and the Iron and Steel Pavilion where composers like Xenakis and Toru Takemitsu presented tape music. The sound system of these other pavilions was similar to that of the *Pepsi Pavilion*, from the use of many loudspeakers and the movement of sound across space to the control console allowing various forms of electronic modulation. If anything, they were more extravagant: the West German Pavilion had fifty loudspeakers installed across its walls; the Iron and Steel Pavilion boasted an impressive array of 696 speakers under the floor and 124 hanging from the ceiling. No document indicating the slightest interest on Tudor's part has been found.

Perhaps he was just too busy, perhaps more focused on exploring the multiplicity *within* his instrument rather than comparing it with a multiplicity of others. At least for Tudor, the comparison with other musical pavilions may have been something that belonged to the view from outside. But one must of course step out of the *Pepsi Pavilion* at some point.

4

Since the sound system was used by visiting artists from the second week, Tudor must have made the majority of his nine or ten programs before then. He could perhaps have gone on indefinitely, as the software librarian Burchfield reflected half a century later:

> *If we had stayed in the Pavilion for the six months that we were supposed to be there, he would have come out of that with totally other pieces than what we had in that first month or so, because it would have definitely grown and grown and evolved.*[68]

But on April 25, 1970, E.A.T. was ordered to leave the premises of the *Pepsi Pavilion* on immediate notice. Against Pepsi's strict demands to leave behind every single piece of

[67] Tudor, "Postcard to M. C. Richards (October 23, 1958)," Box 26, Folder 2, Mary Caroline Richards Papers, GRI.

[68] Burchfield, "Interview by Nakai and Driscoll."

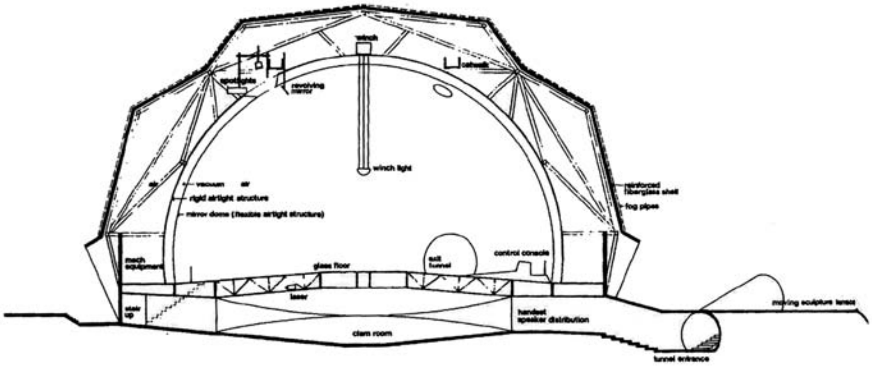


Figure 5.14 E.A.T. | *Pepsi Pavilion*, diagram
Klüver/Martin Archive | Courtesy of Experiments in Art and Technology

equipment and all the material the corporation had paid for, Tudor and others managed to remove the *Pepsi Tapes* and smuggle them out across the perimeter fence. With all the tapes and artists gone, Pepsi had no choice but to blast from the thirty-seven loudspeakers of Tudor's giant instrument the theme song from their previous offering at the 1964 New York World's Fair: *It's a Small World*.

As the lyrics to the well-known song attest, scale is a matter of perspective—but only to a certain extent. A given instrument suggests smaller components inside itself, as well as larger instruments that can be composed outside it using itself as a component. But there must be a physical limit to this constant relativization of scales if an instrument is to be actually composed and performed by a human being. How small is not so difficult to imagine—for Tudor, it must have been at the level of electronic components and integrated circuits. How large, on the other hand, is not so obvious.

Although Tudor was forced out from his giant instrument, a year of planning and a month spent inside it had modified him considerably, as if it were another yoga of long duration. Like the haunting control signals of the organ or the "Rock Environment," the *Pepsi Pavilion* would go on to bias his subsequent path in absentia. It was only with the benefit of hindsight that Tudor would select the four programs that best addressed the multiplicity of his instrument and the complex layers of inside and outside under the rubric of *Four Pepsi Pieces*. But once outside its premises, as the building receded into the distance, the same instrument may have also appeared smaller to Tudor's eyes. After all, the *Pepsi Pavilion* does look like *one* thing when seen from outside (Figure 5.14). Soon after returning from Japan, he began searching for the location of his next project. Tudor now wished to extend the scale of the instrument beyond the confines of man-made architecture into the expanse of a natural landscape.

Chapter 6
Island Eye Island Ear

Knavelskär

1

A report written in December 1974 by E.A.T. on the project *Island Eye Island Ear* informs the readers of the following facts:

> Knavelskär *is an island in the Swedish archipelago.* [...] *It is 800 meters long and 100 meters wide along most of its length, with 200 meters wide at its widest point. Its area is slightly less than 100,000 square meters. The highest elevation is at Top Hill 18 m. It is formed of uneven granite rock formations of varying heights, resulting from the glacial gee whose traces are still visible. On the eastern side the cliffs fall steeply into the sea while on the western side there are two beaches and several flat areas at sea level. The water surrounding the island is very deep, ranging from 36–77 meters. There is very little soil and vegetation consists of a few forest areas of birch and fir, many mosses and lichen, and a variety of sub-arctic flowers, and a few patches of berries. The island is a refuge for the eider and seagulls.*[1]

The report goes on to describe in detail a series of events that took place on the same island five months earlier. On July 7 of that year, Tudor set foot on *Knavelskär.* He was accompanied by a party of four or five people led by E.A.T. president Billy Klüver and his assistant Julie Martin. They carried with themselves two parabolic reflectors—one of 1.8 meters and the other of 1.2 meters—and a pair of smaller-sized Chinese woks, along with a large amount of electronic equipment including signal generators, loudspeaker drivers, oscilloscopes, and amplifiers. The owner of the uninhabited island had built a summer house near the South Dock Bay where the party set their base.

For the next two weeks, they stayed on the island researching its flora and fauna, landscape and rock formations, weather and wind patterns (Figure 6.1). Experiments were also conducted on the different configurations and positions of the parabolic speakers assembled from the equipment they had brought. Fujiko Nakaya, who had enveloped the entire *Pepsi Pavilion* with fog three years before, flew in from Tokyo

[1] E.A.T., "*Island Eye Island Ear*, Proposal (December 3, 1974)," Box 21, Folder 1, David Tudor Papers, GRI.

Reminded by the Instruments. You Nakai, Oxford University Press (2021). © Oxford University Press.
DOI: 10.1093/oso/9780190686765.001.0001.

Figure 6.1 Fujiko Nakaya | Composite photograph of *Knavelskär* | 1974
Klüver/Martin Archive | Courtesy of Experiments in Art and Technology

and joined the expedition for the second week. Swedish choreographer Margaretha Åsberg also visited the island to imagine what dances could be staged there. Tudor had invited his friend Jackie Monnier, who made kite art; although she wrote back enthusiastically on June 28—"I love the idea of your island project"—she could not make it to Sweden this time.[2] So, together with Klüver and Martin, he stopped by Villiers sous Grez in north-central France to pick up her kites before heading up to Sweden.[3]

On the thirteenth day, the group held a meeting to discuss the concept and the name of their new collaboration. The goal set by Tudor sounded like a contradiction: to reveal the nature of the island using technology. Everyone agreed that "Reflections" was too flat a title, but no one proposed a better alternative that day.[4] Within a month after his return to New York, Tudor came up with a new name. In the first proposal draft, typed on September 3, the *Knavelskär* project received the title of *Island Eye Island Ear*.[5] A concert was announced to take place ten months later in July 1975, but Tudor would work for more than ten years for its realization.

2

The project had begun officially about a year earlier. On October 27, 1973, Tudor was in Sweden with Klüver and Martin attending the opening of "New York Collection

[2] Jackie Monnier, "Letter to David Tudor (June 28, 1974)," Box 56, Folder 5, David Tudor Papers, GRI.
[3] "Driving with him from Paris to Stockholm in 1974," Klüver and Martin recalled in 1996, "we stopped at every major cathedral on the way and he described in detail the qualities and complexities of their organs" (Klüver and Martin, "Sound into Image: The Collaboration between David Tudor and Sophia Ogielska," in *Toneburst: Maps and Fragments, 1995–1996*, catalog, 1996).
[4] E.A.T., "Report on Experiments for 'Knavelskär' Project (August 8, 1974)," Box 21, Folder 1, David Tudor Papers, GRI.
[5] E.A.T., "Proposal for *Island Eye Island Ear* (September 3, 1974)," Box 21, Folder 1, David Tudor Papers, GRI.

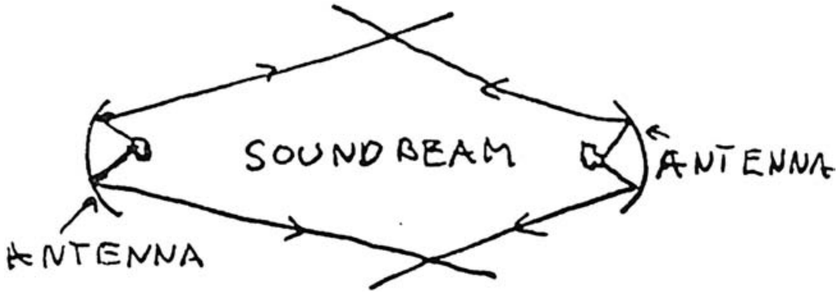


Figure 6.2 Tudor | Drawings of "Sound Beams" | 1974
Klüver/Martin Archive | Courtesy of David Tudor Trust

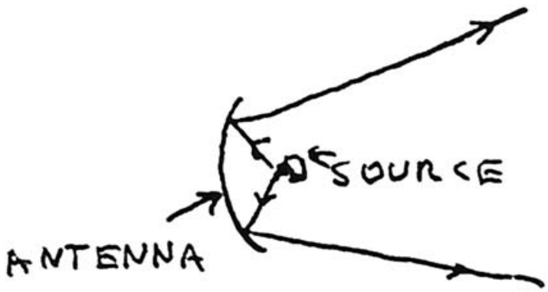


Figure 6.3 Tudor | Drawings of "Sound Throws" | 1974
Klüver/Martin Archive | Courtesy of David Tudor Trust

for Stockholm" at the Moderna Museet. According to Martin's later recollection, at one point in the evening, Tudor began "outlining an idea he had for a concert on an island."[6] The outline of that idea can be revived from proposals and documents in his archive:

(a) Sound is recorded at different locations on the island over the course of a year;
(b) The recordings are played continuously from loudspeaker drivers at the focus of parabolic reflectors and smaller woks, installed across the same island;
(c) The reflectors and woks are positioned either in pairs facing each other to create "sound beams" (Figure 6.2), or on their own as "throws" (Figure 6.3) to direct sounds to "natural reflectors" like rocks, trees, hills and ravines, thus covering the island with scattering beams, reflections, and refractions of sounds displaced in time and space.

6 Julie Martin, "Jackie Matisse in America," Klüver/Martin archive.

It was certainly not the first time Tudor had brought up this idea. Forty years later, Nakaya remembered how it was shortly after their expulsion from the *Pepsi Pavilion* in May 1970 that Klüver began searching for an island upon Tudor's request. They had a specific purpose in mind, she reminisced on January 7, 2014: "They were looking for an island that could be used as a 'musical instrument.' "[7] She went on to describe why Tudor wanted an instrument that big: "The particular scale of the place was very important. It was to be an island of a size that matched the maximum scale for feedback to occur."[8] Just like the number of channels and loudspeakers in Osaka, Tudor's conception about the physical specifics of his new instrument was very real: "He was looking for a fairly large and elongated island that would take about twenty minutes to get from one side to another and about an hour to go around."[9]

The search appeared to have ended that evening in Stockholm. Among those who were listening to Tudor talk was Jeanette Bonnier, a member of the Bonnier family who owned, in addition to one of the largest media groups in Sweden, a small uninhabited island not far from where they were. As Martin reflected:

> *Jeanette Bonnier, a Swedish art collector, who had been one of the leading supporters of the project to acquire the Collection, offered them the use of* Knavelskär, *a small Island in the Swedish archipelago off the coast south of Stockholm, on which she had a summer house.*[10]

Quite fortunately, this particular island happened to meet all the conditions of size and shape Tudor had in mind for his new instrument.

3

Nakaya suggested that the idea of an island traversed by multiple sound beams had its direct roots in the *Pepsi Pavilion*. Tudor had indeed worked with beams both inside and outside his giant instrument in Osaka—although they were beams of light. Visitors entered the *Pavilion* through a tunnel that descended into the darkened Clam Room where red, green, blue, and yellow laser beams emanating from the ceiling moved silently around the floor, forming complex patterns. This was something Tudor had proposed in one of the first meetings for the project: "a shower of laser light whose output would be modified by sounds."[11] He knew exactly whom to ask. Lowell Cross had become the artistic director of the Tape Music Center at Mills College in the summer of 1968, and began collaborating with Carson Jeffries, a physics professor from nearby UC Berkeley, to develop a laser system that expanded his early

[7] Fujiko Nakaya, "Interview by You Nakai," Tokyo, Japan, January 7, 2014.
[8] Ibid.
[9] Ibid.
[10] Martin, "Jackie Matisse in America" emphasis added.
[11] Lindgren, "Into the Collaboration," in Klüver et al., *The Pavilion: Experiments in Art and Technology* (New York, NY: E. P. Dutton, 1972), 50.

experiments to visualize sound on x-y screens. After Tudor performed a pilot version at Mills College on May 9, 1969, Cross and Jeffries completed a revised version they called *Video/Laser II* by February 1970, just in time for the World's Fair.[12] In the new system, four krypton laser beams of different colors were deflected by galvanometer mirrors whose movement could be controlled by audio signals (Figure 6.4). Contrary to previous performances, the sounds that controlled the lasers were themselves unheard in the Clam Room: the music was only *seen* as the movement of the colored beams (Figure 6.5).[13]

As the visitors proceeded upstairs into the mirror dome, another form of light beam awaited them. Tony Martin had developed a light system that could control and be controlled by sounds through the console it shared with Mumma's *Pepsi Modifier*. "So he was on the right [of the console], and I was on the left," he reminisced on January 23, 2018, "and I could patch any of my information to David, and David could patch any of the sound information to me."[14] Martin's system was composed of two elements: (a) three spotlights, which, similar to the lasers downstairs, bounced on mirrors that could be moved around with servo-motors to illuminate individuals or define areas of the floor; and (b) one huge "winch light," a hemispherical housing with three 1-kilowatt bulbs that hung from a winch at the center

[12] On October 30, 1969, Cross wrote to Tudor: "I have decided that our part should be called *Video/Laser II* since we will be working with a new and different system" (Lowell Cross, "Letter to David Tudor [October 30, 1969]," Box 52, Folder 7, David Tudor Papers, GRI).

[13] In an article published in 1970, Cross described in detail the process of developing the *Video/Laser* system: "Performance of *Video/Laser I* demonstrated the need for at least four X-Y deflectors for the Expo project, to allow simultaneous and independent control of separate red, yellow, green, and blue displays. We concluded that custom-made galvos with smaller, self-contained magnetic structures would be required. Four X and four Y galvanometers were built in accordance with our specifications by the Transducer Division of Bell and Howell. The Data Instruments Division of the same company furnished two 4-channel galvanometer amplifiers. The final version of the improved system for Expo '70 was completed during January and February, 1970. The precision machine work required for mounting the laser, the galvors, and the other optical and acoustical hardware was handtooled by [Carson] Jeffries in his Berkeley sculpture studio. To augment the functions of the galvo amplifiers, he and I each built electronic control panels.

During the short time that we were able to work with our completed system, Jefferies, Tudor, and I investigated its applications to the very special properties of laser light, and we all contributed additional audio/video/laser pieces in this new medium. The works for scanned projections took advantage of the sharpness, intensity, and pure spectrum colors of the rapidly moving collimated laser beams. Stationary scanned projections (usually produced with stable function generators) permitted the generation of intersecting colored surfaces through mist of smoke. The connection of photocells into the system led to regenerative conditions of optical feedback. With photocells, amplitude followers, or function generators driving the galvos at very slow scanning rates, the single-frequency nature of the laser's coherent radiation produced large kinetic diffraction patterns as the beams swept through various translucent optical materials. These patterns, high in information content but not directly controllable, underwent totally unpredictable organic transformations in time as the galvos responded to the amplitudes of our input signals" (Cross, "Audio/Video/Laser," *Source: Music of the Avant-Garde* no. 8 [1970], 26–36; reprinted in Larry Austin and Douglas Kahn, eds., *Source: Music of the Avant-Garde 1966–1973* [Berkeley: University of California Press, 2011], 272).

[14] Tony Martin, "Interview by You Nakai," Brooklyn, NY, January 23, 2018.

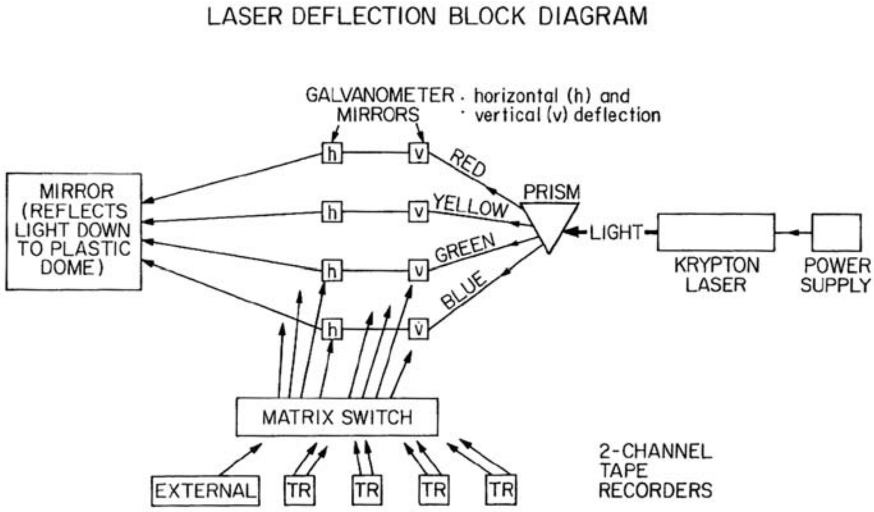


Figure 6.4 E.A.T. | Block diagram of the Laser Deflection System | 1970
Klüver/Martin Archive | Courtesy of Experiments in Art and Technology

Figure 6.5 Lasers in the Clam Room | 1970
Photographer unknown | Klüver/Martin Archive | Courtesy of Experiments in Art and Technology

of the dome and could go up and down a 12 meter line.[15] The audio signal could turn these lights on and off.

Meanwhile outside, the *Pepsi Pavilion* was covered with Nakaya's fog. Forrest Myers, who had been using searchlights to make giant light sculptures, had proposed to erect four towers framing the dome, each with two xenon light beams that shone through the fog in the evenings. When the question of how to produce sufficiently solid beams arose, what influenced the direction of the lights was not music but a musician: "To realize this, Myers took up David Tudor's suggestion to directly shine two focused lights toward each other."[16]

4

In a sense, the light beams of different forms that traversed and framed the *Pepsi Pavilion* in and out were an extension of the x-y video system. Like moving laser beams and spotlights, the dancing Lissajous figures on screen were produced by a process of deflection inside the cathode ray tube: electron beams bent by signals modifying electric (or magnetic) fields. But this process was hidden from view in TV sets and oscilloscopes. Now that the beam was taken out of the box and made giant in scale, it became apparent that sound did not *generate* what is visible but *modified* what was already visible. In other words, sound was visualized as the *difference* it introduced in other materials. This was particularly notable in the Clam Room, where the instrumentalized sound remained inaudible. The movement of lasers revealed the presence of another occult signal that could not be sensed directly, only reflected upon. Like Tudor's input to Myer's work which was never officially credited, music influenced appearances without itself making an appearance.

Because of this, the transformation from light beams to sound beams that the switch of instrumentation from the *Pavilion* to the island entailed was not simply a

[15] This description follows the account of the light system in *The Pavilion* (Lindgren, "Into the Collaboration," 52–53), and my interview with Martin on January 23, 2018: "The main system which I connected with David's sound was spotlights that illuminated viewers, three spotlights and they bounced off mirrors, so the mirrors were under little servo-motors, so it could aim, if you're in the dark, the mirror would sweep over and maybe illuminate you, and you could see yourself in space. Usually in a kind of a donut of light, because the other light was a winch light. The winch light was my invention to go 3000-watt accumulation of three bulbs in a dish that went down through the focal point. And just above your head it would stop, and that would make the biggest circle of light. As it went up, it was focusing on the dome itself which made a huge lens. So that winch light was on chains and it could move all the way to the top. And when it was at the top, it would be the biggest, most ambient light, and when it went through the focal point which made the most crystalline circle of light, and down, and narrower and narrower and then finally at the bottom. That was controlled also from the console. So the winch light illuminated people and the environment, and the spotlights illuminated individual viewers more, and the sound could make them go on and off. Three spotlights that could move, and one huge winch light" (Martin, "Interview by You Nakai"). Lindgren's account adds a third element: two high-intensity, small diameter, spot beams shining from opposite sides of the dome, about 10 feet from the floor. However, according to Julie Martin's recollection, "There were no lights near the floor of the Mirror Dome. […] Maybe the third system was planned, but was never implemented" (Martin, "Comment on the Manuscript of *Reminded by the Instruments*," January 2, 2019).

[16] Lindgren, "Into the Collaboration," 53.

matter of mapping a mechanism from one sensory domain to another, but also from one supersensory domain to another. The analogy was reflexive: what modified sound beams as sounds modified light beams? One thing was visible: natural reflectors like rocks, trees, hills, and ravines—which is to say, the island itself. But like the direction of Myer's spotlights following Tudor's suggestion, parabolic reflectors also faced each other to create sound beams. One clue to what kind of control signal they expected lies in the constancy of instruments. In spite of all the influence from the light beams, there was only one component Tudor took from Osaka to *Knavelskär*: Nakaya's fog. The miniature water droplets that had enwrapped the 45-meter-wide instrument were obviously useful in terms of the physical scale of the new instrument, which would easily surpass that size. But there was another realization Tudor appears to have made, perhaps as he observed the particular ways the fog formed and reformed constantly outside the *Pepsi Pavilion*. In doing so, Nakaya's work, which she described as "negative sculpture,"[17] was making visible something that otherwise was not, something that would matter increasingly more at an outdoor island: wind.

5

Much later on November 24, 1988, when he was interviewed in Grenoble, France, Tudor revealed the primary instrument of *Island Eye Island Ear* which he found himself still working on after all those years:[18]

> *I think that wind is wonderful to use in music. I have an environmental project that I have been thinking about for more than ten years. I don't know when it will be realized. It uses fog and a sound beam created by two antennae faced to one another. If you are here, you will hear it very loud, if you are there, you will hear it very weak. The wind transforms the sound. If it is really strong in one place, the wind comes and the harmonic content of the sound is displaced. The wind displaces the fog, dissipates it, and reforms it elsewhere. It's the same thing for the kites.*[19]

As a current of air moving from areas of high pressure to areas of low pressure, wind is invisible. For the human eye, it only appears as a modulation of appearances. From his early organist days, Tudor had learned to harness the wind as a source generated by the instrument, later expanding this to other instruments as a bandoneonist or a vocalist.[20] In all these cases, sound was generated by a flow of air setting a physical resonator to vibrate. But at *Knavelskär* the wind was given a

[17] Fujiko Nakaya, in E.A.T., "Commentary on the *Fog Sculpture* (1970)," Video, Process Art.
[18] This was in response to the interviewer's observation: "You like to mix and combine the means of artistic expression" ("Interview," *Revue et Corrigée* 2 [Spring 1989], 10 [Box 65, Folder 7, David Tudor Papers, GRI]).
[19] Ibid.
[20] Tudor's engagement with the voice is detailed in Chapter 8.

different role: instead of source material, it became a control signal that modified other source materials.

The entire project appears to have revolved around this focus from the very beginning. According to Julie Martin, Tudor was quick to decide on his collaborators: "David's first notes showed his ideas of having collaborators who would add visual elements to the performances and he thought of the fog sculptures of Fujiko Nakaya and Jackie's kites with their long airborne tails."[21] The fog and the kites not only added something to be seen *to* the sound beams but rendered visible something that could not be seen *like* the sound beams. In other words, the three main instruments Tudor chose to reveal the nature of the island all acted as sensors of wind more than anything else, making what they sensed sensible to the human audience through their own audible or visible modifications.[22]

The collaborators were in agreement about this. When Klüver asked her to describe the nature of her medium on November 24, 1978, Nakaya replied, giving just one specific example: "Fog responds constantly to its own environment, revealing and concealing the features of the environment. Fog makes visible things invisible and invisible things, *like the wind*, visible."[23] Monnier, on her part, added a postscript to her letter to Tudor written on January 17, 1976, in which she described her plans to use colored snow to reflect the kites in the sky: "What I wish to do is to call people's attention to the wind: a natural source of energy."[24]

Island Eye Island Ear

1

During the two-week expedition to *Knavelskär*, Tudor explored the nature of his new instrument day after day. He quickly discovered how the course and the phase of a sound beam were modified by the wind. The effect became most pronounced when the source was a complex wave.[25] The parabolic reflectors were also pointed toward rocks from different angles to search for stronger points of resonance and reflection using a variety of inputs that included sine and square waves, frequency sweeps, and modified bird sounds salvaged from the *Pepsi Pavilion*. Tudor noted a difference between two events caused by the "throw" speakers: sound could be "reflected," bounced off the rock and heard as an echo (Figure 6.6), or it could be "diffracted," directed toward the edge

[21] Martin, "Jackie Matisse in America."

[22] This also explains why Tudor appeared to be detached from the rotating loudspeaker project that the other members of CIE were focused on, as Rogalsky noted: " 'The rotating loudspeaker project was something that David never wanted to get involved with,' Driscoll stated" (Rogalsky, "Idea and Community," 345). The effect of wind is certainly more perceptible in a stationary beam.

[23] Fujiko Nakaya, "Interview by Billy Klüver (November 24, 1978)," in E.A.T., "*Island Eye Island Ear*: A Sound and Cloud Environment on Boulder Island (January 11, 1979), Appendix I, 9," Box 21, Folder 8, David Tudor Papers, GRI; emphasis added.

[24] Monnier, "Letter to David Tudor (January 17, 1976)," Box 21, Folder 4. David Tudor Papers, GRI.

[25] E.A.T., "Report on Experiments for 'Knavelskär' Project (August 8, 1974)," Box 21, Folder 1, David Tudor Papers, GRI.

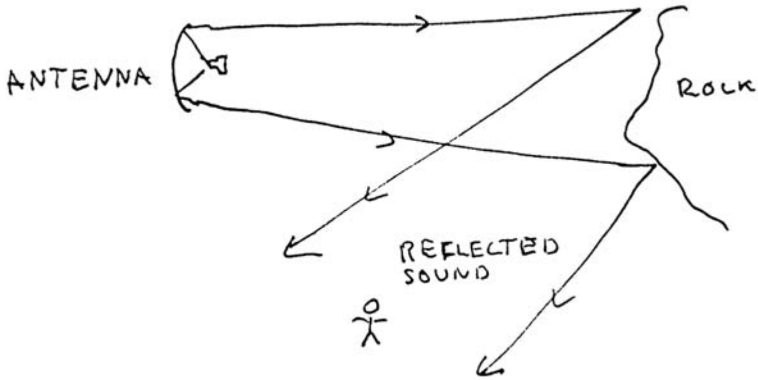


Figure 6.6 Tudor | Drawings of "Reflected Sound" | 1974
Klüver/Martin Archive | Courtesy of David Tudor Trust

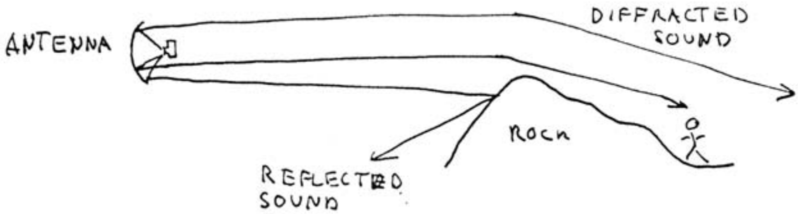


Figure 6.7 Tudor | Drawings of "Diffracted Sound" | 1974
Klüver/Martin Archive | Courtesy of David Tudor Trust

of a rock and heard on the other side (Figure 6.7).[26] The woks emphasized the second and third harmonics of sound, especially when a square wave or a signal of variable frequency was used. When used as a baffle behind the driver, they acted as a low-pass filter, attenuating the higher harmonics. The sound beams were found to be sufficiently sharp at a distance of fifty-five meters and they stayed locally distinct (Figures 6.8 and 6.9).[27]

With these results in hand, Tudor walked around the island, reading each natural object as a potential reflector or diffractor of sound. A detailed map was prepared in which he inscribed the specific locations for seven pairs of sound beams and fourteen sound throws (Figure 6.10). In the same way, Nakaya chose where to install her negative sculptures. Monnier wanted to fly her kites and helium balloons nearby to interact with the fog.[28] They both needed wind, but not too much wind as that would disperse the fog away. *Island Eye Island Ear* thus conceived of the entire island as a giant modifier of various instruments that had been brought there to sense and

26 Ibid.
27 Ibid.
28 In the initial stage of the project before she dropped out, Margaretha Åsberg considered installing various sorts of mirrors for people to interact with, thus contributing also to the myriad of reflections involved

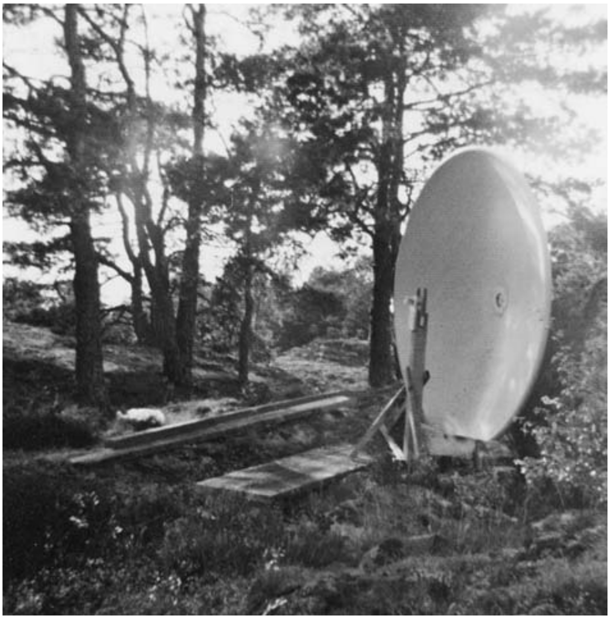


Figure 6.8 E.A.T. | Antenna installation on *Knavelskär* | 1974
Photographer unknown | Klüver/Martin Archive | Courtesy of Experiments in Art and Technology

respond to its nature. In other words, rather than a given material to be observed directly, nature appeared only indirectly through how given materials were modified.

2

Despite using electronic signal generators during the expedition, Tudor wanted all sound sources going into the sound beams and sound throws to be from the island itself, recorded at different locations at different times of the year. Once collected, specific recordings would be chosen according to the nature of the modifying instrument, which is to say the particular reflectors in various parts of the same island.[29] As Martin recalled:

> *He would use as input sounds he recorded on the island for a year before the concert: ice cracking, birds, wind in trees, storms, other underwater sounds. These would be processed in his electronic equipment and allow people to compose their own experience of the sounds of the island.*[30]

which had led someone to propose the tentative title of "Reflections" for the project (E.A.T., "Report on Experiments for 'Knavelskär' Project [August 8, 1974]").

[29] In a similar way, Nakaya's fog system also used water taken from the island, converting them into fine droplets to be released wherever the nozzles were placed.
[30] Martin, "Jackie Matisse in America."

Figure 6.9 E.A.T. | Wok installation on *Knavelskär* with Tudor and Billy Klüver | 1974
Photographer unknown | Klüver/Martin Archive | Courtesy of Experiments in Art and Technology

So the sonic sensors that revealed the wind and stones and other natural resources of the island were themselves natural resources of the island, stored, delayed, modified, transported, and output at other locations, at other times, using other means.[31] Technology thus allowed *Knavelskär* to become both the modifier and the modified. Nevertheless, there is something very puzzling about Tudor's system: nothing made the process repeat itself—there appears to have been no inherent return path. Although he claimed to define the "maximum scale for feedback to occur" by turning an entire island into an instrument, *no feedback as such makes an appearance in his plan*. Neither the use of acoustic feedback as explored in *Microphone*, nor electronic feedback as explored in *Pepscillator*, seems to have been considered for *Island Eye Island Ear* at any point.[32] In other words, if Tudor was indeed testing the limit of

[31] In recent performances of *Rainforest*, John Driscoll and Phil Edelstein of CIE have started using the technology of convolution, which simulates the particular resonance of an object by analyzing its impulse responses. Therefore, the sounds that probe nature are derived from nature itself in this case as well. Curiously with *Rainforest*, however, this has led to the possibility of eliminating the actual physical objects serving as instrumental loudspeakers.

[32] This is all the more puzzling given the fact that Tudor was primarily dealing with both kinds of feedback in other works made around the same time. For instance, *Untitled* from 1972 was a thorough exploration of electronic feedback, using the oscillations of no-input circuitry to both generate and modify sound; and Tudor had just been in residency at Mills College in May 1973 where he built a new version of *Microphone* which of course used the principle of acoustic feedback. More detailed discussion on these works are in Chapters 7 and 8.

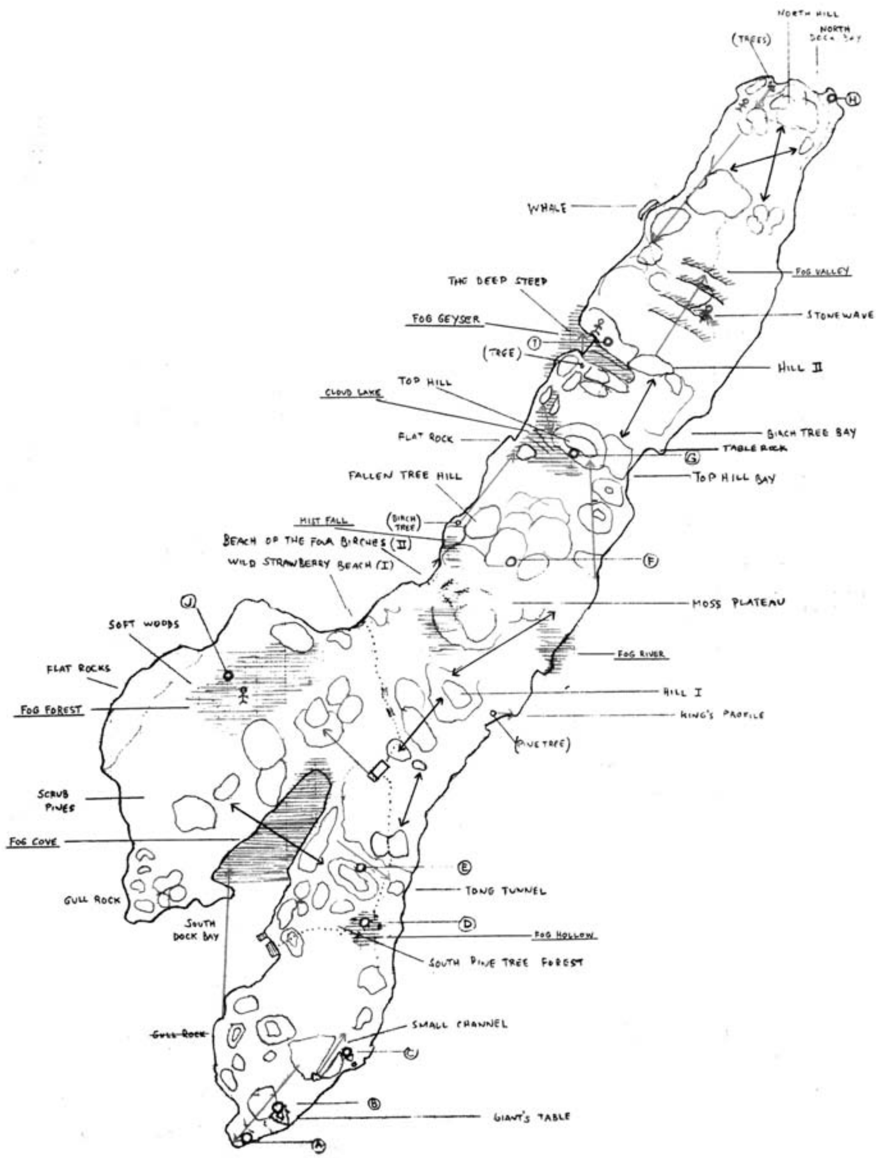


Figure 6.10 Tudor | Map of *Knavelskär* showing sound beams (darker arrows, blue in original), sound throws (lighter arrows, red in original), and areas of fog (line shades, green in original) | 1974
Klüver/Martin Archive | Courtesy of David Tudor Trust

feedback in *Knavelskär*, the path that returned the output to the input must have been neither electronic nor acoustic.

There is in fact only one component in the system even remotely capable of establishing feedback in spite of the separation in time and space between input and output: the visitors who walked *inside* the giant instrument, listening to sounds and committing some of them to memory so that they might be identified with some other sound heard in another part of the island. A human could connect space by moving from one place to another, and connect time through reminiscence. As Cross had told him in the fall of 1966, Tudor had already experienced himself as a feedback "component" in *Musica Instrumentalis*. The estimate for "the maximum scale for feedback to occur," specified as the particular size and form of the island—"twenty minutes to get from one side to another, and about an hour to go around"—may not have been derived from any technical considerations of non-human equipment, but rather from the psychological and physiological conditions of human memory.

The individual experience of each visitor indeed appears to have been the central focus of the project which inspired the very use of extremely localized sound beams. When Klüver interviewed him about the island project on November 24, 1978, Tudor described what kind of experience he wanted to create: "First of all, intimacy. So that when you come upon a feature that I've arranged within a given space, you feel that you are alone with it. And it won't matter whether you're surrounded by people or not."[33] The insular nature of Tudor's giant instrument in this way would have reflected the insular nature of each visitor's experience.

3

These speculations cannot be verified since the project at *Knavelskär* was never actually realized in the end. But precisely for the same reason, *Island Eye Island Ear* remained a speculation for Tudor as well. In the meantime, he was often performing the large-scale version of *Rainforest* with the former participants of his workshop at the New Music in New Hampshire summer festival. Soon, he began describing the forest of instrumental loudspeakers as if it were a miniature analog of the instrumentalized island—a virtual *Island Eye Island Ear*.

On June 27, 1975, a year after the *Knavelskär* expedition, Tudor wrote to Michael Shamberg who was coordinating programs at The Kitchen in New York City,[34] where he had performed *Rainforest* two months earlier with the members of soon-to-be CIE. Shamberg had asked for any corrections to the description of *Rainforest* before it was printed in the annual catalog of the downtown venue. Tudor indeed had one thing

[33] David Tudor, "Interview by Billy Klüver (November 24, 1978)," in E.A.T., "*Island Eye Island Ear:* A Sound and Cloud Environment on Boulder Island (January 11, 1979), Appendix I," 3-4, Box 21, Folder 8, David Tudor Papers, GRI. Emphasis added.

[34] Shamberg, who was also the co-founder of the video collective Raindance Corporation, published the book *Guerilla Television* in 1971 (New York, NY: Henry Holt & Company, Inc) in which, taking cues from Marshall McLuhan, he argued for a counter-cultural approach to the use of visual media from the premise that "all technology is biased." It was Fujiko Nakaya who translated this book into Japanese in 1974, the very same year of the *Knavelskär* expedition.

to add: "Suspended resonant sculpture & found objects, electronically transduced, mixed with their transformed *reflections* in an audio system.*"[35]

Now that the audience walked around the forest of hanging giant instrumental loudspeakers, what became central in Tudor's mind was the relationship between the sound of one instrument heard directly and its "transformed reflection," the same sounds picked up by contact microphones, equalized and output from commercial loudspeakers set around the space. Almost a decade later, on September 3, 1984, Tudor gave a more detailed description of *Rainforest* to John David Fullemann using the same wording:

> *the purpose of the contact mike is to take the resonant frequencies which you hear at best very close to the sounding object; to take those into an ordinary loudspeaker which you can consider not as auxiliary but as enhancement. What that does when you establish the proper tonal balance is that you've got a* reflection *of the sound which you can distance in space.* [. . .] [*The piece*] *becomes larger and there's a coherence there that's deceptive which I like very much, because as you move through the space there are sounds that you hear, that you've heard before or have heard somewhere else.*[36]

Sonic reflection triggered mental reflection—it composed a "deceptive coherence" in the mind of each walking listener. What made this process possible was the application of memory, as Tudor explained to Teddy Hultberg another four years later on May 17, 1988: "It becomes like a reflection and it makes, I thought, quite a harmonious and beautiful atmosphere, because wherever you move in the room, you have reminiscences of something that you have heard at some other point in the space."[37] This mnemonic process was obviously conditioned by the repetitive nature of the music of *Rainforest* based on oscillating amplifiers which recycled more or less the same characteristics as listeners moved from one instrumental loudspeaker to its reflection (perhaps also reminiscent of the way Tudor recycled more or less the same description to talk about the piece across the years).

In speculating about the island, Tudor enhanced the scale of reminiscence in regards to both time and space—the sound of the spring beach could be heard in the winter ravine—to explore the limits of feedback. When Klüver interviewed him on November 24, Tudor's description of how *Island Eye Island Ear* worked was indeed reminiscent of the "deceptive coherence" that was synthesized in the listener's mind through memory in *Rainforest*[38]:

[35] Emphasis added. Tudor attached a footnote here: "* If too much copy, minimum would be: Electronically transduced resonant sculpture & found objects" (David Tudor, "Draft of a Letter to Michael Shamberg [June 27, 1975]," Box 55, Folder 1, David Tudor Papers, GRI).

[36] Tudor, "Interview by Fullemann," davidtudor.org.

[37] Tudor, "Interview by Teddy Hultberg," davidtudor.org.

[38] Nancy Perloff has observed the connection between the role of memory in *Island Eye Island Ear* and another work Tudor created in collaboration with Jackie Monnier and the video artist Molly Davies in 1983: "Since the mixture of sounds originated from different island terrains recorded at different times of year, visitors experienced the sounds as constructed rather than live and thus as memories of their natural source terrain. This play with memories of sounds served as a precedent for *Sea Tails*" (Perloff, "Hearing Spaces: David Tudor's Collaboration on *Sea Tails*," *Leonardo Music Journal* 14 (2004), 35). *Sea Tails* is discussed in Chapter 9.

> *I want it to meditate on the various natural features of the island and to present them in a kind of heightened way. For instance, my intention is to take a sound which lives there naturally to a very definite environmental situation and to put it into another environmental situation so that the way you experience the same sound is slightly transformed by a different environment. In that way you don't forget the sound; it lives with you in different ways.*[39]

4

According to a narration inserted in the video documentation of *Rainforest* by George Bolling from November 24, 1975, the coherence that only exists privately in the mind of each wandering listener is ultimately the "composition" itself:

> *What is left then is for the listener to roam the space integrating the sound of each object into the total sound environment. Listening to each object emphasizes its sound over all the others. This process shapes the sounds of* Rainforest*. This is not passive listening. It is the active role of composing. David Tudor brings to* Rainforest *a selection of sounds and defers the final act of composing to the audience. Because each person experiences* Rainforest *differently, there are as many compositions for each performance as there are members in the audience.*[40]

Or, as many performances for each instrument, in the case of the island. The particular trajectory a visitor took mattered, as well as the memory accumulated along the way, since each path formed a different coordination with the technologically enhanced island, which now also recorded and sensed itself. Every visit would activate a different reminiscence and a different performance.

But the process of reflection extended further. Nakaya regarded her fog as "a negative sculpture" which showed the wind through its own modifications.[41] But when Klüver interviewed her on November 24, 1978, she noted that wind modulated the appearance of material not only in the present but also across time:

> *I want to sensitize people to the different features that one can experience beyond a present time experience of the island—not just the flaming leaves but the features that are timeless or change over a long time period—the way the wind reacts to the contours of the island, the way the trees are bent by the wind.*[42]

[39] Tudor, "Interview by Billy Klüver (November 24, 1978)," 1.

[40] George Bolling, "Rainforest, 1981," Box 37A, Item V10, David Tudor Papers, GRI. Despite the year in the title, this video was very likely filmed at the De Saisset Art Gallery in Santa Clara, CA, on November 24, 1975. Bolling worked as a curator there and was responsible for organizing the *Rainforest* performance that day (Tudor, "Letter to George Bolling [October 24, 1975]," Box 19, Folder 7, David Tudor Papers, GRI). He also attended the show, as attested in other photographs of Tudor and Bill Viola taken by him.

[41] Nakaya, in E.A.T., "Commentary on the *Fog Sculpture* (1970)."

[42] Nakaya, "Interview by Billy Klüver (November 24, 1978)."

What appears to be still is also modulated, simply on a time scale beyond "present time experience," weathered and transformed over millennia. In this way, the proposed "enhancement of wind" involved not only perceivable modulations in the present but also imperceptible modulations that lay beyond the here and now. The latter could only be perceived by reflecting on what was visible and audible. The "nature" of the island that the collaborators always claimed the project intended to reveal was not as apparent as it may have looked—that is precisely why there was a need to reveal it in the first place.

This realization also coordinates nicely with Tudor's otherwise puzzling idea of collecting the source material for his sound beams in different seasons over a year. The visitor would not remember them, of course, but the sounds would themselves "remember" the influence of wind through which the history of the island could be reflected upon. Tudor's plans for how to document the project can be understood in the same way: he thought of recording the entire soundscape from up in the air, or to make a recording for four hours per day for seven days and then compress the entire recording into four hours.[43] It was as if *Knavelskär* had its own giant sensory organs to perceive its own sounds which were partially reflected in the perception of each human visitor—but then again, this was what Tudor's title had been suggesting all along: *Island Eye Island Ear.*

5

Perhaps ironically for a project that aimed to "reveal the nature of the island through technology," *Island Eye Island Ear* struggled with charges of environmental destruction from the beginning. In addition to the failure to obtain a grant to support the project, initial plans for *Knavelskär* were abandoned when it was discovered that the uninhabited island was actually inhabited by creatures other than humans: grouse had built their egg-laden nests all around.[44] The search for a more suitable island followed, although Tudor's specifications for his giant instrument made this a challenging endeavor: "The reason the project turned out to be so difficult," Klüver reminisced on May 17, 2001, "was that there are only a few places in the world that had the kind of islands with the terrain David needed, with bedrock outcroppings and a variety of wooded areas and vegetation."[45]

In 1977, three years after the *Knavelskär* expedition, a short-lived plan was drafted for Seward Park in the Bailey Peninsula near Seattle. It was abandoned even before any of the artists had the chance to survey the land.[46] The following year, Klüver found

[43] Tudor, "Interview by Billy Klüver (November 24, 1978)," 5–6.

[44] Nakaya, "Interview by You Nakai." Julie Martin recalled somewhat differently in January 2019: "Fujiko may be right about the bird habitats, but I remember that it was more about the lack of funding, and difficulty of finding funding in Sweden that led us to look for an island nearer home" (Martin, "Comment on the Manuscript," January 2, 2019).

[45] Billy Klüver, "Talk on David Tudor, Getty Center (May 17, 2001)," Klüver/Martin archive.

[46] E.A.T., "*Island Eye Island Ear*: Plan of Implementation for Seattle Concert (December 10, 1977)," Box 21, Folder 6, David Tudor Papers, GRI.

a state-owned island in Saranac Lake, in New York State, similar in size to *Knavelskär*. At the end of August 1978, Tudor made a brief visit to the site and selected the locations to place the reflectors. In mid-September, an official request to hold a two-week concert for five consecutive summers on Bluff Island was submitted to the New York State Department of Environmental Conservation (DEC). The proposal now focused on environmental concerns, even describing the project as "An Environmental Concert."[47] Klüver estimated 200 to 300 visitors per day traveling to the island on ferries, but stressed that neither the concert nor any of the equipment used would cause permanent damage to the environment.[48] Noise nuisance, if found, would be immediately corrected by readjusting the parabolic reflectors or the sound level.[49]

It turned out that this was not enough for the DEC. The request was denied on the grounds that the concert would violate the regulations of the State Land Master Plan, ruin soil and plant life, and cause severe health problems.[50] Klüver quickly drew up a revised plan, which "conform[ed] more closely to the guidelines established by the Department of Environmental Conservation."[51] The concert was now described as "a nature walk on Bluff Island" for visitors who will "follow predetermined trails identified by a cover of wood chips," with the very modest aim to "direct the attention of people to the beauty of nature."[52]

In addition to these considerations, Klüver obtained further assurance on environmental safety from the Department of Forestry of nearby Paul Smith's College, as well as enthusiastic support from part of the local community.[53] However, a petition opposing the plan to turn Bluff Island into a musical instrument was already circulating among the local residents. Permission to use the site was denied on October 20, on the grounds that the state land is "classified as 'forever wild' and as 'wild forest,' and mechanical equipment was prohibited in such areas according to the state laws."[54]

Klüver did not give up. By November, he had managed to find a privately owned island in the same Saranac Lake area. Negotiations with the local part-owner of Boulder Island—whose actual name, "Corey Island," was replaced by a fake name Klüver came up with to buffer public attention—proceeded smoothly, until two other part-owners, siblings of the first, who neither lived in the area nor visited the island, opposed the project. In early January 1979, Klüver finally announced the cancellation of the plan for holding *Island Eye Island Ear* in the Saranac Lake area.

[47] E.A.T., "*Island Eye Island Ear*: An Environmental Concert (September 18, 1979)," Box 21, Folder 6, David Tudor Papers, GRI.
[48] Ibid., ii.
[49] Ibid., 7.
[50] "Island Project Opposed," *Adirondack Daily Enterprise*, October 18, 1978.
[51] E.A.T., "*Island Eye Island Ear*: Description of a Concert for Bluff Island (October 4, 1978)," Box 21, Folder 7, David Tudor Papers, GRI.
[52] Ibid.
[53] "Bluff Island Concert Discussed at Center," *Adirondack Daily Enterprise*, October 17, 1978.
[54] "Sponsors of Bluff Island Project Grateful for Publicity Given Show," *Adirondack Daily Enterprise*, October 20, 1978.

6

The opposition to the project appears to have been of a complex nature. On one level, it was likely fueled by a then-recent decision by the DEC to evict a few hundred tent platforms set on Bluff Island by the locals.[55] People demanded that the State Constitution be inflexible to the proposal since it had been inflexible for them. But two editorials printed in the *Adirondack Daily Enterprise* reveal a more subtle cause of resistance that was not simply about environmental damage: utter puzzlement about what the project claimed to do. The sentiment was apparent in the two headings: "Something for Those Who Would Improve on Nature,"[56] "We Like Bluff Island the Way It Is."[57] The conflict was between what one newspaper described as "the unorthodox *nature* of the project"[58] and the image of *Nature* that the outspoken locals, along with the DEC, held. The anonymous author of one editorial said it best when he summarized the problem in the form of a conditional: "if you feel that nature is not enough for you on Bluff Island and would rather have it amplified and changed, then by all means support the planned concert on Bluff Island."[59] The problem, then, was that Tudor somehow did feel that "nature" was not enough.

Instrumental Natures

1

On November 24, 1978, right after the Bluff Island plan was abandoned, Klüver conducted separate interviews with Tudor and Nakaya. These were subsequently transcribed and included in the appendix of the short-lived proposal for Boulder Island. Answering Klüver's questions, Tudor first explained that the use of technology was to "enhance" nature so that the physical "reflection" of the same sounds encountered in more than one way would trigger a mental reflection in the listener. The process of technical enhancement was therefore a process of revelation:[60] "a lot of electronic processing is going to go into these sounds to first of all reveal special qualities in them which you might not notice when you're hearing them yourself. But when you hear them transposed into a different space, you immediately know that you are hearing them."[61]

[55] Editorial, "Something for Those Who Would Improve on Nature," *Adirondack Daily Enterprise*, October 20, 1978.
[56] Ibid.
[57] Editorial, "We Like Bluff Island the Way It Is," *Adirondack Daily Enterprise*, October 18, 1978.
[58] T. O'Conell, "Unique Concert Offered to Area for Bluff Island," *Press-Republican*, October 10, 1978.
[59] Editorial, "Something for Those Who Would Improve on Nature," *Adirondack Daily Enterprise*.
[60] In the original interview, Tudor had actually equated the two words: "I believe that that word [enhance] came about because my first term was reveal, which is really how I feel about it. It's bringing something out, which is there already. 'Enhance' is a poor substitute for that" (Tudor, "Interview by Klüver (draft)," Box 111, Folder 25, Experiments in Art and Technology records, GRI).
[61] Tudor, "Interview with David Tudor by Billy Klüver (November 24, 1978)," 1.

As the interview proceeded, however, Tudor gradually enhanced the very concept of "nature" to the technologies themselves: "it seems to me that the way I use the technological medium, it's just more of what's already there. I don't see, for instance, what's unnatural about a parabolic reflector. They exist in nature already, perhaps not in perfect forms, but neither am I after a perfect form."[62] If the entire island is seen as an instrument, any difference between technological components and "natural" ones becomes a matter of degree. The means to enhance and reveal nature also has its own nature. What was revealed through this particular enhancement of nature through language were the "special qualities" in Tudor's own *idea* of "nature." All things have their own nature, he appeared to believe, which is usually hidden from direct observation but could be revealed through a process of enhancement.

2

The source for this idea is yet again found in the writings of Rudolf Steiner. Arguing against the age-old polarity between matter and spirit in a lecture given on August 20, 1911, the occult philosopher referred to the concept of nature in ancient Greece to claim that every process in the world must be seen as an expression of the spirit inherent in the material.[63] Nature was this inner essence of each thing, and anthroposophy the spiritual training necessary to perceive such occult nature. As always, Tudor followed his material faithfully—but exercised some poetic license in his realization.

Between August 26 and 29, 1960, Tudor wrote a letter to M. C. Richards from Venice. Aside from reporting how he was practicing the bandoneon he had purchased in Berlin, Tudor confessed to his then-partner, who would also become an anthroposophist under his influence, that he was going through a difficult period where everything "seemed outwardly purposeless & energyless."[64] Attributing this problem to the incapacity of reaching "a penetration of the moral," he offered a self-diagnosis that was reminiscent of Steiner's prescriptions:

> *Now if only I can learn to "look" thru what I see (which I'm now aware is only a projection of my own inner weakness), I'll be able to hold this as a life experience, & to see things lit with their own nature (as one saw them as a child). I've never lost this ability in regard to sounds; but of course one is not just a listener.*[65]

[62] Ibid., 4.

[63] "Thus we can say that today there is a longing to reconcile the opposition between nature and spirit, an opposition which did not yet exist in ancient Greece. And the fact that attempts are made, that societies are established, to examine the activity and nature of laws in the physical world other than purely chemical, physiological, biological laws, is proof that the longing to resolve this opposition is very widely felt. It is part of the mission of our own Spiritual Science to resolve this opposition between spirit and nature" (Rudolf Steiner, *Wonders of the World: Ordeals of the Soul, Revelations of the Spirit* [London: Rudolf Steiner Press, 1963], 49).

[64] Tudor, "Letter to M. C. Richards (August 26–29, 1960)," Box 26, Folder 2, Mary Caroline Richards Papers, GRI.

[65] Ibid.

Whether he managed to cure himself of this malady for good is unknown, but a temporary solution appears to have been reached shortly afterward. What changed the situation was not the metaphysical clairvoyance of his mind, however. Instead, it arrived in the physical form of a letter from elsewhere, as he reported to Richards two months later, on October 28: "I too have been awfully discouraged, wanting out of it all, etc., but one morning an invitation to play in Madrid & Barcelona arrived & I felt suddenly better!"[66] At the end of the same correspondence Tudor offered consolation to his partner who had written to him about her own discouragement in realizing how their poet friend Charles Olson "doesn't care for my new long poem, too philosophical etc."[67] The advice he gave was to ignore not only Olson but also what Steiner's followers had to say as far as poetry was concerned: "the path you have chosen in your latest poems is a lonely one, you mustn't expect approval outwardly, even from friends (& certainly not from Anthroposophists)."[68]

In this way, Tudor's connection with Steiner's teachings was a complex affair; yet the influence lasted a lifetime. He became an official member of the Anthroposophical Society in July 1957,[69] when he abruptly canceled his scheduled appearance at the International Summer Courses for New Music in Darmstadt and instead spent his days going to the Anthroposophy Summer School.[70] On November 2, 1994, almost forty years later and shortly before his death, Tudor revealed to Rogalsky a specific concern that had guided him throughout the years, which he had deliberately kept a secret: "part of my interest in life is spiritual endeavors, which I don't speak about

[66] Tudor, "Letter to M. C. Richards (October 28, 1960)," Box 26, Folder 2, Mary Caroline Richards Papers, GRI.

[67] M. C. Richards, "Letter to David Tudor (undated [October 1960])," Box 58, Folder 7, David Tudor Papers, GRI.

[68] Tudor, "Letter to M. C. Richards (October 28, 1960)."

[69] "Acknowledgement of Membership to the Anthroposophical Society in America (July 1957)," Box 102, Folder 1, David Tudor Papers, GRI.

[70] On July 11, Tudor wrote to Richards, who was staying in Mexico at the time: "conscience spoke to me every day in a loud voice, and I went to work often with the thought to become aware of the actual situation, positive or negative—of course always forcing the hopefully affirmative, trembling underneath. then late saturday night, in the midst of working frenziedly the tenseness suddenly slackened, underneath (like a desperately growing plant whose roots are undercut), and I knew that it was all a sham. only then, at that moment, I could list the various works to do; the pieces to be performed, the lectures to be given, the material to illustrate them prepared, the rehearsal-preparations—and not a one could I do rightly. much too ambitious a project to be undertaken without all one's soul-force—why couldn't I see that months ago? at that date of course I had to cable and say illness—nothing else would leave any open doors. hated to say it. all the work, the preparations—it was terribly difficult to carry through that decision. [. . .] now looking forward to a period of calm—hoping for the calm of the peaceful soul—that hasn't been for years. and looking forward to the A. Summer School (July 25–28 and August 10–25)—there are courses on music" (Tudor, "Letter to M. C. Richards [July 11, 1957]," Box 26, Folder 2, Mary Caroline Richards Papers, GRI). A month later, in another letter from August 3, he reported: "next week the school starts and I shall be there most days, sometimes all day. usually pack a lunch, bottles of yogurt with things in it and wild greens" (Tudor, "Letter to M. C. Richards [August 3, 1957]," Box 26, Folder 2, Mary Caroline Richards Papers, GRI).

because I don't want them to be identified."[71] As with the winds of *Knavelskär*, these were control signals that remained occult.[72]

The materials he left, however, gives a glimpse into what was behind the veil of secrecy. His personal notes reveal Tudor as a dedicated reader of Steiner's texts, albeit not a blind follower. Like the unique trajectories of each island visitor, Tudor read his material in one specific way and not the other. The strong bias in his reading even suggests that he applied Steiner's lessons for approaching the nature of things when he approached Steiner's own writings and tried to look through what he saw to see its inner nature. Similar to his realizations of other composer's materials, the method of biasing his approach to Steiner according to Steiner's own nature could certainly lead to an appearance of infidelity.

3

Nowhere was this infidelity more apparent than in matters of music and musical instruments. Anthroposophically speaking, Tudor somehow always went for the wrong instrumentation. He certainly did not expect approval from anthroposophists in this regard. To begin with, the piano was a terrible choice. On March 8, 1923, during the sixth lecture of what later became published under the telling title of *The Inner Nature of Music and the Experience of Tone*, Steiner attacked the very instrument Tudor exerted his virtuosity on:

> *An orchestra is an image of man; it must not include a piano, however. Why is that? The musical instruments are derived from the spiritual world; the piano, however, in which the tones are abstractly lined up next to each other, is created only in the physical world by man. All instruments like the flute or violin originate musically from the higher world. A piano is like the Philistine who no longer contains within him the higher human being.* [. . .] *Naturally, the piano is a beneficial instrument—otherwise,*

[71] Tudor, quoted in Matt Rogalsky, "'. . . In Rehearsals, or Preparation, or Setup, or from One Performance to Another': Live Electronic Music Practice and Musicians of the Merce Cunningham Dance Company." MA thesis, Wesleyan University, 1995, 129; also, "Interview by Rogalsky," davidtudor.org.

[72] Consequently, he kept a double life. As Tudor's fame grew, presenters invited him to give concerts all over the world. But especially in Europe, he was sometimes asked to include in his repertoire at least a number of classical music works. Tudor's customary answer to this was that it was impossible, as he had written sometime in mid-1958 to the conductor Hermann Scherchen: "It has been too difficult for me to maintain a repertoire of classical music [. . .] I play classical music only upon special request" (Tudor, "Draft of Letter to Hermann Scherchen [mid-1958]," Box 51, Folder 7, David Tudor Papers, GRI). Concert programs and correspondences found among his papers reveal what these "special" occasions were: throughout the 1950s and into the following decade, Tudor performed at anthroposophy-related concerts where he was required to play music from previous centuries—Bach, Beethoven, Handel, etc.—precisely the ones he had claimed to have denounced. He also taught and attended the Anthroposophy Summer Schools in Spring Valley, New York, and continued to accompany Sigurd Rascher, a dedicated anthroposophist, at concerts of the Anthroposophical Society in the early 1960s.

> *we would have to rely from the beginning on the spiritual in musical instruction in our materialistic age—but it is the one instrument that actually, in a musical sense, must be overcome. Man must get away from the impressions of the piano if he wishes to experience the actual musical element.*[73]

Thankfully, Tudor did leave "the impressions of the piano" behind around the time he officially became an anthroposophist himself. But the new instrument he turned to was even a worse choice. Rudolf Steiner's wife Marie was fierce when it came to music made by machines, as she wrote in the introduction to her husband's book *Eurythmy as Visible Speech*—another favorite of Tudor's that he specifically recommended to Richards in a letter written on October 2, 1958.[74] Whereas the piano was in some sense "beneficial," mechanical music was downright damaging:

> *. . . this mechanical, noisy music, which rattles from all the gramophones, from the wireless, from the pianolas, and which even in many of the best London theaters has taken the place of the orchestra. The demons of machinery here find means of access; they gain a hold on the human being through his movement, through his vitality. They do not only influence his brain, but enters into this externalizing of that which should remain as inner mood of the soul. The mechanical musical instruments exercise their powerful, soul-deadening forces, doing away with all atmosphere and feeling.*[75]

Steiner's texts, according to Marie, were written precisely to counter this demonic influence of mechanical music: "He sounded the awakening call which can free humanity from the dangers of becoming animalized, stupefied and mechanized."[76] Tudor appears to have been utterly deaf to the sound of this alarm as far as his own music was concerned. The demons of machinery may have influenced him just too much.

But inconsistency was also lurking within Steiner's teaching itself. On the one hand, it was said that all physical instruments were products of materialism so there was always a need to recall their metaphysical nature. In the same lecture where he advised his audience to overcome the influence of the piano, Steiner even laid out a peculiar myth to account for the immaterial origin of all instruments: "Musical instruments appeared to man at first as imaginations. Musical instruments were not invented through experimentation; with the exception of the piano they have been derived from the spiritual world."[77] The story goes that humans then proceeded to materialize what only existed in the mind, thus triggering a downfall.

[73] Rudolf Steiner, *The Inner Nature of Music and the Experience of Tone* (Spring Valley, NY: Anthroposophic Press, 1983), 75.
[74] Tudor, "Letter to M. C. Richards (October 2, 1958)," Box 26, Folder 2, Mary Caroline Richards Papers, GRI.
[75] Marie Steiner, "Introduction," in *Eurythmy as Visible Speech* (Spring Valley, NY: Anthroposophic Press, 1931), vii.
[76] Ibid.
[77] Steiner, *The Inner Nature of Music and the Experience of Tone*, 62–63.

On the other hand, in spite of claiming an inner nature for all materials, Steiner set a clear preference, regarding some instruments more natural than others: mechanical ones were inferior to acoustic ones, and within the latter category, the piano was inferior to all the rest. One can only imagine what he would have thought about pavilions and islands. The hierarchy was embedded in the origin myth. At the very top of the ladder was the "higher human being," the most spiritual of all matters from whose imagination all other instruments had emanated—and, according to Steiner, a musical instrument in its own right.

4

How Tudor *actually* read Steiner therefore matters.[78] In his surviving notes, he never once cited Steiner's view on musical instruments, as if he had skipped over the entire anthroposophic mythology concerning their spiritual origin. Yet there was a single exception, for he did keep returning to the occult philosopher's remarks on one particular instrument: the human body.[79] Three series of lectures appear most prominently among his papers:

(a) *The Inner Nature of Music and the Experience of Tone*, which brought together two groups of lectures by Steiner, the first given in 1906, and the second between 1922 and 1923. As Erika V. Asten clarifies in her foreword to the English translation, these were "the only two sets of lectures that Rudolf Steiner gave primarily on musical subjects."[80] She then points the readers to another text: "The only other lecture cycle musicians can turn to is the tone eurythmy course, given in Dornach in February 1924 and published as *Eurythmy as Visible Music*."[81]

(b) Tudor indeed owned *Eurythmy as Visible Music* and its sequel *Eurythmy as Visible Speech*, given also in Dornach, between June and July 1924.

(c) Although not mentioned by Asten, there was another lecture that could interest musicians: *The Ear*, given around the same time as the second part of *The Inner*

[78] His papers contain a variety of anthroposophy-related materials extending from Anthroposophic News Sheets, brochures, Bio-Dynamics periodicals, flyers of Eurythmy concerts, printed copies of Steiner's lectures, library slips of borrowed anthroposophy books, and many notes he took from his readings whose sources show a wide range of interest: *The World of Senses and the World of the Spirit, The Spiritual Hierarchies, Foundation Stone Meditations, The Mantric Proverbs, Guidance in Esoteric Training, Planetary Evolution of the Arts, Nine Lectures on Bees, Calendar of the Soul, The Course of My Life*, to name just a few.

[79] Following Tudor's death in 1996, his collection of books dispersed. Some of those related to electronics found their way to Wesleyan University, and others related to anthroposophy and spiritualism were sent to the library of Camphill Village, an anthroposophy-based community in Kimberton, PA, where M. C. Richards was living at the time. From there, they appear to have scattered further and could not be tracked.

[80] Steiner, *The Inner Nature of Music and the Experience of Tone*, vii.

[81] Ibid, viii.

> *Nature of Music* on December 9, 1922, which focused on the organ of listening. Tudor not only owned a copy of the first English translation,[82] but also a typed-out copy of the entire lecture.

Taken together, these lectures outline Steiner's thoughts on the instrumental role of the human body for the inner nature of music. At the center of his teaching was the polarity between "sound [Klang]" and "tone [Ton]," the physical sound waves and the metaphysical content experienced by the listener. The former served as a carrier for the latter but the two were not to be confused. "What lives here in the air is basically the body of tone"[83]—in other words, "tone" is the inner nature of "sound."[84] Steiner used a specific word to describe the relationship between the two: "Physical music is but a *reflection* of the spiritual reality."[85] Like a radio engineer, the occult philosopher reasoned that this reflection of tone in sound could be processed back to tone through a counter-reflection in each listener. That was precisely the role our listening organs played: "The ear is actually the organ that reflects back inside us the tone living in the air, but does so in a way that separates it from the element of air. [. . .] The ear is a reflection instrument for our feeling of tone."[86] In other words, the ear was a (de)modulator of something that cannot be perceived directly, like a *Beat Frequency Oscillator* for the spirit. And tone, in turn, was like an inaudible control signal modifying the audible, the wind sculpting the fog and sound beams without itself being seen.

Tudor appears to have taken these teachings to heart. In his notes, the polarity between sounds and tones shows up again and again, like this paraphrase of a section found in the fourth lecture of *The Inner Nature of Music and the Experience of Tone* (Figure 6.11): "air formation of the Tone (body of tone) (music's life element) air is resistance medium which supports tone—the tone intrudes itself forcibly upon the air & the air gives tone the possibility of resting upon it. tone itself is a spiritual thing."[87] According to this definition, the reflection between a sound and its technically enhanced double that Tudor sought in the instrumental islands

[82] Steiner, "The Ear," in *Anthroposophical Movement: Weekly News for English-Speaking, Members of the Anthroposophical Society* IV, no. 15 (April 10, 1927); no. 17 (April 24, 1927); no. 18 (May 1, 1927) (Box 102 Folder 1, David Tudor Papers, GRI).

[83] Steiner, *The Inner Nature of Music and the Experience of Tone*, 40.

[84] In another lecture he gave on December 17, 1920, Steiner explained, "We hear the tone initially as earthly human beings, the air being the medium and bearer of this tone. But that is all it is—the medium. Someone who regards the vibrations of air as the essence of the tone is like someone who says that we only have our physical organism, and there is no such thing as the soul. [. . .] The air's vibrations are only the outer expression of the tone. Its inner essence is largely an etheric element" (Steiner, *Universal Spirituality*, quoted in: *Music: Mystery, Art and the Human Being* [Forest Row, UK: Rudolf Steiner Press, 2016], 129).

[85] Steiner, *The Inner Nature of Music and the Experience of Tone*, 6.

[86] Ibid., 49. The translation quoted here is a more recent one by Matthew Barton, contained in the anthology *Music: Mystery, Art and the Human Being*, 126.

[87] Tudor, "Notes from *The Inner Nature of Music and the Experience of Tone* (undated)," Box 107, Folder 2, David Tudor Papers, GRI. The corresponding passage is the following: "tone needs air for support. Just as man stands on the firm ground, so—in a somewhat more complicated way—tone has its ground, its resistance, in the air. Air has no more significance for tone than the ground for the person who stands on it. Tone rushes toward air, and the air makes it possible for tone to 'stand.' Tone itself, however, is something spiritual" (Steiner, *The Inner Nature of Music and the Experience of Tone*, 40).

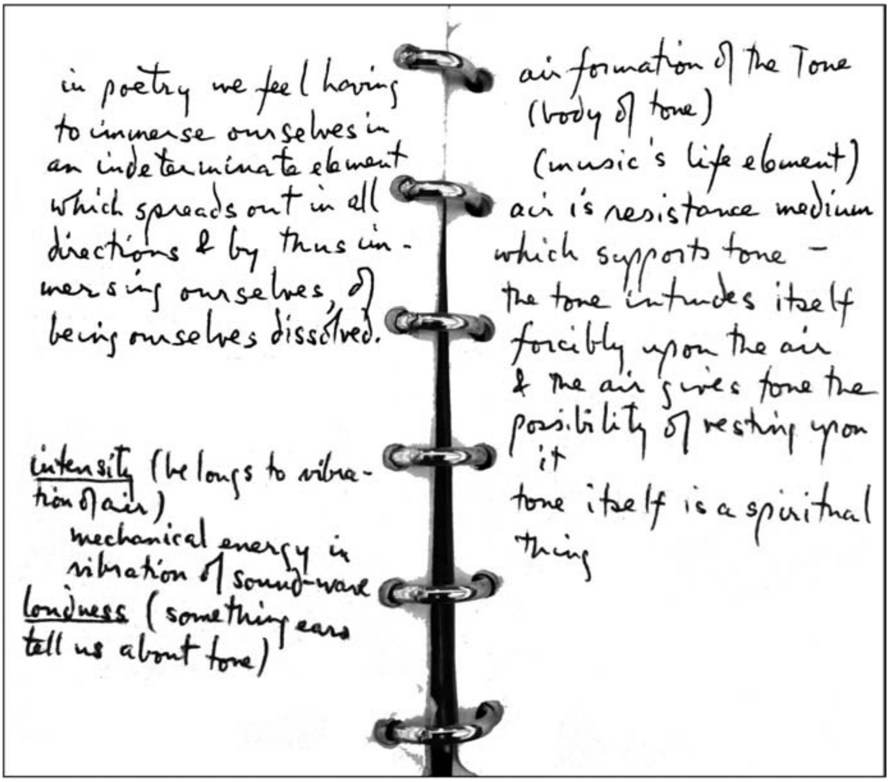


Figure 6.11 Tudor | Notes from *The Inner Nature of Music and the Experience of Tone* | Undated

DTP, Box 107, Folder 2 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

and rainforests is a secondary phenomenon, itself reflecting the primary reflection of tone in sounds, and aimed at triggering a tertiary reflection in each listener to recover the tone after its earthly transmission.

5

One difference between Steiner's thoughts on the "reflection instrument," which Tudor noted, and his thoughts on other instruments, which Tudor ignored, was that the former were always presented through a detailed observation of human physiology. In *The Ear*, Steiner focused on the series of transductions—conversion of one form of energy into another—involved in the process of listening: the airwaves entering the ear canal are first converted into mechanical vibration by the eardrum; this vibration then moves the ossicles, three small bones in the middle ear, at the end of which it is converted into a vibration of fluids filling a spiral-shaped tube in the inner ear called the cochlea; this fluid wave triggers sensory hair cells covering the cochlea which convert it into electrical pulses that are sent to the brain. In particular, Steiner saw great significance in the fact that the inner ear is placed in a fluid, understanding its function to be a protective buffer against gravity. For him this was proof of the ear's escapement from physical forces and its integration into the metaphysical domain: "Truly the ear is no earthly citizen; in all its organization it is a citizen of the Spiritual world."[88]

In addition to this nature of the ear, there was another mechanism of the human body Steiner regarded as fundamental to the experience of music: the rhythmic rising and falling of the cerebrospinal fluid caused by respiration. When one breathes out, the fluid in the brain descends to the diaphragm area through the spinal column, and when one breathes in, the same fluid is pushed back to the brain. It was the coordination between this inner rhythm of the breath and the demodulation of tone in the inner ear that formed the basis of Steiner's view of the human body as a musical instrument: "What streams in through the ear as tone, the impressions of sound that live in us, becomes music as it meets the inner music that comes about because our whole organism is a remarkable musical instrument."[89]

The interesting thing is not so much *what* Steiner described, but *how* he described it. For he took great pains to coordinate the metaphysical nature of music with the physical mechanism of the human body. The experiences of tone did not belong to the earthly world, but the reason why they did not belong did. Which is to say that the anthroposophical account of the *Human Body* as a musical instrument stood in strong contrast to the account of non-human instruments forever arrested within the polarity of immaterial imagination and material experimentation, and the irreversible downfall from one to the other. As far as the *Body* was concerned, the nature of a musical instrument was neither completely physical nor metaphysical, but lay somewhere in between the two.[90] The polarity holding up the entire hierarchy of instruments thus breaks down at the very top of the ladder.

6

When composers began to regard him as a musical instrument, Tudor was delighted. Upon reading Sylvano Bussotti's letter explaining the name in the title of *Five Piano Pieces for David Tudor* as a specification of the instrument and not a dedication, he immediately recalled the theory of the respiratory mechanism he had read in Antonin Artaud's writing, which was also reminiscent of Steiner's teachings on the same subject. But the task of *David Tudor* as an actual musical instrument was

[88] Steiner, "The Ear," in *Anthroposophical Movement: Weekly News for English-Speaking, Members of the Anthroposophical Society* IV, no. 17 (April 24, 1927), p. 1 (Box 102, Folder 1, David Tudor Papers, GRI).

[89] Steiner, *Kunst und Kunsterkenntinis*, quoted in: *Music: Mystery, Art and the Human Being*, 139.

[90] I called this nature "mesophysical" in a lecture I gave at the Anthroposophical Society of Oslo on September 11, 2017.

based on something that never appears to have entered Steiner's metaphysics of musical instruments: physical coordination with other instruments. This focus was only enhanced when he left behind "the impressions of the piano" for live electronics, placing himself as a component within the complex of modular instruments that hoped to influence one another.

On September 29, 1985, toward the end of a 90-minute workshop held at the Mobius Art Center in Boston, Tudor was asked a question by one of the participants. He had just talked about how changes in music brought about by electronics are not easily perceived because of conceptual biases—"you think music hasn't changed, but it's changing"[91]—and although the recording of the conversation is too distorted to make sense of the actual question, the student apparently wanted to know how to actually change one's mind to perceive the changes that are indeed happening. In response, Tudor gave a suggestion that was clearly influenced by his reading of Steiner:

> *There's only one thing which can change your mind about what music is, and that is if you can make a differentiation between "tone" and "sound." If you can do that, then you have a clue to where the music is. Because "tone" is something that happens inside you, and "sound" is something that happens in space. And if you have that differentiation then it will lead somewhere.*[92]

But the influence ended there, for the specific example he went on to give of just where this differentiation could lead diverted completely from the conceptual biases of anthroposophy: "For instance, that for me is to not use an oscillator, not to depend on a montage of prerecorded tape, to find out what the electronic components were doing themselves."[93] This immediate coordination between the importance of tone "happening inside you," and the method of discovering what the instruments "were doing themselves" is puzzling. To make sense of the analogy, it is necessary to equate "you" with "them": something that happens inside a listener is also something that happens inside an instrument. The instruments have their share of private inner nature that is reflected in their tone, revealed through their sound. In other words, Tudor appears to have believed that the equation Steiner set between humans and musical instruments worked in both directions.

That is why when the coordinated instruments were activated, Tudor saw them as springing to life, as he described to Hultberg three years after the Mobius workshop: "there is a point where a certain sound-world or a certain color conception can appear, an electronic set up that's hooked together with a certain idea. And all of a sudden you realize that it has a life of its own."[94] In this explanation, the instruments become inspirited only when they are hooked together. The metaphysical experience

[91] Tudor, "Workshop at Mobius Art Center, Boston (September 29, 1986)," Box 2A, C75, David Tudor Papers, GRI.
[92] Ibid.
[93] Ibid.
[94] Tudor, "Interview with Teddy Hultberg."

of music requires physical activation. As Tudor learned long ago when he switched back to the most philistine of all instruments and thus initiated his descent into materialism as far as anthroposophy was concerned, hearing something in the mind's eye and ear was not enough—one needed to do it actually.

The spiritual endeavors that secretly accompanied his music in no way conflicted with Tudor's pursuit of mechanical instruments. On the contrary, his response to Rogalsky at the end of his life made it sound as if it was not in spite of, but rather because of his interest in the occult that he got involved in electronics in the first place:

> *well, I've had my share of friends who, who look askance at the fact that I'm involved in electronics, and I had to accept their criticism. And I just, uh, well, part of my, uh, part of my interest in life is, is, you know, spiritual endeavors, which I don't speak about them because I don't want them to be identified.*[95]

7

But the occult influences did reveal themselves from time to time. At the end of the interview on November 24, 1978, Klüver asked one last question about the prospect of *Island Eye Island Ear*: "You think it's going to be beautiful?" Tudor answered in the affirmative, then described the sadness he would feel if the project could not be realized, using a term Steiner frequently used to address the spiritual dimension of the human body:

> *I wouldn't want to miss it myself. I've always felt that about this project. Ever since we tried things out on an actual island, I already knew then. I thought it was so gorgeous. I mean the experience I had in sound and in watching the fog, they were so beautiful that I knew that I didn't want to miss doing this. I mean if it doesn't happen, there's going to be a hole in my* astral body.[96]

Throughout the 1970s and well into the next decade, Tudor kept referring to *Island Eye Island Ear* as his major work, despite the uncertainty of its realization. Klüver remembered asking Tudor a "low-level question" in the middle of the difficulties they faced: " 'David, do you want to do this project?' His answer was, 'As long as I live.' "[97] As late as July 1984, Tudor sent a letter to the National Endowments for the Arts, asking for the extension of their grant for *Island Eye Island Ear*, mentioning "a new possibility of finding an appropriate island in the Thousand Islands area of the St. Lawrence River."[98] The project, however, was never to be realized during his lifetime.

95 Tudor, quoted in Rogalsky, "Live Electronic Music Practice and Musicians of the Merce Cunningham Dance Company," 129.
96 Tudor, "Interview with David Tudor by Billy Klüver (November 24, 1978)," 6; emphasis added.
97 Klüver, "Talk on David Tudor at the Getty Center (May 17, 2001)."
98 David Tudor, "Letter to National Endowment for the Arts (July 24, 1984)," Box 21, Folder 10, David Tudor Papers, GRI.

The impossibility of realization may itself be understood as an answer to what Tudor set himself to discover: "the maximum scale for feedback to occur." Perhaps an island was just too big, and outdoor nature just too indeterminate. In parallel to the never-ending attempts to secure an island, Tudor began pursuing a series of works that aimed to discover electronic components as "natural objects." In the absence of an island with a nature to reveal, the instruments would reveal their own nature. Most of his subsequent works returned once again to indoor environments. But even then, *Island Eye Island Ear* continued to hold a very special place in Tudor's heart, probably all the more so because it was never materialized. He would reflect on its possibilities from afar, and its reflections would appear in many realizations. *Knavelskär* thus became something close to a general reference ground for Tudor—although somewhat paradoxically, as this generality was rooted in the utter specificity of the instrument:

> *I want other people to have the joy of experiencing the absolute uniqueness of an island. When you're on an island you always feel, no matter how many people are there, that there's a remoteness which leads you to look very closely at everything there, which you wouldn't do if you had the feeling that you could go somewhere else.*[99]

[99] Tudor, "Interview with David Tudor by Billy Klüver (November 24, 1978)," 2.

Chapter 7
Natural Objects

I. Sources

Double Music

1

On February 1, 1971, the composer Hans Otte, who had been organizing Radio Bremen's new music festival Pro Musica Nova since 1961, wrote to John Cage and invited him to appear in the next festival with David Tudor as his performer. Cage replied ten days later, thanking Otte for the invitation but informing him about the change that had occurred over the years:

> *However, circumstances are greatly changed: David Tudor is now a composer in his own right, and he concentrates beautifully on circuitry both audio and video, rarely touching the piano. We are the best of friends but we don't give concerts together as we did formerly. Recently (Oct '70) I gave performances in Paris without him and I was not happy with the way the music was played.*[1]

While in Paris to attend the festival of his works he mentioned and shortly afterward, the composer had held a series of conversations with the musicologist Daniel Charles, which later became published under the title *For the Birds*.[2] It was during

[1] John Cage, "Letter to Hans Otte (February 11, 1971)," reprinted in: "Program, Pro Musica Nova," Box 77, Folder 8, David Tudor Papers, GRI.

[2] The materials for *For the Birds* underwent a curious history of revisions, rewritings, and retranslations, which makes it impossible to date the conversations with any certainty (or significance, for that matter). When the transcript of the original interviews conducted between late 1970 and early 1971 were sent to Cage presumably in 1972, the composer did not recognize himself in many passages. As Cage explained in the introduction, "Some tapes apparently had been damaged or lost or inadvertently erased, so that it had sometimes been necessary for Daniel Charles to compose my responses to his questions. Instead of 'correcting' his work, I suggested the use of two different typefaces for my responses. One would indicate that I could hear myself speaking, the other that I couldn't. [. . .] This idea was accepted but still the book was not published. In fact, in order to please the publisher, Charles later made a new version, in some cases an abridgement of the earlier one, in others having new material, 'conversations' written by Charles himself, following new articles or letters or tapes of lectures that I sent to him. I made no changes in the final version" (Cage and Charles, *For the Birds: John Cage in Conversation with Daniel Charles* [Boston, MA: Marion Boyars, 1981], 11). Furthermore, when preparing the English version of the book after the French one was first published in 1976, the material underwent another series of transformations, as its editor Tom Gora writes in his "Note on the Book's History": "it was soon discovered that the original taped interviews—in English—had been lost. This necessitated the very Cagean task of retranslating a translation. Needless to say, the result is not at all a record of actual conversation, but rather our performance (or interpretation) of a John Cage score. A further intermingling of categories that makes John Cage very happy" (ibid., 7).

Reminded by the Instruments. You Nakai, Oxford University Press (2021). © Oxford University Press.
DOI: 10.1093/oso/9780190686765.001.0001.

this exchange that he revealed how in all his works since 1952 he had tried to achieve something that would interest *David Tudor*.[3] However, the very nature of this "instrument" had triggered its own transformation: "it is in David's nature not to repeat what has been done—because he must always go forward."[4] Cage confessed how this placed him in an awkward situation, where he repeatedly found himself composing with Tudor in mind even when writing for other performers and instruments. Still, he admired the choices his friend had made:

> *What strikes me is his devotion to electronic circuits both audio and video* [. . .] *I must stress that to this day he has always accorded to this work, which is his very own, the same respect that he devoted to the work of composers working outside his own preoccupations. David Tudor was present in everything I was doing. . . . Today he is present in himself. And I am truly very happy about that.*[5]

Happy about what Tudor was doing on his own, yet unhappy about what he himself was doing on *his* own, Cage decided to use Otte's invitation to work with his former collaborator once again. Two months after his first reluctant response, in a second letter written on April 29, the composer informed Otte of a change of plan (or instrumentation): "I have spoken to David Tudor. He would be willing to collaborate, but I'd propose that you also present some of his work, if you engage him."[6] Tudor's music was thus proposed, although only as a possible addendum to the program which still focused on him performing Cage's compositions: "I would be pleased (if he is willing) to have all 5 Carillon works played by David."[7] However, a third letter written three months later on July 27 completely did away with the idea of Tudor being Cage's performer. Reporting that he yet again "had a good talk with David Tudor," Cage outlined the finalized plan:

> *What we offer for the European transmission is: MESOSTICS RE MERCE CUNNINGHAM (my work which I would vocalize) with an as yet untitled work by David Tudor (electronic).* [. . .] *For the concert (3 hours) we offer MUEAU* [sic] *(my work which I would*

[3] Cage, *For the Birds*, 178.
[4] Ibid.
[5] Ibid. Cage's reaction to Tudor's moving forward was not always so kind-hearted. In a letter to Christian Wolff written on January 17, 1974, Cage described Tudor's bitter departure as follows: "I knew that it had to stop because of a recurring twisted expression around his lips [. . .] he was clearly suffering because he was doing 'my' work" (quoted in Kenneth Silverman, *Begin Again: A Biography of John Cage* [New York, NY: Alfred A. Knopf, 2010], 257). Carolyn Brown reported a particularly violent outburst that she witnessed in September 1970, just a few months before the conversation with Charles: "he did say he hated what Gordon and David T. are doing with electronics. 'It's *not* musical composition. David is *not* a composer.' And then he said, 'But I'll use what they've discovered' " (Carolyn Brown, *Chance and Circumstance: Twenty Years with Cage and Cunningham* [New York, NY: Alfred A. Knopf, 2007], 558).
[6] Cage, "Letter to Hans Otte (April 29, 1971)," reprinted in: "Program, Pro Musica Nova."
[7] Ibid.

> *vocalize) with RAINFOREST (David Tudor's electronic work).* […] *This situation pleases me for it in no way interrupts David's work.*[8]

2

Much later, during an interview with Joel Chadabe on September 8, 1993, Tudor recalled how Cage had arrived at the idea of presenting two completely different works simultaneously. The source was an old piece for percussion quartet he had co-composed with Lou Harrison back in 1941. In this collaboration, the two composers decided in advance on the total number of measures, then each worked completely independent of the other, superimposing the results only at the end.[9] This was, of course, the method Cage was at the time using in his work with Merce Cunningham, where the music and dance shared the same rhythmic structure but were composed separately and brought together only in performance. Cage and Harrison gave a dry name to their joint effort: *Double Music*. According to Tudor, it was the influence of this material from thirty years earlier that inspired Cage to propose in 1971 a new way to collaborate with him which no longer depended on the duality of "sound system" and "indeterminate composition":

> *The idea was that we should each do our own work, but simultaneously. It's an idea which he had in his mind, the idea of simultaneous composition, and I know the first time he used that idea was a collaboration with Lou Harrison, and it was an idea which persisted in his mind, so he organized the tour for the two of us.*[10]

3

The tour Cage organized was extensive. Aside from the two concerts at Pro Musica Nova on May 5 and 8, additional concerts in Bonn (May 18), London (May 22), Basel (June 5), Pamplona (July 2), and Berlin (July 11) were scheduled. As Cage explained to

[8] Cage, "Letter to Hans Otte (July 27, 1971)," reprinted in: "Program, Pro Musica Nova."
[9] Cage composed soprano and tenor, Harrison composed alto and bass.
[10] Tudor, "Interview by Joel Chadabe," davidtudor.org. Cage had already referred to *Double Music* in a letter to Walter Hinrichsen written on March 3, 1968: "My new work for computer, *HPSCHD*, will be finished hopefully by June 15. As with *Double Music* (Cage-Harrison), this work is a collaboration with Lejaren A. Hiller" (Cage, "Letter to Walter Hinrichsen [March 3, 1968]," in *Selected Letters*, 382–383). Another influence Tudor leaves out is Cage's concurrent endeavors in *Musicircus* to have many people play different music simultaneously. In his first letter to Otte, Cage in fact mentioned his experience of performing *Musicircus* in Paris which failed because "the performers [did] not sympathize with my notion that many musics may be heard at one & the same time" (Cage, "Letter to Hans Otte [February 11, 1971]).

Otte, for each occasion the duo would perform either of the two duet programs: one that superimposed two preexisting works—Cage's *Mureau* and Tudor's *Rainforest*—and the other that was to be newly composed—Cage's *Mesostic Re Merce Cunningham* and Tudor's "as yet untitled work."

The presenters naturally wished to know the title of this latter new piece. On September 29, 1971, Mimi Johnson, who had become Tudor and Cage's agent around then, wrote to Otte assuring him, "I'll remind David Tudor that you need the title for his piece."[11] The work nevertheless remained untitled in early 1972 when Johnson sent a note to Tudor asking him to "make a little blurb about *Rainforest* and maybe the famous untitled new piece."[12] In the end, Tudor appears to have been unable to decide on the title before the premiere. In the concert program of Pro Musica Nova, his part of the simultaneous duo performance was credited simply as "Untitled/New Electronic Piece."[13]

Such indifference to titles was in Tudor's character. Thirty years later, Gordon Mumma still remembered well how his friend appeared to not care about what to call the new piece he was composing for MCDC in March 1968: "David Tudor's role in the title is absolutely clear in my memory. […] From time to time (before the premiere in Buffalo) I asked David if he'd made a title. 'No, not yet, I'm too busy with the work.' When Merce finally titled the choreography as *RainForest*, David replied, 'Now there's a title.' "[14] This unconcern was also reflected in Tudor's constant difficulty for framing what he produced as "composition"—his initial reluctance about being called a "composer," or the later indecision about how many versions of *Rainforest* existed. Titles, be they of work or profession, appeared to be external labels that were secondary in the view from inside. They were, by nature of Tudor's approach, a mere afterthought.

4

Although he may not have known how to call it, Tudor knew what he was going to do by January 1972, when he drew the earliest dated sketch of *Untitled* that survives in his papers (Figure 7.1). The diagram shows modular components arranged in two chains of feedback. In each chain, two *Cybersonic Output Splitters* ("SPL") take the returning signal from two *Olson Preamp Mixers* ("O.P".) and split it into five routes, each of which process the signal differently using various phase splitters and shifters (boxes with numbers indicating phase angles), along with *Tone Controls* ("TC"), and a *Tunable Amplifier* ("T" in triangle). These parallel processing channels are summed in two groups of four and modulated against one another using the *Cybersonic Spectrum Transfer* ("ST") in the top channel or a *Four Quadrant Multiplier* ("QM")

[11] Mimi Johnson, "Letter to Hans Otte (September 29, 1971)," Box 18, Folder 11, David Tudor Papers, GRI.

[12] Mimi Johnson, "Typed blurb of *Mureau* with a note to David Tudor (undated, early 1972)," Box 18, Folder 11, David Tudor Papers, GRI.

[13] "Program, Pro Musica Nova."

[14] Mumma, quoted in: Rogalsky, "Idea and Community," 95.

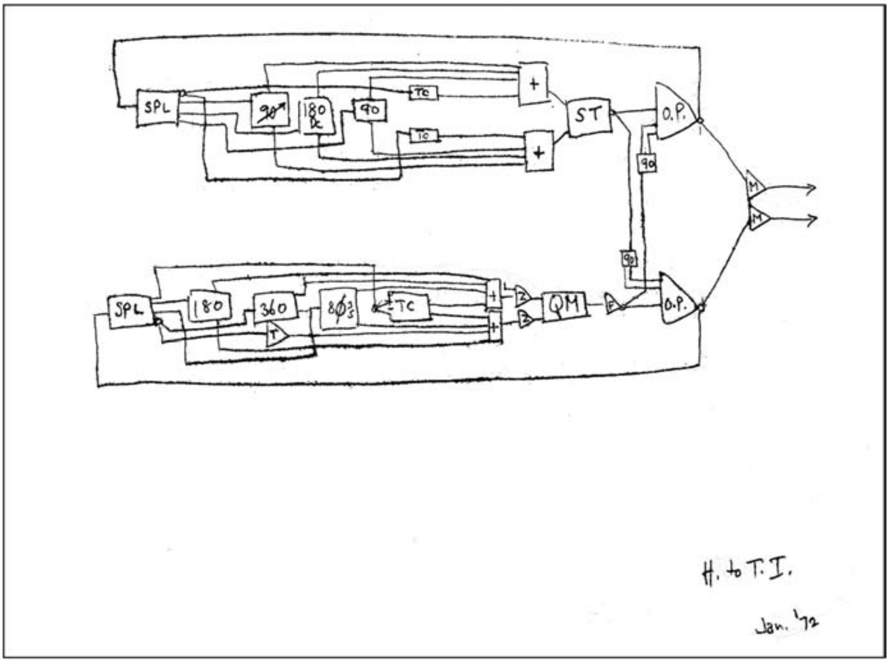


Figure 7.1 Tudor | *H. to T. I.*, diagram | January 1972
DTP, Box 3e, Folder 3 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

in the bottom channel. The modulated signals are split in two, each going into both *Olson Preamp Mixers* (one further split via a 90-degrees phase splitter), so the two feedback chains are also crisscrossed at the output.

Twelve years later, when the recording of *Untitled* was released from Lovely Music in 1984, Tudor wrote a composer's note which described the untitled piece as continuing the exploration of no-input electronic feedback he had pursued in *Pepscillator* and other works: "The configuration of devices & their inter-connections was conceived of as a 'Giant Oscillator,' with random characteristics variable by a performer's response & consequent actions."[15] By thus composing a giant instrument that oscillated on its own, Tudor could create music from the inner nature of materials without having to resort to external language. Titles could be attached later—or never, as appears to have been the case in 1972.

However, the January 1972 sketch, drafted around the time Johnson was struggling to get a title out of Tudor, already contains a name written above the date in the lower right corner of the page: "H. to T.I." This shorthand stood for "Homage for Toshi Ichiyanagi," which later would become the subtitle of *Untitled*. Tudor's early decision

[15] David Tudor "*Untitled*, composer's note," Box 3e, Folder 3, David Tudor Papers, GRI.

to dedicate the work to Ichiyanagi was an act of remembrance: the idea of configuring modular components in a feedback loop had developed out of his earlier attempt to realize a material the composer had written. The later subtitle therefore reveals not only Tudor's source but also his focus. Although he may not have known what to call it, he had already identified his new work by the particular *network topology* of instruments connected to one another with no exterior input.

Activities for Orchestra (Source A)

1

On May 29, 1972, five months after drafting the *H. to T.I.* diagram, Tudor was in Brussels and answered a joint interview with Cage broadcasted on KPFA radio. Over the course of an hour, Tudor remained mostly silent, letting his eloquent partner do all the talking as usual. It was only toward the end of the broadcast that the anonymous interviewer started asking questions specifically to Tudor, who finally began conversing in response. After explaining why he quit the piano—"I got tired of the sound of it. And I had a great desire to not have to hear it anymore!"[16]—Tudor turned to the two works he was presenting in this European tour. He first described the instrumental loudspeakers of *Rainforest*, and then how the other new, untitled work had come along:

> *I had dealt with a very complex processing in a certain work by Toshi Ichiyanagi, which he composed for the Merce Cunningham called* Activities for Orchestra*. And his instructions, which he gave to the performers to perform the electronic parts, were very vague and dealt with things that you couldn't define as a precise action. For instance, he says, "divide," or "add," or "subtract," or "multiply," or "take something away," and such notions. As I was working with that, I discovered one day that those processes were applicable to a hookup of electrical components which didn't contain any input signal. And I discovered it by accident, and for that reason, I dedicated all that work to him.*[17]

[16] KPFA Radio, "Interview with John Cage and David Tudor [audio recording]," May 29, 1972, Other Minds Audio Archive, accessed December 15, 2018: http://archive.org/details/am_1972_05_29

[17] Ibid. Tudor made a similar acknowledgement of the same material during his interview with Teddy Hultberg in May 1988, naming Ichiyanagi, along with Mumma, as the two people who were "very important in different ways" and "really set my mind to thinking about electronics in such a way that I began to think about sound sources": "[Ichiyanagi] at one point composed a piece for the Merce Cunningham Dance Company which was to be an orchestra piece but in typical Ichiyanagi fashion, he decided that he had to make parts even though it didn't matter whether the whole orchestra was there or not. Toshi's score was one of such vagueness that it made me think, how can I do this with electronics? His proposition for the performer was to make choices between various ideas. Like 'add something,' 'subtract something,' 'multiply something,' 'divide something.' It had nothing to do with electronic music at that point, but the question was: 'what kinds of performing actions can I make that are going to satisfy those conditions?' " (Tudor, "Interview by Teddy Hultberg," davidtudor.org).

Activities for Orchestra was a series of works Ichiyanagi started writing in 1962. The basic idea was to compose parts for different instruments on separate occasions, gradually increasing the number and enlarging the orchestra over the years. The first part he wrote was for brass—it also ended up being the only one to be published.[18] In 1967, when Cunningham commissioned from him the music for the new choreography *Scramble*, Ichiyanagi wrote down a sketch for the next part of the *Activities for Orchestra*. According to his own reminiscence on September 13, 2012, this was the only material (or set of materials) Ichiyanagi produced. He also did not remember seeing it ever again after it was passed over to the musicians of MCDC:

> *At the time I had only worked out the structure of the piece, so I think the score I gave them was not for any specific instrument, but something that could be used by any instrument.* [. . .] *Basically, all the scores had the same form, perhaps differing from one another only in the details.* [. . .] *It did become a company repertoire, but I was surprised that they could actually perform it with the little material I had given them. Well, I suppose if you use electronics, you can, umm, broaden the music.*[19]

2

This material has not been found. And neither Mumma nor David Behrman, who later performed the music with Tudor, could recall any details of how they actually performed it when asked half a century later.[20] But shortly after the premiere of *Scramble/Activities for Orchestra* on July 25, 1967, at the Ravinia Festival in Chicago, Mumma had published an article in which he described Ichiyanagi's material with a fresh memory:

> *The musicians (a minimum of three) each perform multiple activities: either several instruments simultaneously or a single instrument with complex electronic sound manipulation. Though scored for western instruments (French horn, Bandoneon, piano and celesta, and percussion), the music for* Scramble *has a sound texture reminiscent of Japanese classical theatre music.* [. . .] *The score is composed in cued sequences which are scrambled by the musicians in performance.*[21]

[18] Ichiyanagi explained in September 2012: "For me, that work is not finished yet. I wanted to write for more instruments, but a lot of things prevented me from developing the piece [. . .] I couldn't keep up with the composition because of other things to do, so the whole project has been halted. [. . .] So it is a piece for the orchestra, but can also be performed as a solo" (Toshi Ichiyanagi, "Interview by You Nakai," Tokyo, Japan, September 13, 2012).

[19] Ibid.

[20] Mumma, "Interview by You Nakai," November 4, 2014; Behrman, "Interview by You Nakai and John Driscoll," May 28, 2015.

[21] Gordon Mumma, "Four Sound Environments for Modern Dance," *Impulse, Annual of Contemporary Dance* (1967), 14.

Among other details, Mumma reveals the instrumentation. But the number of instruments—the commas articulate four groups—does not correspond to the number of musicians in MCDC at the time, which was three: Tudor, Cage, and Mumma. "A minimum of three" very likely refers to them, but its designation as a lower limit in addition to the instrumentation suggests that Ichiyanagi was thinking about at least one more person. Indeed, the program note from MCDC's performance at the American Dance Festival on August 5, 1967—just ten days after the premiere—lists the musicians and their respective instruments, revealing the surprising identity of the fourth performer:

> *Percussion and Electronics*: John Cage
> *Bandoneon and Electronics*: David Tudor
> *Horn and Electronics*: Gordon Mumma
> *Piano and Celesta*: Toshi Ichiyanagi.

It turns out that the composer of *Activities for Orchestra* was touring with the company that year. Ichiyanagi was himself one of the musicians who somehow managed to "actually perform it with the little material [he] had given them." The instruments match those Mumma described: only Ichiyanagi chose the option of using several instruments at once; all the others chose a single instrument with electronic sound manipulation. It is possible that this surprised the composer, whose original sketch, according to Mumma's retelling, was scored for Western acoustic instruments. That would explain his somewhat awkward reasoning in retrospect about how it was all possible: "Well, I suppose if you use electronics, you can, umm, broaden the music." At the same time, the material appears to have worked quite well with electronics to the extent that Tudor at one later point stopped realizing it with the amplified bandoneon, his standard instrumentation of the day. What he realized was that all the arithmetic operations instructed in the score could be performed with electronic components configured in a feedback loop with no-input. Tudor thereby switched the category of instrumentation accordingly from "a single instrument modified electronically" to "the use of simultaneous several instruments"—albeit the latter were now all electronic.

3

Coordinating Mumma's account with Tudor's, the basic format of Ichiyanagi's sketch-score can be reimagined: cued sequences of arithmetic operators. Asked about the meaning of these mathematical symbols that Tudor remembered—"things that you couldn't define as a precise action"—Ichiyanagi reminisced forty-five years later:

> *When I was thinking about the nature of how each instrument is performed I became interested in the treatment of overtones [*bai-on*] in different instruments. Woodwind*

> *instruments are good at dealing with overtones, brass instruments not so much, and with piano, you can manipulate overtones if you play inside the instrument. And there are two types of overtones, one that goes upwards, and the other that goes downwards. I was thinking a bit about both. So it was probably related to that.*[22]

Overtones can be harmonic, adding integer multiples to the fundamental tone, or inharmonic, if the addition is by non-integer multiples. Undertone series or subharmonic spectra extend below the fundamental tone and mirror the overtone series. Ichiyanagi's hesitation about brass instruments, despite writing the first part in the series for them, was probably because of the inharmonic nature of their overtones. The published score of *Activities for Brass* contains no arithmetic operators.[23] If electronic instruments are involved, however, overtones and undertones can be manipulated with ease. Indeed, the modulation of overtones (or frequency spectra, as Mumma liked to call them) in the bandoneon sound was what both Tudor and Mumma were focusing on circa 1967, in *Mesa* as well as in *Bandoneon!*. And as the analyses of those two works showed, this could be done using instruments specifically designed to function as arithmetic operators to the incoming signal: A mixer is a *summing* amplifier; a modulator *multiplies* two signals to produce their *sum* and *difference;* a frequency shifter (like the *Spectrum Transfer* in "single-spectrum" mode) could then *divide* that output by *subtracting* the *sum* part with a low-pass filter and leaving only the difference part which is a fraction of the original signal;[24] op-amps stand for operational amplifiers, so called because they performed arithmetic operations with signals—and when they did, they altered the overtones and undertones of the resulting sound.

4

In the 1972 interview, Tudor added a puzzling remark which appeared to suggest that Ichiyanagi's operators, like Bo Nilsson's numbers, turned out to be a bluff: "Because without trying to figure out what in hell he could have meant … you see, whereas actually he didn't mean anything, which I'm also very grateful for."[25] The puzzle may have been in appearance only. But yet again, the attempt at actually solving it brought forth something unforeseen. And fortunately, Tudor documented the processes he undertook: among his papers, there is a series of block diagrams related to the realization of *Activities for Orchestra* across the years. When analyzed in chronological

22 Ichiyanagi, "Interview by You Nakai."
23 Ichiyanagi, *Activities for Brass* (New York, NY: CF Peters, 1962).
24 This operation is called "single-sideband modulation," and will be discussed later in the chapter. In contrast to the frequency shifter which operates on complex waveforms over their full frequency spectra, a frequency divider usually takes a square or pulse wave and outputs a square wave whose frequency is at even divisions (½, ¼, and so on) of that input signal. It is often used to generate sub-octaves to fortify the bass register like the *Electro-Harmonix Octave Multiplexer* (Instrument 0300) that would appear frequently in Tudor's performances in the 1980s. In diagrams, Tudor drew the symbol of the instrument appropriately with a division sign.
25 KPFA Radio, "An Interview with John Cage & David Tudor."

order, these materials reveal the trajectory from the initial electro-acoustic configuration to the later no-input feedback.

(a) *Mexico City* (July 1968)

The earliest sketch of *Activities for Orchestra* that can be dated is from a year after the premiere, drawn on a paper with the letterhead "Hotel Ritz, Mexico D.F." (Figure 7.2).[26] The footer promotes the 1968 Summer Olympics, which was held in the same city in October. From July 15 to 20 of that year, Tudor was indeed in the capital of Mexico with MCDC, presenting a program that included *Scramble/Activities for Orchestra* on the 18th and 19th.

The diagram centers around the *Cybersonic Spectrum Transfer* ("ST"), whose output goes into the *Olson RA-637 Preamp Mixer* ("PM") and from there to the *Cybersonic Output Splitter* ("SPL"). Two outputs from the *Splitter* ("3, 4") are fed back to the *Preamp Mixer*, while the other two ("1, 2") are fed back to two 4-in/1-out mixers ("+")—probably *PA-292 Microphone Mixers* that had appeared in *Variations II*—whose summed outputs are returned to the two inputs of the *Spectrum Transfer* through the *Switchcraft Stereo-Monaural Signal Selector in Reverse* that allowed Tudor to reverse their roles as program or carrier signal. There are four loops here. Despite the basic constancy of instruments, what differentiates the configuration of *Activities* from the parallel processing channels of *Fontana Mix* or *Bandoneon!* is this proliferation of feedback paths.

The mixers also receive a variety of other inputs. The top one mixes a sine wave from the dual *Midland Audio Generator*, a pulse wave from the *Pulser* ("PLS"), and input from an unknown source labeled "ER" and "DM"; the bottom one mixes two square waves—one from the *Fog Horn* ("FH" inside a dotted square) and the other from the dual *Midland Audio Generator*—and the bifurcated output from the *Beat Frequency Oscillator* ("BFO") whose frequency and amplitude are modulated using a *Variable Oscillator* ("VO") and the *White Noise Generator* ("WN"), just like in *Fontana Mix*, which also goes directly into the *Olson Preamp Mixer*. None of these inputs, however, corresponds to the bandoneon. Within a year from the premiere, that is to say, Tudor had shifted to a purely electronic realization of *Activities for Orchestra*.[27]

(b) *3-Channel Version* (Undated)

There are three more undated diagrams, almost identical in content, which expand the Mexico City diagram by adding a second pair of *Preamp Mixer* and *Splitter*

[26] Tudor, "Sketch for *Activities for Orchestra*, Mexico City (June 1968)," Box 4, Folder 2, David Tudor Papers, GRI.

[27] One available recording of *Activities for Orchestra* is included in the *Music for Merce* CD Box set. It is from MCDC's performance at the Brooklyn Academy of Music on May 15 or 17, 1968—two months before they visited Mexico City. The musicians and instrumentation were as follows: David Behrman, viola; John Cage, piano, voice, percussion; Gordon Mumma, horns, live electronics; David Tudor, piano, live electronics; Malcolm Goldstein, violin; Max Neuhaus, percussion. The primary sounds are electronically modified, within an overall tranquil soundscape dominated by layers of extensive feedback (Various, *Music for Merce: 1952–2009,* Disc 2, New World Records (80712), 2010, 10 CDs).

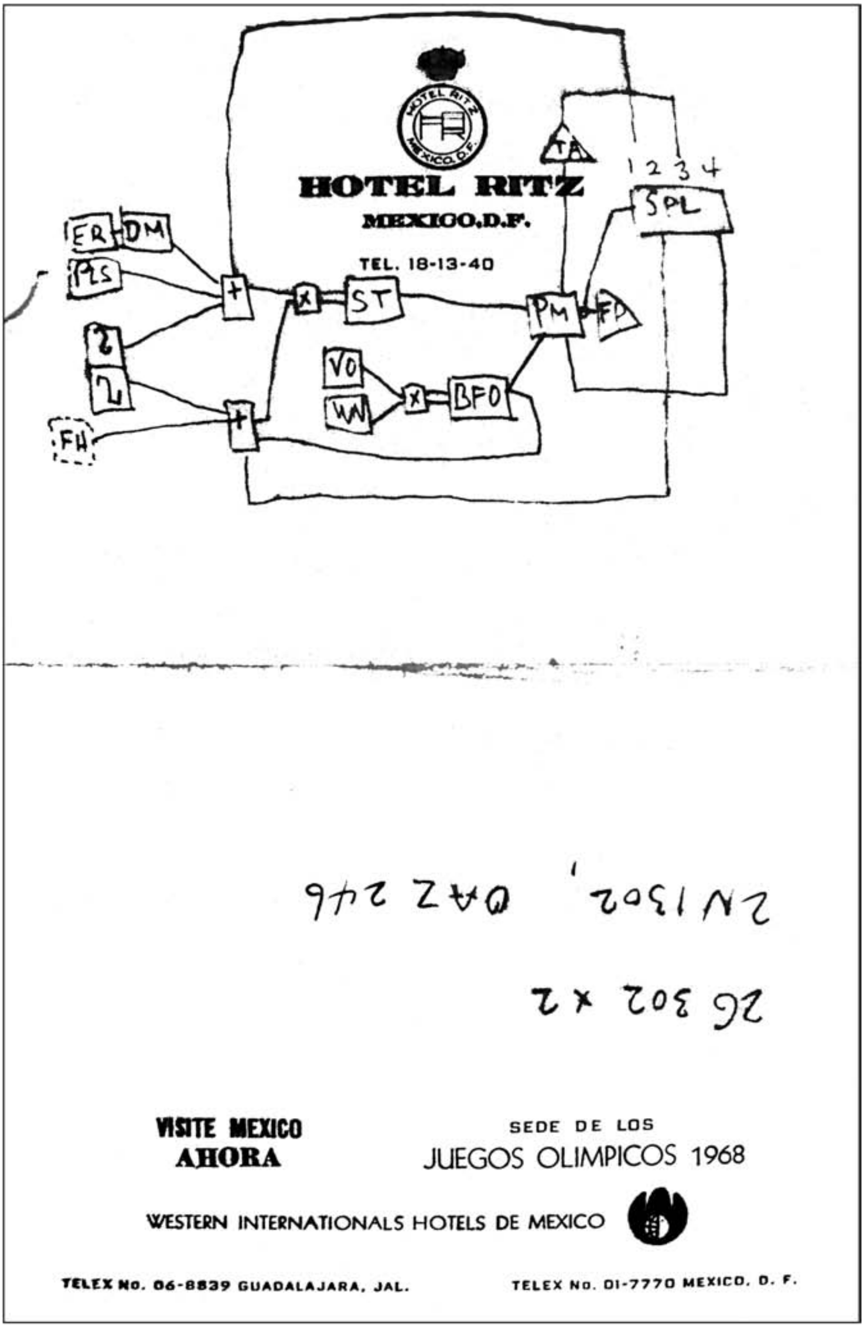


Figure 7.2 Tudor | *Activities for Orchestra*, sketch | Mexico City, June 1968
DTP, Box 4, Folder 2 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

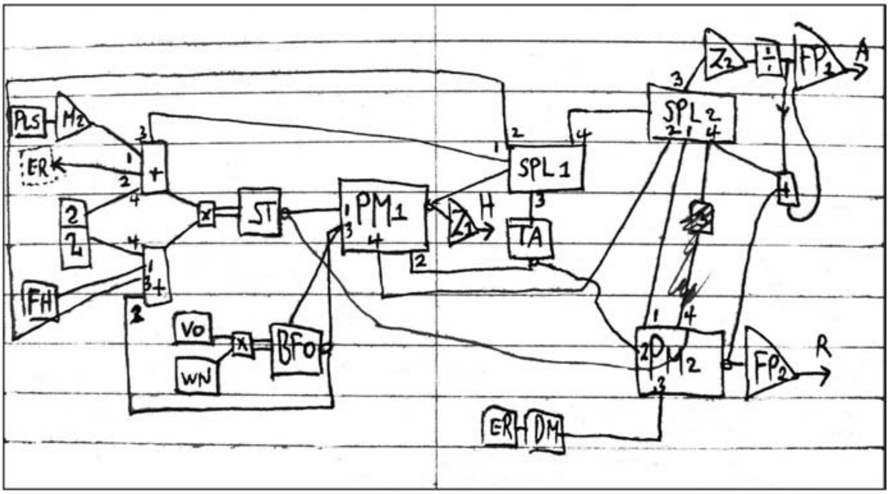


Figure 7.3 Tudor | *Activities for Orchestra (3-Channel Version)*, diagram | Undated
DTP, Box 4, Folder 16 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

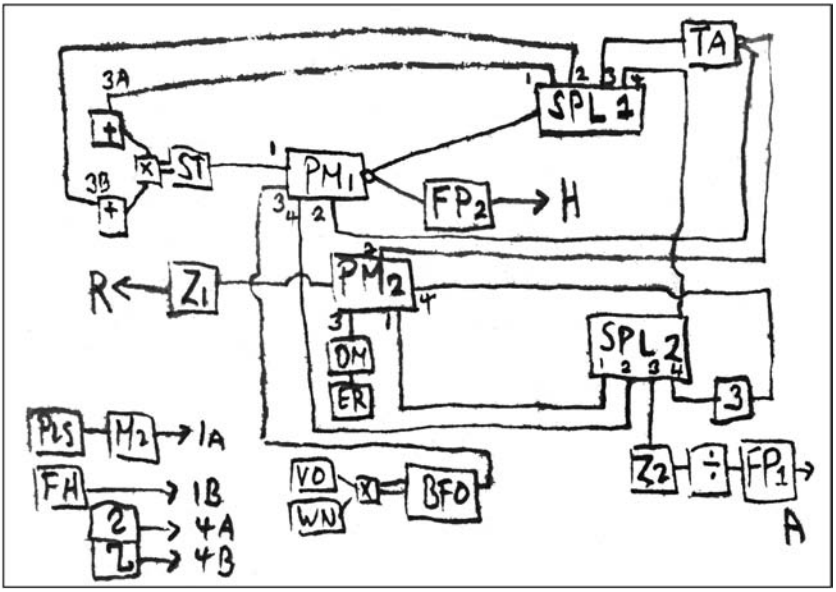


Figure 7.4 Tudor | *Activities for Orchestra (3-Channel Version)*, diagram | Undated
DTP, Box 3, Folder 1 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

(Figures 7.3, 7.4, and 7.5).[28] The instruments overlap with the sound system of June 1968, except for the insertion of a *Tunable Amplifier* ("TA") in the feedback path, as well as the addition of amplifiers in the output stage, which has increased to three

[28] Two of these are found in Box 3, Folder 1, and one in Box 4, Folder 16, of the David Tudor Papers at GRI. Although they are all undated, there is a copy of the B-2 diagram with the caption "Activities for Event #153 (Merce Cunningham) Amiens, 1970" written later in Tudor's hand (Box 3, Folder 1). That may indeed

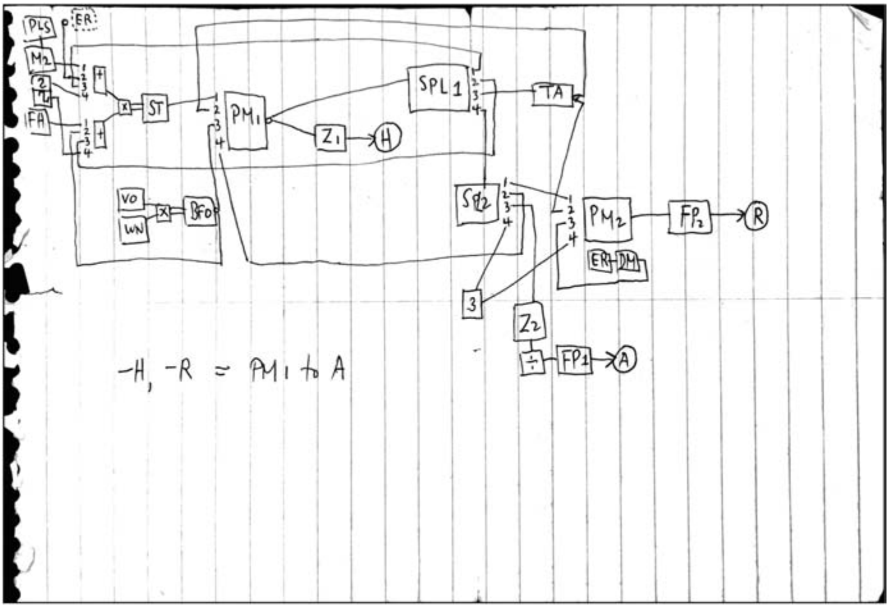


Figure 7.5 Tudor | *Activities for Orchestra (3-Channel Version)*, diagram | Undated
DTP, Box 3, Folder 1 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

channels designated with unidentified initials "H," "A," and "R." Two sets of amplifiers (drawn as a right-sided triangle) are assigned: *Z-amp* ("Z1"/"Z2"), a dual preamplifier with a high input impedance (of 1 MΩ) that Tudor composed from a schematic Mumma sent him on May 8, 1968,[29] and an unidentified, similarly dual device ("FP1"/ "FP2"). A divider also appears near the output("÷").

The neatly drawn and signed but undated diagram of *Activities for Orchestra 3-channel version* is a generalization of these three diagrams (Figure 7.6). The *Spectrum Transfer* is referred to here as a "MOD[ulator]," the *Preamp Mixers* and the *Tunable Amplifier* as "EQ[ualizer]s," and the *Output Splitters* as "DIST[ributors]." All the inputs are only specified inside a parenthesis as "ELECTRONIC." In other words, what Tudor composed was a giant *processor* for unspecified group of sources, as noted in the title of the diagram: "electronic processing for *Activities for Orchestra*."

be its provenance, but the details do not match the other "Amiens" sketch discussed here. Another puzzling aspect of this caption is that the numbering of *Events* had not reached "153" in 1970—it would take another six years to get there in early 1976.

[29] It was called *Z-amp* because of its high input impedance—"Z" being the symbol for impedance—and also formed the amplifier section inside the two *Cybersonic Output Splitters* that Tudor owned. Using Mumma's schematic, Tudor made two boxes that each contained two independent circuitries. Several sketches that he used in constructing the instruments are found among his papers. The *Z-amps* have been identified as Instruments 0175 and 0176.

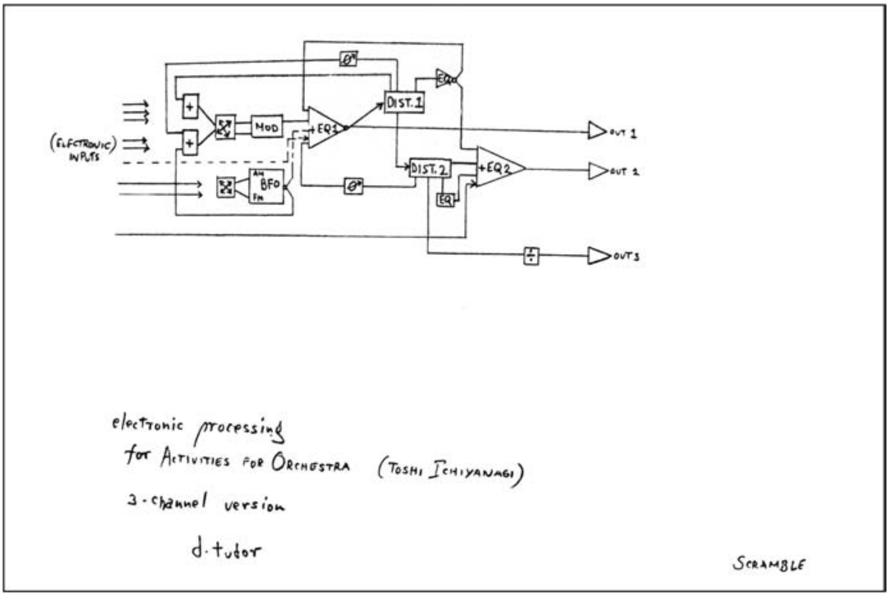


Figure 7.6 Tudor | *Activities for Orchestra (3-Channel Version)*, generalized diagram | Undated
DTP, Box 3, Folder 1 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

What this processor processed was no longer acoustic instruments but indeterminate electronics inputs. Hence, as long as Tudor's sound system had an output, he could also use that as input and let the instrument recycle itself. After all, in 1968 he had just built the *Rainforest* oscillators by patching the output of a commercial amplifier back to its input and inserting various processors in the feedback path. Given his nature, Tudor may have wished to enlarge things further in scale. Indeed, the four feedback paths that appeared in the Mexico City diagram remain in this configuration: two between the "DIST[ributors]" and "+EQ1" and two between "DIST" and the dual mixers going into "MOD." As feedback multiplied, external inputs would function more and more as triggers to activate the giant processor as a giant oscillator—a simple pulse or sine/square wave would therefore suffice.

(c) *Amiens* (June 1970)

Another diagram which can be dated carries the label "Activities Amien" in the lower right corner, revealing its connection to MCDC performance in Amiens, France, which took place two years after the Mexico tour on June 17, 1970 (Figure 7.7). Like the three-channel version, input has been reduced to sine and square waves from the dual *Midland Audio Generator*, pulse waves from the *Pulser*, and some signal from "B.O.," which is likely an acronym of "Balanced Oscillator." There is only one output channel, and the *Preamplifier Mixer-Output Splitter* combo ("PM-SPL") is again reduced to just one pair. But as input and the basic chain of modulation are simplified, more materials are inserted in the

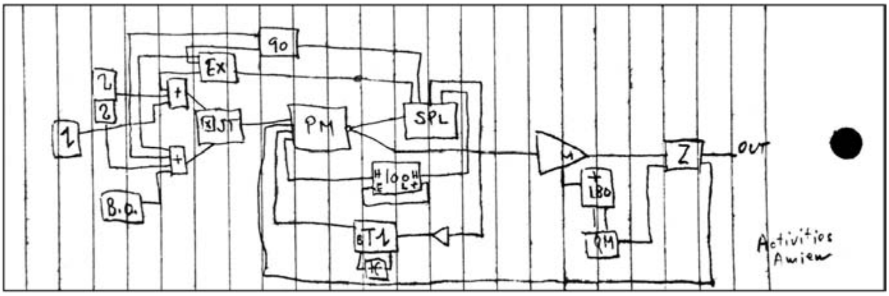


Figure 7.7 Tudor | *Activities for Orchestra*, diagram | Amiens, June 1970
DTP, Box 3, Folder 1 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

feedback paths. The smaller two loops between "SPL" and "PM" now go through two saturated amplifiers: a *Roundhill AA-100 amplifier* ("100," the letters "l" and "h" indicating low or high impedance)—used prominently as oscillators for *Rainforest*—and a *Triggered Pulser* ("T" with a zig-zag). The larger two loops between "SPL" and the two mixers ("+") also have their processors: a *90-degree Phase Splitter* ("90") which divides the signal into different phase degrees, and an *Electronic Crossover* ("EX") which divides the signal into different frequency ranges.[30] Tudor draws the output stage as well. The signal from the *Preamp Mixer* goes into another amplifier "M" (*Microphone Preamp*, perhaps) and from there it splits in two: one going directly into a *Z-amp* ("Z") and the other taking a detour through a *180-degree Phase Splitter* ("180") and a *Four Quadrant Multiplier* ("QM"), which will later play a principal role in *Untitled*.

5

A new type of instrument makes an appearance in the Amiens diagram whose job is to split or shift the phase of incoming signals. The same kind had also appeared in the generalized diagram as two phase symbols (Φ) inserted in the feedback paths and will go on to populate the sound system of *Untitled*. They seem to have sprouted out of nowhere as far as *Activities for Orchestra* is concerned, suggesting another source of influence. A clue about where they came from is actually found in the periphery of one diagram examined earlier. When the paper on which the Mexico City diagram was sketched is turned upside down, three sets of letters and numbers in Tudor's hand can be read: *2G302, 2N1302*, and *OAZ246* (Figure 7.8). The first and the third are even repeated on the back of the same paper (Figure 7.9). These are names of electronic components, the first two being transistors and the last one a diode.

[30] An *Electronic Crossover* works as a combination of low-pass and high-pass filters. From photographs of performance settings, as well as documents found in the David Tudor Papers, it is certain that Tudor owned a *Heathkit Electronic Crossover (Model XO-1)* which was a two-way crossover unit with adjustable cutoff frequencies on both ranges ("Heathkit Electronic Crossover [Model XO-1] Manuals," Box 39, Folder 4, David Tudor Papers, GRI).

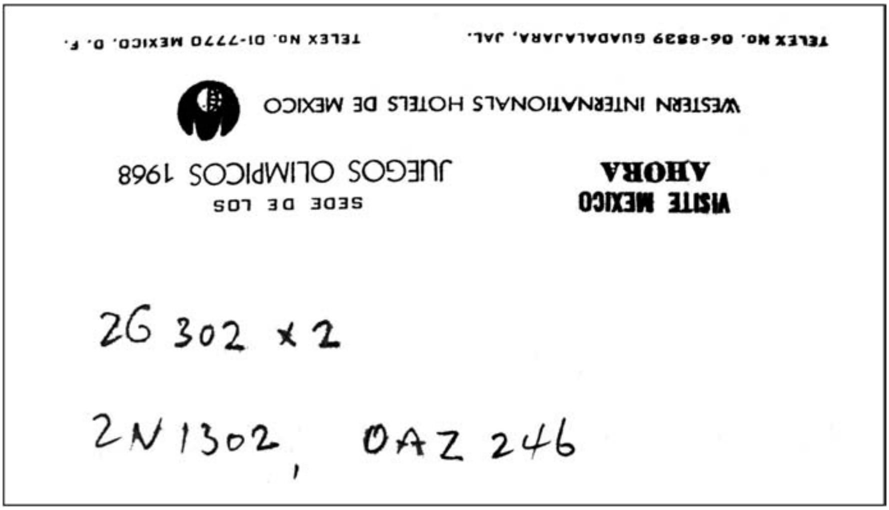


Figure 7.8 Tudor | Component names beneath the Mexico City diagram | June 1968
DTP, Box 4, Folder 2 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

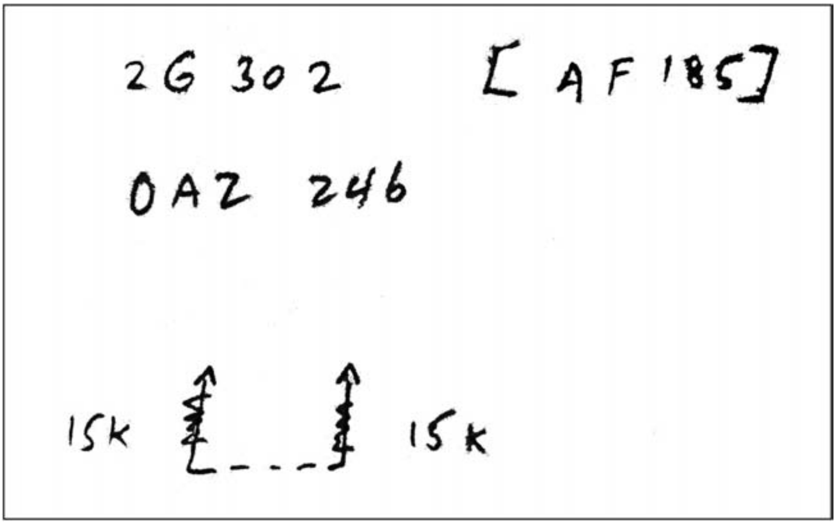


Figure 7.9 Tudor | Component names at the back of the Mexico City diagram | June 1968
DTP, Box 4, Folder 2 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

Scattered across the fifteen boxes composing the "electronic section" of the David Tudor Papers at the Getty Research Institute is a large number of popular electronic magazine cutouts. In Box 44, Folder 1, there is an article containing exactly

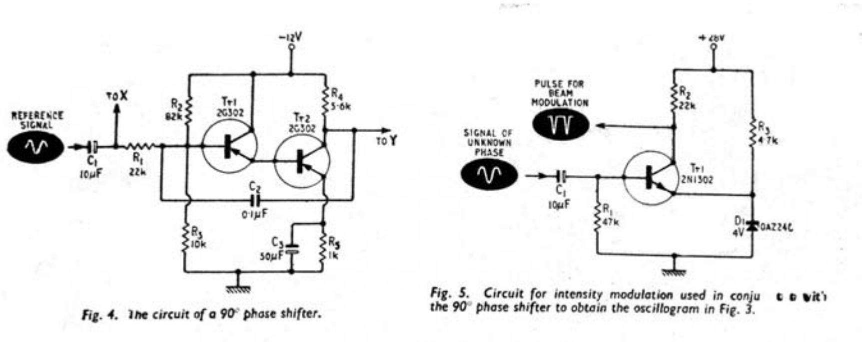


Figure 7.10 G. B. Clayton | Schematics of *90-degree Phase Shifter* and *Voltage Spike Converter* in "Direct-Reading Phasemeter" | *Wireless World* (August 1966)
Courtesy of Electronics World | www.electronicsworld.co.uk

the same three components as the ones Tudor wrote down in July 1968: "Direct-Reading Phasemeter," written by G. B. Clayton, and published in the August 1966 issue of *Wireless World* (Figure 7.10).[31] The author, who was at the time lecturing at Liverpool College of Technology, presented several techniques for measuring the phase difference between two sine waves. One method consisted of applying the first signal along with its 90-degree phase-shifted version to the vertical and horizontal inputs of an oscilloscope which creates a circular sweep on the display. The unknown phase position of the second signal could then be displayed by converting it into a voltage spike that modulates the intensity of that oscilloscope beam. Clayton provided the schematics for two circuits necessary to do this: a 90-degree phase shifter, and a converter of signals into voltage spikes. The former uses two *2G302* transistors, and the latter one *2N1302* transistor and one *OAZ246* diode. In another part of the archive, Box 39, Folder 8, a notebook page is found in which these two schematics are copied out in Tudor's hand, along with a drawing of the spatial layout of how to connect the components to actually compose the *90-degree Phase Shifter* (Figure 7.11).

With this information, it becomes possible to search for the corresponding instruments among the collection at Wesleyan University. It turns out that Tudor actually built both of them. The *90-degree Phase Splitter* which realizes G. B. Clayton's source material is Instrument 0037. All the components match and the Dymo labels for the two outputs—"X" and "Y90"—also follow the letters in the original schematic (Figures 7.12, 7.13 and 7.14). For some unknown reason, the *Voltage Spike Converter* ended up being encased in one box with another completely independent circuit—it is one half of Instrument 0006 (Figures 7.15 and 7.16).

The other half is identified as a *180-degree Phase Shifter*, whose schematics Tudor again copied out from an unidentified source, drawing the layout next to it on another page from the same notebook found in another part of the archive, Box 46, Folder 3 (Figure 7.17). In

[31] G. B. Clayton, "Direct-Reading Phasemeter," *Wireless World* (August 1966), 391–394 (Box 44, Folder 1, David Tudor Papers, GRI).

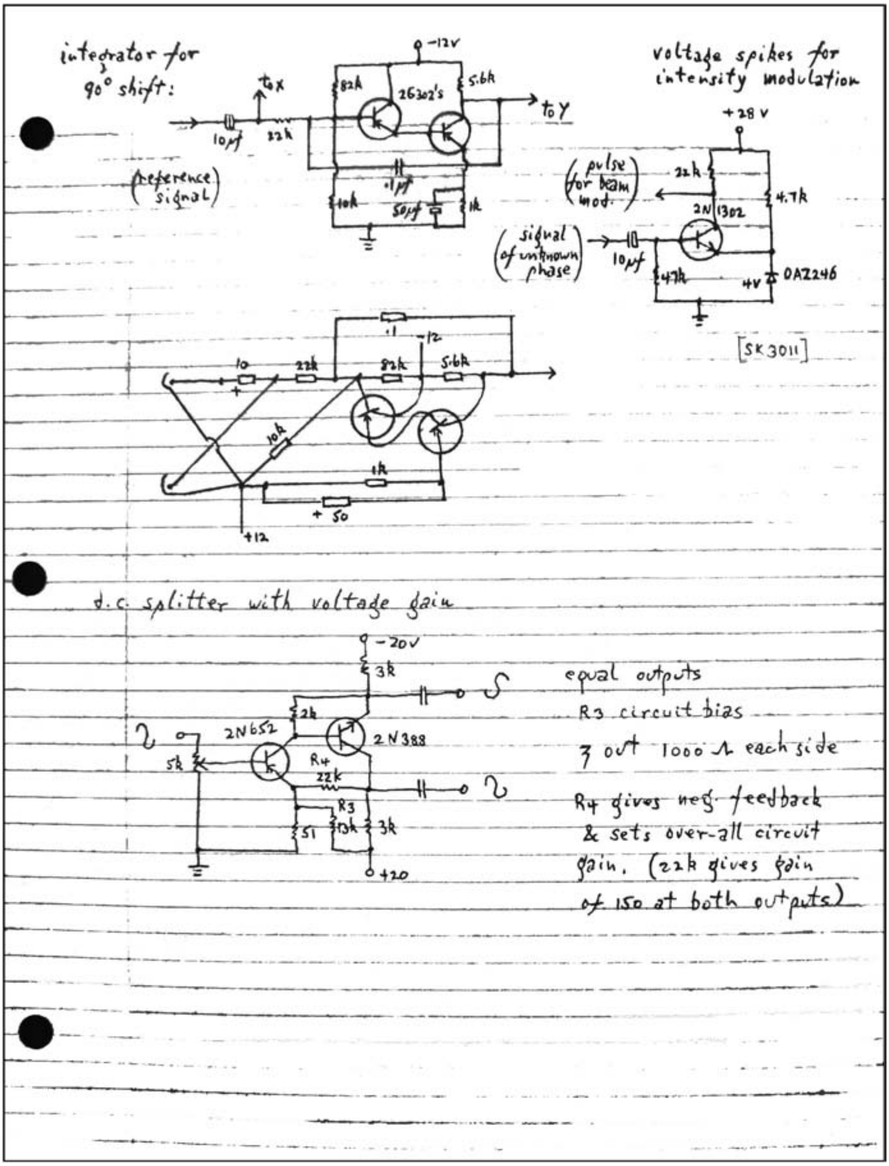


Figure 7.11 Tudor | Copy of Clayton's schematics and corresponding layout diagrams | Undated

DTP, Box 39, Folder 8 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

yet another location, Box 37, Folder 6, the same layout drawing of this *180-degree Phase Shifter* is found on a letterhead of the Coachman Motel in Bloomington, Illinois (Figure 7.18). A receipt from the same motel, stuck in Box 125, Folder 2, reveals that Tudor stayed there from April 29 to May 2, 1968 (Figure 7.19). According to program notes found in Box 76, Folder 5, he performed a piece called *Reunion* with Cage and Mumma on April 29 at the Illinois Wesleyan University, followed by a performance

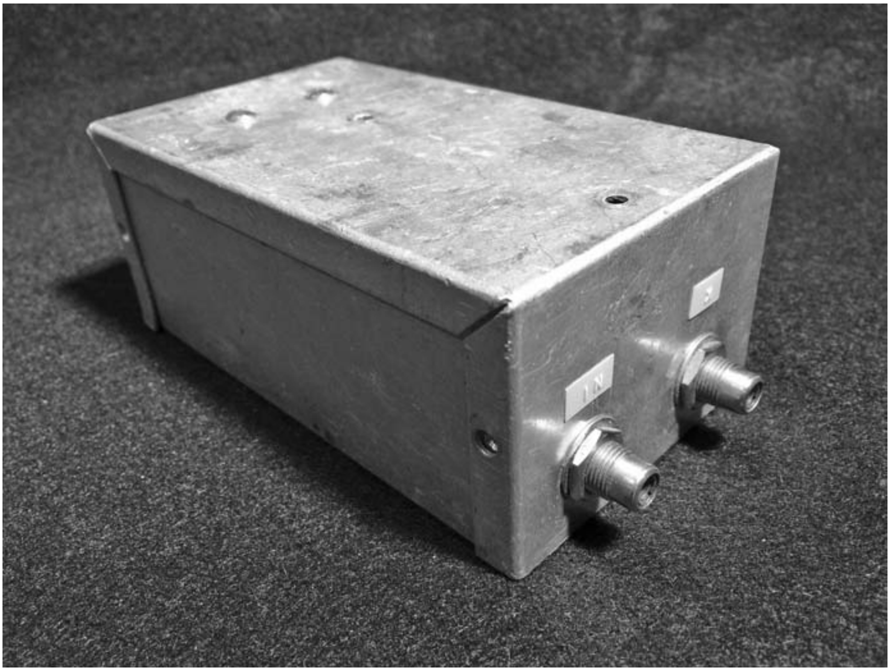


Figure 7.12 Tudor | *90-degree Phase Shifter*
DTC, Instrument 0037 | World Instrument Collection, Wesleyan University

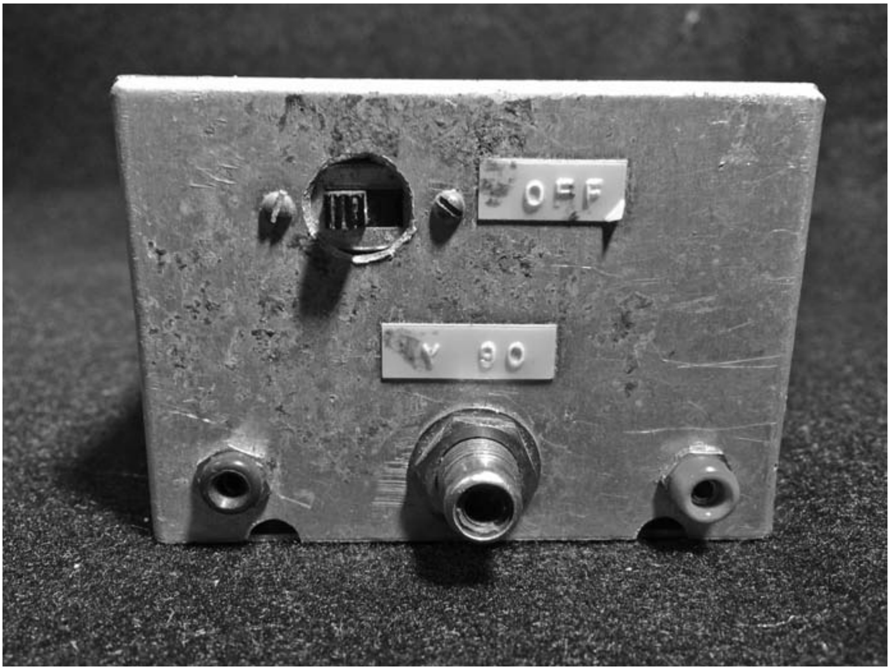


Figure 7.13 Tudor | *90-degree Phase Shifter*
DTC, Instrument 0037 | World Instrument Collection, Wesleyan University

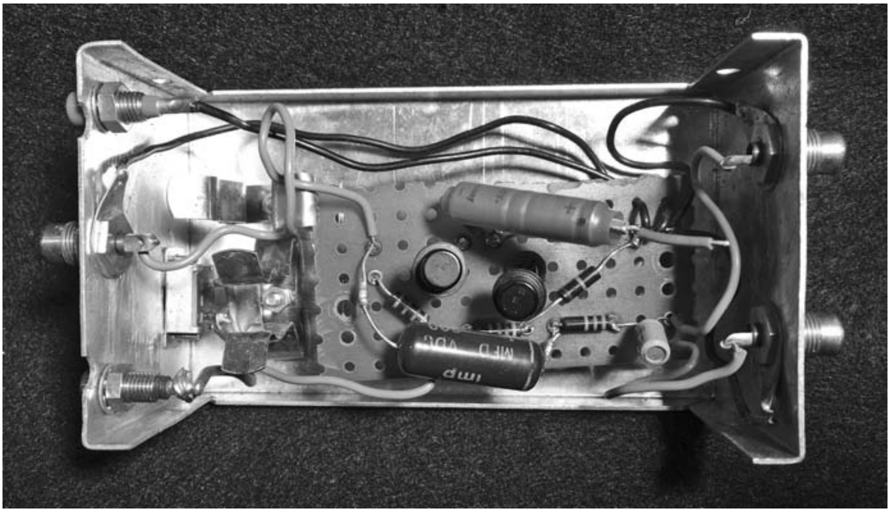


Figure 7.14 Tudor | *90-degree Phase Shifter* (interior)
DTC, Instrument 0037 | World Instrument Collection, Wesleyan University

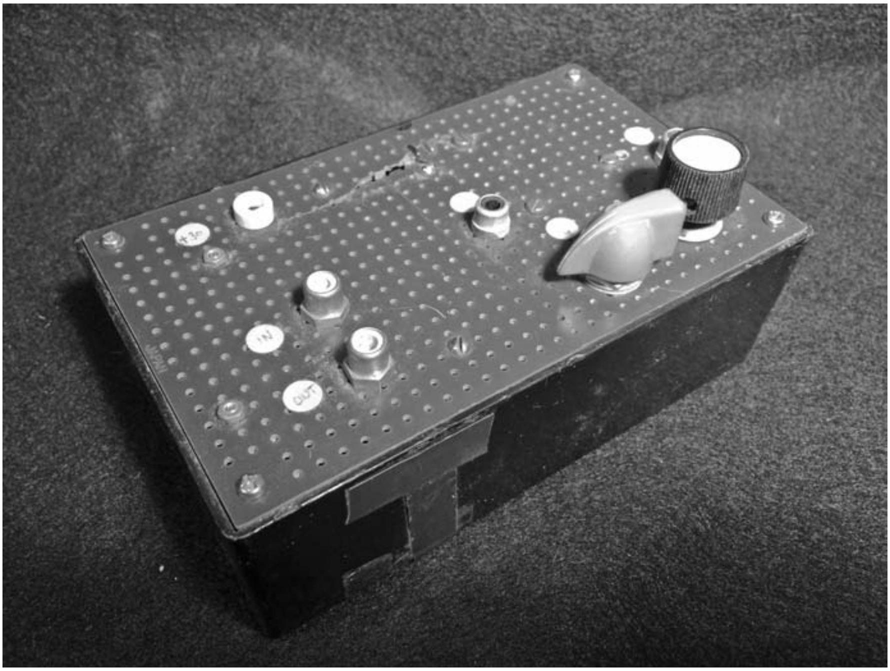


Figure 7.15 Tudor | *Voltage Spike Converter + 180-degrees Phase Shifter*
DTC, Instrument 0006 | World Instrument Collection, Wesleyan University

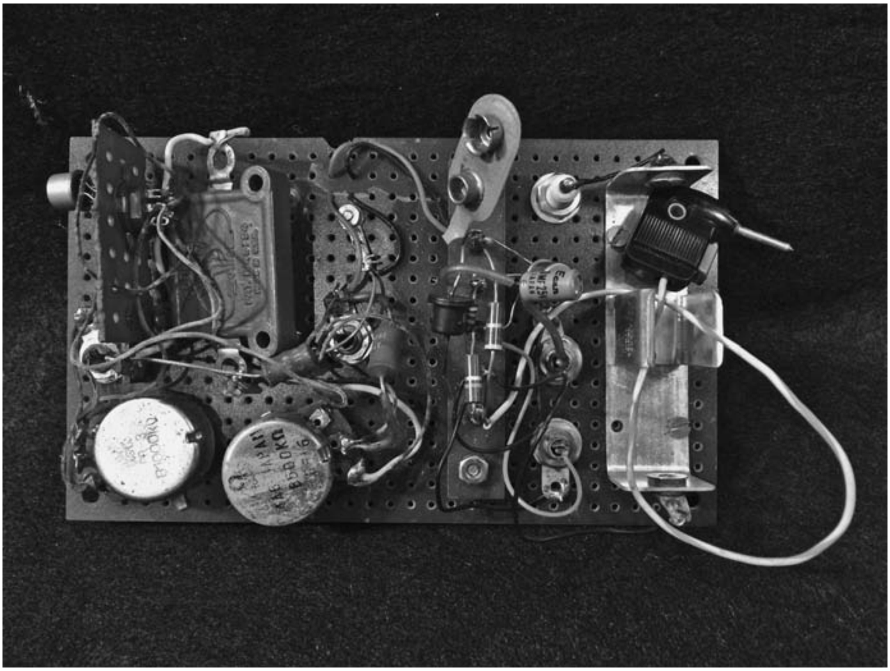


Figure 7.16 Tudor | *Voltage Spike Converter + 180-degree Phase Shifter* (interior)
DTC, Instrument 0006 | World Instrument Collection, Wesleyan University

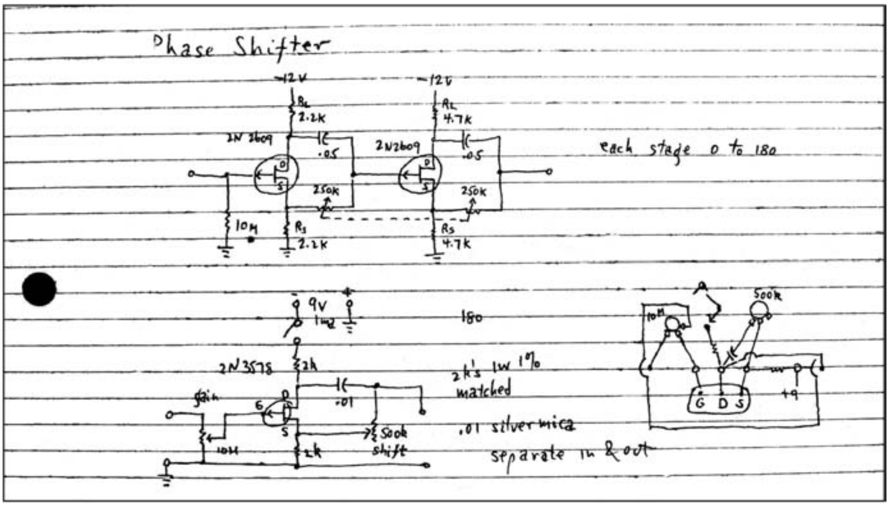


Figure 7.17 Tudor | *180-degree Phase Shifter*, schematics and layout diagram | Undated
DTP, Box 46, Folder 3 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

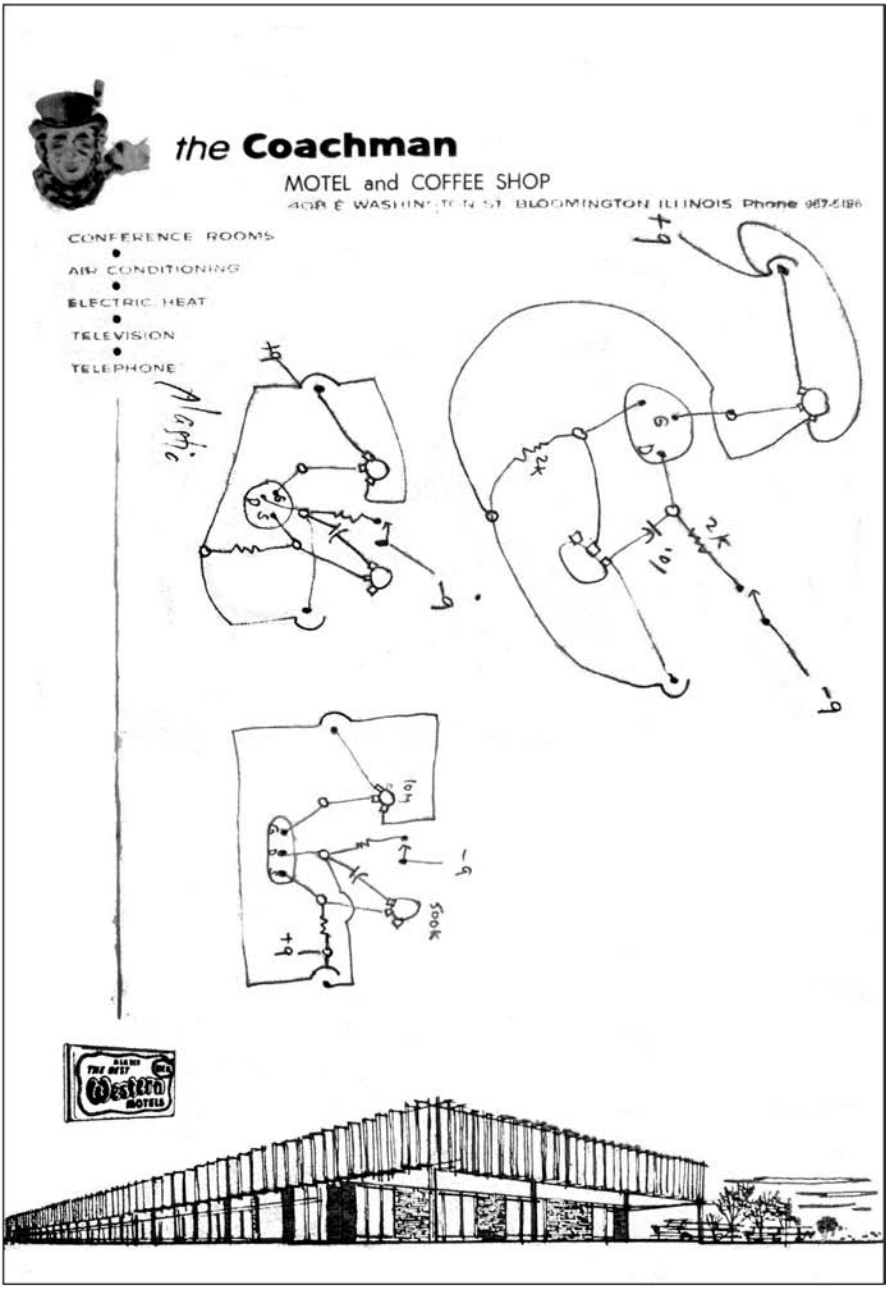
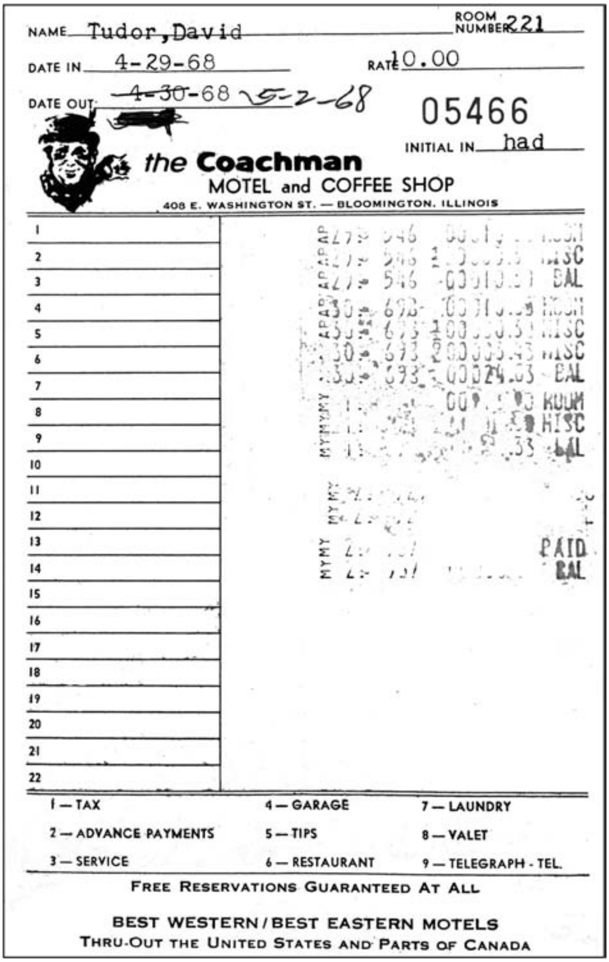


Figure 7.18 Tudor | *180-degree Phase Shifter,* layout sketch | April 1968
DTP, Box 37, Folder 6 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust



NAME Tudor, David ROOM NUMBER 221
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the Coachman
MOTEL and COFFEE SHOP
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Figure 7.19 The Coachman Motel | Receipt (April 29–May 2, 1968)
DTP, Box 125, Folder 2 | Getty Research Institute, Los Angeles (980039)

with MCDC at the Illinois State University on May 1.[32] In this way, the dual *Voltage Spike Converter/180-degree Phase Shifter* can be more or less dated: Tudor was already figuring out the layout of components by May 1968, so the composition of instrument very likely took place around the same time.

Other instruments have been identified and dated through a similar procedure, revealing a curious fact: Tudor began making all these phase-splitting and shifting

[32] "Program, *Reunion* by John Cage, Gordon Mumma, David Tudor, at Westbrook Auditorium, Illinois Wesleyan University (April 29, 1968)," Box 76, Folder 5; MCDC, "Program, Illinois State University, Gym Event Number 2, at University High School (May 1, 1968)," Box 76, Folder 7, David Tudor Papers, GRI.

devices in the spring of 1968.[33] But there is something puzzling about this discovery. For according to Lowell Cross's reminiscence in 2001, Tudor was already interested in the phenomenon of phase-shift by the fall of 1966 when they met in Stony Point to prepare for *Bandoneon!*. Perhaps naturally so, given that the composer of *Musica Instrumentalis* had then recently converted him into a feedback component that produced phase-shift effects:

> *he was* [. . .] *ready to engage in discussions and ask questions. "Tell me about phase shift." He knew that phase (time) relationships between two channels were important considerations in stereophonic sound and the consequent relationships between stereo and x–y displays. He wanted to pursue the use of phase shift in electronic feedback circuits.*[34]

Nevertheless, Tudor did not do so until 1968. There are no phase shifters and splitters in any of the diagrams or lists of instruments dating to the two years in between. This remained true even when Tudor started focusing on purely electronic feedback during the realizations of *Activities for Orchestra:* the Mexico City diagram drawn in July 1968 does not include any phase-related components. What finally triggered the shift appears to have been, once again, a change of instrumentation.

Reunion/Video III (Source B)

1

On March 5, 1968, John Cage organized the first performance of *Reunion* in the Ryerson Theatre in Toronto. Using a special chessboard constructed by Cross, Cage played chess with Marcel Duchamp, while the spatial position of the chess pieces controlled the gating and distribution of music performed by Tudor, Mumma, Cross, and Behrman.[35] Thus, Tudor was placed in the contrary situation to which he would find

[33] The *D.C. Splitter with Voltage Gain*, which Tudor drew out on the same page as the two Clayton schematics, gave out two complementary signals whose phase difference was 180 degrees. The source material for this phase splitter was the article "DC Phase Splitter Adds Voltage Gain," written by R. E. Risely and published in *Electronic Design* on February 3, 1964. The actual instrument Tudor built has been identified as Instrument 0015. The back of the notebook page where Tudor copied out the schematic for the *180-degree Phase Shifter* is also filled out with schematics and layouts of phase splitter circuits that he copied from various popular electronics magazines. The corresponding instruments have all been identified as well: another *Phase Splitter* which also puts out two signals whose phase difference is 180 degrees (Instrument 0018), and two *Balanced Transformerless Splitters* (Instruments 0010 and 0017).

[34] Cross, "Remembering David Tudor: A 75th Anniversary Memoir (1966)," lowellcross.com, accessed December 15, 2018. http://www.lowellcross.com/articles/tudor/1966.html

[35] In Cage's description, *Reunion* was not a "work" by him, but a composition of several works performed simultaneously: "On March 5 I am giving a performance in Toronto which will (has already) arouse much interest and activity. I call it *Reunion*. It is not a composition of mine, though it will include a new work of mine, *0'00" II*, which when time permits I will prepare material for and send to you. While it is being performed, in the Toronto case with Marcel and Teeny Duchamp, works by David Tudor, David Behrman, Gordon Mumma, and Lowell Cross are also being performed. These are all superimposed and interrelated electronically so that the special nature of a single work is not distinguishable" (Cage, "Letter to Walter Hinrichsen [March 3, 1968]," in *Selected Letters*, 382).

himself two years later at the *Pepsi Pavilion*: instead of having no control over the input, he only had control over the input. The four musicians were turned into analogs of organ bellow-treaders supplying constant wind to be gated by the manuals. The nature of this sound system created two problems for Tudor: (a) since all the sounds had to go through the chessboard, he could not use his bandoneon or any other acoustic means of sound production; and more importantly, as Cross reflected back in 2001, (b) "He did not like at all the notion of a chessboard controlling his sounds."[36] A similar system in *Variations V* where the movement of dancers controlled the output of music had not disturbed him so much three years earlier. But in the spring of 1968 he could not stand the situation where "the special nature of a single work is not distinguishable," as Cage described in a letter written just two days before the Toronto performance.[37] Tudor paraphrased it in his own terms to Victor Schonfield four years later: "which meant that someone could be producing lots of material for which there was no outlet."[38]

So Tudor came up with a simple solution: "He wore headphones throughout the evening so that he could monitor his own performance."[39] But headphones were not the only monitoring tool he used. Already familiar with the system, Tudor at one point connected the output of his electronics to Cross's modified TV set. The result was a revelation, as he reminisced to John David Fullemann on September 3, 1984:

> *I remember a concert in Toronto that Lowell Cross had organized. His input was a TV oscilloscope. And I happened to be sitting next to him and he was busy trying to make sure John Cage's chess board was operating correctly. So he said: "can you give me an input?" you know for the TV thing and I said sure, so I sent him a line and lo and behold it was all working at 90 degrees and so that caused the situation then to multiply.*[40]

2

No material documenting Tudor's sound system for *Reunion* has been found, so whether any phase-related instruments were already in the setup that day remains unclear. But the double bias of the specific situation—not being able to use an acoustic instrument and not being able to monitor his own sound—pushed Tudor to devise a new way to coordinate existing materials. This realization led to two changes. First, the visual output of sound would become at least as important as its audio output. "Since

[36] Cross, "Remembering David Tudor."
[37] Cage, "Letter to Walter Hinrichsen (March 3, 1968)," 382.
[38] Tudor, "From Piano to Electronics," 26.
[39] Cross, "Remembering David Tudor."
[40] Tudor, "Interview by Fullemann," davidtudor.org. Cross's recollection is slightly different in that he remembers Tudor asking him for the connection: "Perhaps to compensate himself for his diminished sound-producing role, he asked me if I could connect his electronic modules into one of my two modified x–y television sets on stage" (Cross, "Remembering David Tudor").

that time I have come to the point where I don't need to hear the sound anymore, but only to look at it," Tudor reminisced to Schonfield in May 1972 as he was going through Europe with Cage, "because I can tell what it would sound like from seeing it."[41] Like a good reflection instrument, Tudor could demodulate one sensory mode back to another. He may have been hearing sounds in the otherwise silent Clam Room.

Second, phase splitters and shifters would proliferate since Tudor now needed to electronically simulate a particular physical nature of the bandoneon that had made the instrument coordinate so well with Cross's video system: its bi-instrumentality, the capacity to produce two out-of-phase signals. The fact that many phase-related articles he collected and read had to do with oscilloscopes and cathode ray tubes reflects this concern. In the absence of the acoustic instrument, Tudor would create its virtual likeness to visualize audio signals on an x-y display.

3

As Cross recalled shortly afterward in 1970, "[t]his successful interconnection of circuitry led to a joint work, *Video III* which we performed at the invitation of Pauline Oliveros at the University of California, San Diego, on May 10, 1968."[42] Several diagrams of Tudor's sound system for *Video III* and subsequent video pieces are found among his papers (Figures 7.20 and 7.21). None of them is dated, but all share certain likenesses. Most instruments have already made their appearance in the sound system for *Activities for Orchestra* or *Fontana Mix* composed around the same time. But in *Video III*, Tudor makes a systematic use of phase shifters in the output stage, inserting them between the *Olson Preamp Mixer* ("PM") and the *Cybersonic Output Splitter* ("SPL") to impart 90-degrees phase difference to the two signals going into the vertical and horizontal axes of the video display—a virtual bi-instrumentality. The outputs to Cross's system are indicated with the initial "V" for video (in contrast to "A" for audio) in the first diagram, and with a symbol of a Lissajous figure "8" in the second.

Another common characteristic of these diagrams concerns their layout: in all of them, Tudor carefully arranged a vertical symmetry. The modulated output of the *Spectrum Transfer* ("ST") is split in two and sent to two identical channels with the same pair of *Preamp Mixer* ("PM") and *Output Splitter* ("SPL/S"). The two other modulators, *Beat Frequency Oscillator* ("BFO") and *Four Quadrant Multiplier* ("QM"), are similarly placed in parallel. This concern for symmetry certainly reflects the nature of the x-y display system to which Tudor's sound system was coordinated.

[41] Tudor, "From Piano to Electronics," 26.

[42] Lowell Cross, "Audio/Video/Laser," 28. The program note by Oliveros, however, suggests that amplified bandoneon was used on this occasion. She emphasizes the significance of phase differences between the two stereo signals to produce movement: "*Video III* will use live electronic sounds provided by Mr. Tudor's equipment and possibly supplemented by his amplified bandoneon. One output of the necessarily stereo sound source is sent to the vertical and one output to the horizontal deflection circuit of the TV set. The TV images are exactly analogous to the sounds. Selected sound parameters trigger colors and shapes. Phase relationships determine the motion of the images" (Pauline Oliveros, "Program note, *Video III* at the Electronic Sights and Sounds Concert in UC San Diego [May 10, 1968]," Box 76, Folder 5, David Tudor Papers, GRI).

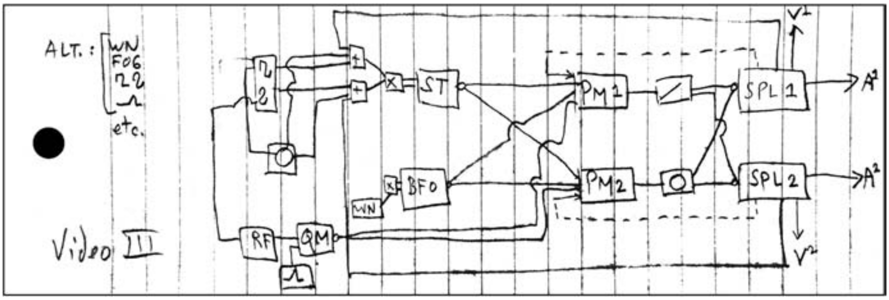


Figure 7.20 Tudor | *Video III*, diagram | Undated (presuably 1968/9)
DTP, Box 44, Folder 4 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust
Note: Phase angles are designated graphically with a circle and a slanted line.

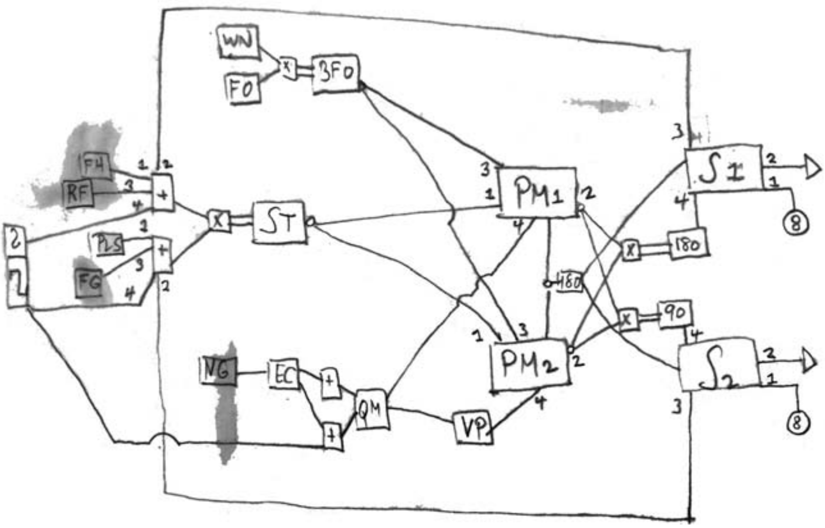


Figure 7.21 Tudor | *Video III*, diagram | Undated (presumably 1968/9)
DTP, Box 44, Folder 4 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

Perhaps most importantly, these diagrams lacked any acoustic input. As if to simulate the situation he faced in *Reunion*, Tudor had stopped using the bandoneon altogether. Now everything had to be done with electronic circuits. Cross noted this when he later summarized the development of his collaboration with Tudor:

> *A significant difference in the production of* Video III *from the techniques of the previous works is in the interconnection of a totally electronic system. No acoustical devices are used except for the loudspeakers in the sound system.*[43]

[43] Lowell Cross, "Audio/Video/Laser," 28.

In this way the two parallel feedback loops of *H. to T.I.* diagram did not only go back to the discovery of no-input feedback that Tudor commemorated in the subtitle; it also went back to another accidental discovery—that of visualized sound. In fact, in the description of *Untitled*, Tudor would specify the primary output of the piece as video, as if audio was itself an afterthought: "works with video outputs as well as audio, or video alone."[44] This other source was not mentioned during the 1972 KPFA radio interview when he reflected on how his then-new piece had come along. But speaking to Fullemann another twelve years later, he reminisced about a second chain of influence which ran parallel to the first:

> *I did lots of video with the same equipment so different things began to be added. And then eventually those components produced other kinds of audio. For instance, the end of the first chain happened in 1972 with a piece that was called "Untitled."*[45]

II. Versions

Untitled

1

The *H. to T.I.* diagram sums the two sources of influence, the numerous feedback paths of *Activities for Orchestra*, and the symmetry and phase-shifting of *Video III*, resulting in a dual loop of components with no input. The neatly drawn "Source Generation" diagram of *Untitled* follows the *H. to T.I.* diagram accurately (Figure 7.22).

The two modulators as well as the two *Olson Preamp Mixers* have been generalized, but the *Tone Controls* ("TC") in each channel are now revealed to have been a set of low-pass and high-pass filters. In the second diagram of *Video III*, Tudor had used an *Electronic Crossover* ("EC") to filter the signal in the same way, providing complementary high and low frequencies to the input of the *Four Quadrant Multiplier* ("QM"). This network topology, which Ron Kuivila called "Formant Shifter,"[46] produced extremely low frequencies that could not be heard, but could nevertheless be used to articulate audible sound, just like the tones of oscillators inside the *Pepsi Modifier* which had given birth to the dancing rhythms of *Pepscillator*.

And like that second program for his giant instrument two years before, this new configuration generated sounds without any input, so Tudor considered its nature to be a "giant oscillator":

[44] Tudor, "*Untitled*, description," Box 3e, Folder 3, David Tudor Papers, GRI.
[45] Tudor, "Interview by Fullemann."
[46] Ron Kuivila, "Open Sources: Words, Circuits and the Notation-Realization Relation in the Music of David Tudor," *Leonardo Music Journal* 14 (2004), 22.

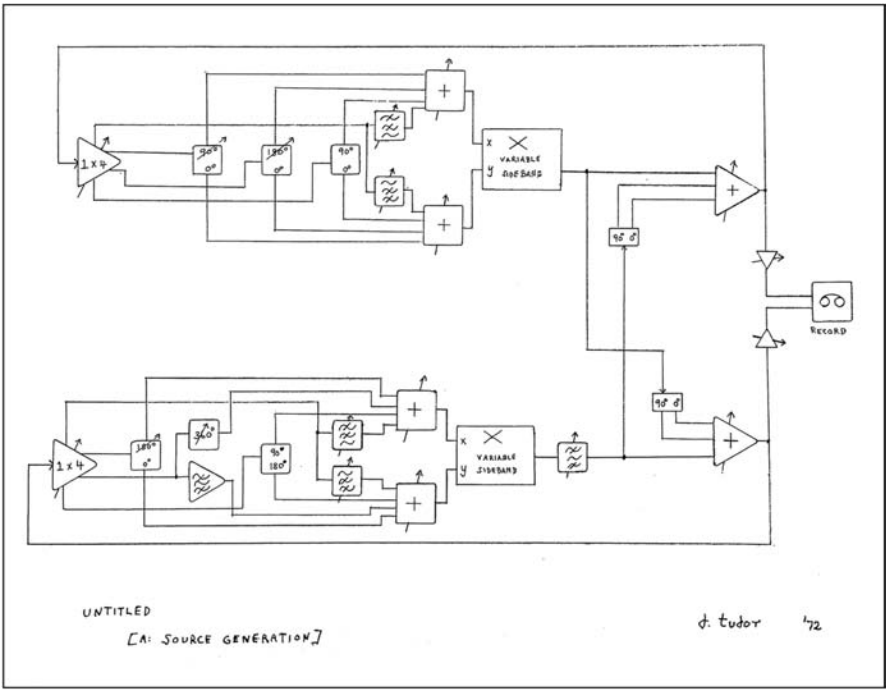


Figure 7.22 Tudor | *Untitled*, Source Generation diagram | 1972
Courtesy of David Tudor Trust

> The generation of *Untitled* begins with 2 chains of components, each chain linked together with multiple feedback loops having variable gain & variable phase-shift characteristics. The configuration of devices & their inter-connections, was conceived of as a "giant oscillator," with random characteristics variable by the performer's response & consequent actions.[47]

But this was only half of the story. For when Tudor set out to actually materialize what he had conceived, the physical nature of instruments again biased his realization. The sheer number of components and feedback loops made the sound system too complex to perform and too cumbersome for a single human performer to carry on tours: "in other words, I couldn't take four suitcases of equipment," he explained the problem later during his workshop at the Mobius Art Center on September 29, 1985.[48] Tudor's solution was pragmatic as usual, reminiscent of his apparent disregard for the difference between "natural" sounds and their recorded reproduction in *Island Eye Island Ear*: he simply recorded the output of his giant oscillator three times, and in performance used

47 Tudor, "*Untitled*, description from 1982," Box 4, Folder 21, David Tudor Papers, GRI.
48 Tudor, "Workshop at Mobius Art Center, Boston (September 29, 1985)," Box 2A, C75, David Tudor Papers, GRI.

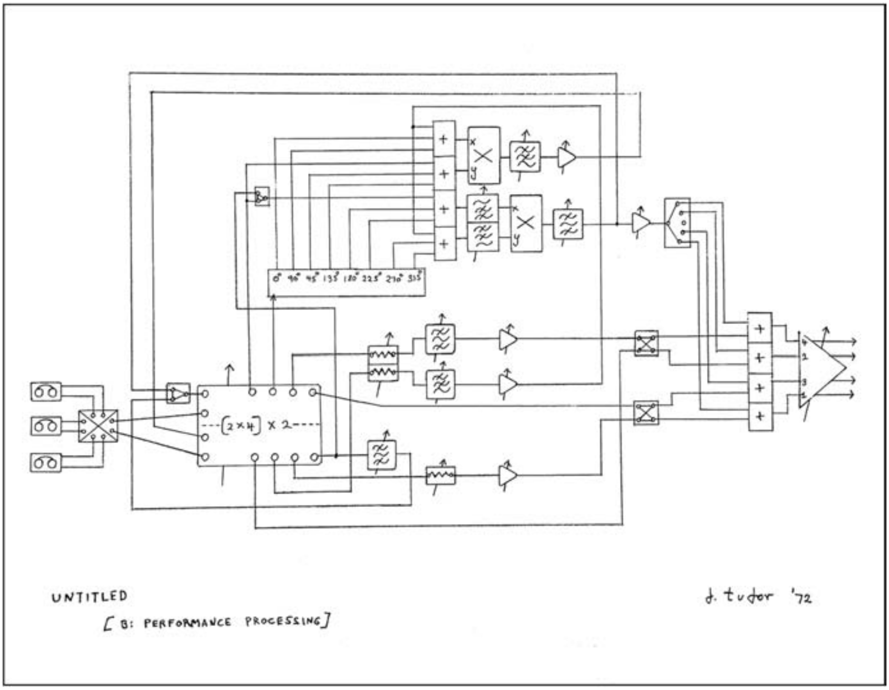


Figure 7.23 Tudor | *Untitled*, Performance Processing diagram
Courtesy of David Tudor Trust

these tapes as input to a more simplified system. These three tapes are found among the many recordings he owned, now archived as part of the David Tudor Papers at GRI. They are all labeled "Homage to Toshi Ichiyanagi, Study," and all dated 1972.[49]

Accordingly, there is a second diagram of *Untitled* with the caption "Performance Processing" (Figure 7.23). The three *Study Tapes* are placed as inputs at the bottom left corner. Although the lower half of the sound system focuses mostly on output processing, the upper half is dedicated to additional oscillation and modulation of the input through multiple feedback loops.

On June 5, 1972, one month into the European tour, Tudor and Cage performed at the Basler Theatre in Basel, Switzerland. The photographer Peter Stöckli took a photograph capturing a large part of Tudor's setup, which was printed thirty-nine years later in the May 1991 issue of the German magazine *du* dedicated to "Composer John Cage" (Figure 7.24).[50] Most of the instruments in this photograph have been identified and matched with the "Performance Processing" diagram, thus making it possible to track what Tudor did in coordination with extant boxes at Wesleyan (Figures 7.25 and 7.26).

[49] Tudor, "Homage to Toshi Ichiyanagi, Study 1 (1972)," Box 1A, C28; Tudor, "Untitled (Homage to Toshi Ichiyanagi), Study 2 (undated)," Box 5A, C220, side B; "Homage to Toshi Ichiyanagi, Study 3 (1972)," Box 1A, C30, David Tudor Papers, GRI.

[50] Peter Stöckli, "David Tudor, John Cage in Basel, 1972," *du*, May 1991, 83.

Figure 7.24 Tudor and Cage with the sound system of *Untitled* | Basel, June 1972
Photo: Peter Stöckli | *Du Magazin Nr.5* | All rights reserved.

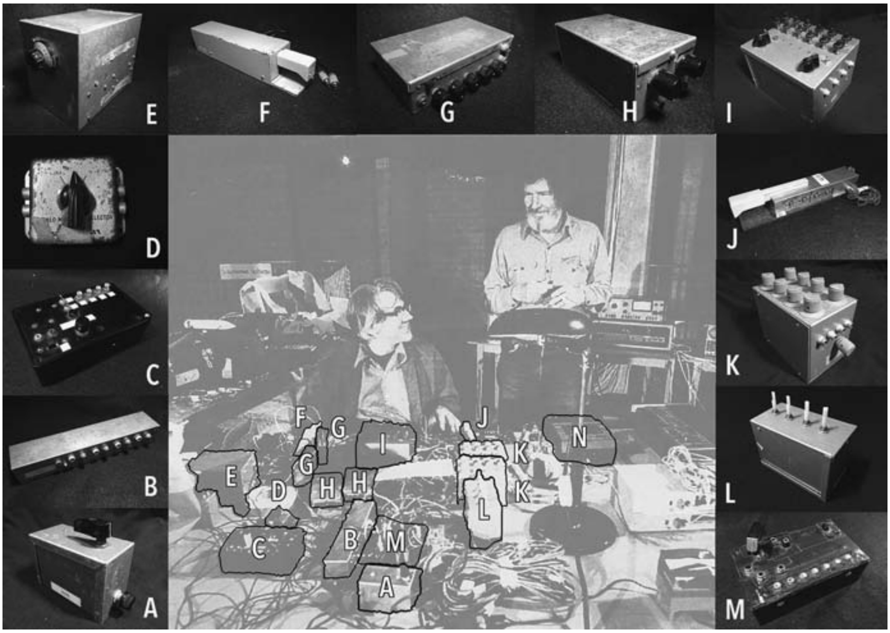


Figure 7.25 Identification of instruments in the Basel photograph

A = *360-degree Phase Shifter* (0229); B = *Multi-Input Mixer* (0096/0097); C = *Four Quadrant Multiplier* (no #); D = *Switchcraft Stereo-Monaural Signal Selector with Reverse* (0159); E = *Beat Frequency Oscillator* (0021); F = *Single Photocell Key* (0252); G = *E.A.T. 4-Channel Equalizer* (0126/0127/0128); H = *Z-amp* (0175/0176); I = *Dual Audio Multicoupler* (0513); J = *Dual Photocell Key* (0253); K = *Single Audio Multicoupler* (0196/0223); L = *Dual Tone Control* (0040) M = *Multioutput Phase Shifter* (0007); N = Tape recorder.

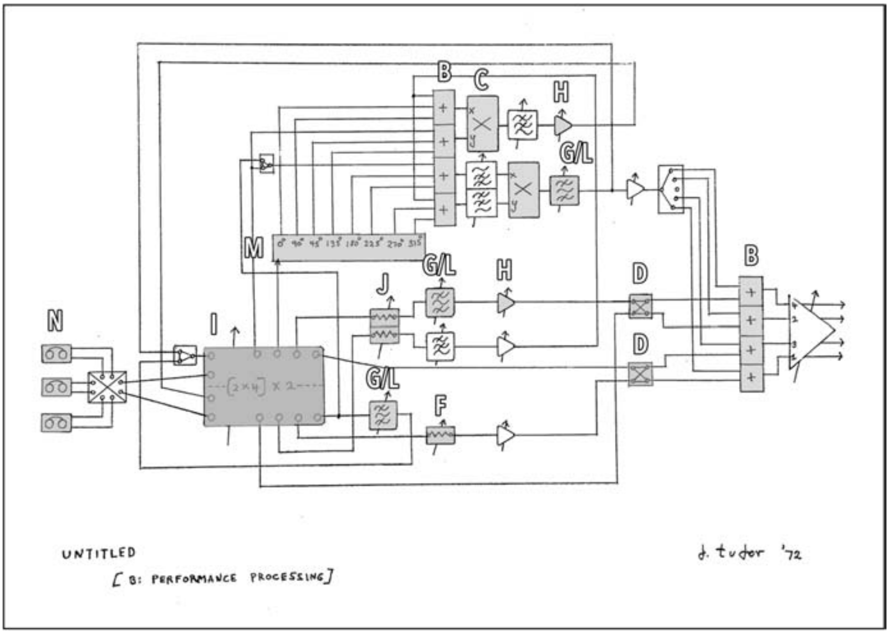


Figure 7.26 Identification of instruments in *Untitled*, Performance Processing diagram

N = Tape recorder; I = *Dual Audio Multicoupler* (0513); J = *Dual Photocell Key* (0253); F = *Single Photocell Key* (0252); G = *E.A.T. 4-Channel Equalizer* (0126/0127/0128); L = *Dual Tone Control* (0040); H = *Z-amp* (0175/0176); D = *Switchcraft Stereo-Monaural Signal Selector with Reverse* (0159); M = *Multioutput Phase Shifter* (0007); B = *Multi-Input Mixer* (0096/0097); C = *Four Quadrant Multiplier* (no #).

2

Dual Audio Multicoupler (Instrument 0513)

The three *Study Tapes* are first mixed and routed by a dual device each side of which takes two inputs and outputs four (Figure 7.27). The source material Tudor used to build this instrument was another hobby electronics magazine article titled “Build an Audio Multicoupler,” written by Don M. Wherry and published in the July 1970 issue of *Popular Electronics*.[51] Wherry’s instrument offered a solution to a problem: how to prevent one tape recorder’s malfunction (becoming open-circuited or short-circuited) from influencing the others when recording to multiple recorders from a single source. The *Audio Multicoupler* used field-effect transistors (*2N5457*) which are voltage-controlled electronic gates with high impedance, one at the input and one at each output line, to isolate the outputs from each other as well as from the input. The FETs also amplified the signal so there was a two-stage gain which amounted to 8–10 dB of amplification.[52]

Tudor took some poetic license in realizing the material. The article described an instrument with one input and three outputs, but he expanded this to two inputs and

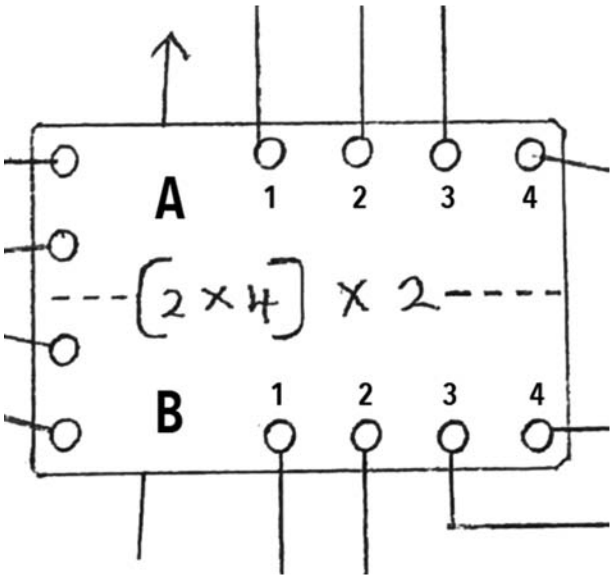


Figure 7.27 Tudor | *Dual Audio Multicoupler* (Instrument 0513), icon
Courtesy of David Tudor Trust
Note: letters indicating the two parts of the instrument and numbers for each output added.

[51] Don M. Wherry, “Build an Audio Multicoupler,” *Popular Electronics*, July 1970 (Box 41, Folder 1, David Tudor Papers, GRI).
[52] Ibid., 32.

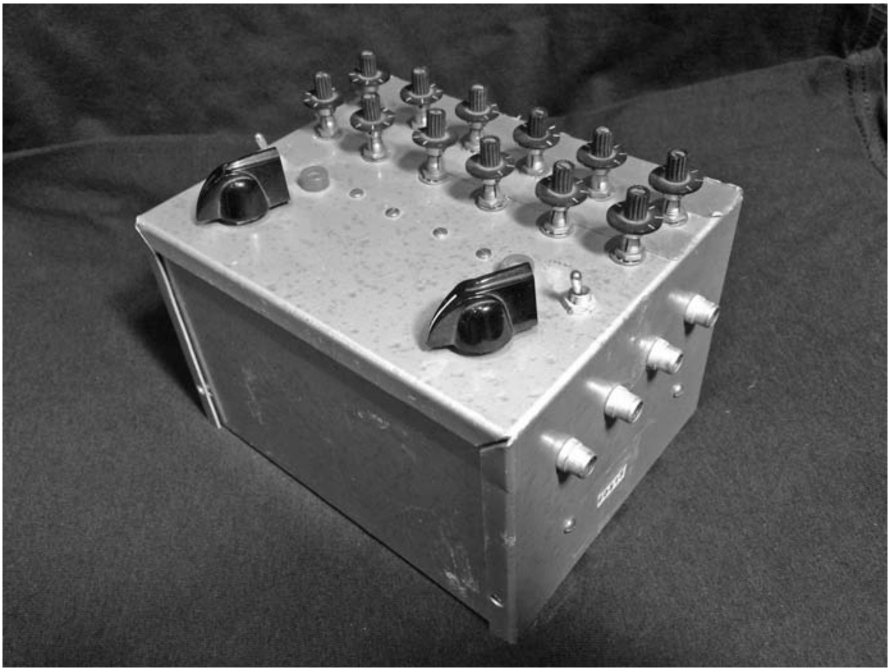


Figure 7.28 Tudor | *Dual Audio Multicoupler*
DTC, Instrument 0513 | World Instrument Collection, Wesleyan University

four outputs. He also put an additional gain control for each output and then housed two circuits in one box, making a dual instrument (Figure 7.28). The two rows of six dials on the corresponding Instrument 0513 are the gain controls of the two *Audio Multicouplers* inside (each with two inputs plus four outputs). The two rotary switches beneath were supposed to enable the selection of different routing paths between the inputs and outputs. But although he drew schematics to realize this, nothing is actually connected to the switches inside the box. Tudor composed two other instruments (0196 and 0223) each housing a single copy of the same *Multicoupler* circuit, and these do have a switch to select between "4-in 4-out," "2-in 2-out," and "1-in 4-out." The instrument in the "Performance Processing" diagram is the dual version, as indicated by the label "[2 x 4] x 2," although the single ones also appear in the Basel photograph. In one sketch found in Box 4, Folder 17, Tudor differentiates the two circuits in the same box simply as "A" and "B," writing out where each of their output goes with abbreviations and acronyms (Figure 7.29).[53] In particular, the output B4, labeled "fbBA," fed the signals from *Audio Multicoupler B* back to *Audio Multicoupler A*, thus connecting the two instruments which otherwise would have stayed independent.

[53] Tudor, "Sketch for *Untitled*," Box 4, Folder 17, David Tudor Papers, GRI.

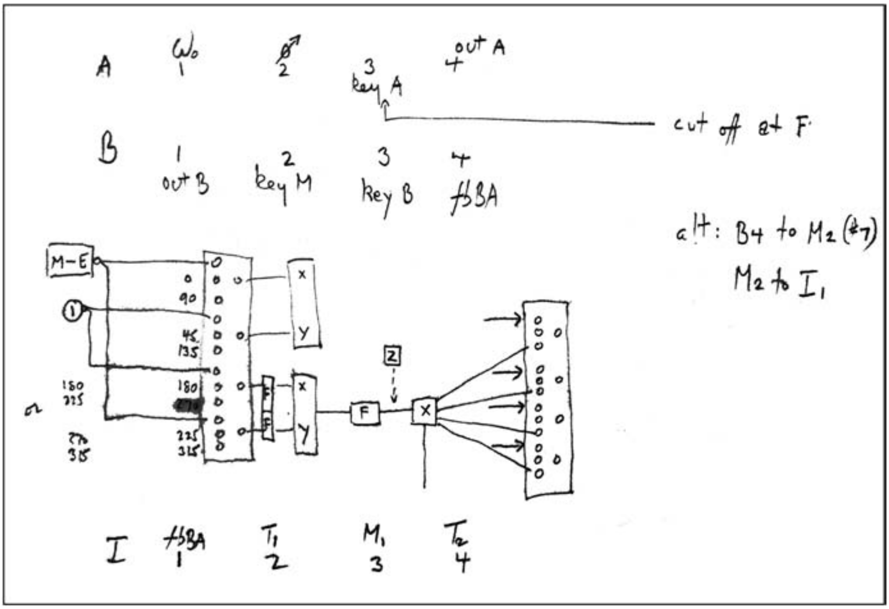


Figure 7.29 Tudor | *Untitled*, sketch | Undated (presumably 1972)

DTP, Box 4, Folder 17 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

Note: "A" and "B" refer to the two *Audio Multicouplers* housed in Instrument 0513. The four outputs on each side are listed ("fbBA" = feedback from B to A). "I" at the bottom refers to the "input" to the *Audio Multicoupler* ("T" = Tape, "M" = Modulation Network). "M-E" going into the quad *Mixer* refers to the chain of *Electro-Harmonix Mole Bass Booster* and *Electro-Harmonix Ego Microphone Booster* that output B2 ("Key M") passes through before reaching the Modulation Network.

3

Touch Sensitive Photocell Keys (Instrument 0252/0253)

The other seven outputs of the dual *Audio Multicoupler* go in different directions. Four of them—two from each side (A3/A4 and B1/B3)—are output processing routes that send the signal to the quad *Mixer* (drawn as four stacks of boxes with plus signs) on the right end of the diagram. Two routes go through additional gating, filtering, and amplification (A3 "key A"/B3 "key B") before they are each coupled with another route coming directly from the other side of the *Multicoupler* (B1 "out B"/A4 "out A") using the *Switchcraft Signal Selectors*, which gave Tudor the option to crisscross the two incoming signals or output them as one. The first pair of instruments down the two modification routes are drawn in the diagram as a horizontal zigzag (indicating resistor) with an arrow behind (indicating variability) (Figures 7.30 and 7.31). This symbol stood for two peculiar devices whose physical nature must have been quite familiar for Tudor, as each was built out of a single organ key (Figures 7.32 and 7.33). In the Basel photograph, they indeed appear right in front of him, one assigned to each hand, turning the sound system of *Untitled* into a partial keyboard instrument. Tudor did not make these modified keys, but he had them specifically made for him.

Over the summer of 1968, Cage was busy working with Lejaren Hiller on the production of *HPSCHD*, an extravagant multimedia event using 51 monaural tapes, 7 amplified harpsichords, 84 projectors, and many more things. At some point he showed Tudor the score for *Solo I*, composed for the virtuoso to play on one of the amplified harpsichords. It had been a while since Cage had made something specifically for his former pianist, and this material was very different from the rest of the *Solos*. All the others were composed using a computer program called *DICEGAME* which, based on Mozart's *Musical Dice Game*, selected measures of Mozart and other composers from a pre-composed universe of possibilities. But *Solo I* was a transcription of another program called *HPSCHD* which could randomly divide the octave in different ways up to 56, determine other parameters like inflection value, ornamentation, and dynamics, and play back the results using a sawtooth wave that simulated the sound of the harpsichord. Cage had simply chosen the results obtained when the computer split the octave in 12 so that the notes could also be played on an actual keyboard instrument. In other words, both programs automated chance operations, but the unit relegated to chance was significantly smaller in *HPSCHD* (a sawtooth wave) than in *DICEGAME* (a measure) so that the computer determined not only the sequence of events but also the minuscule parameters of each individual sound. Consequently, *Solo I* was much more difficult to play, with a constant change of dynamics from one note to the next.[54] Cage even resurrected time-space notation, equating five inches to one second. In all respects, he had tailor-made yet another puzzle for his friend.

Tudor's solution reflected his concern at the time. That year, he had started making all the phase-related instruments following *Reunion* in March and had presented the amplified barbecue grill version of *Books for 3* in April. So it was natural for Tudor to take Cage's challenge as being posed not for him but for the complex network of instruments

[54] Stephen Husarik, "John Cage and Lejaren Hiller: HPSCHD, 1969," *American Music* 1, no. 2 (Summer, 1983), 10.

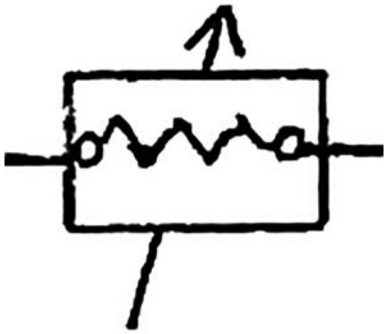


Figure 7.30 Tudor | *Single Photocell Key* (Instrument 0252), symbol
Courtesy of David Tudor Trust

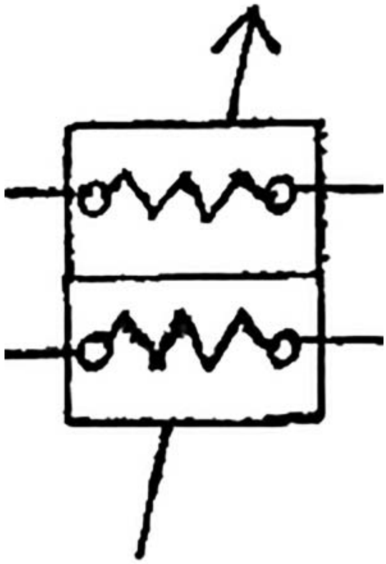


Figure 7.31 Tudor | *Dual Photocell Key* (Instrument 0253), symbol
Courtesy of David Tudor Trust

he was part of. Instead of disciplining himself to realize the score on the instrument, he thought of extending the instrument itself to solve the task at hand. If Cage had tailor-made the puzzle, Tudor would tailor-make the solution in material form—or ask somebody who could, as Cage revealed in a letter written on September 27:

> *On seeing* Solo I*, David Tudor suggested the designing of a pressure-sensitive amplitude control permitting 30–35 changes per second. I appealed to Hugh Le Caine of the National Research Council (Ottawa), and, free of charge, I have received two such devices, designed by René Farley, currently being tested by David Tudor. This will have*

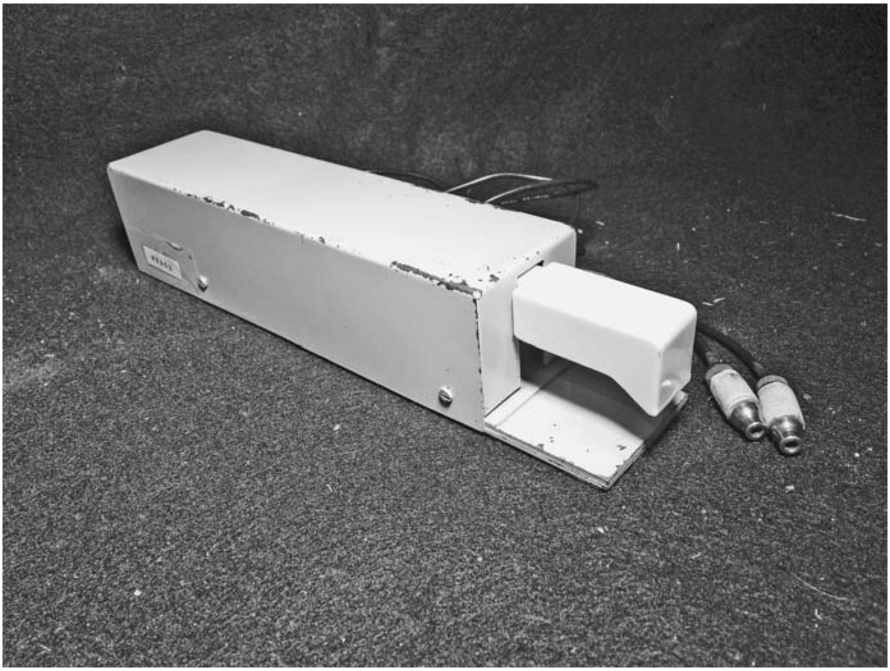


Figure 7.32 René Farley | *Single Photocell Key*
DTC, Instrument 0252 | World Instrument Collection, Wesleyan University

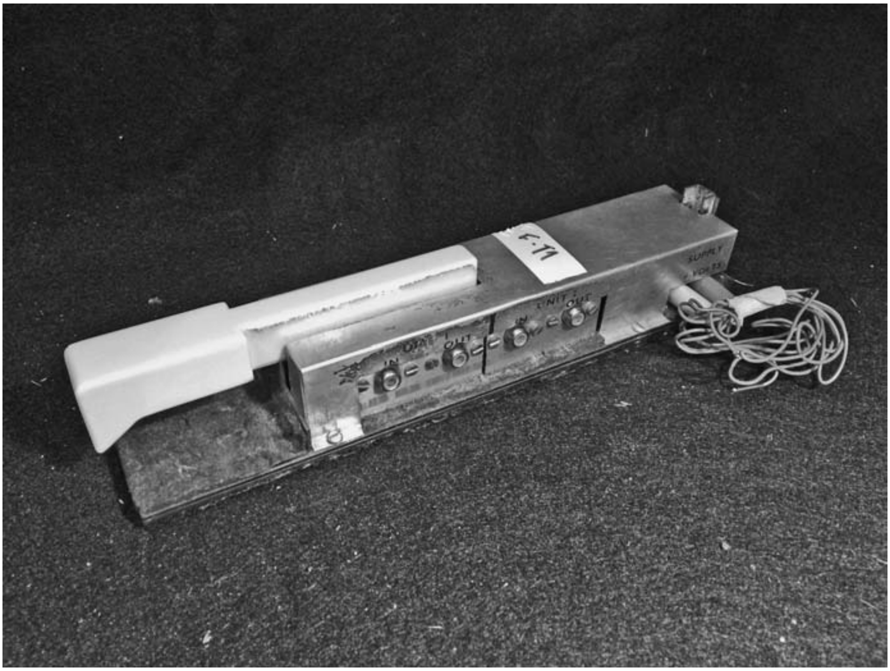


Figure 7.33 René Farley | *Dual Photocell Key*
DTC, Instrument 0253 | World Instrument Collection, Wesleyan University

> *a usefulness for electronic music generally and will bring to the harpsichord specifically characteristics never before possible. It will be operable manually or by foot.*[55]

What Farley, technical assistant to Le Caine, designed was a simple attenuator using an organ key and a photocell resistor, an electronic component that changes its resistance value according to the intensity of light on it. The key controlled the movement of a shutter with a hole set in between a lamp bulb and the photocell resistor. So when it was in the up position, the input signal was cut off; as it was depressed, the hole in the shutter allowed more and more light to reach the photocell, resulting in a greater signal at the output.[56]

Farley understood the nature of his instrument as an enhancement of the organ, as he wrote in an article published in October 1968:

> *Amateur organ builders will find that touch-sensitive keys make a fascinating addition to the home organ. You can, for instance, add an extra touch-sensitive manual which bypasses the swell pedal to give accents and tones with touch-controlled attack and decay which will give a more lively sound to your organ. Interesting rhythmic effects can be produced by the addition of touch-sensitive keys to your organ*.[57]

In other words, the instruments worked as a corrective to one thing the organ could not do and the piano could: the control of dynamics using the keys. By September 1968, Tudor had received two of these *Photocell Keys* from Ottawa. One of them (Instrument 0252) was a single device. The other (Instrument 0253) was a dual device accepting two inputs[58] which would appear as two symbols stacked on top of one another in the "Performance Processing" diagram. For the initial use in *HPSCHD* they were indeed used with a Baldwin electric keyboard.[59] But whenever the keys subsequently reappeared in Tudor's setup, it was not to enhance other keyboard instruments but to interface other modular electronics. Nevertheless, the keys' physical nature did coordinate the world of sound systems with the world of keyboards that Tudor knew so well. For just like the organ manuals that gated the continuous supply of wind, the two *Photocell Keys* gated the never-ending feedback of his giant oscillator.

[55] Cage, "Letter to Daniel Alpert (September 27, 1968)," *Selected Letters*, 388.

[56] An article in the October 1968 issue of *electron* authored by Farley details the mechanism. I thank Gayle Young for sending me a copy of this article and clarifying the details of these instruments.

[57] René Farley, "Touch-Sensitive Key," *electron* (October 1968), 38.

[58] According to the customs declaration form Tudor kept, the National Research Council of Canada sent just one piece of "Touch-Sensitive Key" to Stony Point on September 18, 1968 (National Research Council of Canada, "Customs Declaration Form for Touch-Sensitive Key [September 18, 1968]," Box 40, Folder 2, David Tudor Papers, GRI). However, Cage wrote about receiving two. Le Caine's letter to Cage written on August 20 mentions sending "an experimental key": "We hope that you will be able to test this key and write us regarding the design of the final key, based on your experiments on the first key" (Hugh Le Caine, "Letter to John Cage [August 20, 1968]," Gayle Young Collection).

[59] Sara J. Heimbecker, "John Cage's *HPSCHD*," PhD dissertation, University of Illinois at Urbana-Champaign, 2011, 53.

4

Multioutput Phase Shifter (8Ø) (Instrument 0007)

The four remaining outputs from the dual *Audio Multicoupler* (A1/A2/B2/B4) are sent to the second quad *Mixer* in the modulation and feedback section of the diagram. Two from each side of the instrument go directly there (A1/B4), albeit with a small router to select either or both. Another (B2) goes through a modification process similar to the two output modification routes, using one channel of the dual *Photocell Key*, a low-pass filter, and an amplifier before bifurcating and reaching the *Mixer* at two points. These four signals enter each of the four sections of the quad *Mixer* where they are mixed with the remaining output from the *Audio Multicoupler* (A2), which has now been split into eight by an elongated box with numbers of phase angles inscribed (Figure 7.34).

Often labeled as "8Ø" in the diagrams, this instrument could take one input and then output eight signals each 45 degrees apart from one another with constant amplitude (Figure 7.35). The source material was the schematics of a "Multioutput Phase

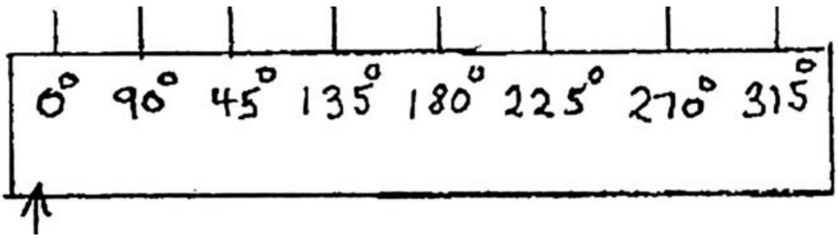


Figure 7.34 Tudor | *Multioutput Phase Shifter* (8Ø) (Instrument 0007), symbol
Courtesy of David Tudor Trust

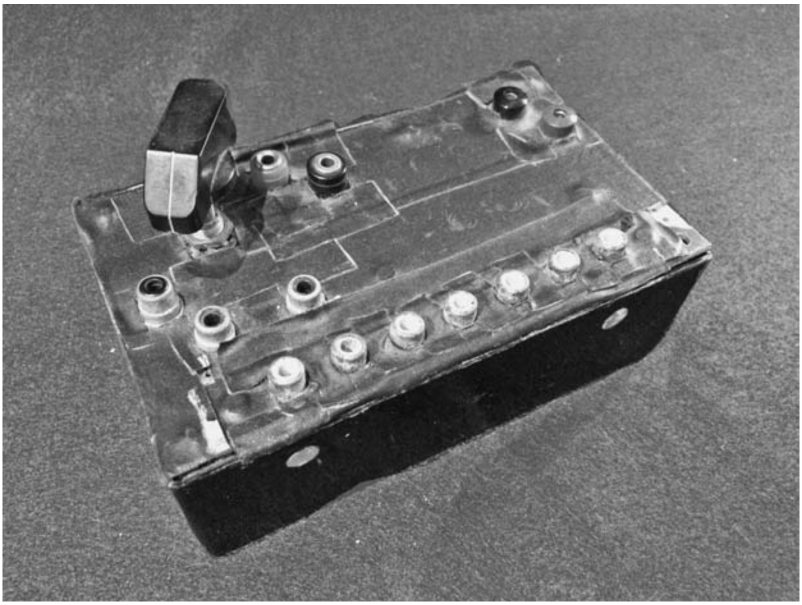


Figure 7.35 Tudor | *Multioutput Phase Shifter* (8Ø)
DTC, Instrument 0007 | World Instrument Collection, Wesleyan University

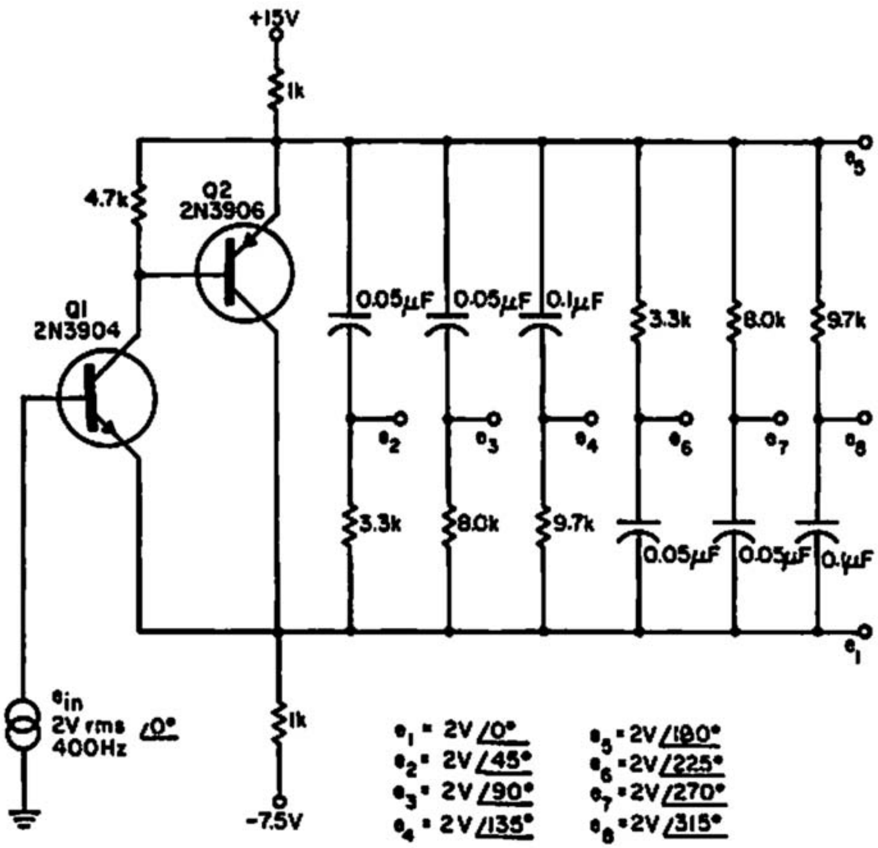


Figure 7.36 A. G. Lloyd | *Eight-Output Phase Shifter*, schematics
Electronic Circuits Manual (*Electronic Design*, October 1967, 130–132) edited by John Markus | Copyright McGraw Hill.

Shifter" designed by A. G. Lloyd and published in *Electronics Design* in 1967 (Figure 7.36). Although the original article has not been found among Tudor's papers, the same circuit was later reprinted in 1971 as part of *Electronic Circuits Manual*, a book which he owned.[60] The two transistors *2N3906* compose an amplifier around which RC (resistor-capacitor) pairs are arranged to generate the eight necessary phase angles. Tudor added a switch that is nowhere in the source, which allowed him to select one of the eight fixed outputs to appear at the extra output as well.

[60] John Markus, ed., *Electronic Circuits Manual* (New York, NY: McGraw-Hill, 1971), 551. Tudor's copy of this book is now at Wesleyan University along with other books on electronics that he owned. The same anthology also contains a reprint of the source schematics for Instrument 0015: *Phase Shifter with a Gain of 150* by R. E. Risely, originally published as "DC Phase Splitter Adds Voltage Gain," *Electronic Design*, February 3, 1964, 46–48 (*Electronic Circuits Manual*, 547).

The phased signals from the *8Ø* box are grouped in pairs, carefully arranged so that the first two are differentiated by 90 degrees (0 and 90; 45 and 135), and only the other two retain the original 45 degrees (180 and 225; 270 and 315). Each type of pairs is then mixed with either the modified (B2) or non-modified (A1/B4) signal from the *Multicoupler* using the quad *Mixer*.

5

Multi-Input Mixer (Instrument 0096/0097)

The two quad *Mixers* that Tudor drew identically as four stacks of boxes, each with a plus sign (Figure 7.37), were indeed two identical instruments that he composed for *Untitled*. Michael Johnsen has identified the source as the *RCA Solid-State Hobby Circuits Manual* published in 1970.[61] Circuit No. 21 is a *Multi-Input Mixer* with a gain of approximately unity (1) (Figure 7.38). The design is for seven inputs, although

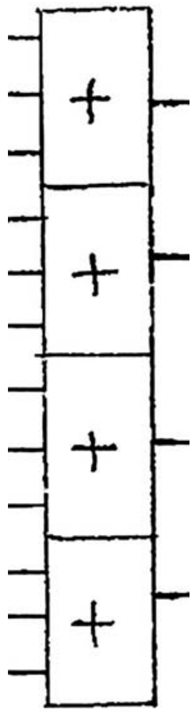


Figure 7.37 Tudor | *Multi-Input Mixer* (Instrument 0096), symbol
Courtesy of David Tudor Trust

[61] RCA, "Solid-State Hobby Circuits Manual," Technical Series HM-91, 1970.

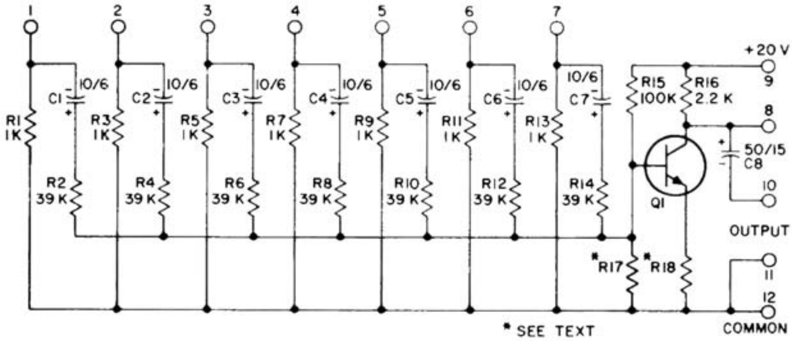


Figure 7.38 *Multi-Input Mixer*, schematics
RCA Solid-State Hobby Circuits Manual |

the manual mentions the possibility of wiring as many as three mixers in parallel. The seven inputs go through a simple network of resistors and capacitors that the anonymous author calls the "zero-point switching method": the input capacitor (10 microfarads) is kept charged by a parallel pull-down resistor (1 kΩ) connected to the ground to buffer the cracks and pops that can occur when moving plugs in and out. Tudor again modified the material slightly and encased four 3-input mixers next to one another in an elongated metal box (Figures 7.39 and 7.40). Using this box to mix signals with phase differences coming from the *8Ø* box resulted in comb-filtering, where the summed signals cancel or amplify one another through constructive or destructive interference.

6

Four Quadrant Multiplier/MC1494 (QM)

The mixed signals then go through two parallel modulation networks (Figure 7.41). Tudor's own shorthand in his sketch (Figure 7.29) labels them as "M" and assigns a number to each. In M1, the two 90-degree pairs (B2+0+90 and A1+45+135) are multiplied by a modulator, whose product goes through a variable low-pass filter and amplifier, before returning to the *Audio Multicoupler B*. In M2, the two 45-degree pairs (B4+180+225 and A1/B2+270+315) each pass through complementary low-pass and high-pass filters before being modulated by a second modulator—the so-called Formant Shifter network, which had already appeared in many previous diagrams. The product is filtered by a band-pass filter, then split in two directions, one feeding back to the *Audio Multicoupler A* and the other sent to the *Quad Multi-Input Mixer* at the output. The two modulators are generalized in the diagram, of course, but there are other materials that can be used to de-generalize them.

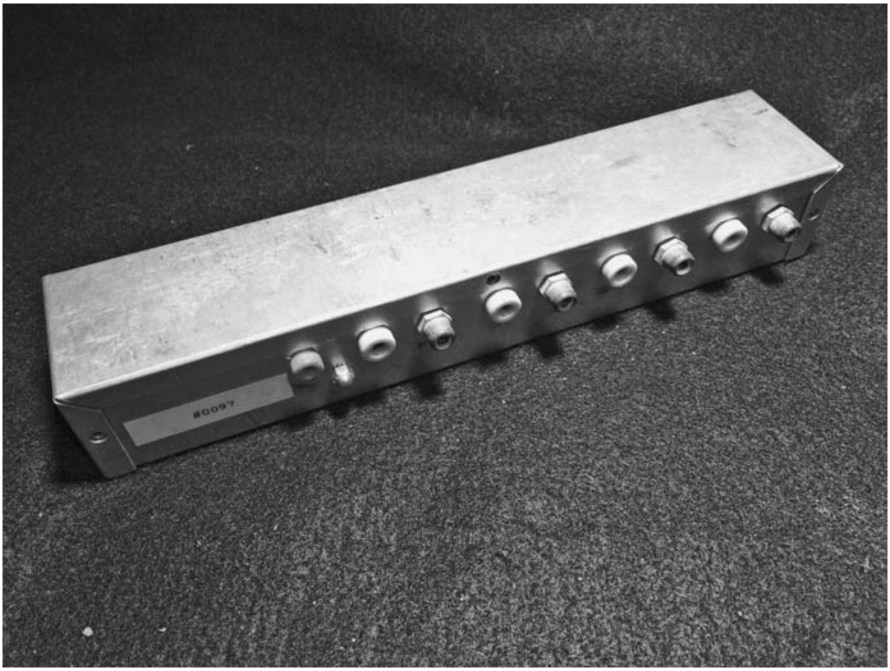


Figure 7.39 Tudor | *Multi-Input Mixer*
DTC, Instrument 0096 | World Instrument Collection, Wesleyan University.

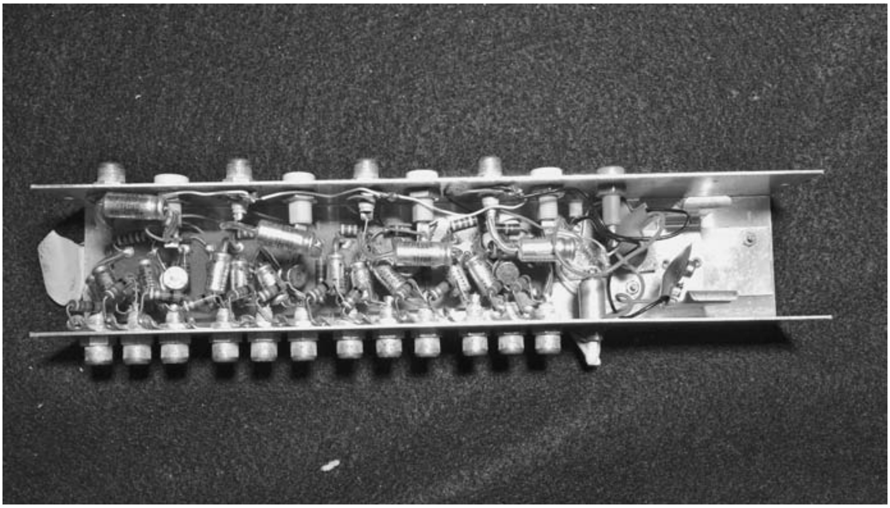


Figure 7.40 Tudor | *Multi-Input Mixer* (interior)
DTC, Instrument 0096 | World Instrument Collection, Wesleyan University

Among Tudor's papers are two notebooks he carried around at the time he composed *Untitled*. One is a blue Maruman notebook which has the words "spiral note" written on the cover and contains the early sketches for the "Performance Processing" system.[62]

[62] Tudor, "Blue Maruman Notebook," Box 4, Folder 21, David Tudor Papers, GRI.

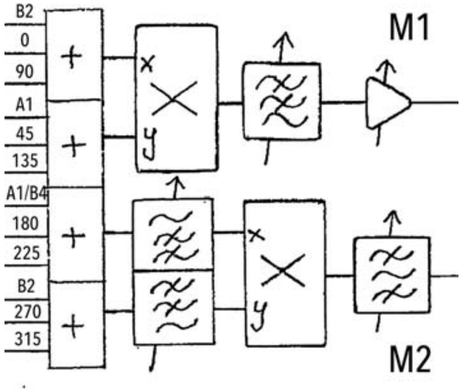


Figure 7.41 Tudor | Diagram of the Modulation Network (close-up)

Courtesy of David Tudor Trust

Note: Phase angles and output of the *Dual Audio Multicoupler*, as well as the labels of two Modulation Networks added.

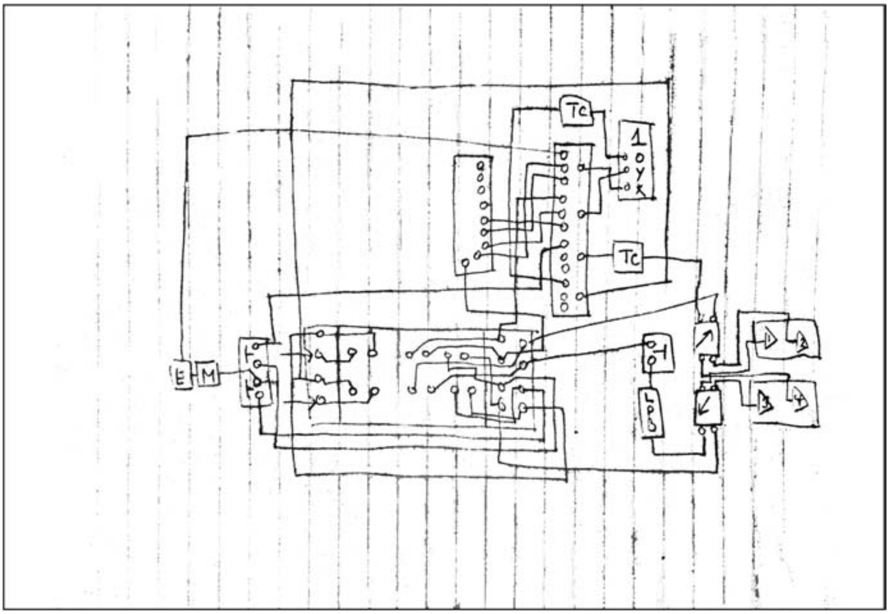


Figure 7.42 Tudor | *Untitled*, sketch in blue Maruman notebook | 1972

DTP, Box 4, Folder 21 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

Note: “TC” refers to *Tone Control*; (0040) “LPB” to *Electro-Harmonix LPB-1 Linear Power Booster* (0149); and “M-E” to *E-H Mole* and *Ego*.

Not all the instruments are there, but the M1 network appears from the very first sketch (Figure 7.42) and in all subsequent ones: the first two outputs of the *Quad Multi-Input Mixer* are modulated by an instrument labeled "1" with two inputs "x," "y," and one output "o." The letters and the number reveal which specific modulator Tudor had in mind.

Sometime in the late 1960s, Tudor had composed a kit modulator built around the IC chip *Motorola MC1494* (Figures 7.43 and 7.44). This chip was a multiplier and since its two input signals could both swing in both polarities it was called the *Four Quadrant Multiplier*. The acronym "QM" had appeared in the *Video III* diagrams complementing the *BFO* network (Figures 7.20 and 7.21), near the output in the Amiens diagram of *Activities for Orchestra* (Figure 7.7), and as one of the two modulators in the *H. to T.I.* diagram, this time paired with the *Spectrum Transfer* (Figure 7.22). One distinct characteristic of this modulator was its versatility. The four-position selector switch transformed the instrument into one of four arithmetic operators: multiplier, divider, frequency doubler, or balanced modulator/amplitude modulator/phase detector. Two other toggle switches further turned the multiplier and divider function into a square and square root function, respectively.[63] The white tape attached to each of the inputs and outputs on the actual box indicate their function using the same initials as the notebook sketch: "o" for output, and "y" and "z" for the two inputs.

The number "1" suggests the existence of number "2." Indeed, after using the modulator for some years, Tudor made a copy of the same instrument, possibly in time for *Untitled*. So M2 could have employed this second *QM*. Following their appearance in *Untitled*, the same modulators showed up in many diagrams of subsequent works throughout the 1970s, almost always used inside the Formant Shifter network. After Tudor passed away in 1996, the two *QM*'s remained in the basement of MCDC until they were discovered in 2011 and sent to Wesleyan University to join the other instruments—because of this, they are not yet numbered.

7

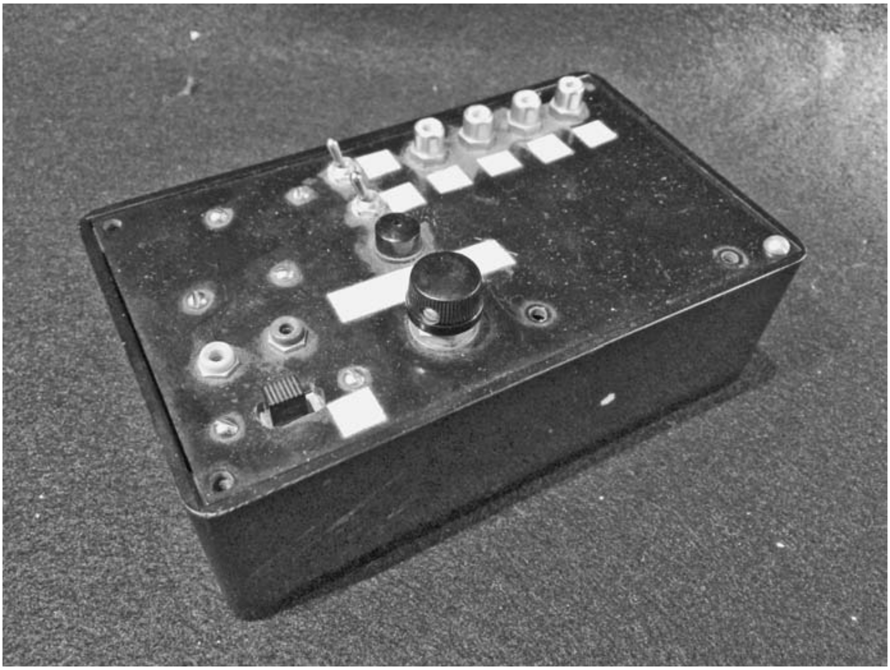
A second notebook related to *Untitled* contains sketches of schematics, list of article titles, and notes from readings that Tudor made in composing the sound system.[64] Although none of the pages is dated, there is a photo of Tudor that Mumma took during the Midwest tour with MCDC in April 1971 (Figure 7.45) showing him working on the same notebook (upon very close observation, one can glimpse the words "… independent … voltage excitation," which is found on one of the pages) (Figure 7.45).

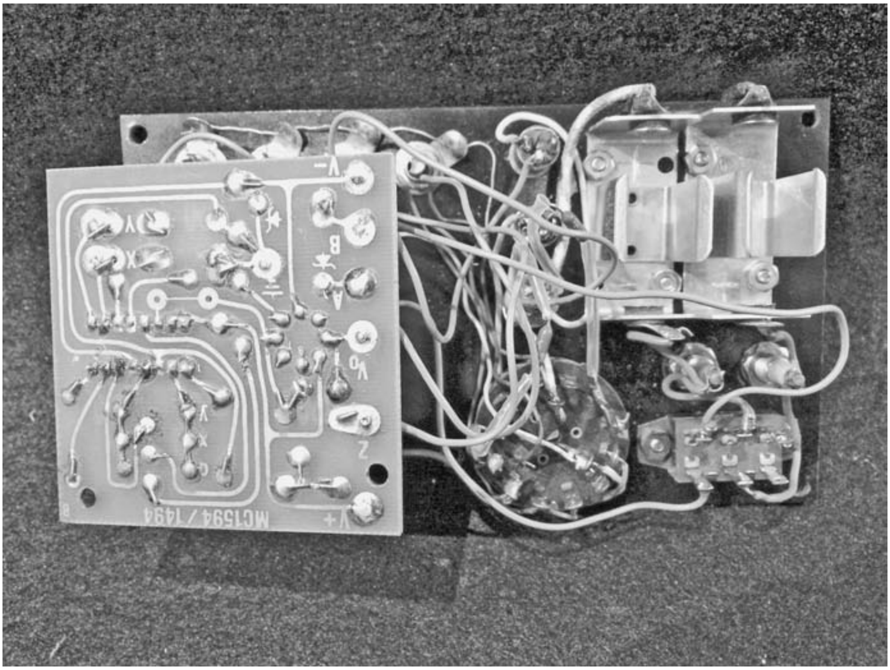
In particular, the topic of single-sideband modulation seems to have interested Tudor greatly around this time.[65] For instance, a flow diagram from John Spalding

[63] Among Tudor's papers are three pages of notes detailing the composition of the modulator. They document him trying to figure out the switching between all the multiple functions of the kit (Tudor, "Notes for *QM*," Box 45, Folder 2, David Tudor Papers, GRI).

[64] Tudor "*Untitled* Notebook," Box 4, Folder 21, David Tudor Papers, GRI.

[65] This was first noted by Michael Johnsen, who also heard the effects of single-sideband modulation in the recordings of *Untitled*.





Figures 7.43 and 7.44 Tudor | *Four Quadrant Multiplier*

DTC, no # | World Instrument Collection, Wesleyan University

Figure 7.45 Gordon Mumma | Photograph of Tudor working | April 1971
Courtesy of Gordon Mumma

Prichard's 1938 thesis "Generation of Higher Order Subharmonics by Regenerative Modulation" is copied out in one of the pages, which shows how to generate subharmonics by connecting a modulator, filter, and an amplifier in series, and then feeding the output of the amplifier back to the modulator (Figure 7.46).

The basic principle is simple and well known: the frequency of signal fed back from the amplifier (f2 = f1/2) is half of the original input signal (f1). The modulator produces the sum (f + f1/2 = f3/2) and difference (f–f1/2 = f1/2) of the two signals, after which a low-pass filter attenuates the higher sum product (upper sideband), leaving only the difference (lower sideband = f1/2) to be amplified and output. If the feedback part is taken out, this is essentially how Mumma's *Cybersonic Spectrum Transfer* worked in "single-spectrum" mode. Tudor also copied a variation of this basic mechanism using a harmonic generator in the feedback path. The same topology is found in the M1 network in *Untitled*, where the product of the modulator goes through a low-pass filter, thus suppressing the upper sideband and leaving only the subharmonics of the input to be amplified and recycled through the system—a giant *Spectrum Transfer*, so to speak.

Tudor's notes also show him studying a newer process of single-sideband modulation called the "phase-shift method." In contrast to the "filter method" just described,

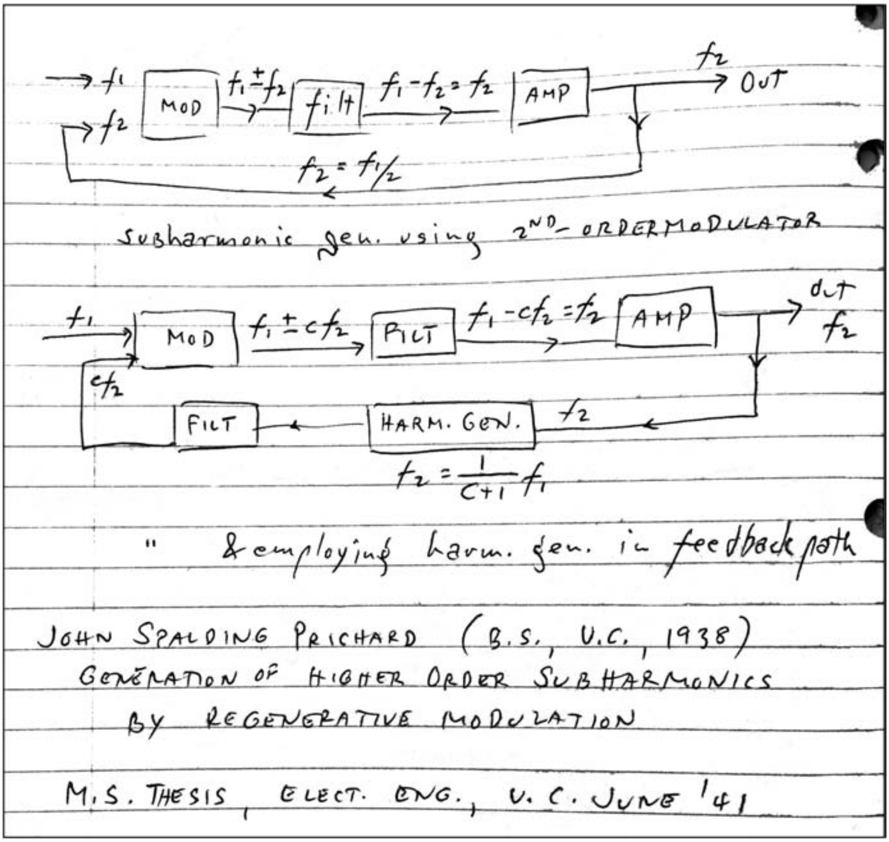


Figure 7.46 Tudor | Notes from John Spalding Prichard, "Generation of Higher Order Subharmonics by Regenerative Modulation" | Undated (presumably 1971)
DTP, Box 4, Folder 21 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

suppression of unwanted sideband can be attained by using two parallel phase-shift networks to obtain two signals differing 90 degrees in phase, each of which then modulates a carrier signal whose phase difference is likewise set appropriately. When the two products of these parallel processes are combined, the relative phase difference between them results in the cancellation of one sideband (upper or lower depends on whether the combination is additive or subtractive). Tudor copied out several examples of parallel phase-shift networks that could produce two signals whose phase difference is exactly 90 degrees. None of these circuits seems to have been made, let alone used, although his readings could have influenced the basic topology of the "Source Generation" system of *Untitled*: two parallel phase-shift networks that take the same input signal and produces outputs that are out of phase with one another, which are then modulated separately before they are combined.

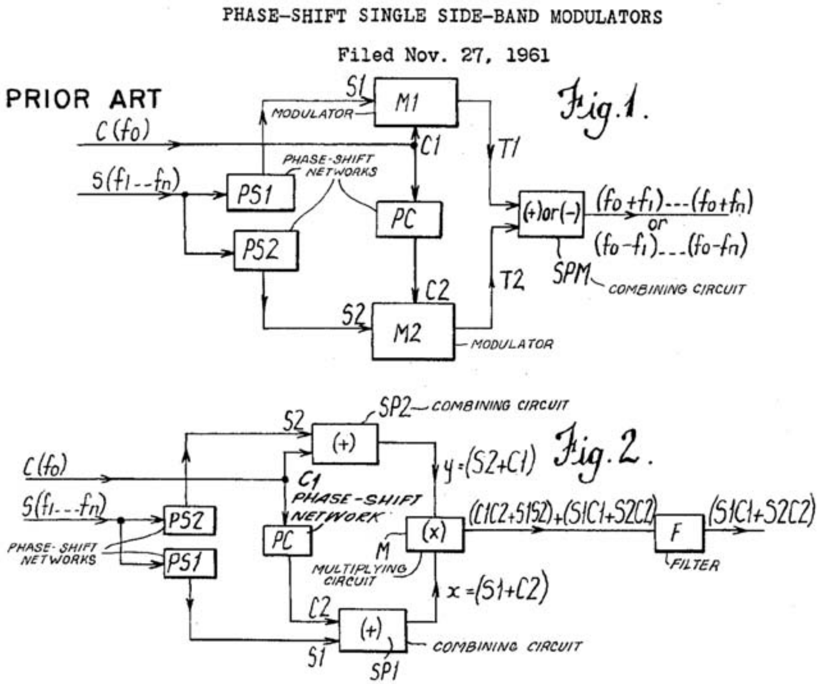


Figure 7.47 Wolja Saraga | Diagram explaining the difference between prior methods of single-sideband modulation and his new method | December 21, 1965 | United States Patent 3225316
United States Patent Office

Another title Tudor wrote down in his notebook was Wolja Saraga's patent for "phase-shift Single Side-Band Modulators" (Figure 7.47). This was a novel form of the phase-shift method proposed in 1961, in which two parallel combining circuits were used instead of modulators to process the out-of-phase outputs from the two phase-shift networks.[66] If the phase difference between the two modulating signals and two carrier signal are *not* matched, as in the usual form of the phase-shift method, but are paired oppositely, Saraga realized that single-sideband can be obtained by modulating the outputs of the combining circuits with a single multiplier and filtering the product appropriately. It is possible that this model was another source of inspiration for Tudor in conceiving the M1 network, where he created two pairs of signals with 90-degrees phase difference (both within themselves and between the pairs), which

[66] Wolja Saraga, "Phase-shift single side-band modulators," United States Patent 3225316, December 2, 1960.

were added separately at the *Quad Multi-Input Mixer*, multiplied by a single modulator and filtered at the end to obtain the lower sideband.

Natural Objects

1

A page after the first sketch of *Untitled* in the blue Maruman notebook, Tudor drafted what appears to be the first description of his new music. This was even before the second modulation network (M2) had appeared.

> untitled is part of a never-ending series of discovered works in which the electronic components are found to be natural objects. ~~common to all is that no initial input signals are used whatsoever. versions differ according to whether control signals are used among the interstage components, & the method of handling the final output.~~
>
> Because multiple phase shift stages are present in the hookup, some works in the present series are video outputs as well as audio, or v.o. alone.
>
> [. . .]
>
> the entire series is ded. to T. I.
>
> The present version contains no control signals.[67]

After another draft toward the end of the same notebook, Tudor completed the description before the premiere—the German translation of the whole text was read aloud at the start of the first performance of *Untitled* and *Mesostics Re Merce Cunningham* at Radio Bremen on May 8, 1972.[68] The edits from the first draft are very small, only moving the order of sentences, adding, erasing, and replacing a few words. Even the crossed-out parts reappear in other places. Which is to say that by the time he wrote down the first extant draft, Tudor already had a fairly good idea of what he wanted to do. But something more significant is also revealed: *he was already calling the work "untitled" before the premiere*—so the title was *not* a description of there being none. It could have started off as such when Tudor failed to send the title in time to be printed on the program. But even then, he appears to have quickly come to terms with it, drafting his description of the new piece with the title "Untitled" and handing it to the German presenters in time for it to be translated. Thus, the naming process of *Untitled* resembled that of *Rainforest* where Tudor, who couldn't think of a good title, waited for Cunningham to come up with one, and then made that his own—presumably because it worked as a good name for the music as well. *Untitled* did not simply end up being untitled; there was a process

[67] Tudor, "Blue Maruman Notebook," Box 4, Folder 21, David Tudor Papers, GRI.
[68] This can be heard in the recording included in *The Art of David Tudor: 1963–1992* (disc 3), New World Records (80737), 2013, 7 CD.

of reclamation. When he was told that the work would have to be printed as untitled, Tudor's response may have been the same as four years before: "Now there's a title."[69]

2

Yet Tudor's description of *Untitled* contains more puzzles than the sheer fact that the title is already there. The overall reasoning appears to be clear. Tudor inverts the common use of the term "natural instruments" to address non-electronic instruments:[70] it is rather electronic instruments that are found to be natural objects. This was indeed a general manner of speech that he kept returning to when talking about his music. Soon after finalizing the description of *Untitled*, for instance, he connected the revelation of *Activities for Orchestra* to the understanding of electronic music as a natural phenomenon during the 1972 KPFA radio interview:

> *So I found then that* there *was a process that existed just as a tree does; you know, a tree between rain and earth and sunshine. So that piece deals simply with that: how to make the equipment perform itself. It's all actuated by overloading the situation with an output voltage. But at no point do I introduce a signal. Whereas in some pieces I have, I have done that. I use a signal which is not considered to be an input signal, but acts as a control—I mean technically it's known as a control signal.* [. . .] *But this work is new for me, because I completely wish to avoid any control whatsoever over the material.*[71]

Five minutes earlier in the same interview he had indeed used the exact same words with which he described the electronics of *Untitled*—except this time, it was to talk about yet another piece:

> *Well, I feel that I have something that I can call my work when I discover a natural process. Or, when I discover an instrument as a* natural object*. That's how my piece* Rainforest *came about. Because I had felt for many years that loudspeakers are an obscenity. Or, at any rate, it's a false notion, they don't exist.* [. . .] *And so I was dreaming one day, and I thought how nice it would be to have a whole forest, or orchestra of loudspeakers, each one with a quite different sound. Which means that they should have the sound that they have, rather than reproducing some other sound which is in somebody's mind. And of course that entails, or it carries with it, the knowledge that even if it's capable of reproducing a single frequency, yet it's still an instrument. So it's not at all necessary to reproduce a broad range of sound in order to have a loudspeaker, which is an instrument. So then with that, all of a sudden I saw that that itself was a natural process because that instrument doesn't need any music in it.* [. . .] *In other words,*

[69] Mumma, quoted in Rogalsky, "Idea and Community," 95.
[70] For instance: "In our quest to find things about natural instruments that we can 'steal' and use in our electronic designs . . ." ("Electronotes [June 20, 1978]," Box 43, Folder 5, David Tudor Papers, GRI).
[71] KPFA Radio, "An Interview with John Cage & David Tudor."

> *the very simplest electrical impulse is going to cause the loudspeaker to vibrate, and there's no necessity whatsoever for a sophisticated electronic processing.*[72]

The reasoning, again, appears to be clear. If the electronics arranged in feedback in *Untitled* did away with the need for input, the instrumental loudspeakers of *Rainforest* did away with the need for music. The latter was therefore also very much like the sound system of *Activities for Orchestra* dedicated to the complex processing of simple inputs such as sine, square, or pulse waves. In all cases, the initial source signal was a mere trigger to activate the system, like the random thermal noise used to set an oscillator going. Almost left to their own devices, the instruments would produce sounds that only they have. Unlike tools, they would leave their traces all over and determine the nature of what is done. And it was at this very moment when materials are found to be natural objects that Tudor would reclaim their music as his own. "I started to become really conscious of the nature of the instruments I was dealing with. And at that point, I felt that it was my music," he explained in the 1972 KPFA radio interview. "So less and less, I played other people's music."[73] And more and more he let the equipment perform itself.

3

What is puzzling, however, is not *what* Tudor says. It is *how* he repeats it again and again. For if discovering instruments as natural objects is a *general* approach in his electronic music, then it ceases to be a nature *specific* to *Untitled*. The many attempts for a similar discovery could all be part of "the never-ending series of discovered works." But the problem runs deeper, because the goal of finding instruments as natural objects was not the only thing his music shared: they also shared the means to that end, which is to say actual instruments. And this happened to be particularly true between the two works Tudor explicitly connected to that idea. In the blue Maruman notebook, the sketches of *Rainforest* and *Untitled* appear one after the other, using the same group of equipment in different configurations: the *Photocell Keys*, the *Audio Multicouplers*, the *Quad Multi-Input Mixers*, the tone controls and filters, and so on (Figure 7.48).[74] Instruments were first shared as actual objects before they were discovered as natural objects.

This was obviously due to the constraint of touring. Both works had to be performed using the limited amount of equipment Tudor could carry around on his own across Europe. But being coupled for the tour had other consequences too, as the connection between *Untitled* and *Rainforest* went beyond the constancy of instruments and ideas about instruments. Tudor drafted a new description of *Rainforest* in the blue Maruman notebook, just five pages before that of *Untitled*, in which he observed one nature of the sound system he had not realized at the time of its premiere four

[72] Ibid.
[73] Ibid.
[74] Tudor, "Blue Maruman Notebook," Box 4, Folder 21, David Tudor Papers, GRI.

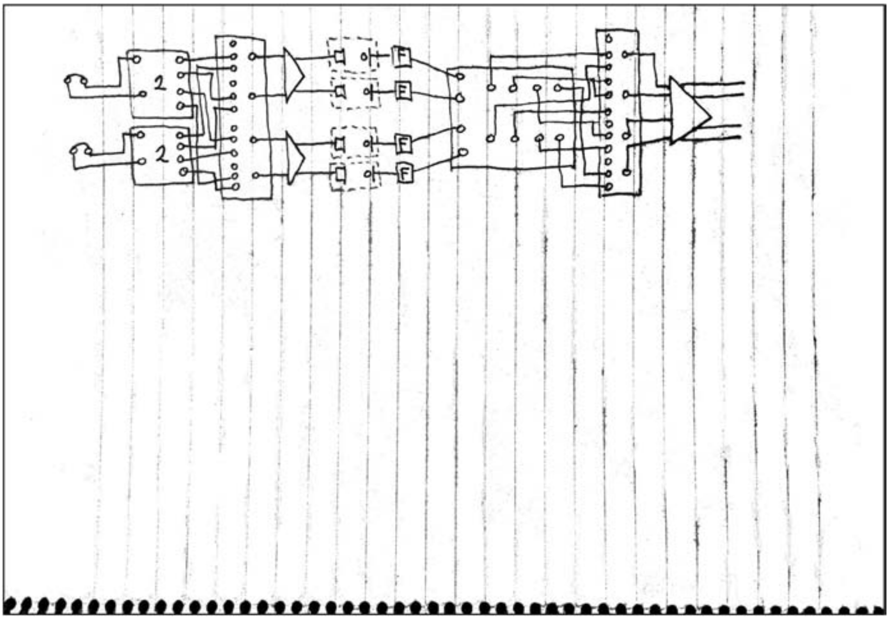


Figure 7.48 Tudor | *Rainforest*, sketch in blue Maruman notebook | 1972
DTP, Box 4, Folder 21 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

years before: "the work is open at both input & output."[75] In 1972, this became something to point out, since it was the exact opposite of what he had set for the other work he was touring with: "no initial input signals are used whatsoever." *Untitled* and *Rainforest* thus appear complementary to one another as far as input and output were concerned. In spite of sharing the same resources and the same goal of revealing their nature, the two works had polar focuses.

4

As his exploration of giant instruments had shown, however, the difference between inside and outside—and therefore between an open input and no-input—was relative to the scale of observation, itself grounded on the physical scale of Tudor's own body. And it was this bias of *David Tudor* as a natural object, so to speak, that in turn biased the otherwise neutral appearance of instruments as natural objects. For not only the number of instruments he could physically carry around while touring resulted in the constancy of instruments *between* the two works, but the number of instruments he could physically handle during a

[75] Ibid. Also: "Program note, John Cage/David Tudor, Tage Neuer Musik, Konzerte der Stadt Bonn (May 18, 1972)," Box 77, Folder 8, David Tudor Papers, GRI.

performance resulted in the inconstancy of instruments *within* an apparently single work. As the two diagrams of "Source Generation" and "Performance Processing" reveal, *Untitled* was always performed using the three *Study Tapes* as input, since the sheer number of instruments and feedback loops made the entire network of natural objects too complex for even a virtuoso to perform in concert. Having eight arms—as he once informed Cage—was apparently not enough. Whether or not *Untitled* is a "no-input" work therefore remains an open question, whose answer depends on how one understands the relationship between the generated source and the actual performance.

When he drafted the description in the blue Maruman notebook, Tudor filtered out this indeterminacy by stressing the closure of "no-input." Language thus provided a cover-up. But the different ways to conceive where *Untitled* starts and ends survived in the same text as a strange confusion of scales distorting the clarity of natural objects with zero or almost zero input. This revolved around the polarity between "series" and "versions."

It is clear from what Tudor wrote that *Untitled* is part of a larger, never-ending series, but other than that, his description allows multiple readings that do not coordinate well with one another: all the "versions" can be *Untitled*, in which case the "present version" from the 1972 tour is only one of the many possible realizations; or all the "versions" can belong to a larger "series" which is itself untitled, and in relation to which *Untitled* is the name only attached to the "present version." The condition of no-input is explained as being "common to all," but it is not clear if this "all" refers to the "series" or the "versions." Tudor describes what is specific about the "present version," but he also describes the difference of output form in relation to "some works in the present *series*." The dedication of the "entire series" to Ichiyanagi only amplifies the indeterminacy, as "Homage for Toshi Ichiyanagi" was used as a subtitle for *Untitled*. In short, Tudor's description makes the status of *Untitled* oscillate between a whole and a part of the whole.[76] The structure of his solution yet again composes a synecdoche, similar to oscillators inside oscillators, white noise generators inside white noise generators, and islands inside islands: *Untitled* appears to be a version of its own series.

5

One day in 1995, Tudor gave a series of diagrams related to *Untitled* to the artist Sophia Ogielska, who was at the time working with him on one of the very last projects of his life. The collaboration consisted in turning the diagrams of *Untitled* from more than twenty years before into works of visual art. Aside from the

[76] Like *Untitled, Rainforest* was conceived as a "series" of works having different "versions" that were distinguished by the number of components, input source, and handling of output. The frequent confusion in the numbering of *Rainforest* versions is therefore reminiscent of the inherent difficulty in determining whether the title *Untitled* refers to the series or the version.

"Source Generation" and "Performance Processing" diagrams, the gift to Ogielska included three other neatly drawn diagrams, each with a title and the categorical designation "GENERALIZED," all of which are found among his papers at GRI as well: one for "Generation"—different from "Source Generation"; another for "Output Processing"—also different from "Performance Processing"; and the third for "Pamplona," the city in Northern Spain where Tudor and Cage performed the last concert of their duo tour on July 2, 1972. But there were also three other diagrams that Ogielska received which have not been found anywhere else. They corresponded to the three generalized diagrams in their titles, but all carried another designation instead: "ACTUAL" (Figure 7.49). The names of actual instruments used are written out accordingly.

The division of categories between "Generalized" and "Actual" would have been easy to understand if not for the fact that the division of titles between "Output Processing" and "Pamplona" already appeared to do so. The further division of each title into two categories reveals a complex oscillation between the actualization of generalized material and the generalization of actualized one. Since *Untitled* was performed only four times in 1973, the "actual" version of "Output Processing" must have been derived from either one or all of the three other performances before the tour reached Pamplona: Bremen, London, and Basel. The remaining Pamplona performance retained its name even when generalized, presumably because it was so different from all others. Among other things, this suggests strongly that M2 was not

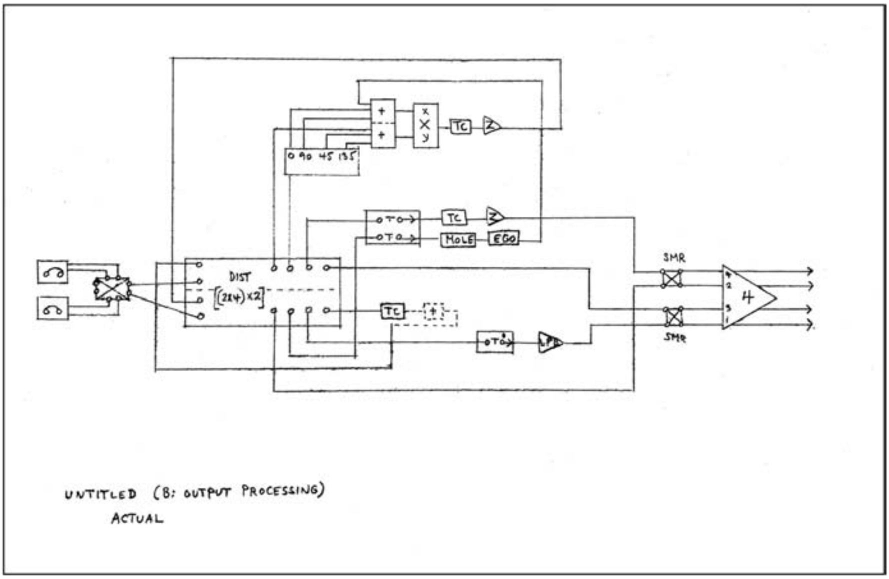


Figure 7.49 Tudor | *Untitled*, Output Processing, Actual diagram | Undated
Sophia Ogielska's Private Collection | Courtesy of Sophia Ogielska and Andy Ogielski

used until Pamplona, as it does not appear in the other “Output Processing” diagrams, neither generalized nor actual. The oscillation is not stabilized by the most generalized looking “Performance Processing” diagram either, as this one is now revealed to be a (re-)“generalized” version of the Pamplona setup, which is strangely also closer to the “Actual” diagram of Pamplona (Figure 7.50) than its “Generalized” counterpart (Figure 7.51).

In other words, the two generalizations of Pamplona do not match. Their difference is not trivial either: the Pamplona “Generalized” diagram retains the addition of M2 but erases the feedback path from its output back to the *Audio Multicouplers*. Which is to say that the Formant Shifter network, commonly used to impart rhythmic articulation to feedback, is not part of the feedback process in this version. All in all, the diagrams Tudor gave Ogielska document how the *generalized* synecdoche of “version” and “series” was *actually* used in his performance of materials.

The discovery of electronic components as “natural objects” in *Untitled* thus turns out to be a complex proposition. However, Tudor’s actual *use* of the polarity between “Generalized” and “Actual” reveals one distinct bias in his reasoning which may be used as a template to further examine this material. For the issue was “how to make the equipment perform itself,” which is to say *Tudor thought instruments needed to*

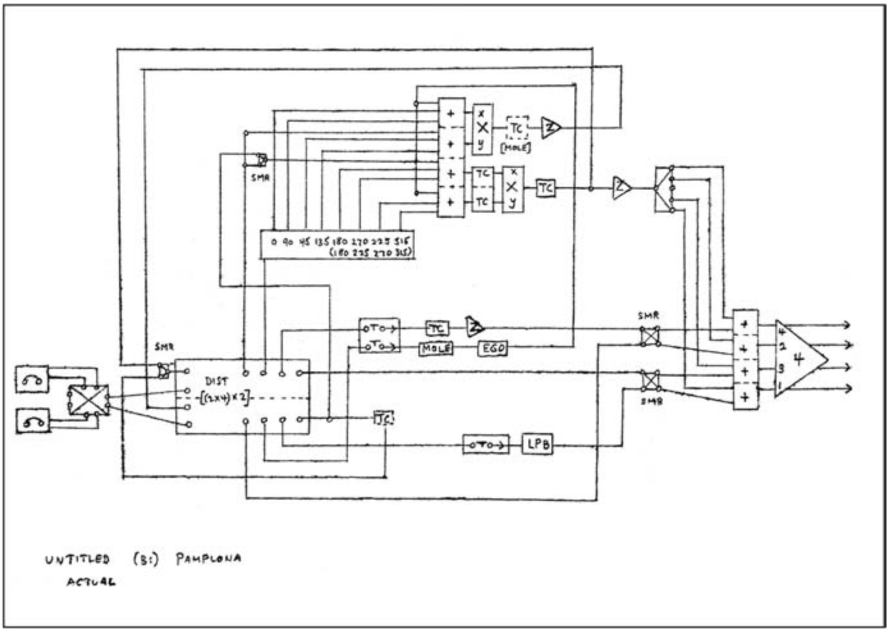


Figure 7.50 Tudor | *Untitled*, Pamplona, Actual diagram | Undated
Sophia Ogielska’s Private Collection | Courtesy of Sophia Ogielska and Andy Ogielski

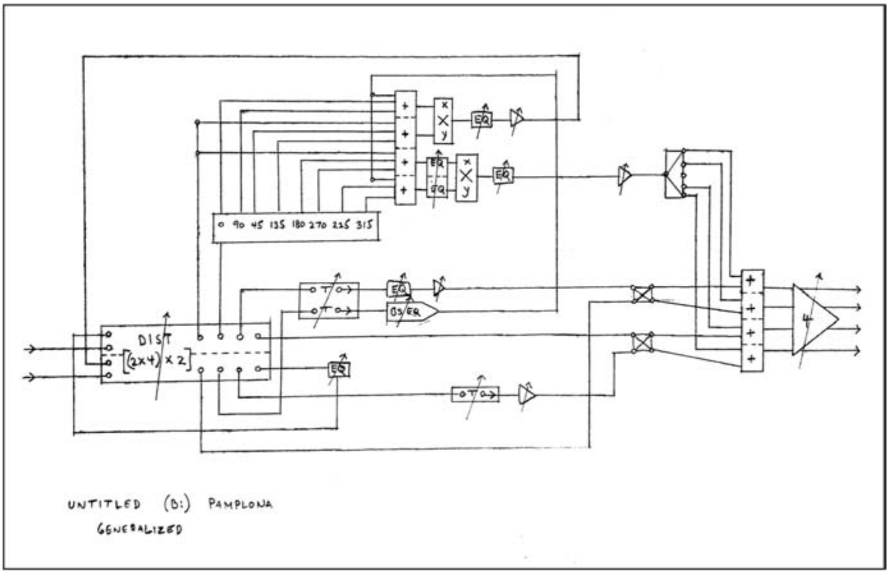


Figure 7.51 Tudor | *Untitled*, Pamplona, Generalized diagram | Undated
Sophia Ogielska's Private Collection | Courtesy of Sophia Ogielska and Andy Ogielski

perform themselves for their nature to be discovered. The status of natural objects was a matter of *act*, so to speak, not of fact. However, this theatrical nature of Tudor's approach does not coordinate so well with the effort of generalization. It would lead to something paradoxical like "Pamplona (generalized)." If the nature of *Untitled* could only be enacted, the specifics of each enactment matters. Each generalization occults an actual realization. So the study of *Untitled* must turn to the history of its performance, whether this be of series or versions.

III. Series

Toneburst

1

Sometime in 1974, Merce Cunningham asked Tudor to compose the music of his next choreography, which was going to be called *Sounddance*.[77] As Fullemann, who

[77] This was a word coined by James Joyce in *Finnegan's Wake*: "In the buginning is the woid, in the muddle is the sounddance and thereinofter you're in the unbewised again, vund vulsyvolsy" (Joyce, *Finnegan's Wake* [New York, NY: Viking Press, 1958], 378).

took over the role of MCDC sound engineer from Mumma in February 1976,[78] reminisced thirty-five years later, these commissions not only allowed Tudor to make a *new* work, but also pushed him to make a new *work*—to frame what he was doing in those specific terms:

> *He would sort of complain about it, but it was fake complaint. He was extremely happy: he made some money, and it gave him an excuse to go make a new piece. So he loved it. "Merce just said, 'I need a new piece, and it's going to be 20 minutes long.' And that's all I got from Merce." So then he had to think: "What am I thinking about? What do I wanna to do? And now I have to call it a piece . . ."*[79]

In 1974, the train of thoughts sooner or later arrived at the decision of using this opportunity to realize what he was not able to realize in *Untitled*: "to perform the whole thing without any tape material."[80] The resulting music also received a title this time: *Toneburst*. According to John D. S. Adams, who in the early 1990s took over the job Fullemann was doing in the late 1970s, it was a piece that Tudor considered "a direct translation of his mind into music."[81]

2

Toneburst was premiered with *Sounddance* on March 8, 1975, at the Center for the Performing Arts in Detroit, Michigan. When Fullemann interviewed him nine years later on September 3, 1984, Tudor explained why it was so difficult to perform everything live in *Untitled*. It was due to the fact that there were two chains of feedback that had to be played simultaneously:

> *I mean the two oscillations coming there, each with their associated controls, and trying to handle that and then trying to handle the output . . . it was not that it was too complicated, it was simply too difficult.*[82]

Two "actual" diagrams from the first two performances of *Toneburst* remain, one in Ogielska's possession dated "3/8/75" (Figure 7.52) and the other at GRI dated "3/15/75" (Figure 7.53) making it possible to see how Tudor solved the puzzle this time.

[78] "David Behrman, with whom I had worked before, was going back and forth [to] Mills [College] already and couldn't do the dance company. So he asked me to come to see a concert in Princeton. In that case Gordon was doing the sounds. It was two nights, and I had never seen the Cunningham Company so I just sat there and watched. And Gordon said, 'Well do you want to do this?' and I said, 'Sure!' About two days later we left for Tokyo with the Company. And that was my preparation" (Fullemann, "Interview by You Nakai," Skype, December 23, 2011). MCDC performed at the McCarter Theater in Princeton on January 14 and 15, 1976. The Australia-Japan tour which stopped by Tokyo took place a month later, from February 28 to April 19.

[79] Ibid.

[80] Tudor, "Interview by Fullemann."

[81] John D. S. Adams, "Giant Oscillations: The Birth of *Toneburst*," *MusicWorks* 69 (1997), 14–17.

[82] Tudor, "Interview by Fullemann."

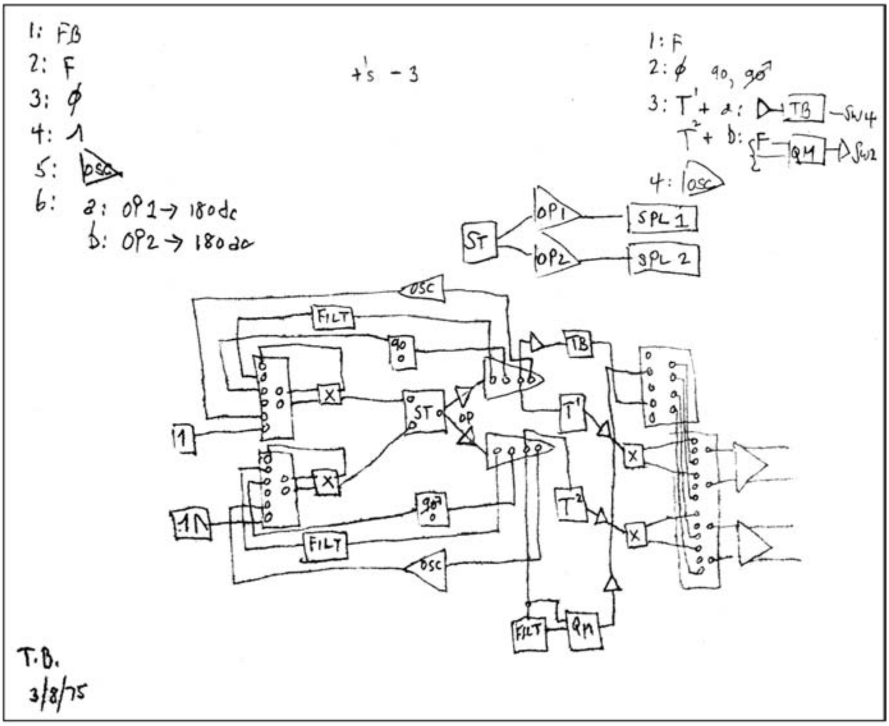


Figure 7.52 Tudor | *Toneburst*, diagram | March 8, 1975
Sophia Ogielska's Private Collection | Courtesy of Sophia Ogielska and Andy Ogielski

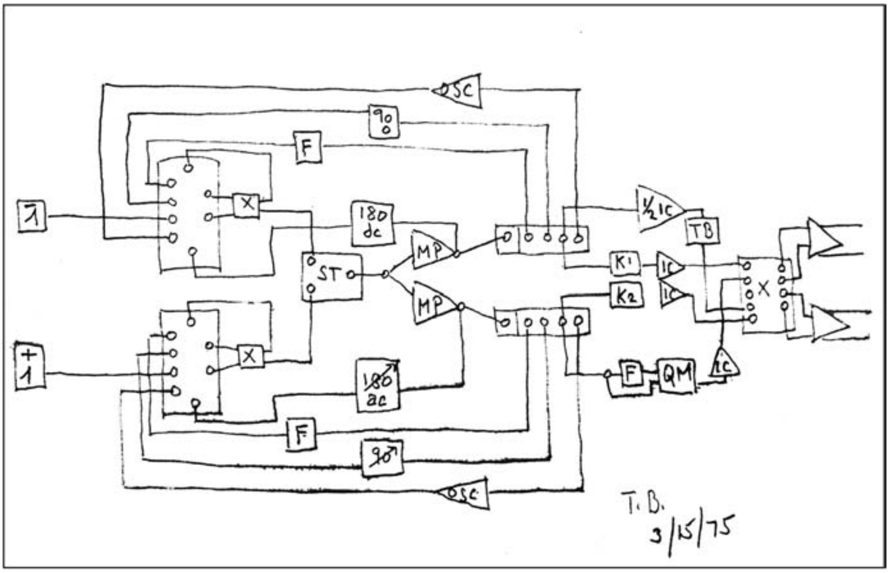


Figure 7.53 Tudor | *Toneburst*, diagram | March 15, 1975
DTP, Box 3e, Folder 2 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

As usual, his solution was deceptively simple: since two were too many, he returned to the use of just one modulator, reviving the configuration of *Video III* centering around the *Spectrum Transfer*, whose output was sent to two symmetrical chains composed of the *Olson Preamp Mixer* ("MP") and the *Cybersonic Output Splitter*. He then inserted all the phase shifters, along with filters ("F") and *Oscillating Amplifiers* ("OSC") in the similarly symmetrical feedback paths all returning to the *Spectrum Transfer* via two *Lafayette PA-292 Transistorized Microphone Mixers* (both modified to receive six inputs). The output processing section consisted of four parallel channels, two with the *Photocell Keys*, one with the *Four Quadrant Multiplier*, and another with a box designated as "TB," which stood for *Toneburst Generator*, the namesake of the piece.[83]

These early diagrams differ somewhat from the generalized diagram which also carries the date "3/75" (Figure 7.54). More instruments populate the latter in both the giant oscillator and the output processing sections. In spite of what he wrote, Tudor could not have drawn this diagram in March 1975 as it contains instruments that he did not own until mid-1976. He may have even created it as late as 1977, for another sketch drawn on the back of a paper with the letterhead of Holiday Inn in Ames, Iowa, where Tudor stayed from March 6 to 10 of that year, still shows him working out the coordination of components—presumably before the performance of *Toneburst* with MCDC which took place on the last day of his stay (Figure 7.55).[84] One of the things he was trying to figure out that day was how to connect the gaint oscillator section with the output-processing channels. The latter had proliferated over the two years since the premiere.[85]

[83] Since *Toneburst* was composed to be performed with Cunningham's dance, Tudor designed his music to have a structure of 18 minutes—the length of the choreography. Billy Klüver and Julie Martin's later article documents the performance flow Tudor had in mind: "During the first 14 minutes he introduces all the elements he wants to introduce and after 14 minutes a pulse is introduced which intensifies in volume and is drawing the piece to the end. The final 4 minutes increase in volume and activity. Eighteen minutes was the minimum time he needed to present the piece, but a concert version could extend for any length of time" (Billy Klüver and Julie Martin, "Sound into Image: The Collaboration between David Tudor and Sophia Ogielska").

[84] Tudor, "Sketch of *Toneburst* (March 6–10, 1977)," Box 4, Folder 12, David Tudor Papers, GRI. He performed *Toneburst* with MCDC on March 10 at Iowa State University.

[85] The giant oscillator section only has one new instrument. The *8Ø* box is no longer used, but there is a new symbol formed by two adjacent circles with an arrow heading in opposite directions. In the sketches, the same dual box is designated with a set of acronyms "D/G" (or "Ld/Lg") that always appear together, sometimes accompanied with a "Ø" sign. This is a complementary phase shifter, which takes a signal and produces two outputs, one leading and the other lagging 180 degrees in phase—lea*D*/la*G* (Tudor obviously could not use the initials this time as both words start from the same letter). It corresponds to Instrument 0460, containing two complementary all-pass filters—which do not filter any frequencies but simply shift the phase of the incoming signal—built around a dual op-amp *LM1458*. The two knobs on the box are indeed labeled "D" and "G." A corresponding schematic in Tudor's hand has also been found among the David Tudor Papers at GRI, in a copy of a fax sent from John Driscoll to Ron Kuivila on September 5, 1995 (Box 39, Folder 3). Neither Driscoll nor Kuivila could remember where this particular schematic came from, or why it was dispatched from one to the other in 1995. A receipt of *LM1458* from July 2, 1976, survives in another section of the David Tudor Papers, which may indicate that the instrument was composed around then ("Receipt from Jameco Electronics [July 2, 1976]," Box 131, Folder 5, David Tudor Papers, GRI). But *D/G* actually makes its first appearance in a sketch drawn on the back of a continuous form paper sheet printed at SUNY Buffalo Computing Center on January 2, 1973 (Tudor, "Sketch diagram [undated]," Box 210, Folder 11, David Tudor Papers, GRI). Curiously, this diagram is almost identical to the "Output Processing" diagram of *Untitled*, except for replacing the *8Ø* box with *D/G* and a *360-degrees Phase Shifter*. The date on the

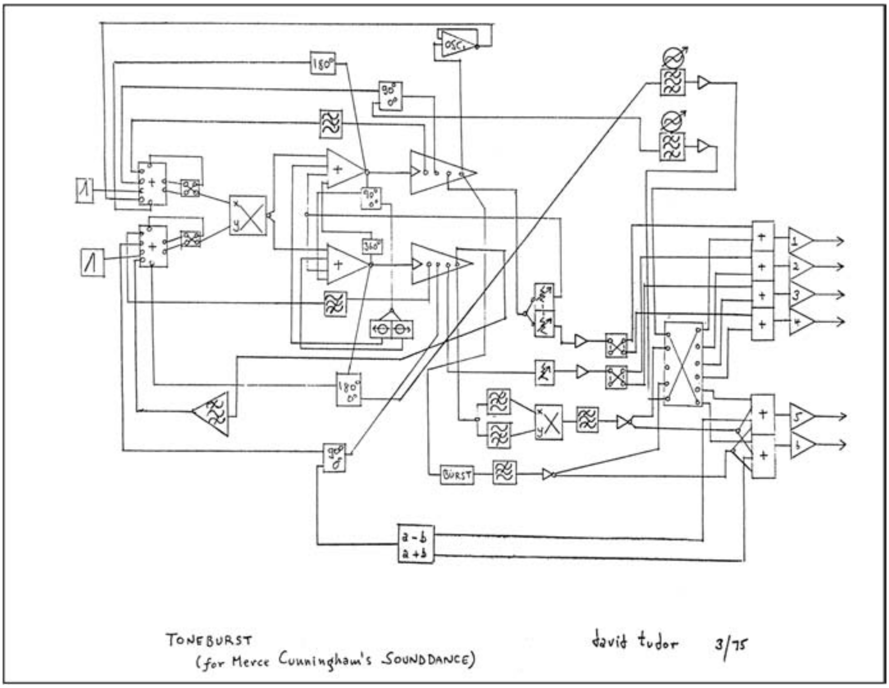


Figure 7.54 Tudor | *Toneburst*, generalized diagram | March 1975 (probably later)
Courtesy of David Tudor Trust

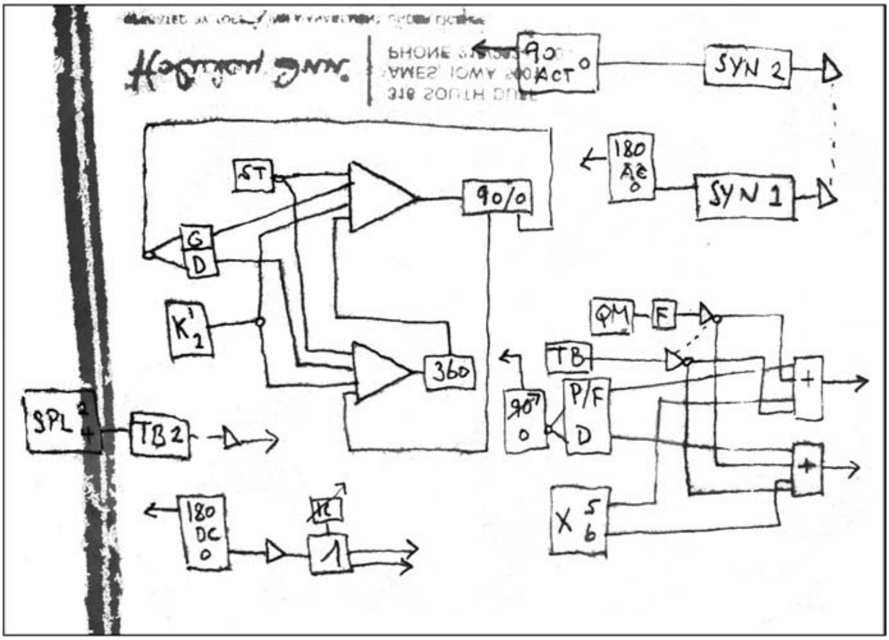


Figure 7.55 Tudor | *Toneburst*, sketch | March 6–10, 1977
DTP, Box 4, Folder 12 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

Ironically, perhaps, once the goal of pure no-input configuration was attained, the giant oscillator immediately began to appear as a single material waiting to be processed.[86] The view from outside had crept in, just as the multiplicity of instruments began to appear as a single *Pepsi Pavilion* when seen at some distance. To compensate for the singularity of the oscillator section, Tudor became focused on the processing of material, as he reminisced when talking to Fullemann in September 1984: "it added output processing so that the same material was being processed in different ways. So that the output appears to be different, although it's the same material."[87] In other words, it was yet another case of polyphony in disguise that Tudor had earlier explored with the instrumental loudspeakers of *Rainforest*.

3

The generalized diagram of *Toneburst* adds four more channels to the output-processing section of the earlier system, ending up with eight parallel ways to create the appearance of many from a single source. The four new channels were actually two kinds of processors, both made out of kits designed to themselves create the appearance of an instrument Tudor knew very well.

PAiA Synthespin (Instrument 0265/0511)

Sold from the synthesizer kit company PAiA Electronics which began its operations in Oklahoma City in 1967, this instrument intended to simulate a simulation: to electronically synthesize the Doppler effects of rotary speakers, themselves invented to imitate the resonance of pipe organs in big churches on an electric Hammond organ. In Tudor's case, it also simulated the effects of the rotating bi-instrumental bandoneon on a see-saw or a spinning stool. What mattered in this chain of simulation was the *effect*, regardless of the mechanism. The vibrato of the rotating sound source was recreated electronically using a band-pass filter that swept back and forth across different frequency ranges. Tudor's symbol appropriately shows a band-pass filter with a variable frequency oscillator on top (Figure 7.56). Two of them appear in the upper right corner of the generalized diagram, both of which are extant in the Wesleyan collection. The earliest appearance of "SYN" in diagrams that can be dated is on April 7, 1975,[88] although Tudor must have already owned one in February 1972 when MCDC toured to Toronto, as the name appears in the manifest for customs clearance

paper does not date the diagram, of course, since Tudor could have used the sheet at any later date, but the likeness of the configuration to *Untitled* does suggest that the sketch was drawn much earlier than 1976.

[86] The same transformation occurred with the *Neural Network Synthesizer* which was initially conceived as a universal instrument yet ended up being a source material, as will be detailed in Chapter 10.
[87] Tudor, "Interview by Fullemann."
[88] Tudor, "Sketch for *Pulsers*, Palomar (April 7, 1975)," Box 4, Folder 21, David Tudor Papers, GRI.

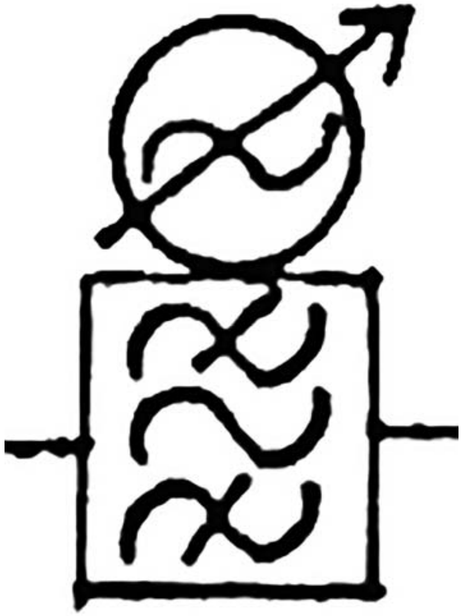


Figure 7.56 Tudor | *PAiA Synthespin* (Instruments 0265 + 0511), symbol
Courtesy of David Tudor Trust

from that month.[89] Indeed, out of the two copies that Tudor owned, Instrument 0511 (Figure 7.57) is the original *Synthespin*, and Instrument 0265 (Figure 7.58) is *Synthespin MK-II*, an updated version that PAiA released in 1973, which added extra inputs for foot pedals to control the speed and range of the virtual rotation.

Phaser/Flanger (Instrument 0039)

The box with the arithmetic operations "a+b" and "a–b" (Figure 7.59) in the generalized diagram is designated with the acronym "P/F" and "D" in the Holiday Inn sketch. This stood for *Phaser/Flanger* and *Delay*, another processor that was born out of the attempt to simulate the rotary speaker. In comparison to the *Synthespin*, this instrument produced a similar sweeping rotational effect through a different mechanism: comb-filtering, the modulation of a signal caused by summing its own delayed

[89] MCDC, "Manifest for Custom Clearance, USA-Canada (February 1972)," Box 30, Folder 3, David Tudor Papers, GRI.

Figure 7.57 Tudor | *PAiA Synthespin*
DTC, Instrument 0511 | World Instrument Collection, Wesleyan University

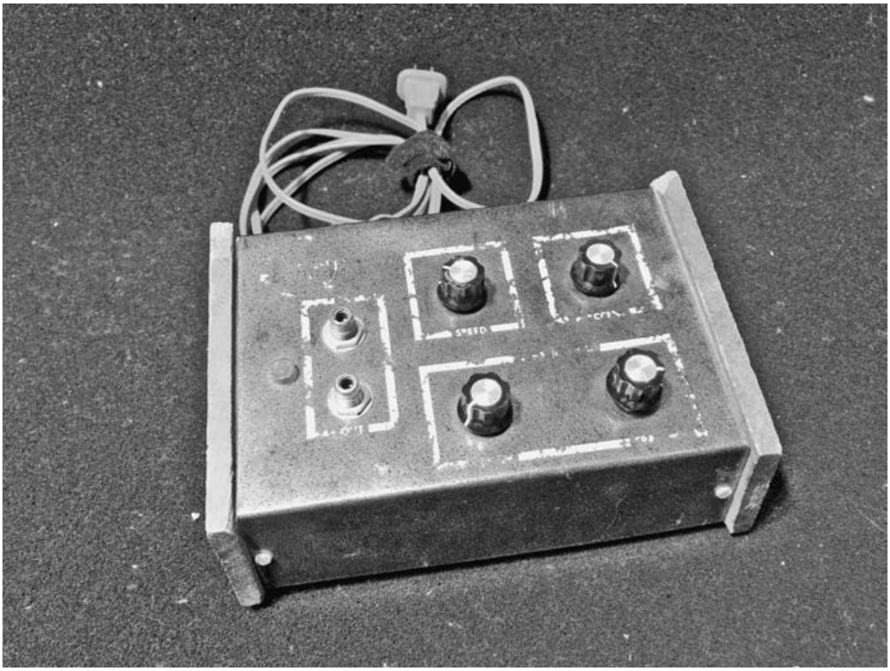


Figure 7.58 Tudor | *PAiA Synthespin MK-II*
DTC, Instrument 0265 | World Instrument Collection, Wesleyan University

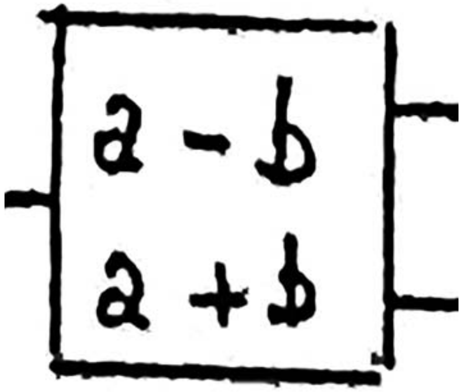


Figure 7.59 Tudor | *Phaser/Flanger*, symbol (Instrument 0039)
Courtesy of David Tudor Trust

(phase-shifted) copy onto itself. In *Untitled*, the same filtering process had been realized by the coupling of the *8Ø* box and the *Quad Multi-Input Mixer*, neither of which makes an appearance in *Toneburst*.

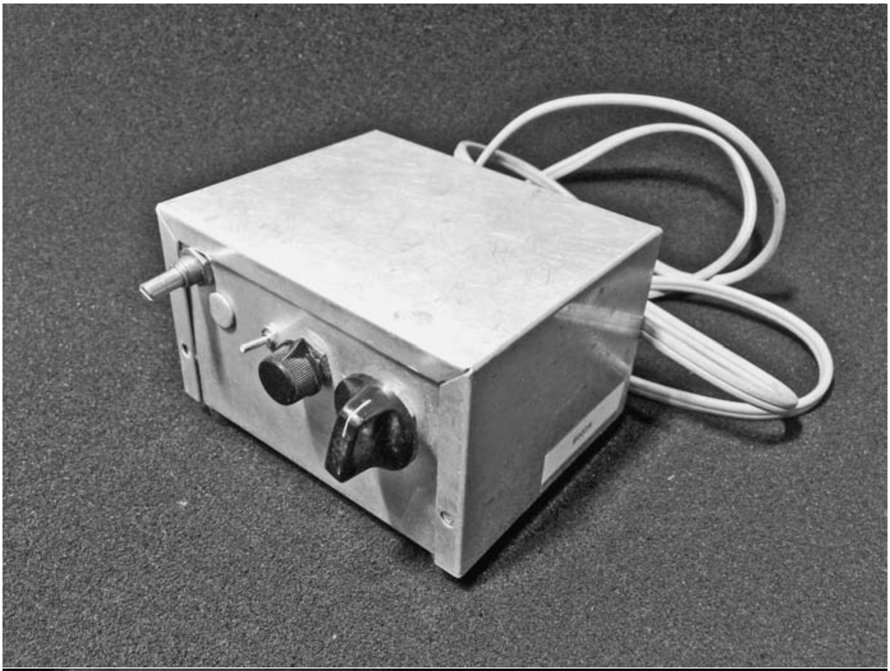
Tudor bought the kit from Phoenix Systems on June 8, 1976, shortly after reading the article "The 'Bucket Brigade' Audio Delay Line" by John H. Roberts in the June issue of *Popular Electronics*.[90] The actual box he made has been identified among the Wesleyan collection as Instrument 0039 (Figure 7.60) which indeed has a separate "D" output to bring out the delayed signal (Figure 7.61). Another pair of outputs labeled "OUT A+B" and "OUT −A+B" corresponds to another function of the *Phaser/Flanger*, which was to simulate stereo sound from a mono source, creating one phased output by summing the delayed signal to the original, and another by subtracting the delayed signal. The arithmetic on the labels refers to this operation, and the box in the diagram indeed receives one input and outputs two.

Toneburst Generator (Instrument 0118)

The first new instrument to appear in the output processing section also lent its name to the work. It was yet again composed from a popular electronic magazine article: "Build an Audio Tone-Burst Generator" by Richard J. de Sa, published in the July 1967 issue of *Radio-Electronics* (Figure 7.62).[91] A toneburst generator is usually a high-quality square-wave generator capable of outputting "tonebursts," variable-width discrete signals created

[90] John H. Roberts, "The 'Bucket Brigade' Audio Delay Line," *Popular Electronics* (June 1976), 33–38 (Box 43, Folder 6, David Tudor Papers, GRI.); Phoenix Systems, "Shipping record of electronic parts (June 8, 1976)," Box 131, Folder 5, David Tudor Papers, GRI.

[91] Richard J. de Sa, "Build an Audio Tone-Burst Generator," *Radio-Electronics* (July 1967), 44–46 (Box 40, Folder 1, David Tudor Papers, GRI).



Figures 7.60 and 7.61 Tudor | *Phaser/Flanger*
DTC, Instrument 0039 | World Instrument Collection, Wesleyan University

Build An Audio Tone-Burst Generator

By RICHARD J. DE SA, Ph.D.

HIGH ON THE LIST OF "HOT" ELECTRONIC items are those amazing little devices known as integrated circuits. Now that their prices have dropped so dramatically, it's quite simple to incorporate a couple of them in a multipurpose test instrument. Here's a practical and useful project for audio testing.

True to their acclaim, integrated circuits allow construction of the instrument with minimum fuss and few auxiliary components. At the same time, they provide versatility, small size and, most importantly, low cost.

When used alone, the instrument puts out a high-quality square wave (rise time under 450 nsec) at five switchable frequencies ranging from 20 Hz to 12 kHz. When the unit is used with an external sine-wave generator, variable-width pulses are produced. The square-wave and pulse outputs are both excellent signals for testing and troubleshooting audio components.

Most important, however, is the instrument's ability to gate or switch an external signal to produce tone bursts. The external signal to be gated can be any waveform—sine or square waves, white noise, even music or speech. Cost runs under $20, and construction should take no more than two or three evenings.

The tone burst is excellent for testing transient response in speakers, amplifiers, tape recorders, crossover networks and other audio components. The gated or switched output provides a close simulation of the rapid attack-and-decay patterns of musical material. The tone-burst waveform is also useful in evaluating overload characteristics of power amplifiers.

Unfortunately, commercial tone-burst generators are complicated and expensive. To reduce complexity and cost, the instrument described in this article uses an extremely simple transistor-gating (chopping) circuit together with two inexpensive (under $1) Fairchild integrated circuits. It produces, as shown, excellent tone bursts. If you've thought of trying integrated circuits, here's a good chance to get your feet wet in them.

Fig. 1 shows the schematic of the generator. Fig. 2 is a simplified block diagram showing its essential features. The unit consists of four subunits. IC1 is connected as a variable-width pulse generator (Schmitt trigger). IC2 is a free-running multivibrator. Q1 and Q2 are the gate driver–amplifier and the gate, respectively. Q3 and Q4 form a compound emitter follower to provide a low-impedance output. A direct-coupled npn–pnp pair is used here so the output is at ground potential.

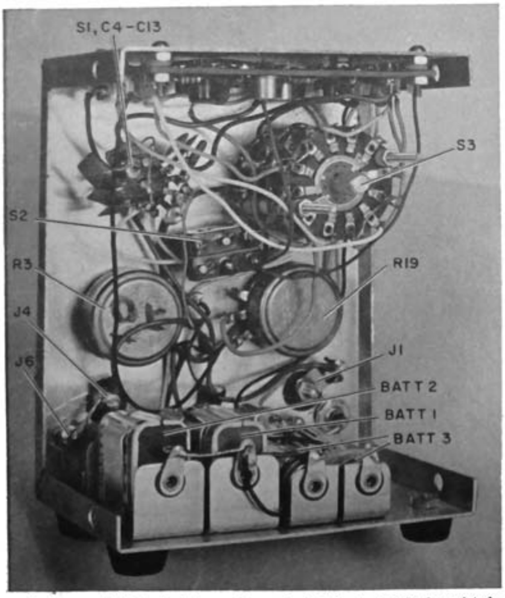
Sine waves introduced at input jack J1 (Figs. 1 and 2) are converted to fast-rise pulses at the input frequency by IC1. Pulse width is controlled by R3. Pulses, applied via C2–R5 to IC2, serve to lock in the square wave produced by free-running multivibrator IC2 (the gating waveform) with the incoming sine wave (the gated waveform). The tone burst will start at the point at which the sine wave crosses the zero axis. The input sine wave also is routed to gate Q2 by R9–R15, to be gated by the output of IC2.

The multivibrator (IC2) produces a clean square wave without the round-cornered characteristic of the usual multivibrator output. In addition, a signal from IC2 is presented at J3 to sync the scope.

The gate (Q2) is a circuit frequently used in analog computer systems. Extremely simple, it is relatively free from switching transients. It is also highly effective. Signal through the closed gate is down more than 65 dB! Note, however, that, with R15 switched into the circuit by S2, "leak" through the gate is increased so that the signal is down only 20 dB from the main tone burst. This feature is useful when you are interested in noting the behavior of the device under test after the main tone burst is switched off.

In addition to its function as gate driver, Q1 amplifies signals obtained from the integrated circuits. Waveforms up to 15 volts peak-to-peak are available at the output jack when the unit is operated as a square-wave or pulse generator.

Switch S3 selects the desired function (OFF, PULSE, SQUARE WAVE, NONGATED, GATED). Each battery is switched into operation only when it is necessary



In the box specified, there is just enough room for batteries to fit behind panel jacks.

Figure 7.62 Richard J. de Sa | "Build an Audio Tone-Burst Generator" | *Radio-Electronics* (July 1967)

DTP, Box 41, Folder 1 | Getty Research Institute, Los Angeles (980039) | Courtesy of Richard J. De Sa by gating sine waves sharply with internal square waves, whose general use is to test other audio components. The particular instrument described in J. de Sa's article could perform this function, although it placed its primary focus elsewhere: "Most important," the author explained, "is the instrument's ability to gate or switch an external signal to produce tone bursts. The external signal to be gated can be any waveform—sine or square waves, white noise, even music or speech."[92] This was exactly how Tudor used it, as an electronic gate that automated what he had been doing manually with the *Photocell Keys*. Placed in the output processing section as a box labeled "burst" (Figure 7.63), the *Toneburst Generator* enabled a flexible gating of the never-ending output from the giant oscillator (Figure 7.64). J. de Sa's design also included a switch for a "leak" function that enabled Tudor to control the degree of gating. Usually, the signal through the closed gate was attenuated by more than 65 dB, but when the "leak" was switched on, the signal would be down only by 20 dB.

4

As if to simulate the mechanism of the *Toneburst Generator, Toneburst* appears as a sort of gate between the earlier pursuit of no-input feedback and the renewed interest in output processing. According to Tudor's recollection of facts, this shift of focus eventually brought the "never-ending series" to an end. The original *Untitled* was performed four times during the 1972 tour, but no more after that. Being the music for Cunningham's dance, *Toneburst* received more than fifty performances between 1975 and 1980, before *Sounddance* was dropped from the company repertoire. Looking back later in 1994, Tudor concluded: "*Toneburst* [. . .] was the last piece in a chain."[93]

But on September 29, 1985, during his workshop at the Mobius Art Center in Boston, Tudor gave a slightly different reminiscence about how he shifted his focus to making one material appear as many. It was not because he had simplified the giant oscillator in *Toneburst*, but rather because he had replaced the two chains of feedback with the three *Study Tapes* in *Untitled*:

> *I couldn't take four suitcases of equipment. So I decided I'm going to do all these sound generation, I'm going to record it, and then use it in performance. So I recorded it just in order to have a body of material that I could use. And the idea was not to be concerned with what it was during performance. I mean it wasn't important which take it was, it wasn't important where the take started, it just meant you had to have something to generate the process.* [. . .] *So that taught me that there's a lot you can do in performance with very very simple material just by manipulating the sound. That was a four-channel piece, so by making the sound appear different in all the four speakers, you have a natural, automatic delay and sound imaging. So after that, I began to work intensely with that, making a sound appear different than the original.*[94]

[92] Ibid., 44.
[93] Tudor, "Aftertalk, STEIM (June 16, 1994)," Video, Private Collection of Molly Davies.
[94] Tudor, "Workshop at Mobius Art Center."

Figure 7.63 Tudor | *Toneburst Generator* (Instrument 0118), symbol
Courtesy of David Tudor Trust

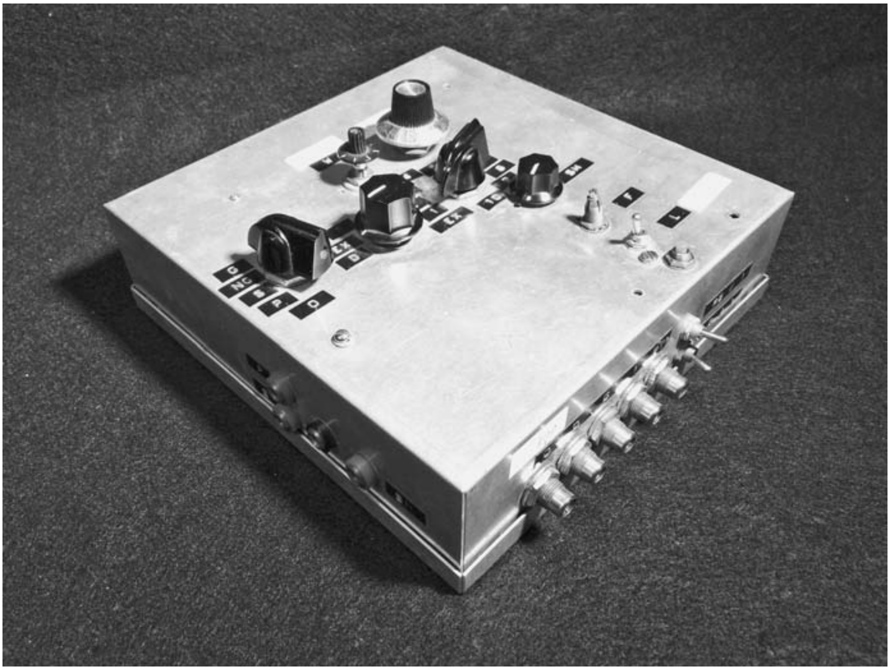


Figure 7.64 Tudor | *Toneburst Generaor*
DTC, Instrument 0118 | World Instrument Collection, Wesleyan University

In other words, the shift never really took place because there was always a leak—no-input feedback always had input in actual performances. And when it ceased to have one, it became an input itself. The materials would appear differently now in six loudspeakers—*Toneburst* was a six-channel piece—expanding the automatic delay and sound imagining, and adding new rotational effects. So the never-ending series may have never even begun. As if to reflect this primordial indeterminacy, the apparent ending of the series was followed by a series of peculiar revivals.

Revivals

1

On June 9, 1982, Tudor revived *Untitled* for a performance at the Theater Bellevue in Amsterdam during the Holland Festival. Strangely, the revival was for one night only. As always, Tudor did not reveal the reason for doing so to any of the other members of CIE who were with him to perform *Rainforest IV* in the same festival. Nicolas Collins had joined the group for this tour and recorded Tudor's solo concert in its entirety upon his request.

Two years later in 1984, Lovely Music released an LP of *Untitled* coupled with *Pulsers*, another no-input feedback piece that Tudor had been performing since 1976. According to the credits, the music was recorded at Airshaft Studio in New York, mixed and recorded by Collins.[95] But Collins himself remembered somewhat differently in 2015: "we generated no new audio material, merely took concert tapes and mixed and mastered them. It was a rather minimal session, as I recall."[96] Indeed, the Lovely LP version of *Untitled*, running a bit over 19 minutes, exactly matches the middle section of the 46-minute-long Amsterdam version—between 10:25 and 29:30, to be precise. The concert tapes Collins recalled using for the LP were, in fact, the recording he himself had made two years earlier.

Tudor therefore appears to have revived *Untitled* in 1982 for the sole purpose of live-recording the performance for a later LP release. That would explain why he performed it only once. He had even asked Collins to be the sound engineer on both occasions. But the 1984 version of *Untitled* does not only coordinate with the 1982 version—a closer listening reveals that the latter is itself a mix of the three *Study Tapes* from 1972. There is thus a nesting of materials, one recording used as the material for the next, all emanating from the same collection of source tapes made when *Untitled* was first conceived (Figure 7.65).

[95] David Tudor, "*Untitled*, Theater Bellevue, Amsterdam (June 10, 1982)," Box 1A, C45B, David Tudor Papers, GRI; Tudor, *Pulsers/Untitled*, Lovely Music (VR 1601), 1984, LP.
[96] Nicolas Collins, "Email to Michael Johnsen," March 4, 2015.

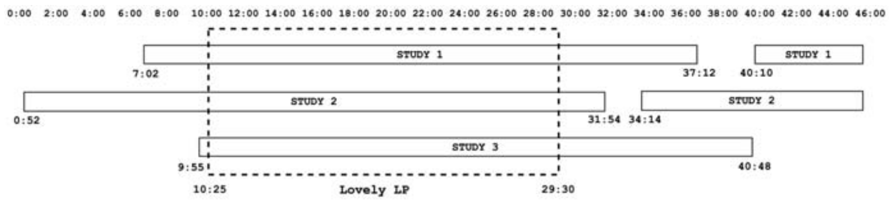


Figure 7.65 Diagram of Amsterdam recording (1982) showing the configuration of three *Study Tapes* (1972) and the section used for the Lovely LP (1984)
Created by You Nakai

2

On March 7, 1995, thirteen years after the one-night revival of *Untitled* in Amsterdam, MCDC revived *Sounddance* during their annual performance series at the New York City Center. Tudor passed away the following year. Since then the musicians and sound engineers of the company have been performing the music of *Sounddance* by mixing a CD Tudor left behind. On June 10, 1994, nine months before the City Center performance, John D. S. Adams had called Tudor (who was in Paris that day) to discuss the possibility of reviving *Toneburst* for the coming resurrection of *Sounddance*. A note found in the Merce Cunningham Dance Foundation Inc. Records at the New York Public Library documents their conversation—and Tudor's frustration:

> *DT said that if CDF [Cunningham Dance Foundation] found it necessary to program* Sounddance *then he could create a tape as a temporary solution. He thinks it is a "totally unsatisfactory" substitution but he will do it because it is impossible for him to perform* Toneburst *again due to the extreme strain it causes to his health.*
>
> *Because he also cannot develop this new work under any pressures of time, he's agreed to the tape as long as we agree that is only a temporary solution.*
>
> *There will be a change in the title of the music both for the tape and the new work but DT doesn't know that yet.*[97]

A week after the phone call, Tudor was back in Amsterdam to perform *Oceans*, his last collaboration with Cage and Cunningham. As he had done twelve years before, he again arranged a separate solo concert during his stay, yet again enlisting the help of Collins who happened to be back in the same city. This time the younger instrument builder was working as the artistic director of STEIM (Studio for Electro-Instrumental Music), so he invited Tudor there on June 16 to perform a new work called *Neural Synthesis*. Fortunately, the film artist Molly Davies filmed the concert in

[97] "ER/JA conversation #2 about Soundance (June 10, 1994)," Box 17, Folder 18, Merce Cunningham Dance Foundation Inc. Records, New York Public Library.

its entirety, including the aftertalk that was moderated by Collins. At one point in the conversation, Tudor suddenly began talking about what must have been occupying his mind for the past two weeks, the task of reviving the music for *Sounddance* and how he solved the difficult puzzle:

> *I have just been compelled to revive a piece from the late 70s and I did it, against my wishes, but it turned out to be a complex proposition because I was not able to perform the piece as I conceived it. The piece was called, the dance was called* Sounddance*, and I had a piece which I had entitled* Toneburst*, which is very particular because it was centered around a* Toneburst Generator *that I had soldered myself together. But it was an outgrowth of, well . . . that was the last piece in a chain. The previous piece which I did is the work that Nic Collins remembers as* Untitled*. So when Merce Cunningham asked me to revive this composition, I completely forgot that I had to pay attention to the title. And so I performed it. The only possibility that I had to recover the sound that I did in* Sounddance *was by using similarly produced material. . . .*[98]

So a mix-up had taken place: either on purpose or by accident, Tudor had revived *Untitled* instead of *Toneburst*. And to revive *Untitled* was to revive the three *Study Tapes*. Tudor's solution can therefore be confirmed by comparing the 1972 tapes with the CDs Tudor made in 1994 and handed over to MCDC, which have been used in all subsequent performances of *Sounddance*. They match exactly, although the latter is heavily processed using many instruments Tudor had gathered over the years to make one source appear as many (Figure 7.66). In this way, a constancy of source materials is revealed in all the performances of *Untitled*, and all the post-revival performances of *Sounddance*.

3

Tudor's account of the mix-up once again made use of the synecdochic duplicity in the title of *Untitled*. The Cunningham Foundation's current description of *Sounddance* carries an addendum: "the original music of *Sounddance* was David Tudor's *Toneburst*. When the piece was revived in 1994, Tudor rethought the music, calling his new score *Untitled (1975/1994)*."[99] His solution, in other words, was *linguistic:* under the "series" sense of the title, Tudor grouped the year that *Toneburst* was premiered—1975—with the year that he revived *Untitled*—1994—to stage the appearance of continuity between the original and the resurrection. But there was of course another year that had been erased in this process: 1972, the year *Untitled* as a "version" was premiered

98 Tudor, "Aftertalk at STEIM."

99 For some reason, this addendum has been erased from the description of *Sounddance* on the Merce Cunningham Trust page, but it still survives in the website of Ballet de Lorraine, which revived the same piece in 2014. "Sounddance," Ballet de Lorraine website, accessed December 15, 2019. http://ballet-de-lorraine.eu/en/pieces/1_Sounddance

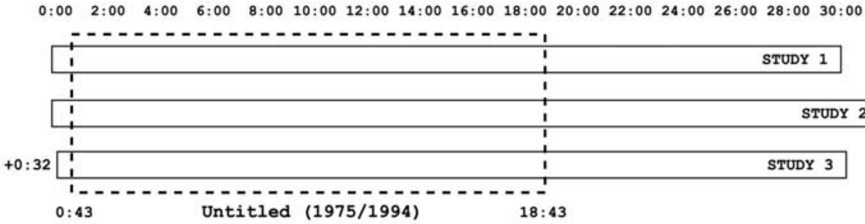


Figure 7.66 Diagram showing the configuration of three *Study Tapes* (1972) in the source material for *Untitled 1975/1994*.
Created by You Nakai

and the three *Study Tapes* made. So while the new title connected *Untitled 1994* with *Toneburst 1975*, the actual source materials connected *Untitled 1994* with *Untitled 1972*. The duplicity of *Untitled* now reappeared as a slippage between the name and the material it named.

Indeterminacies

1

Throughout the phone conversation and the aftertalk, Tudor gave three different reasons for the mix-up: (a) it was too hard on his declining health, (b) the *Toneburst Generator* no longer worked, and, (c) he forgot to pay attention to the title. The first two explain why he could not revive *Toneburst*; the last one why he revived another work in its stead. The forgetfulness about names is nothing new—the very title of *Untitled* serves as a constant reminder. But the fact that Tudor thought *Toneburst* could not be revived because of the physical decay of two instruments—*David Tudor* and the *Toneburst Generator*—is revealing: in a piece that directly translated his mind into music, there was another instrument beside himself that the music could not do without.[100] Yet perhaps this was also evident from the beginning. After all, if one only paid attention to the title, Tudor had named the entire piece after a single component in the electronic complex: *Toneburst*. It was only when this instrument stopped working that he once again started forgetting to pay attention to the title.

But of course there was actually more to *Toneburst* than the *Toneburst Generator*. Behind the synecdoche connecting the title and the primary instrument was the indeterminate coordination of many other instruments.[101] Diagrams and

[100] D. S. Adams, "Giant Oscillations," 14–17.
[101] *Untitled* as a title appears in turn to multiply the synecdoche across all modular components at the expense of leaving all of them unnamed: what gets carried from the level of particular instrument to that of the total electronic complex is *only* the name—or, more accurately, the state of not having one. Thus, *Untitled* presents an inverse of the positive synecdoche in *Toneburst* between the part and the whole—a negative

sketches reveal and collaborators recall how Tudor constantly added and removed components from his sound system.[102] This practice reflected the modular nature of his instruments and the tentative nature of their coordination, always composed at the venue before the performance and decomposed afterward. In other words, each hook-up was a live performance in Wolff's sense, always with "some slippage between the score and what is actually presented to hear," never actually the same. As far as switching of identities go, this was an ideal situation. The sheer number of instruments Tudor often complained about in relation to *Untitled* and *Toneburst* provided the perfect alibi, and touring meant fewer witnesses who could engage in comparison. Behind the synecdochical loop coordinating the whole sound system with a specific part, one piece could turn into another without anyone realizing it.

To be sure, such constancy of names and the inconstancy of what is named—same title, different realization—are the general formula of indeterminacy. As Wolff realized, one performance is always different from another, but this difference only matters in relation to the sameness of other materials such as titles, scores, or instructions—which are all linguistic. The sound of *4′33″* is always indeterminate but the intelligibility of the title must not be so. In the absence of sonic identity, that is to say, it is usually language that provides the necessary identity. In 1982, Cage recalled a time when he heard the recording of some music he did not recognize—that is, until someone informed him of the title and the name of the composer, who happened to be himself.[103] If he remembered the music, the next time he heard the same record he might have been able to coordinate the name with what is named. In the case of *Toneburst*, however, its identity was based not only on linguistic materials, but also on physical ones: Tudor had connected the piece with his mind and the title with a specific instrument. So when these decayed physically, the music lost its token of identity. It was as if the title *4′33″* had become illegible over the years, just like the tiny, fading letters on Instrument 0461 that had once spelled "FOG HORN."

2

Tudor then forgot to pay attention to the title, doing away with the synecdoche coordinating the primary instrument with the entire electronic complex. Instead, he switched the scale of his observation and paid attention to another synecdoche

synecdoche, so to speak. The sound system is identified by a specific instrument despite the multiplicity of others in one case, and by the multiplicity of instruments despite the specificity of each in the other.

[102] John Driscoll and Phil Edelstein, "Interview by You Nakai," November 19, 2011.

[103] Tom Darter, "John Cage," *Keyboard* 8, no. 9 (1982), 18–29, quoted in Richard Kostelanetz, ed., *Conversing with Cage* (2nd edition) (New York and London: Routledge, 2003), 218–219.

Toneburst was part of: it was a version in the never-ending series. As the series was untitled or *Untitled, Toneburst* was now renamed *Untitled 1975*. Constancy was no longer based on the instrument it included but on the series it was included in, so to revive *Toneburst* became a matter of composing another version of *Untitled*. According to Tudor's 1972 program note, what all the works in the never-ending series shared was neither equipment, performance structure, nor output form, but their network topology: configuration of materials in a feedback loop with no-input. So it could have been anything that fit the prescription.

But actually, *Untitled as a version* had another constancy that went directly against the prescribed no-input topology, a constancy of input that was nevertheless shared across its different realizations: the three *Study Tapes*. Since 1972, the identity of music had been grounded on a particular collection of recordings without the title saying so. This may sound like a contradiction: *Untitled*, as a series, identified itself with no-input feedback; as a version, it relied on a specific input source. Yet Tudor always acted as if there were no difference between the two. Even after he decided to use the three *Study Tapes* as input, he continued to describe *Untitled* as a "no-input" work. It was as if the recordings somehow completely stood in for the sound system of "Source Generation" that produced them. This puzzling equation may have been on Tudor's mind not in spite of, but because of, the nature of no-input: by generating and regenerating signals solely within the chain of instruments, the electronics perform themselves, putting out sounds that reveal their nature. If this is the case, listeners cannot help but listen to instruments *through* the sound—recorded or not.

3

However, what the three *Study Tapes* recorded was not the instrument itself. It was a specific *performance* of the instrument that took place one day in early 1972 at Tudor's home in Stony Point. And if one does not resort to generalization, the actual list of instruments influencing the sound in one way or another grows much longer than what is included in the "Source Generation" diagram: starting from Tudor himself, the tape recorder and cassette tapes he used, the room and the suitcase these were stored in, to the space they are played back in and all the equipment used along the way.[104] Cage once argued that "records […] ruin the landscape,"[105] since they appear to cancel indeterminacy by turning the very sound of music into

[104] For the listener today this would further extend to the specific machines and format used to digitize them at the Getty Research Institute or the Merce Cunningham Foundation, as well as the specific equipment provided to listen to them.

[105] Cage, *For the Birds*, 50. David Grubbs has written an intriguing treatise on the complex relationship between Cage and recordings with a very appropriate title: *Records Ruin the Landscape: John Cage, the Sixties, and Sound Recording* (Durham, NC: Duke University Press, 2014).

a constancy. But no landscape needs to be ruined since each playback is essentially a live performance. "Even if I do make a recording which is used during a live performance," Tudor explained in a radio interview on June 14, 1988, "I also do that in a live space so that it has an imprint of my hearing and my perception."[106] He had done exactly that six years earlier when he used the live performance at the Theater Bellevue in Amsterdam as a recording session for the upcoming Lovely LP. The listener to that record may perceive one distinct characteristic of the music which distinguished it from the recordings made back in 1972. It reflected what Tudor had been working on in the ten years since then: various forms of output processing to make one material appear as many. In other words, he had developed a complex form of playback.

It was actually during his conversation with Daniel Charles on October 27, 1970, later included in *For the Birds*, that Cage uttered his well-known proverb about records ruining landscapes. Taken out of context and generalized, it sounds like a criticism. But immediately before and after this comment, the composer was actually talking about a specific recording of *Cartridge Music* he had made with Tudor, in which, following the latter's suggestion, they had superimposed four different performances. "Think about it: four distinct performances," Cage reflected, "You can't do this in a concert hall. In other words, we, David Tudor and I, used the facility of recording to achieve something otherwise impossible."[107] If this praise was a contradiction from his previous complaint about recordings, then it was, the composer reasoned, "a good contradiction."[108] The proverb that followed was therefore a reactionary statement that had already been put into perspective. And the recording of his own music that Cage failed to recognize upon first listening happened to be none other than *Cartridge Music*.[109]

[106] Tudor, "Workshop, Tudor, etc., June 14, 1988, Radio 100," Box 3A, C157, David Tudor Papers, GRI.
[107] Cage, *For The Birds*, 50.
[108] Ibid.
[109] "Well, I always enjoy remembering the circumstance in Beverly Hills when I was having a drink with a friend of mine whose name I've forgotten, and she had a recording that was being played while we were talking and drinking in another room, and it struck me as being a very interesting piece. I asked her what it was, and she said, 'You can't be serious!' It was a piece of mine. Which I didn't recognize. [Did you find out what the piece was?] It was actually *Cartridge Music*. When David Tudor and I recorded it for Mainstream, Earle Brown's record company, he asked us whether we wanted to hear the final mix, and both of us said that we didn't want to hear it, and so that was probably the first time I had heard it" (Darter, "John Cage," *Keyboard* 8, no. 9 [1982], quoted in *Conversing with Cage* [2nd edition], 218–219). This recording was released as *John Cage/Christian Wolff* (Mainstream MS5015, 1963). Grubbs also describes a similar experience about this specific material: "One thing that can be said for this recording of *Cartridge Music* is that up to a point it's likely to sound different with each subsequent listen. It's not easy for a listener to find his or her bearing in this environment of scarpes, zips, rattles, and pale, unintended feedback. Maybe this appealed to Cage or Brown—that this recording, in being so difficult to memorize, so seemingly formless and difficult to really get to know, creates the illusion of being less 'fixed' than other recordings. The listener hears—which means focuses on—something different each time" (Grubbs, *Records Ruin the Landscape*, 89). On April 7, 1988, Tudor admitted having similar feelings about the *Pepsi Tapes*: "Yes. I do re-use them because they never sound the same. They never sound the same. [. . .] And I find that I'm still using that, because that's only an input. It depends on what kind of device is meeting it at the other end. It could sound completely different. So consequently, those tapes that I use, I no longer recognize them. They never sound *au naturel*. Never [*laughs*]" (Tudor, "Presenting Tudor: A Conversation with Bruce Duffie," bruceduffie.com).

This second type of indeterminacy no longer follows the general formula of "same title, different performance." But it is neither a simple reversion of that formula, which might be generalized as "same performance, different title." Rather, in the cases of *Cartridge Music* or *Untitled*, the "sameness" of an apparently singular performance is opened up to reveal a multiplicity involved therein. Tudor obviously knew the identity of his source tapes; most listeners never did. Which means that the "sameness" cannot be generalized. In other words, *the very distinction between determinacy and indeterminacy becomes indeterminate*.

Yet, this is not to set a polarity between language and instruments. For the same is true with titles and names that may appear to be determinate simply because they are fixed in language. A case in point is the word "untitled," which can either be an adjective describing the negative state of "not having a title," or a noun transforming that negativity into a positive name.[110] So *Untitled* could simply be the title of a version in a series which remains untitled. At least that was how Tudor appears to have thought when he tackled the "complex proposition" of 1994 through the indeterminacy inherent in the title he did not choose but had reclaimed. That is to say, he solved the puzzle by realizing the specific nature of the name as material to be performed—which is to say, *as an instrument*. One might recall he had earlier called the scores similarly given to him by the same *name*: "materials."

4

But one may also recall something else. The instrumental use of language relates to another nature of *Untitled* that does not have to do either with natural objects or with their names. In 1972, Tudor had conceived his new music as part of the revived *Double Music*. The two works Cage proposed to couple with Tudor's had something in common: both were texts that the composer would "vocalize" as a singer. Another case of putting language to performative use, the coordination with voice and song had influenced *Untitled* even before the title became a problem.

When Cage invited Tudor to collaborate with him in the spring of 1971, he had just finished a piece called *Sixty-two Mesostics Re Merce Cunningham*. What he had done was to take a book written by the choreographer, *Changes: Notes on Choreography*, along with 32 other books chosen by him, and use chance operations to extract syllables and words from this universe of possibilities. Then he subjected the chosen materials to an additional layer of constraint called mesostics. In

[110] For a more theoretical reflection on this matter, see No Collective and Shinichi Takashima, "Unconditional Restoration (Restored)," in No Collective, ed., *Matters of Act (A)* (New York, NY: Already Not Yet, 2017), 112–113 (online version at Already Not Yet, accessed December 15, 2019: http://alreadynotyet.org/04.html). Also informative is Daniel Heller-Roazen's tracking of the same problematic across the history of Western thought in *No One's Ways: An Essay on Infinite Naming* (Cambridge, MA: MIT Press, 2017), and Laurence R. Horn's very solid book, *A Natural History of Negation* (Stanford, CA: CSLI Publications, 2001).

this system of writing that Cage had been using for some years, the name "Merce Cunningham" was written vertically at the center, around which the extracted fragments of language were placed so that any given letter of the name did not occur between the preceding letter and itself. The results were then written down using a variety of typefaces in different sizes.

When Cage decided to use this piece for his collaboration with Tudor, *Mesostics Re Merce Cunningham* was already completed as a text but had never been performed. To determine the nature of his performance, Cage did something unprecedented, something he had always criticized of others: he asked Tudor what kind of music he was going to make. Yet another "good contradiction," perhaps. As Tudor recalled much later:

> *John Cage did not know what he should, or wanted to do. His part of the performance was called* Mesostics Re Merce Cunningham. *And* Mesostics *are actually poems. So he had to figure out how he could turn these poems into performance. He knew that the whole thing had to be somehow structured. But we worked independently of each other. Now and then he asked me a question—the most significant one was: "Will your piece be continuous?" "Oh yes," I answered: I had no idea how I could end the piece! John Cage knew from thereon that the character of his piece should somehow be contrary to that, and be held together well. He began to practice and decided—to preserve a certain form of identity throughout the poems—that they should always be enunciated in a single breath. So he practiced again. And he noticed that each burst of the poem could last no more than fifteen seconds. His breath did not last any longer. He began to sing the poems and in the end shouted them.*[111]

Thus, between Tudor and Cage, they had arranged a simple contrast of materials: continuous electronic feedback and intermittent outbursts of human voice. This performance style of *Mesostics,* composed specifically to accompany Tudor's yet untitled piece, was later generalized in the form of instruction: "each mesostic when performed should hold together: like a single cry, shout, or vocal event, not including in it longer silences than those necessary for breath."[112]

But the influence was mutual. The nature of *Untitled* as a duet with a singer indeed persisted when the version or the series was revived in the early 1980s, with Kosugi Takehisa's chant replacing Cage's. The vocal counterpart would only be abandoned after the 1994 mix-up, when *Untitled* was forced to disguise itself as *Toneburst*. No listener may have taken notice.

[111] David Tudor, "To Accept What Happens: Aufführungsgeschichte als Werkgeschichte," *Positionen* 26 (1996). Translation from the published German by You Nakai.

[112] John Cage, *Sixty-two Mesostics Re Merce Cunningham for Voice Unaccompanied using Microphone* (New York, NY: Edition Peters, 1971).

But back in 1972, the idiosyncrasy of two works performed at the same time still managed to attract attention. Toward the end of the KPFA radio interview on May 29, the peculiar setting of *Double Music* triggered the interviewer to ask whether there was any relationship between the two musics—to which Tudor answered in his usual, puzzling conciseness: “No, except that we’re both dealing with nature.”[113]

[113] KPFA Radio, “An Interview with John Cage & David Tudor.”

Chapter 8
(Likeness to) Voices

I. Likeness to Music

Pulverization of Language

1

On September 19, 1965, David Tudor and John Cage presented *Talk 1* in Ann Arbor as part of the ONCE AGAIN Festival. The performance consisted of Cage improvising a talk, first with Robert Ashley, then with Robert Rauschenberg, and also briefly with Gordon Mumma.[1] Tudor, assisted by Mumma—to whom he had just shown his bandoneon during a rehearsal break—electronically modified whatever Cage and his interlocutors were saying. The speaker's voice was picked up using "a number of throat-, lip-, and other microphones," and processed through a six-channel sound system.[2] As Cage reflected two years later, "Very little of anything that was said, due to the manipulations of the sound-system by David Tudor and Gordon Mumma, was comprehensible to the audience."[3]

Since his *Lecture on Nothing*, first delivered in 1949, Cage had been processing language in the same way as he did sound materials for composition: in the 1950s, his lectures were composed using rhythmic structures or time brackets obtained through chance operations; toward the end of the decade and into the next, they would be determined using transparency materials.[4] But in every case, the basic unit of meaning—words and sentences—was preserved throughout the various processes language was

[1] "1965 was when we got [Tudor] up to Ann Arbor again, with the bandoneon and all that stuff up on the roof, and we were doing a lot of talking of things. And I helped him set up for *Talk 1*, that I ended up being in the talking part . . ." (Mumma, "Interview by Nakai," November 4, 2016). Also see: Leta E. Miller, "ONCE and Again: The Evolution of a Legendary Festival," *Music from the ONCE Festival, 1961–1966*, New World Records 80567-2, CD, 13–14.

[2] John Cage, "Talk 1 (September 1965)," in *A Year from Monday*, 141.

[3] Ibid.

[4] An example of a text composed in this way is "Rhythm Etc.," which made use of the transparencies of *Cartridge Music*: "There are twenty ordinary non-transparent sheets having biomorphic shapes. There are several transparent plastic sheets, one having points, a second having small circles, a third having a meandering dotted line, a fourth representing the face of a chronometer. By superimposing all the transparent sheets on that ordinary one which had the same number of biomorphic shapes that Kepes had given me subjects, and by adjusting the meandering line so that it intersected at least one point within one of the shapes and made at least one entrance and exit with respect to the chronometer, I was able to make a detailed plan for writing. Points within shapes were ideas relevant to a particular subjects, points outside were irrelevant ideas. The circles were stories, likewise relevant and irrelevant. The numbers on the chronometer were interpreted, not as seconds, but as lines in stenographic notebooks. I arrived, that is, at directives like the following: from line 24 to line 47, tell a story that is relevant to proportion, discuss an idea about rhythm, follow this with an idea that has nothing to do with balance" (Cage, "Rhythm Etc.," *A Year from Monday*, 120).

Reminded by the Instruments. You Nakai, Oxford University Press (2021). © Oxford University Press.
DOI: 10.1093/oso/9780190686765.001.0001.

subjected to. Even when he began to amplify his speech in *0′00″* and *Variations III*, intelligibility remained the composer's concern. One might recall how during the broadcast of "Musik im Technischen Zeitalter" in January 1963, Cage had asked Mr. Krauss to adjust the level of amplification so that what he was saying could be heard without distortion.

As Cage's materials increasingly became pre-texts for Tudor to explore his own live-electronic music, the composer in name did more than just change the function of his job to making telephone calls and raising money: he offered himself as source material to Tudor's sound system in the role he was best at—a public lecturer. This subjection to electronic processing, however, had one significant consequence for Cage, for it destroyed the intelligibility he had long imposed on his linguistic output. Words, let alone sentences, were modulated and pulverized into sounds which made no sense. Syntax and semantics thereby lost their power of coordination. "As soon as you surpass the level of the word, everything changes," Cage reflected when he talked to Daniel Charles in 1970.[5] The interviewer had just asked him about previous texts produced by chance operations and transparencies that were included in *Silence* and *A Year from Monday*, to which Cage had replied: "my essays in the books you mention, didn't deal with the question of the impossibility or possibility of meaning. They took for granted that meaning exists."[6] No longer was that premise a given.

2

If anything, Cage appears to have welcomed this change, for he continued to play the same role in subsequent collaborations with Tudor. On November 24, 1965, two months after *Talk 1*, MCDC premiered *How to Pass, Kick, Fall, and Run*, which used Cage's text of the same title. Just as he had done in his previous lecture series *Indeterminacy*: *New Aspect of Form in Instrumental and Electronic Music* from 1959, the author appeared on stage and read various short stories and anecdotes from his life, each within the span of a minute as the dance went on.[7] Tudor accompanied him again, except this time he did

[5] Cage, *For the Birds*, 114.

[6] Ibid.

[7] When the stories that make up *Indeterminacy* was first published as part of *Silence* in 1961, Cage remembered that the first inspiration of presenting a collection of short stories as a lecture came from Tudor: "Late in September of 1958, in a hotel in Stockholm, I set about writing this lecture for delivery a week later at the Brussels Fair. I recalled a remark made years earlier by David Tudor that I should give a talk that was nothing but stories. The idea was appealing, but I had never acted on it, and I decided to do so now" (Cage, *Silence*, 260). This was certainly not the first time the pianist had adviced the composer how he should compose his lectures, which were, after all, performances. On March 26, 1952, Tudor wrote a letter to M. C. Richards in which he revealed he had just done that—convince Cage to turn his lecture at the Juilliard School of Music in New York City into a performance composed by chance operations: "Tomorrow John + I will give a scandale up [*sic*] at Juilliard—a tossed lecture with its illustrations superimposed! John was unhappy about the business of talking until Morty [Feldman] + I persuaded him that the whole thing should be a real demonstration instead of trying to make sense. So he decided to toss the whole business and now everything goes smoothly. Poor people, they think they are going to find out something. Haha, it will really be dada!" (Tudor, "Letter to M. C. Richards [March 26, 1952]," Box 26, Folder 2, Mary Caroline Richards Papers, GRI). When the "Juilliard Lecture" was finally published in *A Year from Monday* fifteen years later, Cage reflected on Tudor's specific complaint about his previous book in the introduction: "When *Silence* was published, I gave a copy to David Tudor. After looking it over, he said, 'Too bad the *Juilliard Lecture* isn't in it' " (Cage, Foreword, *A Year from Monday*, ix).

not perform in parallel with Cage as he did six years before; instead he modulated what the speaker was saying beyond comprehension. As Mumma looked back in 1975:

> *During the first year of* How to . . . *David Tudor performed with Cage, using Cage's voice as a sound source for his complicated electronic modification procedures. The result was a montage of sonic fragmentation which increased in verbal unintelligibility with each performance.*[8]

However, this turned out to be quite unpopular and thus short-lived:

> *Complaints came not only from the audience but from the dancers. Because of that mysterious "grapevine" procedure of quasi-consensus, which is a typical feature of the Cunningham Company, the electronic modification of Cage's reading was eventually abandoned.*[9]

But the abandonment was by no means final. In a letter to producer John L. Kennedy written five months after the premiere of *How to Pass, Kick, Fall, and Run*, Cage outlined an idea for a concert that he and Tudor had jointly conceived:

> *After discussing this with David Tudor, we came up with the following proposal (since the program would include talk with your host, painter William Ronald): that we involve a sound system designed by David Tudor with my voice as sound source. What I would say would sometimes be understandable, other times not—moving off into sound divorced from ordinary verbal meaning, i.e., music.*[10]

Another five months later, Cage would write to Billy Klüver on September 2 to make a similar offer for *9 Evenings*: "I can be sound source (speaking) and D.T. can arrange the rest."[11]

The odd relationship between a composer who had now turned into a sound source and a performer who arranged everything else was somewhat rectified in the aftermath of *9 Evenings* as Tudor reluctantly began to accept the title of composer. On June

[8] Gordon Mumma, "From Where the Circus Went," in James Krosty, ed., *Merce Cunningham* (New York, NY: E. P. Dutton, 1975), 67.

[9] Ibid. More recently, Mumma recalled: "I don't think it was even a year before they said, 'let's get rid of that electronic junk and let it be what it is!' " (Mumma, "Interview by Nakai," November 4, 2016).

[10] Cage, "Letter to John L. Kennedy (April 24, 1966)," in *Selected Letters*, 342. Cage continued: "We would need, say, 4 to 6 separate channels (amplifiers with loud-speakers capable of taking the power given by the amplifiers) and the assistance of an electronics technician. We would bring other equipment for modulating and transforming the voice. Visually, there would be two areas of interest: the dials and components operated by Tudor, the microphones related to my voice: throat, lip, chest, and then three table mikes we would request your providing" (ibid.). In her commentary to the letter, Laura Kuhn explained: "The referenced performance took place in the Sculpture Court of the Art Gallery of Toronto (a "Special Avant-Garde Concert") on Friday, May 13, 1966, 8:30 p.m. with Cage's *Variations VI* performed by Cage, Tudor, Cross, and Anthony Gnazzo" (ibid.).

[11] John Cage, "Letter to Billy Klüver (September 2, 1966)," Box 2, Folder 1, Experiments in Art and Technology records, GRI. Also on November 26, 1966, Tudor and Cage performed Mumma's *Horn* with the

28, 1968, three months after the premiere of Tudor's second work *Rainforest*, a review by Steve Smoliar appeared in *The Colorado Daily* describing an hour-long "lecture-demonstration" by Mumma and Cage that took place the previous week during MCDC's residency in Boulder.[12] As usual, Cage's lecture served as input source for Mumma's sound system. But this time, Smoliar revealed, the performance was not a realization of Cage's piece—and neither was it Mumma's.

The existence of so-called *Rainforest II*, which Tudor numbered only in retrospect as a version that used a single human voice as input,[13] has been discussed by Matt Rogalsky, who traced the entire performance history of *Rainforest* and lamented: "very little can be learned about the specifics of *Rainforest 2*. […] Much detail seems destined to remain in the realm of speculation."[14] But Smoliar's review informed its readers that the piece he saw in Boulder was a version of *Rainforest* performed in Tudor's absence:

> *It's true that Cage's "lecture" was often incomprehensible. But a notice had been written on a blackboard at the front of the stage which made it quite clear that Cage was not supposed to be a lecturer. He would simply act as the fundamental source of sound for "Rainforest," a composition of David Tudor as realized by Gordon Mumma.* […] *Cage was sometimes cut off completely, and all that could be heard was a single impulse and several levels of feedback.* […] *Occasionally through this maze of sound, one might catch a phrase of Cage's—sometimes witty, sometimes serious, sometimes both. But always Cage read on laconically. After all, it was not what one understood that mattered, it was what one heard.*[15]

3

Not what one understood, but what one heard—as he formulated in his 1966 letter to Kennedy, Cage understood the pulverization of language as a transformation of speech into music.[16] That is to say, language, when processed to a certain degree, takes

composer at the Saville Theatre in London, where they "supplied the voice parts to my performance of the horn and cybersonics" (Mumma, "Two Cybersonic Works: Horn and Hornpipe," in *Cybersonic Arts*, 55).

[12] Steve Smoliar, "Music Communicati ons," *The Colorado Daily*, June 28, 1968, p. 6 (Box 64, Folder 4, David Tudor Papers, GRI).

[13] As Rogalsky has observed, the numbering of the different versions of *Rainforest* came up only as an afterthought. Tudor drafted a list of different performance possibilities in March 1968, which included a version using "One (speaking) voice only as input" (David Tudor, "*Rainforest* description with additional options [M arch 1968]," Box 3, Folder 27, David Tudor Papers, GRI). But the actual number of versions remained inconsistent until 1981 when the LP recording of *Rainforest IV* was released, and the earlier versions became numbered accordingly. For more details, see Rogalsky, "Idea and Community," 22.

[14] Ibid., 142–143.

[15] Smoliar, "Music Communications."

[16] Mladen Dolar offers a synopsis of the long history of this polarity between speech and music as well as the tethering of the voice to the text in the second chapter of *Voice and Nothing More* (Cambridge, MA: MIT

on the appearance of music. This thought seems to have led the composer to reconsider his approach to language in general, regardless of whether electronics were involved or not.[17]

In his 1970 conversation with Charles, just before he reflected on the meaning-biased texts in his previous books, Cage had described how his most recent work called *Thoreau Mix* was composed: he extracted all the remarks about music, silence, and sounds made by Henry David Thoreau in his journal, and subjected the letters, syllables, words, phrases, and sentences to chance operations.[18] According to another description from 1972, the resulting mix, which was written down using typefaces of various styles and sizes, "departs from conventional syntax"[19]—just as his lectures that were modified by electronics. Cage thus appears to have transformed the physical operations of Tudor's sound systems applied to his own speech into chance operations applied to another writer's text. The result similarly pulverized language but did so without the aid of electronics—unplugged, so to speak.

In his 1970 entry to *Diary: How to Improve the World (You Will Only Make Matters Worse)*, Cage described this method in the way of a formula: "To raise language's temperature we not only remove syntax: we give each letter undivided attention, setting it in unique face and size; to *read* becomes the verb to *sing*."[20] True to these words, Cage soon began to vocalize the text he had composed:

> *One day, I gave* Thoreau Mix *in the form of a lecture. It lasted forty minutes. Well, the result has no meaning, or only a very little. But while I was practicing for that lecture, I discovered that I could improvise* [. . .] *I used all the resources of my voice and all the*

Press, 2006). For a very different approach to the same polarity, see Mark Changizi, *Harnessed: How Language and Music Mimicked Nature and Transformed Ape to Man* (Dallas, TX: Benbella Books, 2011).

[17] Gelsey Bell has carefully examined Cage's exploration of the voice in her PhD dissertation. Following Cage's own explanation, she interprets the transition from earlier use of voice as speech to convey meaning in lectures and writings to the later focus on voice as music via the pulverization language as an attempt to emancipate language and/or voice—although it is never clear which—from their tethering to meaning and communication. According to Bell, Cage tried to do to them what he had done to sounds: to let them be themselves. She lists "three factors that are essential to Cage's inclusion of vocalization in 'sounds as themselves'": (a) electronic technology, (b) the encompassing of music into theater, and (c) the preference of process over product (Gelsey Bell, "Voice-Acts: Relationality and Performance in the Vocal Activities of the American Experimental Tradition," PhD dissertation, New York University, 2014, 39–40). Out of these three, however, the latter two are conceptual shifts, and although they may encourage the non-semantic exploration of the voice, do not provide any actual means for doing so, which is given only by the first factor. In addition to these three *positive* factors, there were at least three *negative* factors which biased Cage to turn more specifically to the voice, two of which Bell mentions later: (a) Tudor's focus on electronics (which led Cage to perform his music on his own), and (b) his own arthritis (which led him to perform something other than the piano) (ibid., 48). The third and the most decisive factor is (c) the duality of composition between Cage's indeterminate composition and Tudor's sound system which led Cage to offer himself as a component to the latter even before he began singing on his own. In other words, becoming input material to Tudor's sound system allowed Cage to participate in his own work that was not his anymore, as well as to develop a new approach to language and voice that he could later reclaim as his own.

[18] Cage, *For the Birds*, 113.

[19] Cage, "Foreword," in *M: Writings '67–'72* (Middletown, CT: Wesleyan University, 1972), ix.

[20] Cage, "Diary: How to Improve the World (You Will Only Make Matters Worse) Continued 1970–71," in *M: Writings '67–'72*, 107.

> *elements of language without falling back upon known words or a syntax. I found this experience thrilling.*[21]

Cage thus became a singer.[22] Mumma recalled some thirty years later that the composer was already doing "some 'singing' and 'chanting,'" during MCDC's *Events* in 1970.[23] On March 18, 1971, Jonas Mekas, who had just seen a performance of *Thoreau Mix*, now retitled *Mureau*, wrote in his Village Voice review: "John Cage singing. Yoko Ono, Dylan, and John Cage are my favorite singers now."[24] A year later, the same song would be chosen as the preexisting work to be coupled with Tudor's *Rainforest*—for which Cage had served as sound source four years earlier.

Solo(s) for Voice(s) No. 2

1

But Cage was not the only one singing, and certainly not the first to do so. On August 21, 1963, eight months after their simultaneous performance of *Fontana Mix, Variations II,* and *Variations III* on "Musik im Technischen Zeitalter," Tudor and Cage presented a similar program at Judson Church in New York City as part of the "Six Concerts of the Avant Garde" organized by Charlotte Moorman. *Variations III*, receiving its New York premiere, was performed by its composer. Tudor did not perform *Fontana Mix* this time but used the materials for *Variations II* to play two instruments. And it was not between two amplified pianos that he went back and forth; it was between one amplified piano and his own vocal sounds. "David Tudor [. . .] provided a background of tooth-clicking and groaning through a microphone strapped to his face," Gloria Steinem depicted this little-known side of Tudor's performance in a review that appeared the following January, before describing a more familiar scene: "He actually did spend a lot of time in, if not at, the piano: rather than approach the keyboard, he devoted himself to scraping wires and microphones up and down its strings."[25] Her recollection was illustrated by an accompanying picture taken by a fashion photographer, showing how Tudor would have looked that day: with a *T-45 Lip Microphone*

[21] Cage, *For the Birds*, 113–114.

[22] Bell compared the two realizations of *Mureau* in 1970 and 1972 to analyze Cage's move from speech to song: "In the earlier recording, Cage speaks the text as a storyteller, with the same movements of inflection and emphasis that color *Indeterminacy* or other pieces of writing in which syntax is well intact. Though he claims the text consists of mostly nonsense (certain phrases like the early 'We hear. Does it not rather hear us?' certainly stick out), his reading style searches for meaning, creates meaning, performs meaning. By the 1972 performance, we hear how his vocalizations have begun to embrace nonsense on a fully embodied level with wide fluctuations of pitch, dynamics, and how he has chosen to pronounce the language. There is no denying, by this point, that he is singing" (Bell, "Voice-Acts," 53).

[23] Mumma, "Email to Matt Rogalsky (April 17, 2001)," quoted in Rogalsky, "Idea and Community," 145.

[24] Jonas Mekas, "Movie Journal," *The Village Voice* (March 18, 1971), 67.

[25] Gloria Steinem, "Review," *Show: The Magazine of the Arts* 4, no. 1 (January 1964), 59 (Box 63, Folder 7, David Tudor Papers, GRI).

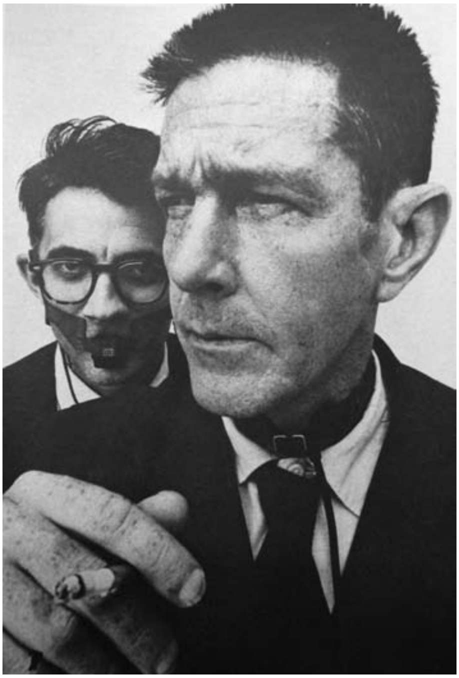


Figure 8.1 Tudor (left) and Cage sporting *Lip* and *Throat Microphones* | 1963
Photo: Hiro (Yasuhiro Wakabayashi) | *Show: The Magazine of the Arts* |

attached to his mouth, standing behind Cage, who sports a *T-30 Throat Microphone*, both US military surplus (Figure 8.1).

2

It is not clear when Tudor first began amplifying and modulating his voice. What is clear is that well before he became a singer, Cage had already transformed speech into music as a composer by giving undivided attention to each letter. In other words, pulverization of language was first conceived for another performer to vocalize. He did this in a piece called *Solo for Voice No. 2*, another set of transparency material created alongside *Cartridge Music* in the summer of 1960—the music that Lowell Cross was seen performing seven years later at Isaacs Gallery in Toronto simultaneously with Tudor's amplified bass drum version of *Fontana Mix*. And if Cage's later confession that all his works since 1952 were composed with *David Tudor* in mind is to be believed, the performer he had in mind in 1960 could very well have been his pianist, who at the time was doing many things other than playing the piano. In any case, as if to complement the use of his sound systems to modulate Cage's voice, Tudor went on to use this material by Cage to modulate his own voice throughout the 1960s.

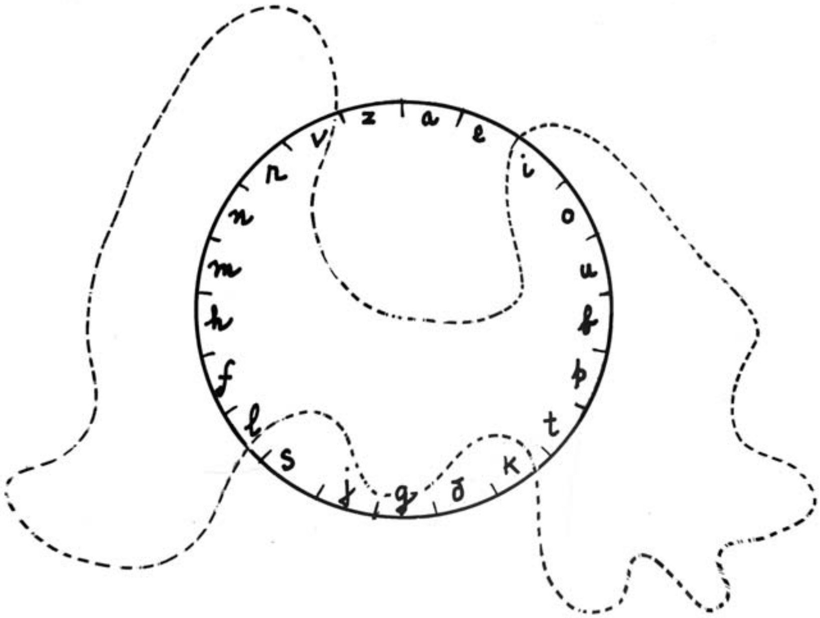


Figure 8.2 John Cage | *Solo for Voice No. 2*, possible superimposition of transparency materials | 1960

The material of *Solo for Voice No. 2* consists of six sheets—five transparent and one non-transparent—that are superimposed to determine the parameters of pitch, amplitude, and proportion of silence to sound. Most notably, a sheet with a circle formed by letters of the alphabet is superimposed onto another sheet with a broken line to determine two letters for a "vocalise" (Figure 8.2).

However, Cage's instruction also described a second method for reading the same material. The letter circle again specifies two letters for a vocalise, but now an additional sheet with a rectangle bisected unevenly by a single horizontal line is used to generate two series of readings for *two* types of instruments:

> Points, lines and curves within the larger part of the rectangle are musical relative to those within the smaller part which are speech, shouts, noises (produced by any means), etc. Points are short sounds; lines are sounds of varying length, curves are slides.[26]

[26] Cage, *Solo for Voice No. 2*, Peters Edition EP 6751.

Through the strange concept of "musical relative," an unspecified instrument is introduced whose sounds are related to, but not the same as, vocal sounds ("speech, shouts")—surprising for a work that appeared to clearly specify its instrumentation in the title. The solo voice now has a counterpart which bears family resemblances.

Cage does not say what this "musical relative" might be, but his categories—short sounds, sounds of varying length, slides—lend themselves well to sounds electronically modified. Indeed, they are marked by the same logical scales of difference Tudor would use to read Cage's parameters in *Variations II* within a year or so: non-movement, movement, movement of movement—the difference between whether or not there is a difference. Given furthermore the fact that the material was composed alongside *Cartridge Music*, it appears that the second method of reading *Solo for Voice No. 2* was very likely aimed at creating an electronic version of the piece using Tudor's sound system. On July 27, 1960, Cage wrote to Tudor, who had been in Europe since the end of May, reporting the completion of two new materials he had named *Solo for Voice No. 2* and *Cartridge Music,* and commenting on the possibility of coupling them in performance: "It can make the situation of congestion of soloists with the cartridges."[27]

3

The two materials were immediately sent across the Atlantic to Tudor, who was staying in Venice. Following its American premiere on August 12 by Marguerite Willauer at the Tanglewood Berkshire Festival, *Solo for Voice No. 2* was performed simultaneously with *Cartridge Music* at Mary Bauermeister's Atelier in Cologne on October 6. It appears that Cage himself took on the role of the solo vocalist on this occasion, while all the other participants—Tudor, Cornelius Cardew, Hans G. Helms, Mauricio Kagel, Nam June Paik, Benjamin Patterson, Kurt Schwertsik, and Christian Wolff—realized *Cartridge Music*. The singer's voice may or may not have been amplified.[28]

In contrast to *Cartridge Music,* which went on to be performed numerous times by Tudor and Cage, *Solo for Voice No. 2* dropped out of their repertoire right after its European premiere.[29] However, on January 21, 1966, perhaps inspired by his increasing use of Cage's voice as sound source, Tudor revived this material from five years before and performed an "electronic version" with soprano Carol Plantamura at SUNY Buffalo, where he was in residency at the time. Fifty two years later, on February 3, 2018,

[27] Cage, "Letter to Tudor (July 27, 1960), Box 52, Folder 3, David Tudor Papers, GRI.

[28] According to David W. Bernstein, "Dunn's C. F. Peters catalogue lists Cage as the performer for *Solo for Voice 2*, the others as participants in *Cartridge Music*. Wolff recalls that the performers all made their own parts and that there was lively discussion of how this should be done. He remembers that the performance was a bit informal and realized at the last minute, but also successful. Wolff does not remember the equipment used at the Bauermeister performance, and wonders how many amplifiers were available, given that Bauermeister's studio was small and not very well equipped" (David W. Bernstein, "John Cage's *Cartridge Music* (1960): 'A Galaxy Reconfigured,' " *Contemporary Music Review* 33, no. 5–6 (2014), 558).

[29] Three years later, on February 28, 1964, Alvin Lucier made a realization of the piece with the Brandeis University Chamber Chorus during the ONCE Festival in Ann Arbor. Neither Tudor nor Cage appears to have been in attendance.

Plantamura remembered rehearsing with Tudor at his dining room table in Buffalo's Victor Hugo Hotel: "David altered my voice, so if I needed to stop for a bathroom break during our rehearsals it was rather difficult, which brought me to laughter which also sounded wacky. So David stressed I should put laughter in the performance."[30] This version of *Solo for Voice No. 2* using Tudor's sound system to fabricate the "musical relatives" of vocal sounds was performed at least eight times over the next three years.[31]

4

In 1967, Tudor and Mumma made a recording of *Solo for Voice No. 2*—now renamed in plural as *Solo(s) for Voices No. 2*—using the voices of the Brandeis University Chamber Chorus conducted by Alvin Lucier as source material. The track was included in the compilation LP *Extended Voices* produced by David Behrman.[32] On March 5, 2016, Mumma tried to recall this realization from half a century before: "For that we used—e.g. Subverted—the possibilities of both Moog and Buchla synthesizers—then being in their relatively early development."[33] Six months later, he added a corrective: "more subvert the Moog things, not the Buchla things."[34] To the question of how they had access to Moog instruments, he reminisced: "Well, we may have borrowed something. I don't remember what it was. Moog also had some modules that we would change back and forth. I think I traded some of them with my own. You know, simple stuff. There was nothing complex. These were sort of sound effects things that we used for *Solos for Voice*."[35]

The thirteen-minute recording is indeed composed of voices amplified, clipped, and modulated in various ways. However, aside from recognizing the variety of sources (speech, shouts, noises) and the results of their modulation (short sounds, sounds of varying length, slides) the family resemblance between the voice and electronic processing suggested in Cage's score is difficult to detect—for one odd reason.

On April 22, 2017, Lucier recalled that after Tudor and Mumma finished recording the track by modulating pre-recorded voices in the studio, the master tape was sent to CBS records in New York City, at which point Cage came in. Upon listening to

[30] Carol Plantamura, "Email interview by You Nakai," February 3, 2018.

[31] The performances were as follows: 1966: February 26, with Alvin Lucier; March 2, with Cage; May 6, with Oliveros, Tudor, Lucier; 1967: February 6, UC Davis: Tudor, Billie Alexander, Larry Austin; March 30: *Solo for Voice 2 with Fontana Mix (Piano and electronic circuits)* (Billie Alexander, Larry Austin, David Tudor); April 1: *Fontana Mix with (16) Solos for Voice 2* (Tudor, Ichiyanagi, Brandeis University Chamber Chorus conducted by Lucier); April 15: Isaacs Gallery: John Cage: *Solo for Voice 2 with Fontana Mix (realisation for piano and electronic circuits)*; 1968: January 8: Cage, *Solo(s) for Voice 2*: Vocal: Charles Boone, Bartlett, Ron Williams, etc./Electronics: Maraldo, Tudor, Anthony Gnazzo.

[32] Various, *Extended Voices*, Music of Our Time series, Odyssey 32 16 0156, 1967. The title was taken from Ichiyanagi's piece of the same name which was also included in the LP. The other works were: Pauline Oliveros, *Sound Patterns*; Alvin Lucier, *North American Time Capsule 1967*; Robert Ashley, *She Was a Visitor*; Morton Feldman, *Chorus and Instruments (II) Chimes*, and *Christian Wolff in Cambridge*.

[33] Mumma, "Email interview by You Nakai," March 5, 2016.

[34] Mumma, "Interview by Nakai," November 11, 2016.

[35] Ibid.

the recording, the composer of the piece expressed his puzzlement—"How odd!"[36] He then proceeded to remix the tape to fit his liking: "Cage actually edited a lot of it, he thought it was too thick. He'd say, take this and this out."[37] In this way, the final sound was processed through one authoritative listener who sacrificed the nature of (his own) written material in favor of how the sound *appeared* to him. As if they had exchanged roles, Cage did to Tudor what Tudor had been doing to Cage all along: to use the material composed by the other to generate new appearances.

Which is to say that as far as performance was concerned, appearance mattered in spite of the nature of the material. Even when he focused on revealing the nature of electronic components in *Untitled*, Tudor's efforts consisted in trying to compose an appearance of that nature using sources which had actually been recorded in advance. For the discovery of natural objects, however, it was better not to speak much about his role in generating appearances, and to act as if everything depended on the instruments who would speak by themselves. But in the case of vocal music the situation was very different. For one thing, the source was a person who could speak already, and quite eloquently so, in the case of John Cage. Thus, the focus in the realization of material was turned inside-out: not to reveal the natural voice hidden behind appearances, but to transform the given voice to proliferate appearances—to stage a polyphony in disguise. Perhaps Tudor was reminded of this nature specific to vocal music when he became engaged in creating multiple appearances from a single no-input source circa 1975.

II. Likeness to Speech

Speech Synthesizer

1

On January 17, 1977, ten years after the recording of *Solo(s) for Voices No. 2*, Tudor bought a Speech Synthesis kit. Dubbed "an experiment in electronic speech production," this product had been assembled by Bell Labs for their High School Science program in 1963.[38] The accompanying booklet introduced the students to the basics

[36] Alvin Lucier, "Interview by You Nakai," Middletown, CT, April 22, 2017. "They were in the studio just sort of mixing. They had the recorded stuff. As I remember, it was all recorded stuff and they mixed it together" (ibid.)

[37] Ibid.

[38] Cecil Coker, Peter Devos, Elliot Pinsor, "Speech Synthesis, An Experiment in Electronic Speech Production, Bell Systems Science Experiment #3" (Murray Hill, NJ: Bell Systems, 1963). This source was discovered by Michael Johnsen, who also noticed that the 1972 *Untitled* notebook already contained the title of this kit: "Speech Synthesis: An Experiment in Electronic Speech Production, Cecil Coker, Peter Devos, Elliot Pinsor, BTL, Bell Systems Science Experiment #3 (Prepared for educational use) '63" (Tudor, "*Untitled* Notebook," Box 4, Folder 21, David Tudor Papers, GRI).

of linguistic organization, the physics of sound, the mechanism of human speech production, and so on, before describing the construction of an electronic vowel synthesizer which simulated the appearance of human speech using non-human materials.

The focus was clearly on the mechanism of how the human body generated speech: the air flow from the lungs (the energy source) is first gated by the vocal cords, which open and close the glottis to convert the wind into an audible buzz; this buzz is then articulated by the physical configuration of the vocal tract (tongue, lips, palate, etc.) to form different speech sounds that are output from the mouth. The vocal tract, which is essentially an air-filled tube, acts as a resonator with a different set of resonant frequencies according to the shape it takes, emphasizing the harmonics of the incoming buzz at irregularly spaced peaks known as "formants."

Given this information, the authors told their teenage readers, it was possible to create an electronic "analog" of the same mechanism using two types of instruments: (a) a generator with a broad and variable spectrum, and (b) a resonator with multiple frequency response. The kit synthesizer they designed materialized the former as a multi-vibrator and the latter as a series of three simple inductance-capacitance resonators feeding into each other.[39] The resulting instrument would produce ten different vowel-like sounds with up to three formants—a cheap imitation, so to speak, of the human male voice.[40]

2

The three Bell Labs coauthors, which included Cecil Coker who would participate in *9 Evenings*, were grounding their approach on a long tradition of experimental research on human speech that had been conducted at their workplace. As the research facility of the world's largest telephone company, Bell Labs had always been interested in finding ways to efficiently transmit the human voice from one location to another across distance. This interest had pushed the development of amplifiers leading to the invention of the transistor in 1947. But there was another chain of research that was conducted in parallel.

In 1928, Homer Dudley, also working for Bell Labs, invented the *Vocoder* (a name coined by squashing the middle part of VOice enCODER), which analyzed human speech using a multi-band filter to separate the voice into multiple frequency bands and an envelope follower to track the signal level in each band. The obtained

[39] Coker, Devos, Pinsor, "Speech Synthesis," 80–81.

[40] The organ is the quintessential synthesizer, which simulates the voices of other instruments as evidenced in the names of the astounding variety of stops that have been developed over history to imitate the character of different instruments (many of them compiled at Edward L. Stauff, *Encyclopedia of Organ Stops*, organstops.org, accessed December 15, 2019: http://www.organstops.org/FullIndex.html). One of the oldest stops dating back to the 1500s is the "vox humana," a reed stop that imitates the characters of the human voice using a metal reed whose vibration frequency approximates the formants to filter the air as it is sent to the pipe. "Its name, however, establishes a tonal goal which has caused countless critics to write it off as unsuccessful or even laughable. While organ builders have tried for half a millenium to imitate the human voice, the most successful attempts only manage to approximate the sound of a male chorus singing in the distance" (http://www.organstops.org/v/VoxHumana.html).

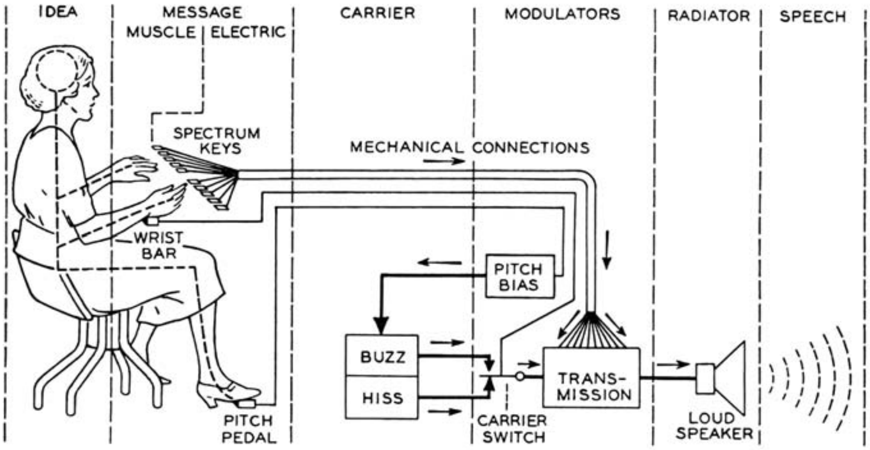


Figure 8.3 Homer Dudley | Diagram of the *Voder* | 1940
The Bell System Technical Journal, Vol XIX, October 1940 | Reused with permission of Nokia Corporation and AT&T Archives

information could then be easily sent across the telephone line and used to control a series of voltage-controlled band-pass filters on the receiving end, which processed a buzz source (for tone) and a hiss source (for noise) to synthesize a likeness to the original speech. In 1937, Dudley developed the receiver-decoder end of this system into a separate instrument he called the *Voder*, which allowed a human operator, rather than signals sent from afar, to synthesize speech by controlling ten band-pass filters with a pressure-sensitive keyboard, the pitch control of the buzz source with a foot pedal, and the switching between the two sources with a wrist bar (Figures 8.3 and 8.4).

The resemblance with the *Speech Synthesizer* designed some quarter century later in the same laboratory is obvious. The kit for high school students was a simplified version of the *Voder*, made more compact through the technological advances that had occurred in the intervening years.

3

Tudor proceeded to build the *Speech Synthesizer*. Among his papers are page after page of notes in his hand copying the schematics, listing the components and their connections, and even drawing the actual layout of components (Figure 8.5).[41]

As usual, he followed the given material thoroughly, even incorporating the suggestions in the appendix of the booklet to modify the instrument by adding a pitch control knob and a multi-position switch to select between the formants. But there

[41] Tudor, "Notes for Speech Synthesis kit," Box 46, Folder 3, David Tudor Papers, GRI.

Figure 8.4 Homer Dudley | The *Voder* Keyboard | Undated
Photographer Unknown | Reused with permission of Nokia Corporation and AT&T Archives

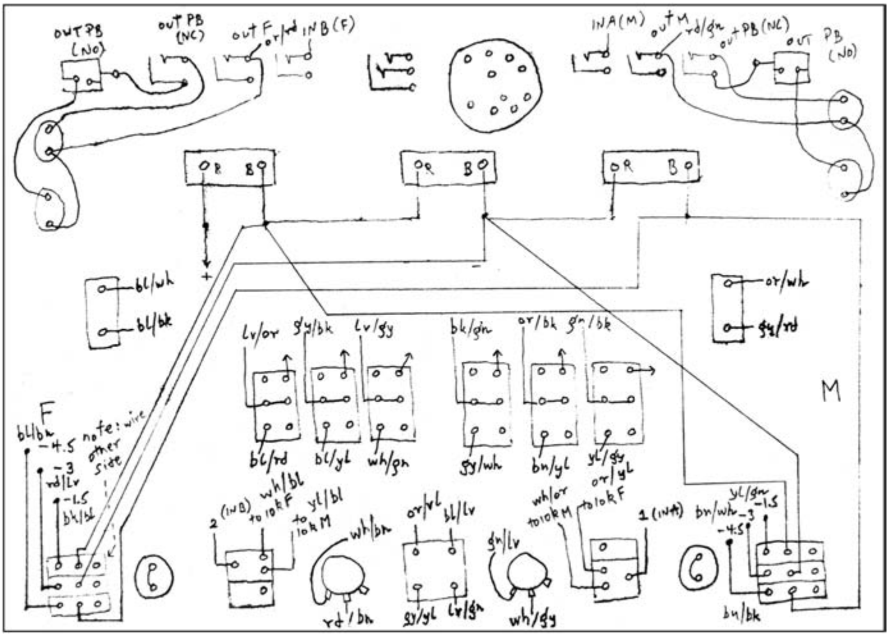


Figure 8.5 Tudor | *Speech Synthesizer* (Instrument 0041), layout diagram | 1977
DTP, Box 46, Folder 3 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

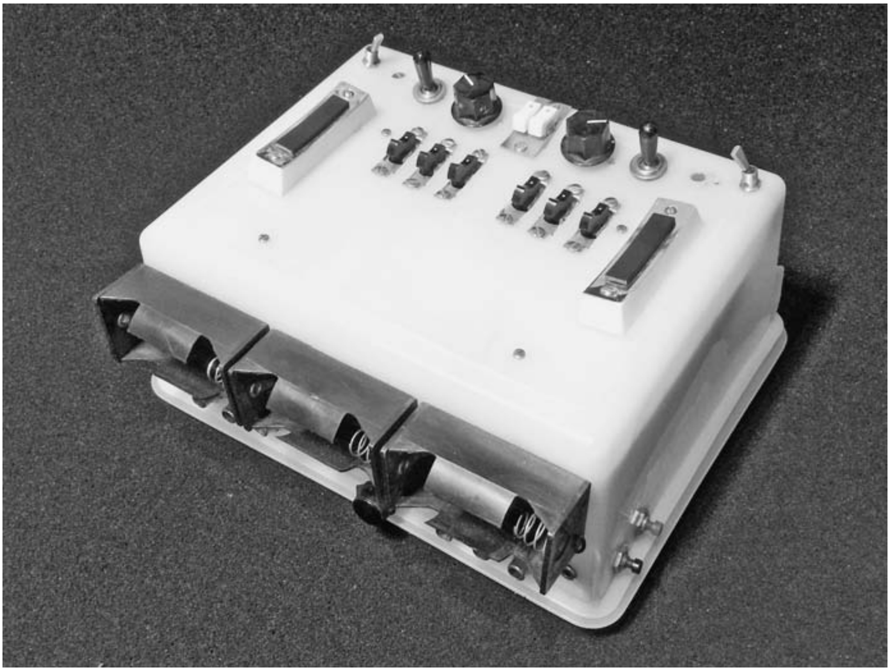


Figure 8.6 Tudor | *Speech Synthesizer*
DTC, Instrument 0041 | World Instrument Collection, Wesleyan University

was one significant departure from the source this time: he added a second circuit to produce a female-like voice, calculating the appropriate capacitance values from the table of average formant frequencies for ten vowels shown in the booklet. The addition of this female voice appears to have been an afterthought: a receipt reveals the purchase of a second Speech Synthesis kit on November 28, 1977, almost eleven months after he bought the first one.

The corresponding instrument has been identified as Instrument 0041 in the Wesleyan collection (Figure 8.6). Encased in a white Tupperware container, it assigns the male and female circuits on each side of its symmetrical and idiosyncratic interface: the four switches on both sides fit neatly to each finger as if to simulate a keyboard instrument—or perhaps more accurately, to simulate the *Voder*, which had itself simulated a keyboard instrument.

The components are all there. However, not all are connected (Figure 8.7). For some reason, after writing pages of notes, designing the box carefully, and soldering most of the components, Tudor abandoned its construction right before adding the finishing touch.[42]

[42] In a speech given at the David Tudor Memorial Service on September 17, 1996, Wolff remembered a similar case: "He spent a year working on Jean Barraque's piano sonata, then decided its music didn't work and cancelled the performance" (Wolff, ". . . how he made all the difference," in *Cues*, 378).

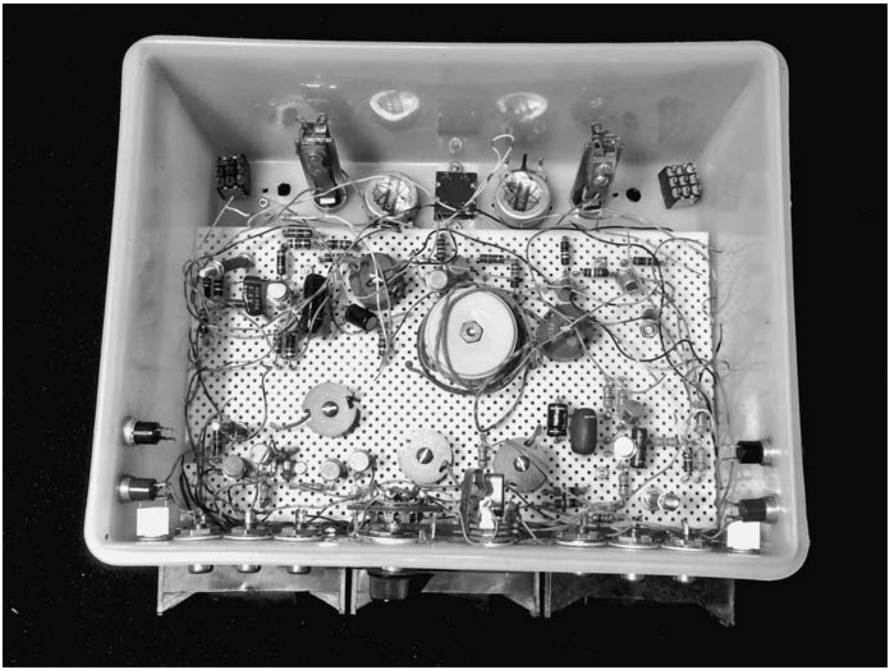


Figure 8.7 Tudor | *Speech Synthesizer* (interior)
DTC, Instrument 0041 | World Instrument Collection, Wesleyan University

4

As an introductory material for high school students, the *Speech Synthesizer* further simplified the simplification that the *Voder* had already realized. Instead of making an exact duplicate of the speech production mechanism, the three coauthors opted for what they called a "terminal analog"—something that only simulates the end results, achieving a similar effect with different means.[43] What mattered therefore was the *appearance* of output: "one that produces sounds with spectral shapes *like* those of spoken vowels, but does not produce them the same way the vocal tract does."[44] Be that as it may, the kit instrument still simulated the mechanism of the human speech production with a multi-vibrator and three resonators—so the analogy was not in appearance only. But whatever the reasons may have been for Tudor's sudden abandonment of this synthesizer, his subsequent exploration of the voice would considerably attenuate a particular focus that had long been central to his music: the physical

[43] One may recall the chain of simulation that extended from pipe organs to *PAiA Synthesipin* and *Phaser/Flanger* by way of rotary speakers, observed in Chapter 7.
[44] Coker, Devos, Pinsor, "Speech Synthesis," 82.

nature of instruments. After all, the benchmark of success in synthesizing speech at Bell Labs was not whether the mechanics of how humans speak were copied accurately, but whether what was spoken could be understood as such. As Max Matthews, who joined the same laboratory in 1954, remembered, the criteria always rested on the listener's end:

> *So people—not I, actually—would work for two or three years on a speech compressor, encoder, and then they would try it out and you couldn't understand it. So they would tear it up and start over again.*[45]

Forest Speech

1

On March 20, 1977, two months after the purchase of the first Speech Synthesis kit, Tudor gave the first documented performance of a work titled *Forest Speech*. It was the last day in a series of shows organized by MCDC at Barnard College in New York City. For a week, the company had been presenting *Events,* a spontaneous form of performance using fragments of choreography gathered from different works which Merce Cunningham had started doing more than ten years before.[46] Each *Event* was numbered, and by the spring of 1977 the count had reached almost 200. On these occasions, the musicians were generally free to play whatever they wanted. As a result, they became a testing ground for new ideas. Mumma, who appeared in many of them with Tudor, stressed their significance for his friend's music: "For Tudor, those *Events* were his laboratory workshop."[47] During the Barnard College residency, the company invited a different musician or composer every day. *Event 191* was assigned to Tudor and Martin Kalve, a member of CIE who also performed with MCDC at the time.

The new music, which Tudor described to John David Fullemann in September 1984 as "a variation of *Rainforest*,"[48] used four instrumental loudspeakers as resonators—analogs of the vocal tract—to create an appearance of speech. As for the

[45] Geeta Dayal, "Porträt / Max Matthews: An extensive interview with the late pioneer of computer music, covering Bell Labs, John Cage, Stockhausen and HAL's voice," *Frieze*, accessed December 15, 2019. https://frieze.com/article/max-mathews-1926%E2%80%932011?language=de A PDF version can be obtained at: https://ccrma.stanford.edu/~aj/archives/docs/all/8

[46] The first *Event* took place on June 24, 1964, at Museum des 20.Jahrhunderts, in Vienna, Austria, with a simultaneous performance of *Atlas Eclipticalis*.

[47] Mumma, "Interview by Nakai," November 11, 2011. A longer quote is as follows: "This is very important: the Cunningham Dance Company had these *Events*, in which the musicians worked collaboratively, and involving things that you could lay out as improvisation, although they were structured. And I went along with a lot of them. I have some of the earliest recordings. For Tudor, those *Events* were his laboratory workshops. And we tended to work independently of each other in those *Event* performances. Not always; sometimes it was planned, and we always structured it. Sometimes there would be interactions, sometimes we were separate" (ibid.).

[48] Tudor, "Interview by Fullemann," davidtudor.org

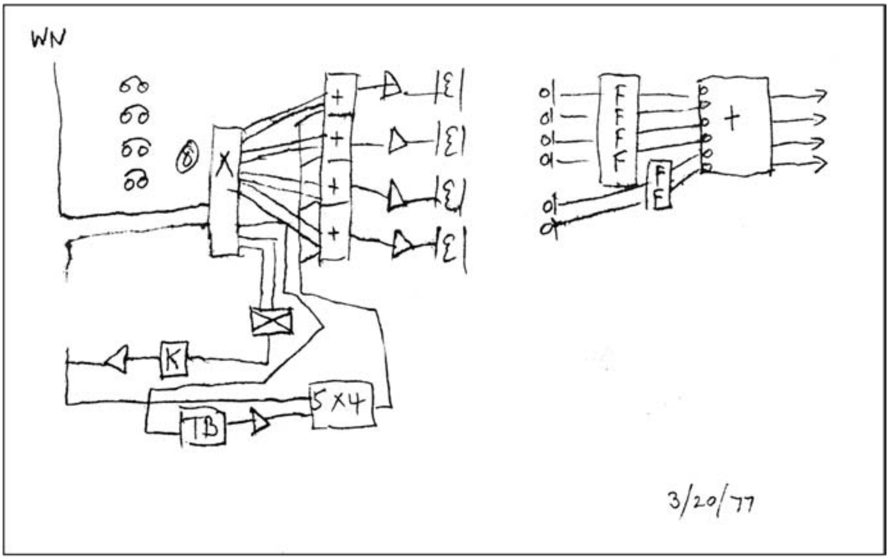


Figure 8.8 Tudor | *Forest Speech*, diagram | Barnard College Event | March 20, 1977
DTP, Box 3, Folder 15 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

vocal cord, a diagram dated "March 20, 1977"[49] reveals that on that day at Barnard, Tudor composed two parallel processing channels: one used the *Toneburst Generator* ("TB") and the other a certain modulator coupled with the *Photocell Key* ("K") to gate the source materials before they were sent to the instrumental loudspeakers of *Rainforest* (Figure 8.8).[50] From the way the two channels were squeezed in between a *Matrix Switcher* and the *Quad Multi-Input Mixer*, it might be more accurate to say he "inserted" the two vocal cord channels into the otherwise standard *Rainforest* configuration.[51]

As Rogalsky observed,[52] gating was what Tudor emphasized in his recollection of *Forest Speech* when he spoke to Fullemann seven years later:

> my piece calls for those photocell switches . . . it calls for a momentary increase or decrease of gain. But however . . . the gain factor isn't as important as the gating factor, so any switch, any electronic gate will be acceptable. It's simply to make a perceptible difference above a certain level, or for that matter below it.[53]

49 Tudor, "Diagram of *Forest Speech* (March 20, 1977)," Box 3, Folder 15, David Tudor Papers, GRI. Rogalsky also examines this diagram in "Idea and Community," 355.

50 Rogalsky stressed the role of the *Photocell Key* in particular: "The most important device in Tudor's *Forest Speech* setup seems to have been a "photocell key" obtained in 1968 from Hugh Le Caine at Canada's National Research Council laboratories, where engineer René Farley had developed them for use in experimental instruments" ("Idea and Community," 355).

51 Tudor also split the channel after the *Photocell Key* in two ways, feeding one of them back to the *Matrix Switcher*, although this option was erased.

52 Rogalsky, "Idea and Community," 355.

53 Tudor, "Interview by Fullemann."

For the input—the analogs of the hiss and buzz coming from the lungs—four stereo tape sources along with white noise ("WN") are indicated. The content of the tapes is not specified. All in all, Tudor appears to have composed, yet again, a giant analog of the *Speech Synthesizer*—itself a terminal analog of the human speech mechanism—which he had probably begun composing in the preceding months. A simulation three times removed, if one also counted the *Voder*.

2

On September 23, 1978, a year after the Barnard Event, *Forest Speech* was expanded into a group version for the CIE performance at The Kitchen in New York City. For this occasion, Tudor wrote a description of the work which revealed how the status of the voice had changed in the ten years since *Solo(s) for Voices No. 2*. Instead of modulating it, Tudor now aimed to synthesize it:[54]

> Synthetic voicings & plosive bursts. Formant resonances, produced with the natural comb-filtering action of "Rainforest" instruments, are used to create vocal illusions. The originating sound materials can be various, & processed with vocoder-like circuit networks.[55]

The processor of materials was specified as "vocoder-*like* circuit networks"—again, an analog of an electronic analog of the human speech production mechanism. Indeed, during the eighteen months between the two *Forest Speech* performances, Tudor had purchased the *Electro-Harmonix Talking Pedal*, a wah-wah pedal dubbed as a speech synthesizer, which used two band-pass filters to simulate vocal formants whose peak frequency swept up and down in coordination with the physical movement of the pedal and gave a male vocal quality to the sound—"reminiscent of Yoda speaking Cantonese," according to one later review.[56] The date on the receipt from Sam Ash in New York is December 16, 1977, suggesting this instrument may have been intended as a replacement for the unfinished Bell Labs *Speech Synthesizer* whose second kit

[54] This is analogous to the status of white noise during the Möbius-strip-like progression of *Bandoneon!* where it flipped from being a source to be modified to something to be (re)generated (i.e., synthesized) via the entire process of modification. The development of *Bandoneon!* is detailed in Chapter 4.

[55] David Tudor, "Description of *Forest Speech*," Box 3, Folder 9, David Tudor Papers, GRI. An application sent to the Rockefeller Fund for Music in January 1981, asking for support in releasing the recording of *Forest Speech,* described the work with a similar wording: "which synthetically creates vocal illusions and resonances" (David Tudor, "Application for Rockefeller Fund for Music [January 12, 1981]," Box 25, Folder 11, David Tudor Papers, GRI).

[56] "it only produces 'A-E-I-O-U' vowel sounds, but it does give a guitar an uncanny vocallike tonality that is reminiscent of Yoda speaking Cantonese" (Chris Gill, "10 Strangest Vintage Effects of All Time," *Guitar World* (December 2006); online version available at guitarworld.com, accessed December 15, 2018: "https://www.guitarworld.com/magazine/weird-science-10-strangest-vintage-effects-all-timeGuitar World). As it so happens, the issue of reminiscence was always at the heart of the wah-wah pedal. Invented by Bradley Plunkett in 1966, the instrument received its name from the particular sound it makes as the internal filter was swept up and down which reminded some listeners of a human voice saying "wah-wah." But it was also reminiscent of the effect trumpet and trombone players often made by moving

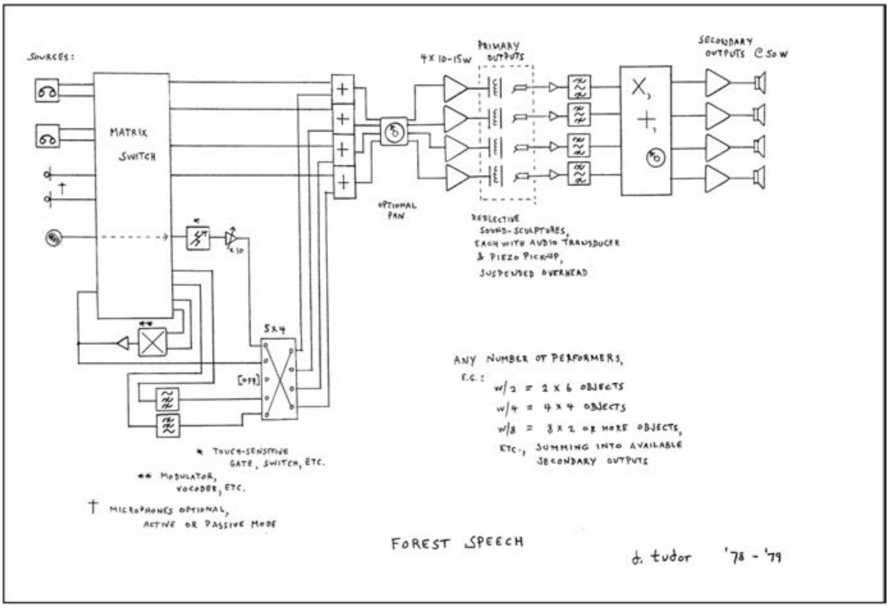


Figure 8.9 Tudor | *Forest Speech*, generalized diagram
DTP, Box 3, Folder 9 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

Tudor had purchased only two weeks before.[57] In any case, a speech synthesizer or something like it is inserted within the giant speech synthesizer, presenting yet another case of instrumental synecdoche. Which is also to say that "vocal illusion" could actually appear before the final synthesis.

The neat diagram drawn after The Kitchen performance follows the description and slightly modifies the Barnard configuration (Figure 8.9). The processor—generalized as "modulator, vocoder, etc."—and the *Photocell Key*—similarly generalized as "touch-sensitive gate, switch, etc."—are now in two separate channels corresponding to the polarity of "synthetic voicings & plosive bursts." One of the split outputs from the vocoder channel feeds back to the *Matrix Switcher. Toneburst Generator* is gone, and a pair of complementary high-pass and low-pass filters are added in its place. Furthermore, the diagram adds two microphones as optional inputs. Indeed, in one later sketch, presumably drafted circa 1980 (assuming from other pages of the same notebook that can be dated), Tudor designated the source as "any simulation of vocal sound (no composed music) microphones also possible."[58] Vocal illusion thus makes its way all down to the source.

a mute in and out of the instrument's bell, which led to Plunkett's instrument being sold under the name of the popular jazz trumpeter "Clyde McCoy." To yet another listener, however, the same sound reminded him of a crying baby, which led to the same instrument being rebranded later to "Cry Baby."

[57] Sam Ash Music Stores, "Receipt for *E-H Talking Pedal* (December 16, 1977)," Box 132, Folder 5, David Tudor Papers, GRI.

[58] Tudor, "Draft of *Forest Speech* diagram," Box 3, Folder 15, David Tudor Papers, GRI.

The reason for this receding of the virtual voice from an illusion at the output to a simulation at the input can only be speculated. For one thing, the *Rainforest* instruments as resonators in no way replicated the particular formants of the human vocal tract. So if the "vocal illusion" aimed at is that of the *human* voice, then its characteristics must be produced before the instrumental loudspeakers. But something uncannier appears to have been on Tudor's mind at first before he began moving the entry point of illusion from the end product of synthesis to the source material. For if the "vocal illusion" is to be produced by the entire sound system, then it must refer to *something other than human speech*. In other words, Tudor may have initially wished to make the instrumental loudspeakers of *Rainforest* do what is in their nature to do—to speak. But perhaps this was already apparent in the title of the piece: *Forest Speech*.

3

To be sure, making loudspeakers speak in their own voice had been the grounding concept of *Rainforest* since its conception circa 1965. That was what made them "instrumental" in the first place, as Tudor reflected to Teddy Hultberg in May 1988: "The basic notion, which is a technical one, was that the loudspeaker should have a voice which was unique and not just an instrument of reproduction, but as an instrument unto itself."[59] Thus, *Forest Speech* appears not so much as an addition of a new element to *Rainforest* but an enhancement of a nature that was there all along. This realization explains one puzzling character of *Forest Speech*: the lack of any distinct character. Simply put, *Forest Speech* sounds very much like *Rainforest*—as revealed by the three extant recordings.

(a) *Barnard Tape* (March 20, 1977)

Fortunately, the only remaining film documentation of MCDC's week-long performance series at Barnard in March 1977 happens to be from the last day when *Forest Speech* was performed.[60] The sound in the 32-minute recording shows a close likeness to *Rainforest* for the most part: a high-pitched repetitive sound pattern set alongside a mid-range metallic drone with occasional mild feedback. However, the music suddenly stops at around 26 minutes, and when it resumes after a minute, there is a new layer of bark-like tonebursts, followed by a low groan-like meandering sound that dominates the remaining three minutes of the performance.

(b) *The Kitchen Tape* (September 23, 1978)

A 25-minute recording of *Forest Speech* is found in John Driscoll's private collection.[61] Presumably from the 1978 concert at The Kitchen, it similarly retains the basic characteristics of *Rainforest* for the first half of the recording, although the sound is much

[59] Tudor, "Interview by Teddy Hultberg," davidtudor.org.
[60] "Barnard event with David Tudor, 1977-03? / choreography by Merce Cunningham," MGZIDF 1937, Merce Cunningham Dance Foundation Collection, NYPL.
[61] Composers Inside Electronics, "*Forest Speech* (undated)," private collection of John Driscoll.

livelier than the Barnard recording. From around 14:30, however, a distinct layer of rhythmic sounds makes an appearance which converses with another layer of more intermittent howl-like bursts for the remainder of the performance.

(c) *The Getty Tape* (1976?)

Another undated 45-minute recording of *Forest Speech* that Tudor himself owned is now archived as part of the David Tudor Papers at GRI.[62] Yet again, the music resembles other *Rainforest* performances: layers of continuous bird and animal-like sounds colored by the resonance of the instrumental loudspeakers.[63] Rogalsky, who analyzed the same recording, deduced that the performance took place circa 1976, prior to the Barnard Event. He was also perplexed by the likeness between the versions: "Curiously, it seems to be barely differentiated from *Rainforest*; the 'vocal illusions' which Tudor suggests ought to make the piece distinct are little in evidence."[64]

4

The lack of difference between *Rainforest* and *Forest Speech* puzzled not only later scholars—it was already a source of confusion for Tudor's collaborators, as Driscoll reminisced while talking to Rogalsky on May 20, 2002:

> *I seem to recall he had a patch [a score diagram] and he spoke very briefly about it, but I didn't think I had been very well prepared to develop the vocal characteristic of it. Partially because it was really source material based, in other words, the* Rainforest *side we all knew, but the real question was then, how do you get it to have that [vocal] characteristic? It obviously has to be in part derived from the source materials. And I think part of the problem for me was I didn't really know if he meant it literally or sort of figuratively—should it be voice-like, should it be voice as a starting point.*[65]

The question is again *where* the "vocal illusion" comes from, or just *what* appears to be speaking. Since *Rainforest* loudspeakers remained more or less the same, Driscoll's reasoning that the difference must be derived, at least in part, from voice-like source materials makes perfect sense. But more fundamentally, his confusion may have been aroused by the sudden demand for *Rainforest* to have a specific *character* of voice—a voice-*like* voice, so to speak—which appears to run against the basic concept of the work: to give the instrumental loudspeakers their own voice, "rather than reproducing some other sound which

[62] Tudor, "*Forest Speech* Dub (undated)," Box 36A, RU5, David Tudor Papers, GRI.
[63] The GRI catalogue describes this recording as "undated," but according to Rogalsky, who obtained the same recording from the Cunningham Dance Foundation, this is a performance of *Forest Speech* with MCDC circa 1976–1977 (Rogalsky, "Idea and Community," 358).
[64] Ibid.
[65] Driscoll, quoted in ibid., 353–354.

is in somebody's mind"[66]—in other words, "the *Rainforest* side we all knew." The puzzle therefore lies in between the actual voice of instrumental loudspeakers and the voice-like sources; which is also to say, between natural objects and matter of appearances, and how Tudor appeared to invert his focus from one pole to the other.

5

Just what is speaking in *Rainforest*, however, was actually never so apparent. Although Tudor had claimed, for instance in May 1972, that the instrumental loudspeakers did not need music and that the simplest electrical impulse would be most efficient in bringing out their nature,[67] he had also described, for instance in September 1984, the inputs to the first version of *Rainforest* in terms of their appearances: "I had used oscillators that made animal-*like* and bird-*like* sounds."[68] This duality between materials that sound like other voices and the voice of material that sounds like no other persisted throughout the many versions of *Rainforest*, albeit somewhat occulted by Tudor's tendency to emphasize only the latter as a natural process.[69] But as a matter of fact—or matter of *act*—it was always through the difference of input source that he distinguished one version from another: "Then for the second version of it I wanted to have *a different kind of input,*" he told Fullemann on September 3, 1984, "I wanted to use a vocal input to the system, the natural resonance of the object and its subsequent amplification. It's a kind of mechanical filter . . ."[70]

This last description had already appeared in the liner notes to the LP of *Rainforest IV* released from Gramavision four years earlier in 1980: "*Rainforest II*, 1969–70, used only vocal inputs to the instruments, exploiting their characteristics as natural resonant *filters* . . ."[71] It was as if the use of human speech as source material had transformed the nature of instrumental loudspeakers from "generating instrument"[72] to "resonant filter." The dominant voice was in the source now, and the role of the instruments was to color it so that it was disguised as many.

[66] KPFA Radio, "Interview with John Cage and David Tudor [audio recording]," May 29, 1972, Other Minds Audio Archive, accessed December 15, 2018: http://archive.org/details/am_1972_05_29
[67] Ibid.
[68] Tudor, "Interview by Fullemann"; emphasis added.
[69] Rogalsky made the important observation that the nature of the instrumental loudspeakers is also partly defined by the types of transducers and pickups used: "The resonance of the object is central to the character of the sound, but it is coloured to a great extent by the frequency response of the weighty transducer, as well as the location on the surface of the object to which the transducer is attached. The frequency response of the pickup used to 'reveal' the object resonances to the audience, is then very important as well; the phonograph cartridges originally used have their own resonances to take into account, and more contemporary realizations have used piezo disc pickups which, while inexpensive and easy to find, are even less linear in their frequency response" ("Idea and Community," 105). This connects to the discussion in Chapter 7 about each playback being a live performance biased by all the instruments involved.
[70] Tudor, "Interview by Fullemann."
[71] Tudor, "Liner notes" *Rainforest IV*, Gramavision (GR-EB 1), 1980, LP. Emphasis added.
[72] Tudor, "From Piano to Electronics," 26.

The next version, composed for the 1972 duo tour, gave even more voice to the source material, so to speak, primarily to balance out the nature of Cage's singing voice, as Tudor continued in his reminiscence to Fullemann:

> *The third version had to deal with the ability to have any input go to any transducer.* [. . .] *I made that system for another simultaneous performance with John Cage* [. . .] *[Mureau] was one of the pieces that changes all the time, so I needed to have a sort of continuous thing, so there I used tape sources, but having the ability to mix them or separate them into different output channels.*[73]

Accordingly, the description of *Rainforest* written for the same tour placed the nature of the instrumental speakers in their ability to "alter *any* input signals according to the different resonating characteristics."[74]

6

But of course it was not "any input signal" that the *Rainforest* loudspeakers received during the 1972 tour. As always, the actual material was something much more specific: recordings from bio-medical and natural scientific sources that formed a part of the tape collection assembled for the *Pepsi Pavilion* project two years before—the same tapes which Tudor and others managed to salvage by smuggling them across the perimeter fence when they were expelled from the giant instrument. This specificity mattered since it was the voice of these *Pepsi Tapes* that influenced the music much more than that of instrumental loudspeakers altering them, as Rogalsky observed:

> *what identifies* Rainforest 3 *as such is in fact the specificity of sound sources, which in most cases may be distinguished even through the colouration provided by the resonant objects.* [. . .] *The role of* Rainforest 3*'s transduced objects* [. . .] *is of far less importance to the identity of the piece than the source tapes.*[75]

A couple of years later, the same collection of recordings would reappear as sources for *Forest Speech*, much to Rogalsky's astonishment: "What is most surprising is the appearance [. . .] of familiar sounds from Tudor's Pepsi Pavilion tape library."[76] The similarity of appearance between *Forest Speech* and *Rainforest* is in this way partially grounded on the constancy of input source, the particular collection of tapes that came out of the *Pepsi Pavilion*.

73 Tudor, "Interview by Fullemann."
74 Tudor, "*Untitled* notebook," Box 4, Folder 21, David Tudor Papers, GRI.
75 Rogalsky, "Idea and Community," 169.
76 Ibid., 358.

The surviving *Pepsi Tapes* indeed played a central role in Tudor's exploration of making one material sound as many. Talking to Bruce Duffie on April 6, 1986, he explained why he liked these recordings:

> *I do re-use them because they never sound the same. They never sound the same.* [. . .] *And I find that I'm still using that, because that's only an input. It depends on what kind of device is meeting it at the other end. It could sound completely different. So consequently, those tapes that I use, I no longer recognize them. They never sound* au naturel. *Never.* [laughs][77]

That was certainly an exaggeration, for they are recognizable. But Rogalsky, who indeed recognized them across the different versions of *Rainforest*, also analyzed the same tapes and found out why they never sounded the same.

> *Tudor favours recordings in which sounds are ever-changing and yet static. Rhythms (as with the "modified night jar" or "bat 1⅞" tapes) are only quasi-repetitive, never establishing themselves for longer than a few seconds. What might be called melodic material (as with the warbling tone patterns of the brainwave recordings) is apparently random and non-repetitive as well. These characteristics hold true for all of Tudor's Pepsi sources, and thus link them together regardless of their origin.*[78]

The *Pepsi Tapes* do not repeat themselves—or more accurately, they *appear* not to. Yet listeners can still identify them, regardless of what Tudor says. And this paradoxical quality, of being perceived the same in spite of being different, is itself the same across all the tapes in spite of their differences. Rogalsky called it the "characteristics" of these sources—aptly so, for a "character" is indeed something that is "ever-changing and yet static," whether in the form of letters or personalities. It is also what Tudor discovered in his electronic instruments, as he wrote about how the "characteristics" of the amplified piano oriented his approach to Cage's material when *Variations II* was revived in the early 1980s,[79] or told Larry Austin toward the end of the same decade about the "personality" he discovers in his modular equipment:

> *In my electronics, I work with an instrumental principle. You're completely right in saying that. They become my friends. They have personalities, that only I see, because of my use of them.*[80]

If personalities or characters are realized only through interaction or use, it is because the observed sameness of something that is actually different is a synthesis on the side of the observer.[81] Tudor's brief explanation of what kind of material he was looking for

[77] Tudor, "Presenting Tudor: A Conversation with Bruce Duffie," bruceduffie.com.
[78] Rogalsky, "Idea and Community," 168.
[79] Tudor, "Notes for *Variations II*," Box 8, Folder 7, David Tudor Papers, GRI.
[80] David Tudor and Larry Austin, "A Conversation, April 3, 1989," davidtudor.org.
[81] Emily Dolan offers an illuminating discussion on "the notion that individual instruments had distinct personalities and characters," which emerged alongside the conception of the orchestra in the

when he chose the *Pepsi Tapes* to perform simultaneously with Cage's song *Mureau* is revealing: "I needed to have *a sort of continuous thing*, so there I used tape sources."[82] The synthetic nature of character creates an abstract continuity of sound on the receiving end even if the actual sound is intermittent or only pseudo-repetitive— it is a "coherence that is deceptive," like the one composed by each wandering visitor of the enhanced island or the electronic rainforest.

In other words, a character is composed out of appearances but is irreducible to them.[83] The appearance of sound only serves as a reminder. But this also means that the listener can be reminded of something quite different from the actual source. Instead of always returning to instruments as natural objects, sound as a character can itself become an instrument to remind the listeners of other not-so-natural matters. Perhaps that is what was on Tudor's mind when he made the otherwise deceptive claim that he no longer recognized the *Pepsi Tapes* in 1986—"They never sound *au naturel*."

7

Driscoll wondered where the vocal character of *Forest Speech* might come from. In at least one draft, it went all the way back to the source material which was specified as "any simulation of vocal sound (no composed music)."[84] Which also reveals something about the character of the *Pepsi Tapes: they reminded* David Tudor *of the voice*.[85]

Tudor thus returns to the modulation of voice, but now the source is itself a simulation, a voice in appearance only. And if his concern was in creating multiple appearances from the "same" source, and if that source was already an appearance, then it is appearances all the way down. What matters now is the character of sound rather than the material bias that generates it; the produced effect more than the producing mechanism.[86] This inversion would

late-eighteenth century (*The Orchestral Revolution: Haydn and the Technologies of Timbre* [Cambridge, UK: Cambridge University Press, 2013], 148).

[82] Tudor, "Interview by Fullemann"; emphasis added.

[83] The same mechanism may also be explained as a threshold problem of bias: what makes a character is a certain degree of indeterminacy (irregularity of appearance) on one level that passes as determinacy (identity beyond appearance) on another level. Pierre Schaeffer once proposed the discipline of "Characterology," which "provides important insights into the nature of instrumental thought. Characterology's purpose is the formulation of 'genres.' These are sound families where sound objects' morphological criteria interact in specific ways" (quoted in Leigh Landy, *Understanding the Art of Sound Organization* [Cambridge, MA: MIT Press, 2007], 84).

[84] Tudor, "Draft of *Forest Speech* diagram."

[85] The British music software company Zero-G, which developed a vocal-synthesizing software called *Vocaloid* in the early 2000s, coined the term "vocal font" to describe the variable yet identifiable voice of their virtual singers—a conceptual union between the two meanings of "character": personality and letter. For a critical examination of *Vocaloid* that focuses on how character profiles—gender and race—are reified and essentialized, see Nina Sun Eidsheim, "Race as Zeros and Ones: Vocaloid Refused, Reimagined, and Repurposed," in Eidsheim, *The Race of Sound: Listening, Timbre, and Vocality in African American Music* (Durham, NC: Duke University Press, 2019).

[86] Perry R. Cook identified two models of speech synthesis: "Synthesis models can be loosely broken into two groups: spectral models, which can be viewed as based on perceptual mechanisms, and physical models, which can be viewed as based on production mechanisms" (Perry R. Cook, "Singing Voice Synthesis: History, Current Work, and Future Directions," *Computer Music Journal* 20, no. 3 [Autumn, 1996], 42). Using this distinction,

be reflected in a shift of instrumentation: instead of no-input feedback using homemade instruments and strictly no synthesizers, Tudor's subsequent pseudo-vocal music would all process found recordings using commercial effects processors and synthesizers. In any case, many of the *Pepsi Tapes* were already pre-processed, sped up or down, or modulated—the sources were already in disguise. The appearance of voice would therefore proliferate, both as material as well as end product of synthesis. Characters will roam around.

Dramatis Personae

Although Tudor had initially assembled more than 500 recordings, the number of tapes that made it across the perimeter fence of the *Pepsi Pavilion* appears to have been rather small, and the ones that he subsequently used even fewer.[87] When these *Pepsi Tapes* are visualized using a sonogram, a curious fact is revealed: *in most cases the random and non-repetitive character is itself in appearance only*. What is perceived is not what is actually there.

1. Neural (Sounds Inside Animals)

At one point during the workshop at the Mobius Art Center on September 29, 1985, Tudor began describing some of the *Pepsi Tapes* in detail. He first talked about a group of recordings related to neural activity collected from laboratories:

> *Brain waves have very slow frequencies so laboratories for the most part gave me already modulated tapes because* [. . .] *in order to make them listenable they wanted to have them stepped up in frequency. It's a very simple process of modulating the wave with another one so that you get it up until what they consider to be an audible range. But with some of the tapes I was very lucky because they had put the modulating signal on one side of the stereo tape, so I was able to demodulate them partially, you know, to get them back more to the original state.* [. . .] *But I then took those tapes and I further processed them . . .*[88]

Tudor's move could be described as a turn from "physical" to "spectral models" of synthesis. However, the division itself remains ambiguous. Cook includes vocoders and formant synthesizers in the group of spectral—which is also to say, terminal analog—models, yet the persistent similarity of their design to the human speech production mechanism also led him to suggest a pseudo-category: "formant synthesizers are spectral models, but could be classified as pseudo-physical because of the source/filter decomposition" (ibid.). Tudor's model could be seen as an extreme form of spectral model that departs even from the pseudo-physical form of speech synthesizers such as the one he had briefly encountered with the Bell Labs kit instrument.

[87] The *Pepsi Tapes* are scattered in various archives and private collections around the world. The David Tudor Papers at GRI houses most of them, while members of CIE also own copies of major ones, some exist in the archives of the Merce Cunningham Dance Foundation, and still others are kept by Tudor's collaborators including Julie Martin and Fujiko Nakaya.

[88] Tudor, "Workshop at Mobius Art Center, Boston (September 29, 1985)," Box 2A, C75, David Tudor Papers, GRI.

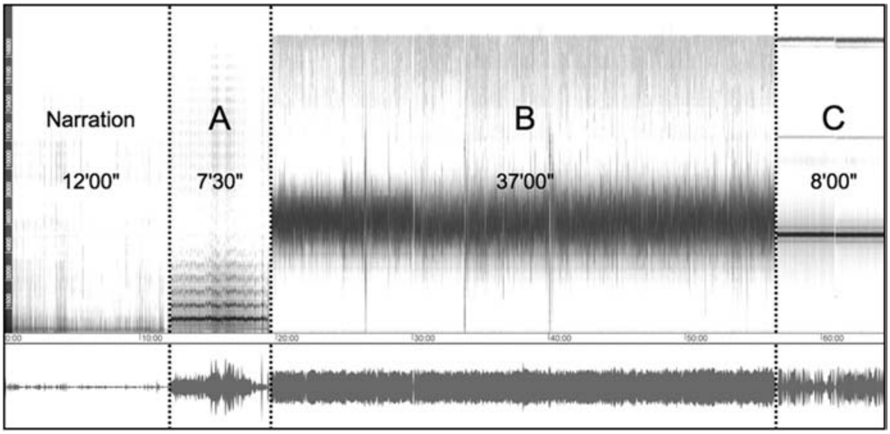


Figure 8.10 *Alpha Waves*, sonogram (64′40″)

There are about five tapes from this category that Tudor used often. All of them are continuous tones except for *Nerves Firing*.

(a) *Alpha Waves* (64'40")

The tape starts with a long narration by Dr. Joe Kamiya of Langley Porter Neuropsychiatric Institute in San Francisco, who researched "the capacity of human subjects to learn how to control their brain waves"—otherwise known as "neurofeedback."[89] According to Kamiya, the brain wave of one of his colleagues was first amplified by a gain of 100,000 and the output voltage was used as control signal to modulate both the amplitude and frequency of a carrier signal. Thus, "when the brain wave gets large in a particular frequency spectrum known as alpha spectrum, tone would get louder. When the frequency of that tone shifts slightly up or down from ten cycles per second, then the tone gets higher or lower."[90]

The recording that starts after the narration is in three parts (Figure 8.10). The first part (A) is seven and a half minutes of continuous, mosquito-like sound wandering narrowly between 500 and 1,000 Hz with strong upper harmonics (12′00″-19′30″). The second part (B) goes on for 37 minutes with another continuous but much faster and high-pitched sound swirling between 4,000 Hz and 10,000 Hz (19′30″-56′30″). The third part (C) is a continuous single tone of circa 6,000 Hz, which is abruptly cut once after four minutes and half (61′00″), only to resume immediately and continue for another three minutes and half.

(b) *Demodulated Alpha Waves* (48'00")

The title suggests this is one of the recordings Tudor demodulated using the modulating signal on the other side of the tape. The 48-minute recording is actually an

[89] "Alpha Waves," R158, David Tudor Papers, GRI.
[90] Ibid.

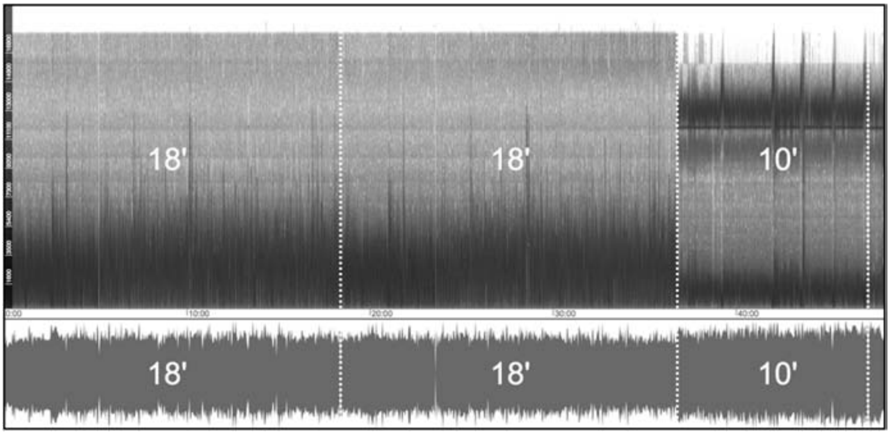


Figure 8.11 *Demodulated Alpha Waves*, sonogram (48′00″)

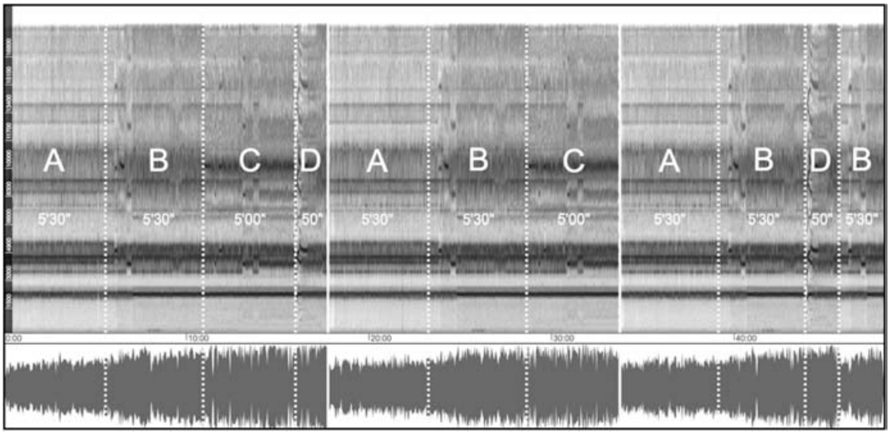


Figure 8.12 *Brainwaves Regular*, sonogram (48′00″)

18-minute segment played twice and then stepped up almost double in speed to 10 minutes (which could in fact be the modulated recording) (Figure 8.11). The first slower part is still quite fast, sounding like a relentless lip blowing.

(c) *Brainwaves Regular* (48'00")

This recording is composed of three bands of continuous wobbly tone that sounds like a boiling kettle (Figure 8.12). The lowest band moves between 2,200 to 2,500 Hz, while the other two bands move in parallel between 3,900 and 5,600 Hz, and between 9,000 and 11,000 Hz. The 48-minute recording can be divided into three parts, each

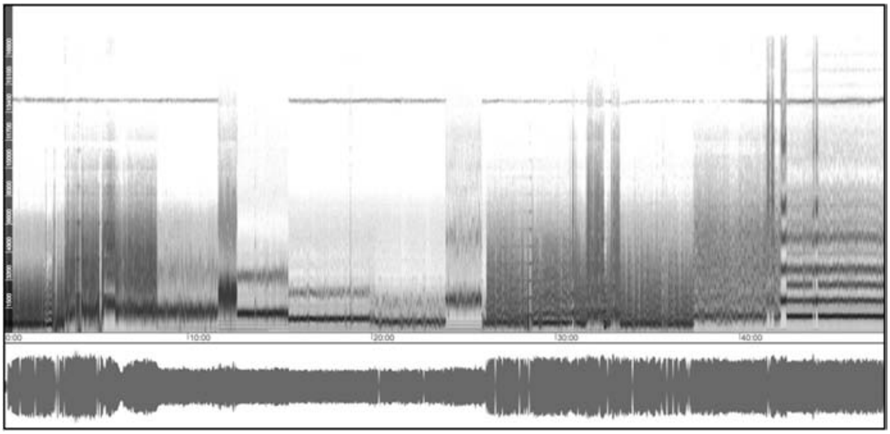


Figure 8.13 *E.E.G.*, sonogram (48′00″)

containing same sections in slightly different configurations and lengths (14 to 18 minutes) (Figure 8.12).[91]

(d) *E.E.G.* (48'00")

The three letters stand for "Electroencephalogram," a recording of the electrical activity of the brain. A thick, continuous warbling tone is segmented in blocks that move the pitch range up or down with occasional high-pitched bursts. No apparent order or repetition can be observed. A faint high-pitched sound of 14,000 Hz rings almost entirely throughout the recording (Figure 8.13).

(e) *Nerves Firing* (48'00")

Originally taken from a collection of nerve sounds, where it is explained that this particular recording is "[t]he firing of a pulsed-type nerve cell in the brain of a cat."[92] A segment of three minutes and twenty seconds is repeated 14 times. A slow, dry

[91] Rogalsky studied in detail how Tudor modulated the *Pepsi Tapes*. In particular, his analysis of speed changes in *Brainwaves* is revealing: "In the case of the brainwave recordings, […] reducing tape speed, and thus transposing its frequency content down as much as two octaves, is a means of revealing complex melodic material which is difficult to parse at the original speed" (Rogalsky, "Idea and Community," 165). Noting the multiplicity of bands, he observed: "The brainwave sonification has several distinct components, pitched low and high. At the fastest playback speed, the lower component is a warbling pitch around 1 kHz, which deviates by about a semitone. The higher component is a combination of fast-moving warbling pitches with most energy in the region of 4–7 kHz, resembling the sound of an insect swarm. When tape speed is reduced by half, the lower warbling tone takes on a more melodic character and it becomes clear there are two higher pitched tone regions, one in the midrange where two tones oscillate between approximately 1000 and 1300 Hz, and one in a higher register which has the character of a sustained scream at around 2900 Hz, with frequent deviations. These variations in tape speed obviously present extended possibilities for matching with *Rainforest 3* loudspeaker-objects, which may each favour only a restricted range of frequencies" (ibid., 166). The frequency range of each band does not correspond exactly to my readings, which may be a result of using slightly different tapes for analysis.

[92] "Nerves Firing," Box 21A, R170, David Tudor Papers, GRI.

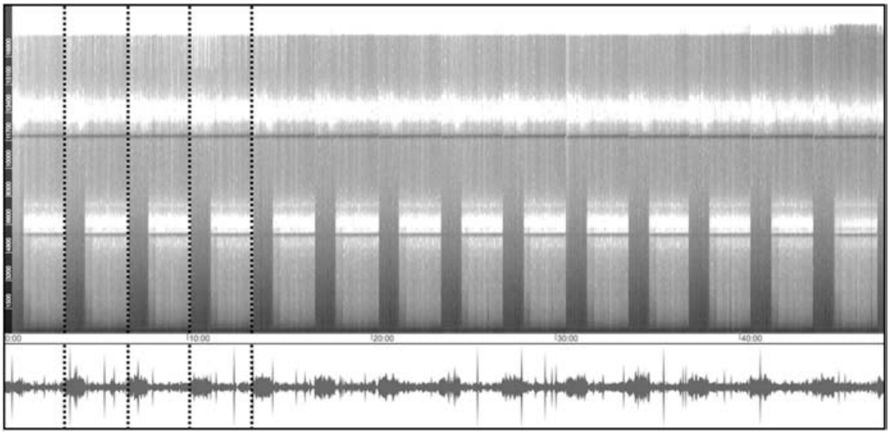


Figure 8.14 *Nerves Firing*, sonogram (each segment is 3′20″)

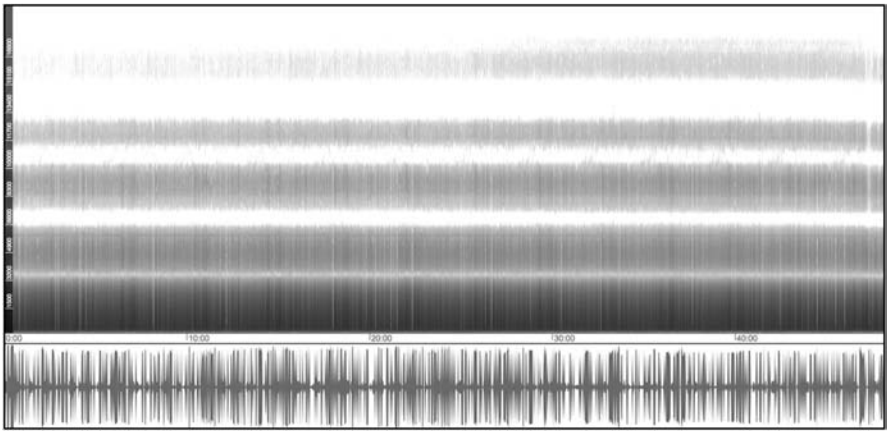


Figure 8.15 *Cat's Eye*, sonogram (48′00″)

clicking pulse continues throughout. Each segment is further divided into two parts: the first, which is just over a minute, has a prominent background noise that is attenuated in the second part lasting 2 minutes and 15 seconds (Figure 8.14).

(f) *Cat's Eye* (48'00")

A continuous low grinding tone, sounding like a slow zipper, that goes on for the entire 48 minutes (Figure 8.15). Although difficult to notice, it is actually composed of multiple repetitions of a four and a half minutes recording, sampled from the same nerve sound compilation tape as *Nerves Firing*. The commentary inserted in the original tape explains that the sound is not taken from the feline's organ of sight, but

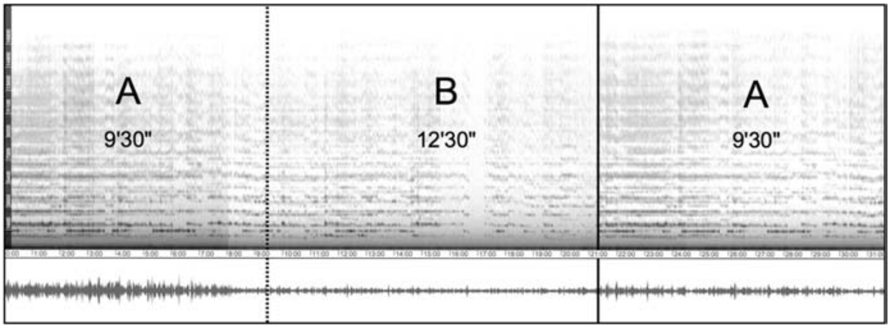


Figure 8.16 *Mosquito in Test Tube*, sonogram (32′00″)

rather from its neural activity: "The firing of a second type of nerve cell in the brain of a cat concerned with the control of movement of the eyes."[93]

2. Insects (Small Animals)

(g) *Mosquito in Test Tube* (32'00")

At the Mobius workshop, Tudor mentioned two recordings of mosquitoes, at least one of which he remembered as being recorded by Peter Poole:

> *I remember one tape he gave me which I've already used in two pieces. So he went to a place where they had millions of mosquitoes, and they were put into a test-tube* [laughter] *and later on they were put into a water jar and the sound came out in a totally different frequency.*[94]

The two recordings are both continuous and drone-like, with occasional Doppler effects as the insects fly close to or away from the microphone. The *Mosquito in Test Tube* is composed of a 22-minute segment whose first section of nine minutes and a half is repeated (Figure 8.16).

(h) *Mosquitoes in a Water Jar* (48'00")

The former software librarian Ritty Birchfield remembered this tape as being recorded by Takehisa Kosugi, who was visiting New York in 1969.[95] She also recalled it was one of Tudor's favorites. The sound is quite similar to *Mosquito in Test Tube*, although overall lighter. The recording can be roughly divided in two almost identical parts (Figure 8.17).

93 Ibid.
94 Tudor, "Workshop at Mobius, Art Center."
95 Burchfield, "Interview by Nakai and Driscoll," New York, NY, September 8, 2014.

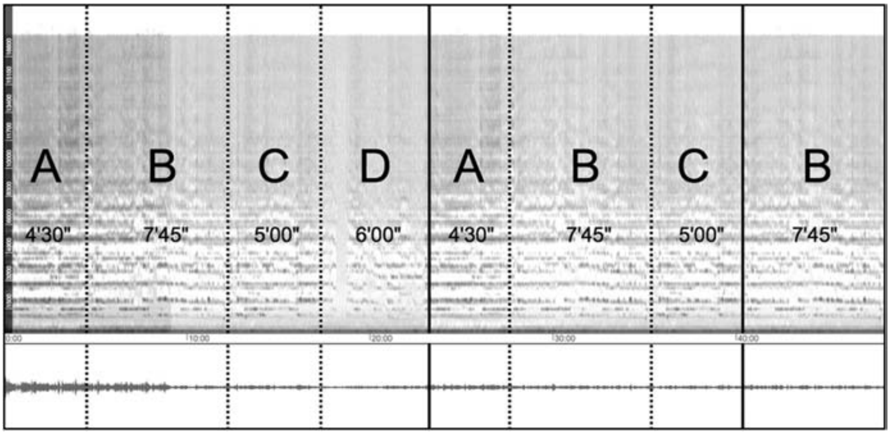


Figure 8.17 *Mosquitoes in a Water Jar*, sonogram (48′00″)

(i) *Longhorn Beetle Walking* (96'30")

Burchfield recalled this one as being their personal favorite: "any time we were upset we would put on the *Longhorn Beetle* recording."[96] A ferocious rambling sound of 30 seconds is repeated throughout the recording, which is divided exactly at the middle (48′00″) (suggesting that the two parts originally came from two sides of one tape). The sound is slightly attenuated in the second part but otherwise identical (Figures 8.18 and 8.19). This recording and the following *Wasp Chewing* were both sampled from the compilation album *Sounds of Insects* recorded by entomologist Albro T. Gaul and released from Folkways Records in 1960, a dubbed tape of which exists in Tudor's collection.[97] In the original record, Gaul provides a brief commentary before each recording: "A large longhorn beetle walking."[98] The devil-may-care attitude with which the creature advances is reflected in the sound, and presumably served to liven up the spirits of the listeners during "earphone time."

(j) *Wasp Chewing* (48'00")

This is another rambling sound similar to *Longhorn Beetle Walking*, but overall sparser and thinner. The perceived tempo is around 77–94 BPM. Actually, the recording is composed of many repetitions of the same 38-second fragment (Figures 8.20 and 8.21). The commentary in the original *Sounds of Insects* tape reveals more details: "Another

96 Ibid.

97 Albro T. Gaul, *Sound of Insects*, Folkways Records, New York, 1960; "Sounds of Insects," Box 32A, R298, David Tudor Papers, GRI.

98 Ibid. The liner notes of the original LP further reveal the long ordeal Gaul went through to obtain this particular recording: "The most troublesome sound to record proved to be those of insect footsteps. The specimens either clung to the protective mesh on the microphone, or they scampered or flew away too quickly to obtain a usable recording. Attempts were made with paper and with aluminum foil attached to a wire "needle" in a phono cartridge; further attempts were made with a specially built ribbon microphone,

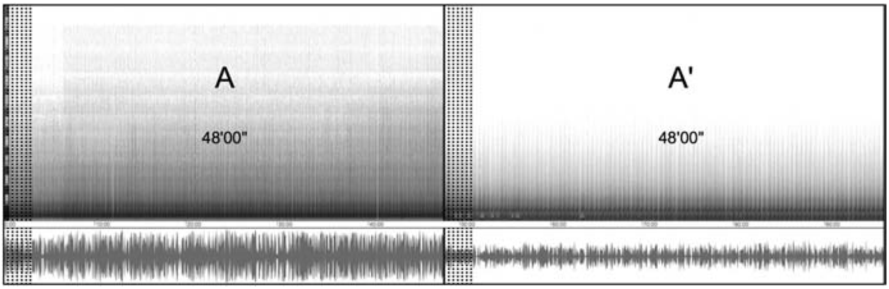


Figure 8.18 *Longhorn Beetle Walking*, sonogram (96′30″)
Note: The second part is an attenuated version of the first

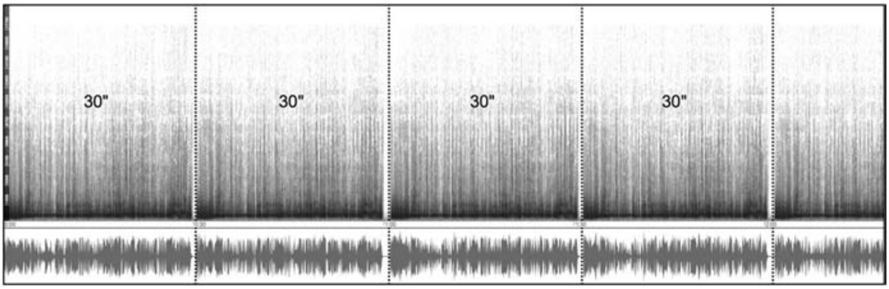


Figure 8.19 *Longhorn Beetle Walking*, sonogram (close-up of the first two minutes and a half)

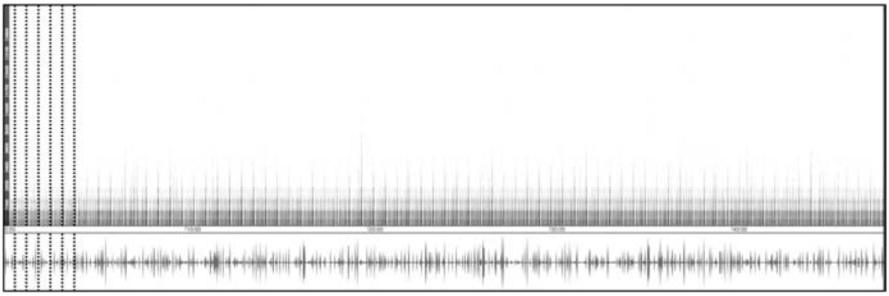


Figure 8.20 *Wasp Chewing*, sonogram (48′00″)

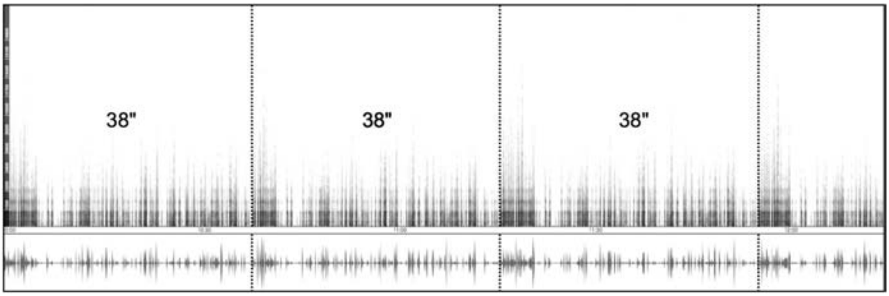


Figure 8.21 *Wasp Chewing*, sonogram (close-up of the first two minutes and a half)

sound which insects make are the eating and chewing sounds. It is [*sic*] small sounds. An especially sensitive electronic equipment is needed to pick it up. Here is a wasp, for instance, chewing the meat off of an old fish bone."[99]

3. Larger Animals

(k) *Modified Nightjar Regular* (48'00")

At the Mobius workshop, Tudor talked briefly about a recording of an Australian bird that he was very fond of: "Nightjar is one of those fantastic sounds produced which is so heavily pulsed, it's one of the best sounds to test the loudspeakers."[100] There are two versions, differing in speed. The regular version consists of a pulse pattern of 38 seconds, each segmented into 19 parts, all starting with a slower pulse which quickly ascends to faster pulses (Figures 8.22 and 8.23).

(l) *Modified Nightjar Slow* (66'00")

This is a slower version of the same Nightjar recording which is dropped down approximately four times in speed from the original. Each segment is stretched to two minutes and half, now revealing 19 sections of varying length (2–10 seconds) (Figures 8.24 and 8.25).

(m) *Bats* (48'00")

Among Tudor's tape collection there is a source tape for this recording labeled "Assorted animal/insect/bird sounds,"[101] from which he edited out the narration informing the listeners that the bats here were recorded by John Hooper in 1964 using a Holgate Ultrasonic Receiver. There were five different kinds—Greater Horseshoe Bats, Greater Horseshoe Bats juveniles, Pipistrelle, Noctule Bats, and Daubenton's Bat[102]—which, all sped up from the original, compose the five parts of a two-minute

large enough for the insects to walk on the ribbon, but the results were poor. The footsteps recorded here were achieved by placing the specimens in a small cardboard box, whose bottom was replaced by a tightly stretched sheet of tissue paper. This was placed with the tissue paper only a fraction of an inch from the dynamic microphone. In effect this provided a double diaphragm of the microphone itself—and the results were not only loud and clear but they sounded alike each time the same insect was permitted to walk" (Gaul, "Liner notes," in *Sound of Insects*).

99 Ibid.

100 Tudor, "Workshop at Mobius Art Center."

101 "Assorted animal/insect/bird sounds," Box 15A, R79, David Tudor Papers, GRI.

102 The narration is as follows: "Cut one, Greater Horseshoe Bats, *Rhinolophus ferrumequinum*, response of Holgate Ultrasonic Receiver when tuned to 82 kHz, recorded by J. H. D. Hooper … 4 ultrasonic sounds of Greater Hoseshoe Bats, a cluster waking up and preparing to fly from a cave, as heard by Holgate Ultrasonic Receiver." "Cut two, Greater Horseshoe Bats, juveniles, *Rhinolophus ferrumequinum*, response to Holgate Ultrasonic Receiver when tuned to 72 kHz, recorded by J. H. D. Hooper … Nursery cluster of juvenile Greater Horseshoe Bats, ultrasonic squeaks as heard by Holgate bat detector." "Cut one, Pipistrelle, *Pipistrellus pipistrellus*, response of Holgate Ultrasonic Receiver, when tuned to 50 kHz, recorded by J. H. D. Hooper … 2 Ultrasonics of hunting Pipistrelles heard by Holgate Ultrasonic Receiver." "Cut one, Noctule Bats, *Nyctalus noctula*, response of Ultrasonic Receiver when tuned to 18 kHz, recorded by J. H. D. Hooper … One, Ultrasonic pulses of hunting Noctules as heard by Holgate Ultrasonic Receiver." "Cut one, Daubenton's, Bat, *Myotis daubentoniid*, response of Holgate Ultrasonic Receiver, when tuned to 50 kHz recorded by J. H. D. Hooper … Ultrasonics of hunting Daubenton's Bats as heard by Holgate Ultrasonic Receiver" ("Assorted animal/insect/bird sounds").

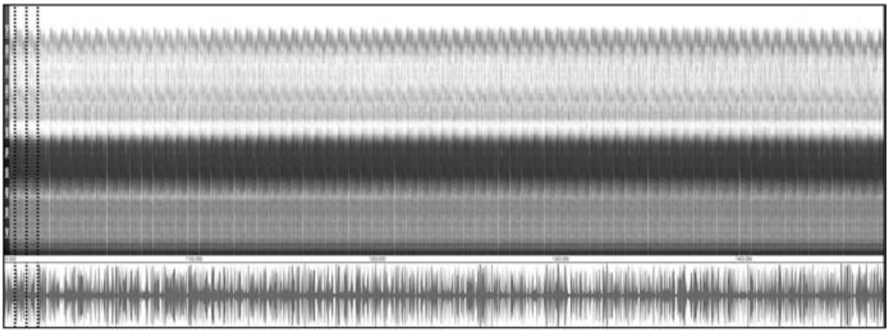


Figure 8.22 *Modified Nightjar Regular*, sonogram (48′00″)

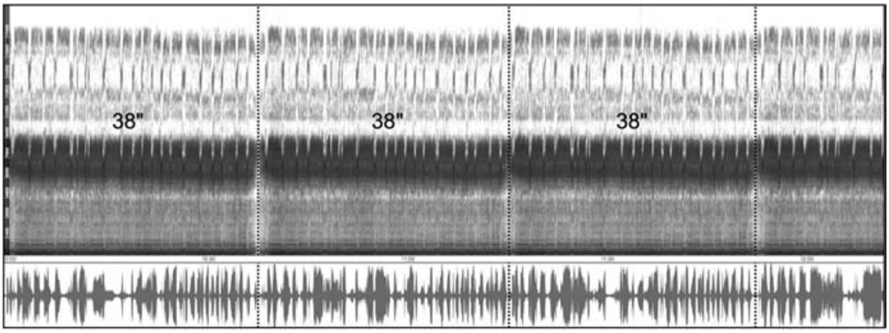


Figure 8.23 *Modified Nightjar Regular*, sonogram (close-up of the first minute and a half)

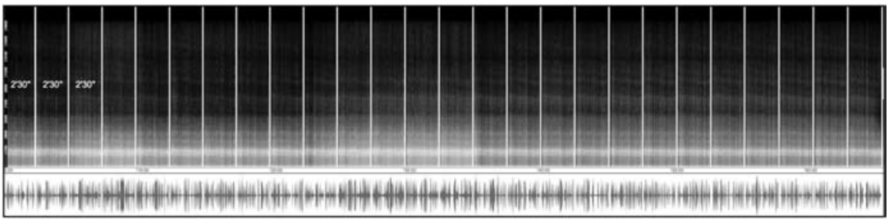


Figure 8.24 *Modified Nightjar Slow*, sonogram (66′00″)

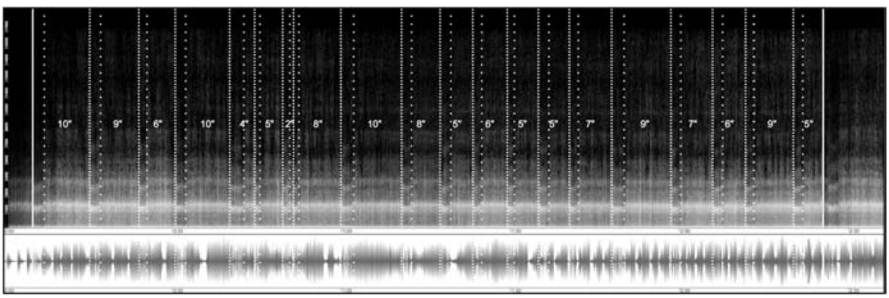


Figure 8.25 *Modified Nightjar Slow*, sonogram (close-up of the first two minutes and half)

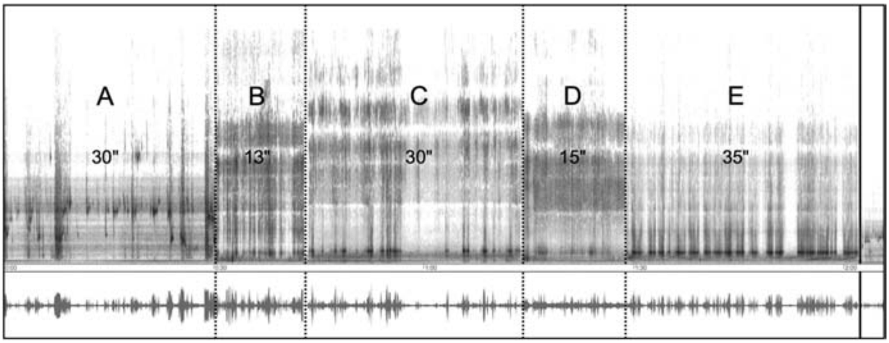


Figure 8.26 *Bats*, sonogram (close-up of the first two minutes showing the five sections articulated by different kinds of bats)

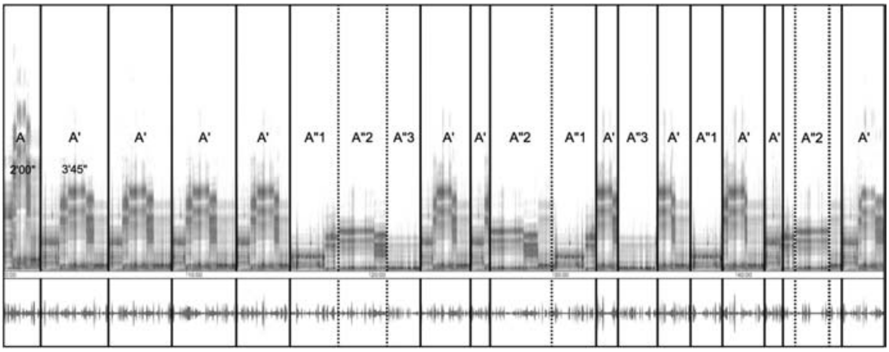


Figure 8.27 *Bats*, sonogram (48’00”)
Note: The first segment A is stretched twice (A’ and A”), each time doubled in duration.

segment. The Horseshoe Bats are quite melodic and lively, and the Pipistrelle gives a high shrilling pulse, while the other two are slower, dragging pulses that sound like a snore (Figure 8.26). This segment (A) is only presented once before being stretched twice, each time approximately doubled in duration and halved in pitch. The first stretched segment of three minutes forty seconds (A′) repeats four times, followed by the second segment further stretched to seven minutes (A″). After this, fragments of A′ and A″ alternate (Figure 8.27).

Weatherings (Nethograph)

1

On September 27, 1978, just five days after CIE’s performance of *Forest Speech* at The Kitchen, Tudor moved some sixty blocks uptown and premiered *Weatherings (Nethograph)* at the New York City Center. For this new music, commissioned for the

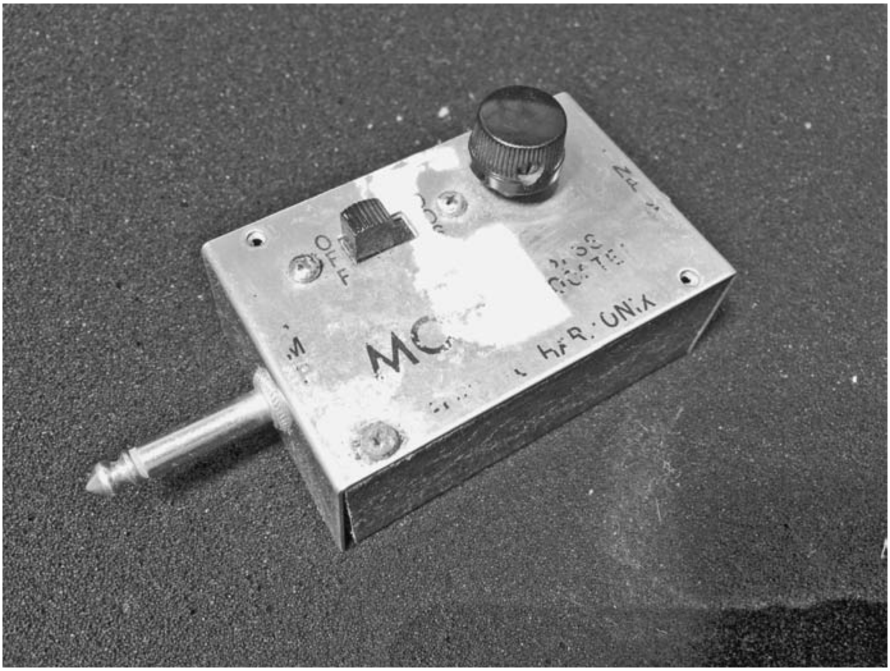


Figure 8.28 Electro-Harmonix | *The Mole Bass Booster*
DTC, Instrument 0149 | World Instrument Collection, Wesleyan University

new Cunningham dance called *Exchange*, he chose a number of *Pepsi Tapes—Alpha Waves, Demodulated Alpha Waves, E.E.G., Wasp Chewing, Mosquito in Test Tube*, and *Modified Nightjar Slow*—and modified them with ten parallel processors. The instruments would vary slightly from one performance to the next, but for the most part, they were commercial effects processors whose market had vastly grown throughout the 1970s. Tudor had a favorite company. Already in 1972, the sound system of *Untitled* included two active filters—plug-in types, not pedals—made by a New York–based manufacturer which had begun its operations four years earlier: a bass booster named *The Mole* (Instrument 0149; Figure 8.28) and a treble booster named *Screaming Bird* (also Instrument 0149; Figure 8.29), both from Electro-Harmonix.

These two animal-like instruments that boosted a particular frequency range of the signal continued to appear inside different sound systems throughout the 1970s, often as complementary filters going into the *Four Quadrant Modulator* in the Formant Shifter network.[103] By the end of the decade, Tudor owned at least seven more effects processors from the same company, all of which appeared in *Weatherings* (though not all at the same time). Like *The Mole* and *Screaming Bird*, each instrument was given a name which turned its function into a character of sorts: *Talking Pedal* (wah-wah

[103] Tudor also owned a number of *Electro-Harmonix Linear Power Booster LPB-1* (Instrument 0149).

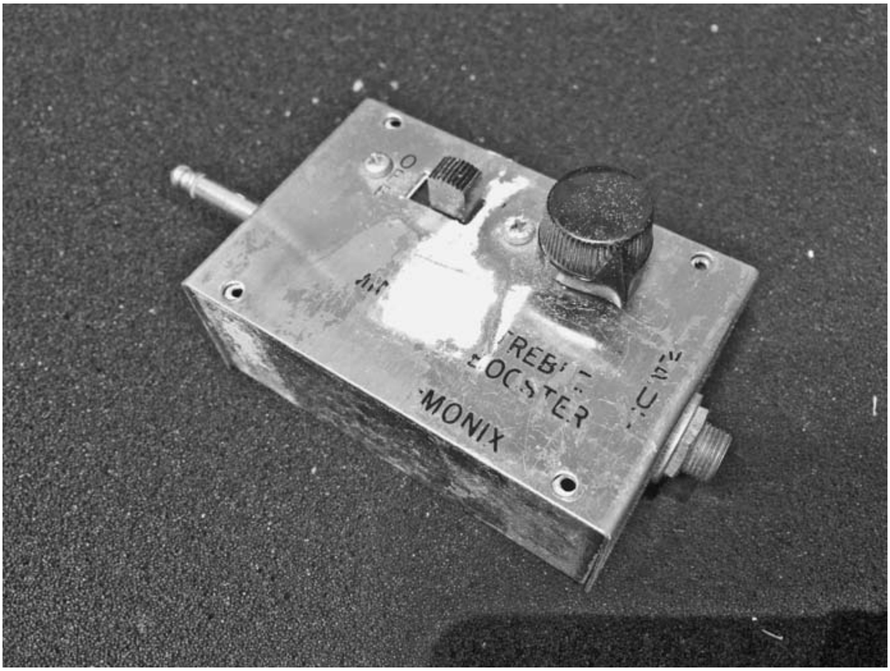


Figure 8.29 Electro-Harmonix | *Screaming Bird Treble Booster*
DTC, Instrument 0149 | World Instrument Collection, Wesleyan University

pedal dubbed speech synthesizer; Figure 8.30), *Octave Multiplexer* (sub-octave generator; Instrument 0300; Figure 8.31), *Hog's Foot* (another bass booster; Instrument 0297; Figure 8.32), *The Silencer* (noise gate dubbed line noise eliminator; Instrument 0276; Figure 8.33), *Clone Theory* (chorus), *Electric Mistress* (flanger), and *Hot Tubes* (vacuum tube amplifier distortion simulator). It was as if these commercial products packaged in advance the personality of instruments that Tudor claimed to discover only through their use. In modifying the *Pepsi Tapes* with such processors, Tudor was transforming one kind of character through another.

2

If the *Pepsi Tapes* were characterized by their likeness to voices, these instruments that processed them were characterized by something else. As the general name of "effects processors" reveals, they all modified sound to create a certain "effect" perceived by the listener. In most cases this was a virtual simulation of another effect produced by another instrument, a terminal analog working in the absence of the actual mechanism. *Electric Mistress* created a likeness to the slight delay produced by pushing the flange of a tape reel as it played back; *Clone Theory* focused on a longer delay

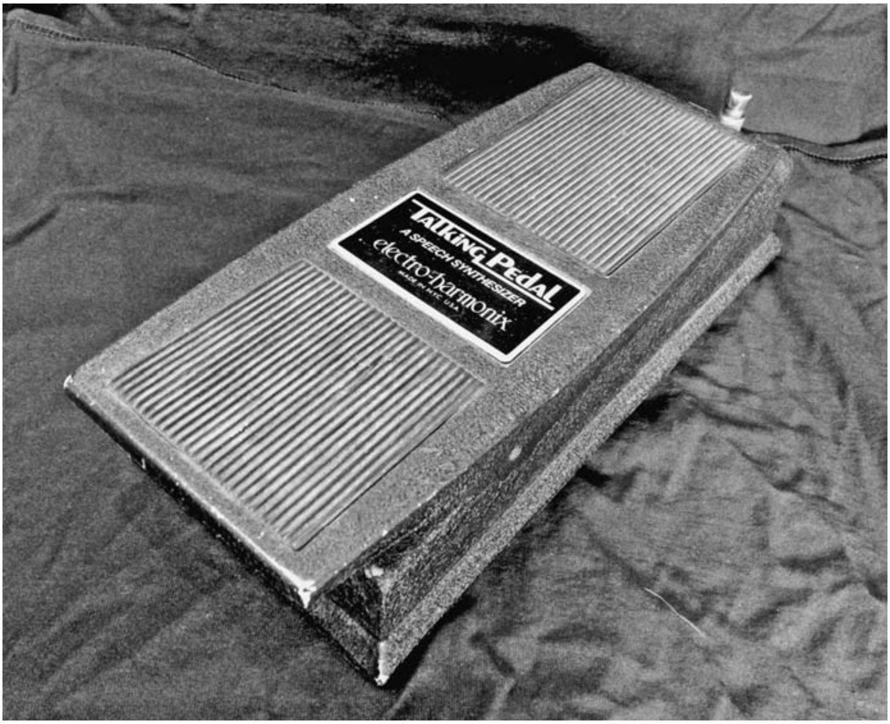


Figure 8.30 Electro-Harmonix | *Talking Pedal Speech Synthesizer*
DTC, no# | World Instrument Collection, Wesleyan University

Figure 8.31 Electro-Harmonix | *Octave Multiplexer*
DTC, Instrument 0300 | World Instrument Collection, Wesleyan University

Figure 8.32 Electro-Harmonix | *Hog's Foot Bass Booster*
DTC, Instrument 0297 | World Instrument Collection, Wesleyan University

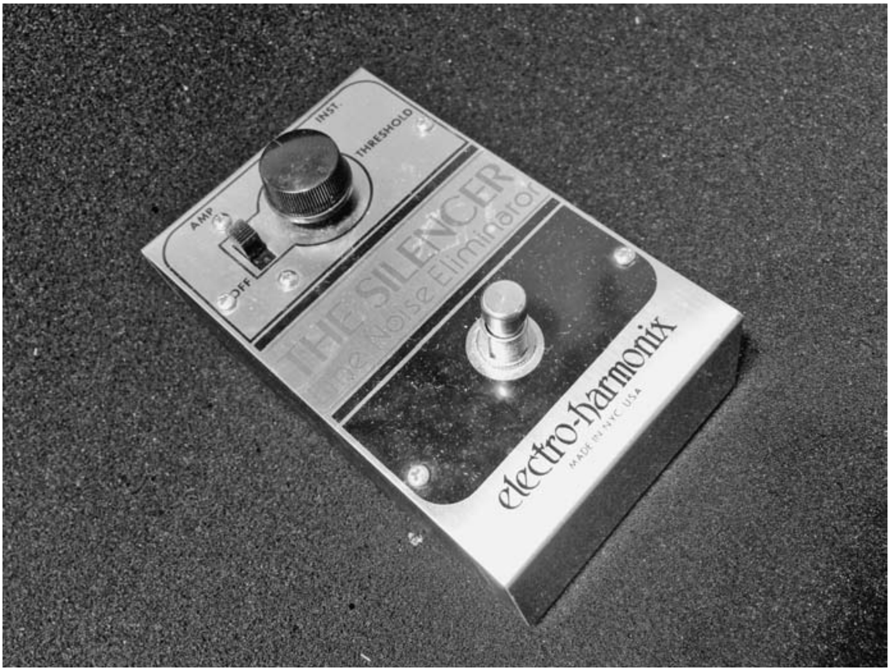


Figure 8.33 Electro-Harmonix | *The Silencer Line Noise Eliminator*
DTC, Instrument 0276 | World Instrument Collection, Wesleyan University

generated across many singers in the chorus; *Talking Pedal* was obviously copying the human male voice; and *Hot Tubes* boasted of itself as the simulator of the unique character of vacuum tube amplifiers.

This virtual nature was shared with other processors used in *Weatherings*, three of which had already appeared in *Toneburst*: two *PAiA Synthespins* and the *Phaser/Flanger*, both simulating the effects of rotary speakers, themselves invented to simulate the resonance of pipe organs in churches on an electric Hammond organ. Two other complementary instruments that often appeared in *Weatherings* also engaged in an act of simulation: the *Vox Repeat Percussion* (Instrument 0257) was a tremolo originally designed for home organs to simulate the strumming of a banjo or a mandolin by modulating the amplitude of the incoming signal with a reverse sawtooth wave, which resulted in chopping continuous tones into percussive short attacks;[104] and an unidentified *Phase-Locked Loop* device (PPL), a voltage-controlled oscillator that could disguise short attacks into continuous tones by locking onto the frequency of the incoming signal. All in all, many characters were born actors.[105]

3

Most of these effects processors used in *Weatherings* were inherited from an earlier no-input feedback piece called *Pulsers* that Tudor first realized circa 1974, around the same time as *Toneburst*. Curiously, this music happened to be itself an act of simulation. Back in 1969, as preparations for the *Pepsi Pavilion* proceeded, Mumma had made a single-channel prototype of the *Pepsi Modifier* with all the same functions as the eight-channel version that was later installed in the *Pepsi Pavilion* (Figure 8.34). Sometime after his return from Osaka, Tudor was reminded of this prototype, which in retrospect appeared as a partial analog of the console of his giant instrument now forever lost. "After Expo 70, that equipment was no longer available," he explained to Fullemann on September 3, 1984:

> *So all the pieces which I did there … I did ten different ones … were virtually gone. So I began thinking about it. Gordon Mumma was working with the Cunningham Company … and one day he brought along his prototype modulator and I asked: "could I use it?" and eventually gave it to me.* […] *My objective was really to find out: "can I imitate what I had done," because I liked that material so much … I didn't want to see it die.*[106]

[104] The Vox Showroom, "Vox V809 Repeat Percussion Module by JEN–1969–1973," accessed December 15, 2018: http://voxshowroom.com/us/misc/v809.html

[105] In general, electronics have long been used to simulate preexisting physical effects with more facility and/or mobility. Recall how Tudor and Mumma used amplifiers in *Quantitäten* to equalize bad pianos and make them sound *as if* they were good. Electronics create virtual appearances of physicality.

[106] Tudor, "Interview by Fullemann."

Figure 8.34 Gordon Mumma | *Prototype Pepsi Modifier*
DTC, Instrument 0130 | World Instrument Collection, Wesleyan University

This effort of resurrection led to a series of simulated *Pepsi Pieces* over the next couple of years that ended up being all tied to a specific collaborator. Viola Farber was a dancer and a choreographer who had been a founding member of MCDC, which she left in 1968 to create a company of her own.[107] On May 14 and 15, 1971, Farber presented an evening of dance at the American Theatre Lab in New York City, which included a piece called *Survey* that used, according to the program note, "music produced from materials collected at the Pepsi Pavilion by David Tudor"—a virtual *Pepsibird* or *Anima Pepsi*.[108]

Three years later, over two weekends in early June 1974, Farber premiered another dance using music by Tudor at the Cunningham Studio. According to Jack Anderson, who later wrote a review of the same piece for the *New York Times* in 1978, Tudor not only provided music but also inspired the title of the dance based on how the music appeared to him:

> *It was composer David Tudor who prompted Miss Farber to name a work "Dinosaur Parts." He was playing some of his electronic music for her one day, including a strange piece that reminded Miss Farber of "rumblings from the depths of the earth*

[107] Farber also played the piano well and performed as the only female pianist in the 18-hour marathon concert of Erik Satie's *Vexations* organized by Cage on September 9, 1963.
[108] Viola Farber Dance Company, "Program Note, American Theatre Lab (May 14–15, 1971)," Box 77, Folder 6, David Tudor Papers, GRI.

> *or the songs that gargoyles might sing." When it was done, he said, "So now you've heard my dinosaur music for dance."*[109]

This "strange" piece that reminded Tudor of long-extinct animals was a new version of *Microphone* which he had revived in May 1973 during his residency at Mills College using the *Prototype Pepsi Modifier*.[110]

By the summer of 1974, the only *Pepsi Piece* that had not been simulated in one way or another was *Pepscillator*. Fourteen years later, speaking with Hultberg in Düsseldorf, Tudor looked back on what he did:

> *Another program I did for the* Pepsi Pavilion *dealt with trying to make the whole system oscillate, again without any sound input. By manipulating the threshold controls to all the modifiers in sequence, rhythms began to appear and the degree of their variability was really extraordinary.* [...] *And again, I couldn't recover the piece because it was so dependent on that system but I happened to have the prototype of the modulator and I thought, "If I apply my feedback principles (which incidentally always start with different degrees of phase change), maybe I could reproduce those rhythms." So I did it.*[111]

The resulting virtual *Pepscillator* was named *Pulsers* and premiered as music for Farber's dance event at the Walker Art Center in Minneapolis, Minnesota, on October 13, 1974, just four months after *Dinosaur Parts*.[112]

4

When he obtained the *Prototype Pepsi Modifier* from Mumma, Tudor followed his habits and did to the new instrument what he had done to all the others: he opened the box and studied how it worked. As he reminisced to Fullemann on September 3, 1984:

> *So when I went inside it, I poked around and I saw various things: there was a chip used, the 1545, which is bipolar in and out. So I immediately took the unused outputs and added another chip. And then I changed the threshold situation.*[113]

109 Jack Anderson, "Choreography Conceived as 'Reporting,'" *New York Times*, February 26, 1978.

110 On February 18, 1974, Lucier, who was planning a joint concert with Tudor at Wesleyan University, wrote to Ahmedabad, India, where the latter was staying, to suggest performing *Microphone* outdoor: "we could do it outside on a terrace in the middle of the new Center for the Arts; [...] Do you like the outdoor idea? I think it would be wonderful to fill the Center space. With dinosaurs. I hope you agree" (Lucier, "Letter to David Tudor [February 18, 1974], Box 19, Folder 6, David Tudor Papers, GRI). This concert took place on May 4 of that year.

111 Tudor, "Interview by Teddy Hultberg."

112 Tudor's later description states the piece was developed "Originally for Viola Farber's Events, Minneapolis, 1975" (Tudor, "Description of *Pulsers*," Box 3, Folder 26, David Tudor Papers, GRI), though the only Minneapolis performance where Farber and Tudor collaborated appears to have taken place in October 1974, which also matches the date on the *Pulsers* diagram.

113 Tudor, "Interview by Fullemann."

Michael Johnsen, who followed Tudor's steps and went inside the same instrument in 2014, has revealed that this was indeed more or less what Tudor actually did.[114] The *MC1545* was a voltage-controlled amplifier IC chip sold by Motorola that Mumma had used for the *Pepsi Modifier* project. When he went inside, Tudor brought out the unused pins of the *MC1545* chip onto the panel, as well as the internal preset resistor (trimmer potentiometer or trimpot) of the noise-gate (squelch) circuit located in between the FM and AM sections to suppress unwanted noise (Figure 8.35). As always, this allowed him to intervene in the internal circuitry at various points—to un-coordinate what had been coordinated. In particular, having access to the preset trimpot meant that the threshold level of noise to be suppressed by the noise gate could be manipulated easily—"I changed the threshold situation." Like the organ keys, he could now open or close the gate to let more or less noise in. Tudor's modification therefore enabled direct control of the degree of feedback oscillation during performance. When coupled with the controls of depth and rate in the AM and FM sections, he could influence the speed and pitch of the recycling rhythm.

These circuit-level observations can be coordinated with other materials. Tudor's redrawings of Mumma's schematics and layout diagrams found among his papers contain marks in red and blue corresponding to the exact spots he made the modifications.[115] It also fits nicely with Tudor's reminiscence to Fullemann in September, 1984, about how he performed *Pulsers* during a three-day CIE concert series at The Kitchen seven years earlier on January 7 and 8, 1977:

> *the first evening when I began to open the threshold, the piece began quite calmly with very slow rhythms.* [. . .] *So it began very calmly and then the fast rhythms began to take over.* [. . .] *Now, the second night I opened up the threshold and all of a sudden . . . it was like you were in a rock and roll hall. The piece was really jumping. So the process of calming it down became quite interesting. But that's the kind of thing I remember.*[116]

[114] Michael Johnsen, "E-mail to You Nakai, John Driscoll, Phil Edelstein, Ron Kuivila, Matt Rogalsky, Matt Wellins," February 11, 2014. Michael's aim was to study the *Prototype Pepsi Modifier* as well as the modifications Tudor applied in order to reverse-engineer the circuitry and build clones of the same instrument. He has accomplished this task and the cloned modulators with which the (virtual) *Pepsi Pieces* can be performed are now available.

[115] Tudor, "Notes and schematics for *Prototype Pepsi Modulator*," Box 41, Folder 1, David Tudor Papers, GRI.

[116] Tudor, "Interview by Fullemann." Tom Johnson wrote a review of the same concert for the January 24, 1977, issue of *The Village Voice* in which he described Tudor's performance in detail: "For his January 7 performance, he had six discreet channels working, so at times quite a few patterns were churning away at once. With the touch of a dial any one of them might speed up, slow down, shift its accent, fade in, or fade out. Some of the patterns seemed to be going through rather complicated changes without the aid of manual adjustments. For almost an hour the patterns shifted continually, and the changes happened so quickly that it was often not possible to keep track of everything. The piece could be considered minimal in that its basic materials are relatively restricted, but it is certainly not the kind of repetitious slow motion that one usually associates with the term 'minimalism.' [. . .] His tableful of equipment must have included at least 15 or 20 separate little components, all of which seemed to require more or less constant attention. A twist here, a twist there, a pause to check some

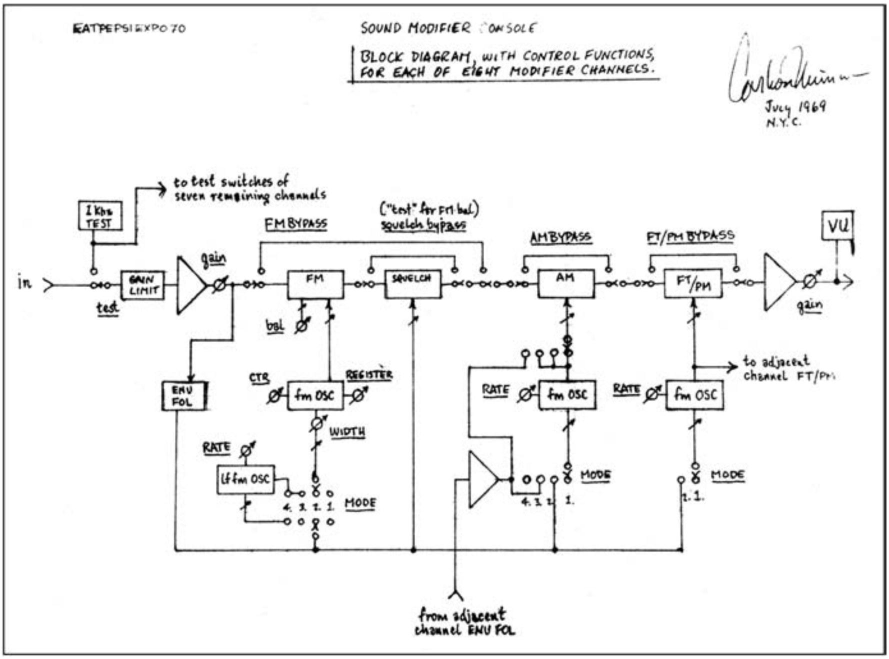


Figure 8.35 Gordon Mumma | *Sound Modifier Console* | July 1969
Courtesy of Gordon Mumma

Like *Pepscillator*, whose re-cyclical rhythmic patterns made the visitors dance in the *Pepsi Pavilion* and gave birth to the working title of "Rhythm," *Pulsers* was described as an exploration of "the world of rhythms created electronically, by analog, rather than digital, circuitry."[117] And indeed, what one hears in the recordings is a continuous oscillation of quasi-regular rhythm—as Tudor described in September 1985 as a matter of course: "Oh, in *Pulsers* the rhythms are regular. They change mostly in their speed."[118] This character appears to have inspired the addition of Kosugi's violin to

connection, an adjustment somewhere else, a delicate fade-in movement, another adjustment, and so on. At least one hand was always in the move, and when he made an adjustment, one could immediately hear what he had done. He remained extremely cool, slouching and smoking most of the time, but a virtuosity came through all the same. [. . .] Somewhere around the middle of the performance an additional element appeared. This was a tape recording of Takehisa Kosugi playing his electronic violin. I'm not sure how Kosugi's electronic violin works, but in this context it sounded a little like a theremin, a little like whale calls, and something like a wolf turned loose in a gymnasium. Its tone slid all over the electronic rhythms, and its more expressive, more soloistic personality added a unique perspective to the basic 'Pulsers' music. I learned later that Tudor had hoped that Kosugi would be able to play his electronic violin live with the performance, which seemed like an excellent idea to me. In fact, that is probably about the only way in which Tudor might improve on what he already has" (Tom Johnson, "David Tudor's Homemade Pulsers," *The Village Voice*, January 24, 1977 [Box 65, Folder 2, David Tudor Papers, GRI]).

117 Tudor, "*Pulsers*, description," Box 3, Folder 26, David Tudor Papers, GRI.
118 Tudor, "*Hedgehog*, Mobius Art Center, Boston (September 29, 1985)," C73, David Tudor Papers, GRI.

accompany the electronic part, as an analog of Cage's vocals that had been coupled with *Untitled*, another no-input feedback music known for its continuous rhythmic character. But the nature of the *Prototype Pepsi Modifier* and the regularity of rhythms it produced also inspired something else, which had to do with proliferating its own voice rather than adding a separate one.

5

The differences between the two feedback *Pepsi Pieces* required different approaches in creating their analogs. For the external acoustic feedback bursts of *Microphone*, Tudor needed to simulate the entire *Pepsi Pavilion* virtually—the switching speaker patterns as well as the spatial reverberation. At Mills College he did this by connecting the *Prototype Pepsi Modifier* to an echo chamber and several *Ling Electronics EPN-10 Peak and Notch Filters*, a "fantastic [. . .] old tube device" that he had found lying around the school during his residency. As he continued his reminiscence to Fullemann on September 3, 1984:

> *It's got three gang-switched frequency controls plus vernier, so you can tune up 59 . . . you tune out 60 cycles and retain 59, 61. It only went up to 5000 cycles.* [. . .] *And I found that by putting the filter into this circuit I could tune the space. It acted as an additional gate.*[119]

In contrast, additional modulation was a peripheral issue for *Pepscillator* which explored the internal electronic feedback of the *Pepsi Modifier*.[120] In the diagram Tudor drew for the first performance of *Pulsers*, the output from the giant oscillator section composed around the *Prototype Pepsi Modifier* (elongated box labeled "FM-AM-FILT") was simply modulated with the Formant Shifter network which was then further mixed with direct output from the same *Prototype Modifier* going through a *Z-amp* (Figure 8.36).[121]

[119] Tudor, "Interview by Fullemann." The description in the manual Tudor kept confirms this recollection: "The Model EPN-10C Peak and Notch Filter is an electronic filter with unity gain from 5 to 5000 cps, except at one frequency. At this frequency (continuously adjustable from 30 to 5000 cps), either a resonant peak or notch can be inserted in the filter response. Peak height or notch depth is continuously adjustable from 0 to 40 db (peaks as high as 70 db) above or below unity gain. The Q of the peak or notch is continuously adjustable from 0 to 1000" (Ling Electronics, "Model EPN-10C Peak and Notch Filter Manual, 3-1," Box 37, Folder 1, David Tudor Papers, GRI). This filter, which appears in the list of instruments Rogalsky compiled in 1999, has gone missing since.

[120] Tudor had a memorable experience in regards to a live-recording of *Pulsers* on March 21, 1976, at the Sydney Conservatorium of Music in which the sound engineer switched off the microphone input five minutes into the piece and recorded only line level, which turned out to be all "clicks and pops" (Tudor, "Interview by Fullemann"). The anonymous engineer thereby lost what Tudor regarded as "one of the best performances I ever had" (ibid.), but inadvertently gave him a new idea about "clicks and pops." The consequences of this realization will be detailed in Chapter 9.

[121] Tudor, "*Pulsers* diagram for V.F. at the Walker Art Center (October 1974)," Box 4, Folder 21, David Tudor Papers, GRI.

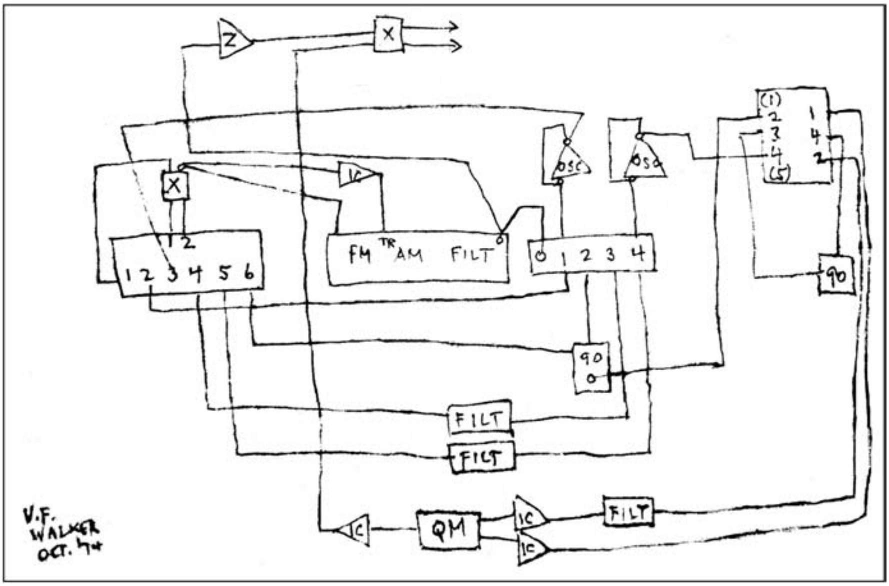


Figure 8.36 Tudor | *Pulsers* for Viola Farber, diagram | Walker Art Center | October 13, 1974
DTP, Box 4, Folder 21 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

However, when the piece was developed into a full-scale work three years later in 1977, Tudor resorted to the same solution he used in *Toneburst* to cope with the same problem of having only one giant oscillator as source (Figure 8.37): he added ten output processing channels to the giant oscillator section, of which eight overlapped with that other no-input feedback music he was performing at the time: (1–2) two *PAiA Synthespins*, (3–4) *Phaser/Flanger* with two stereo outputs ("a+b/a–b"), (5–7) Formant Shifter network with each of the two complementary filters also being output independently, and, (8) *Toneburst Generator*. The two new instruments were *Electro-Harmonix Octave Multiplexer*, which generated a tone one octave below the input signal, and *Vox Repeat Percussion*, which chopped continuous tones into percussive short attacks. Absent instead were the two *Photocell Keys*, which might have been the corollary of having a threshold control inside the *Prototype Pepsi Modifier* already. In any case, as often happens with effects processors, the attempt of simulation had led to the creation of something that was nowhere in the original.

6

Weatherings kept all the output processing channels from *Pulsers* but replaced the giant oscillator section with the *Pepsi Tapes*. By doing so, the multiple disguises of a single voice were transformed into multiple disguises of multiple pseudo-voices. To effectively maneuver this many-to-many configuration, Tudor introduced two

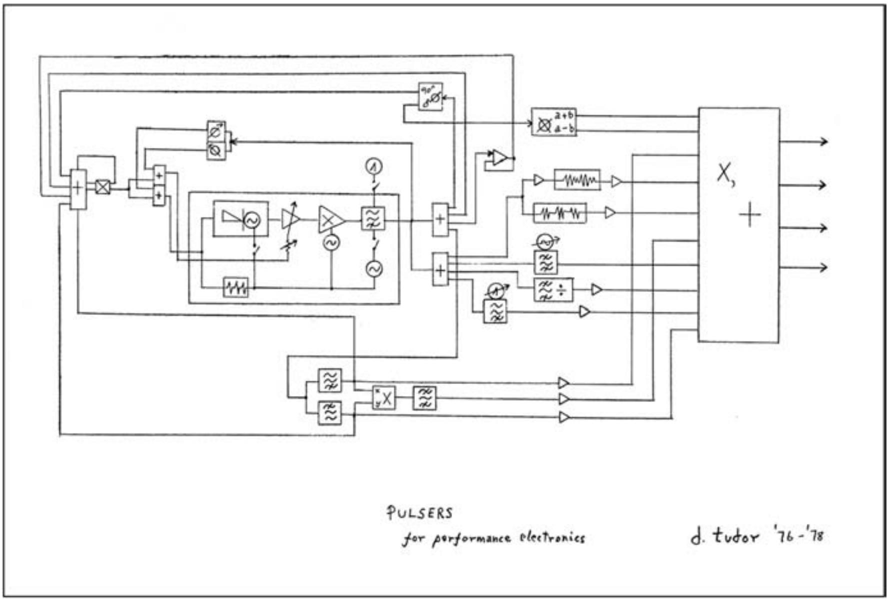


Figure 8.37 Tudor | *Pulsers*, generalized diagram | 1976–78
DTP, Box 3, Folder 26 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

Cherry Matrix Switchers, which made possible a flexible routing between multiple inputs and multiple outputs. As shown in one neatly drawn diagram signed and dated 1979 (Figure 8.38), the source tapes and effects processors were all arranged around these two switchers, one connecting 20 inputs to 10 outputs (20 × 10) and the other 10 inputs to 30 outputs (10 × 30), with 10 outputs from the second feeding back to the input of the first.[122] The other outputs all went into a *TEAC 2A 6-Track Mixer* and two 4-track submixers before being sent out to six loudspeakers. There was also one microphone input ("150" = Sony ECM-150[123]), a remnant carried over from *Forest Speech*.

This particular version, however, appears to have been short-lived. Among the 20 or so diagrams related to *Weatherings* that are scattered across boxes and folders of the David Tudor Papers at GRI, there are only two others in which both *Matrix Switchers* make an appearance. In all the rest, only one of them is used, with the processing channels going straight into the *TEAC Mixer*; and in all except one, the instrument used is of the 10 × 30 type. The only sketch where the 20 × 10 type appears is an unfinished block diagram resembling the finalized

122 Tudor, "*Weatherings*, diagram (1979)," Box 3e, Folder 6, David Tudor Papers, GRI.
123 Tudor purchased this microphone at the airport in Paris on October 29, 1979 ("Receipt for Sony ECM-150, Charles de Gaulle Airport [October 29, 1979]," Box 134, Folder 5, David Tudor Papers, GRI).

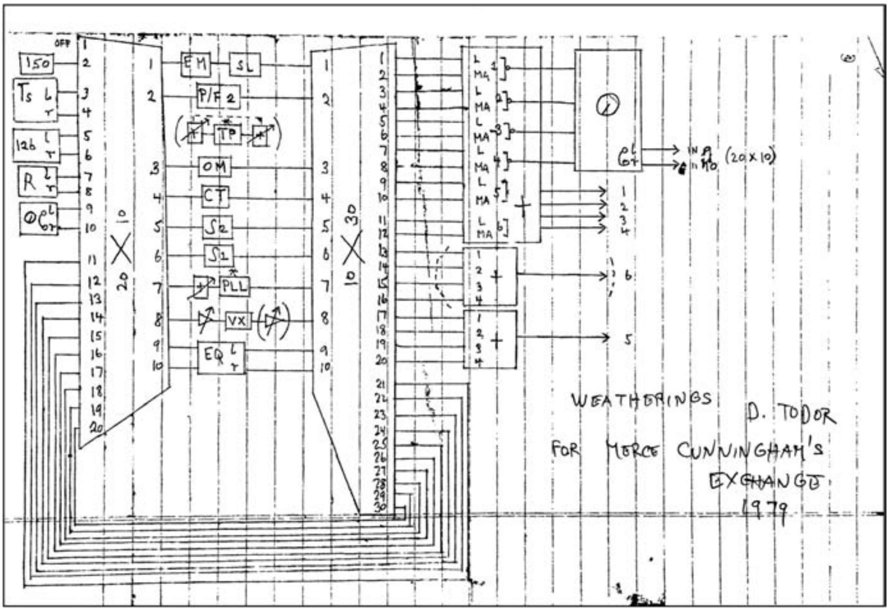


Figure 8.38 Tudor | *Weatherings*, diagram | 1979
DTP, Box 3e, Folder 6 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust
Abbreviations: "EM" = *Electro-Harmonix Electric Mistress*; "SL" = *E-H The Silencer*; "P/F2" = *Phaser/Flanger*; "TP" = *E-H Talking Pedal*; "OM" = *E-H Octave Multiplexer*; "CT" = *E-H Clone Theory*; "S1"/"2" = *PAiA Synthespin*; "PLL" = *Phase-Locked Loop*; "VX" = *Vox Repeat Percussion*.

one dated 1979 (Figure 8.38), drawn on exactly the same kind of lined paper (Figure 8.39).[124]

But these two diagrams are also exceptional for another reason: they happen to be the only documentation of *Weatherings* that are notated *in the form of a block diagram*. All the others employ a new kind of notation where the *Matrix Switcher* and the *TEAC Mixer* no longer appear enclosed in boxes but become mere headlines indicating inputs and outputs—"IN" and "OUT" for the switcher, and "L" (line level) and "MA" (microphone level) for the mixer—with individual sources and processors listed beneath them (Figure 8.40). A logical hierarchy is thus set between the two instruments that have turned into categories and lost their names, and everything else that is named and categorized under them. In an article written in 2004, D'Arcy Gray named this kind of material "matrix maps."[125] They will become the standard notation for most of Tudor's subsequent music, reflecting the fact that a particular configuration has become standardized: tape sources modified by multiple effects processors which are variables that change from one performance to another, placed in between the *Matrix Switcher* and the *TEAC Mixer* that form a constant.

124 Tudor, "*Weatherings*, unfinished sketch (undated)," Box 4, Folder 16, David Tudor Papers, GRI.
125 D'Arcy Philip Gray, "David Tudor in the Late-1980s: Understanding a Secret Voice," *Leonardo Music Journal* 14 (2004), 43.

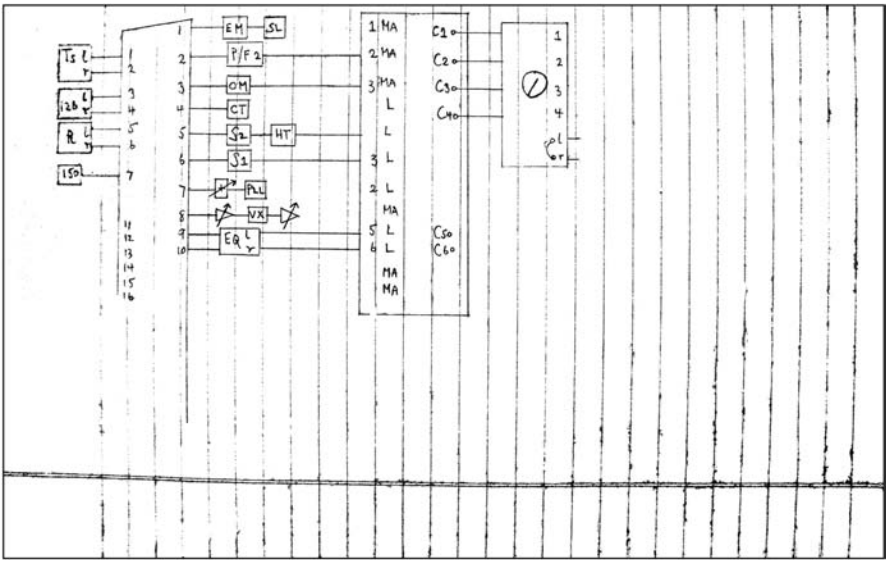


Figure 8.39 Tudor | *Weatherings*, unfinished diagram sketch | Undated

DTP, Box 4, Folder 16 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

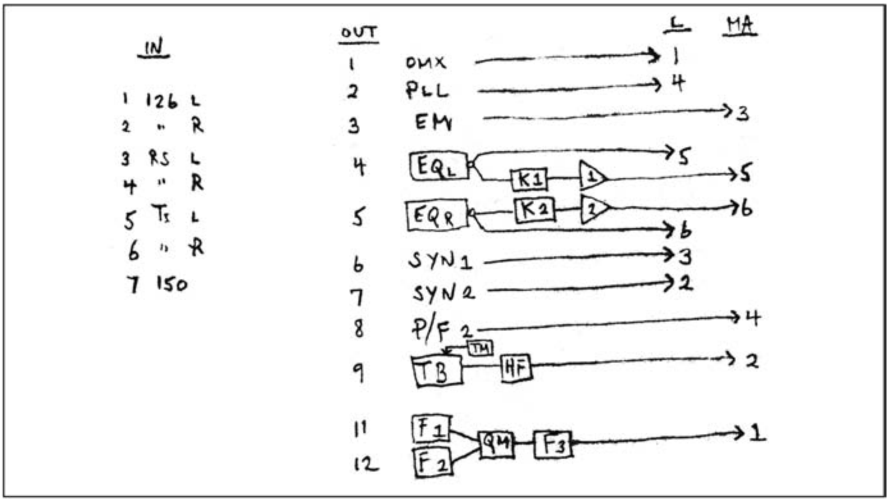


Figure 8.40 Tudor | *Weatherings,* matrix map | Undated

GRI (Box 4, Folder 11) | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

Note: The Formant Shifter network appears in outputs 11 and 12. Abbreviations: "OMX" = *E-H Octave Multiplexer*; "EF" = *E-H Electric Mistress*; "TB" = *Toneburst Generator*; "HF" = *E-H Hog's Foot*.

7

The best way to orient oneself through these maps is to simulate Tudor's habits and carefully observe the material bias of what appears to be neutral. The physical nature of the *Cherry Matrix Switchers* (Figures 8.41 and 8.42) indeed constrained the seemingly universal connection between any input and output in several ways.

One concerned directionality. Although 10 × 30 and 30 × 10 appear symmetrical on paper, the actual instrument only allowed switching between 10 variables for each of the 30 constants, and not the other way around. So if Tudor used the instrument with 10 ports on the input side and 30 on the output side, the question would be which source each processor should take. More than one processor could choose the same input, but each could not choose more than one input at a time. If Tudor turned the *Matrix Switcher* 180 degrees and used the 10 ports on the output side, then the asymmetry would be reversed and the question would become to which processor each source should go through. More than one input could go to a single processor, but each could not choose more than one processor at a time. In other words, depending on the side with the 30 ports, the instrument could be either *output-biased* (10 × 30) or *input-biased* (30 × 10). For the 10 × 20 type, it was the other way around: 20 variables

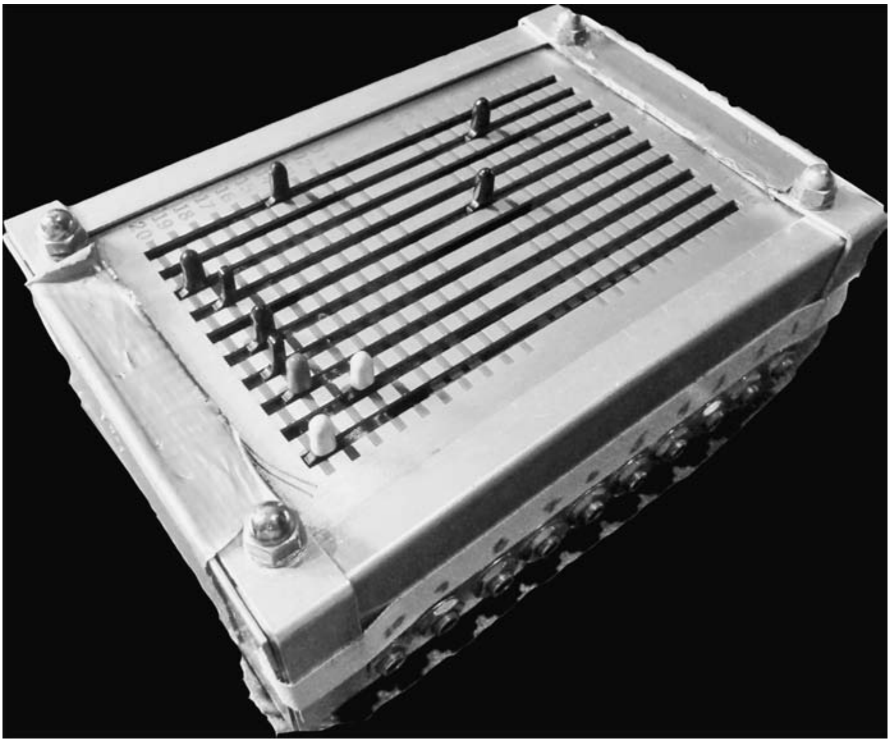


Figure 8.41 *Cherry Matrix Switcher 20 × 10*
DTC, no# | World Instrument Collection, Wesleyan University

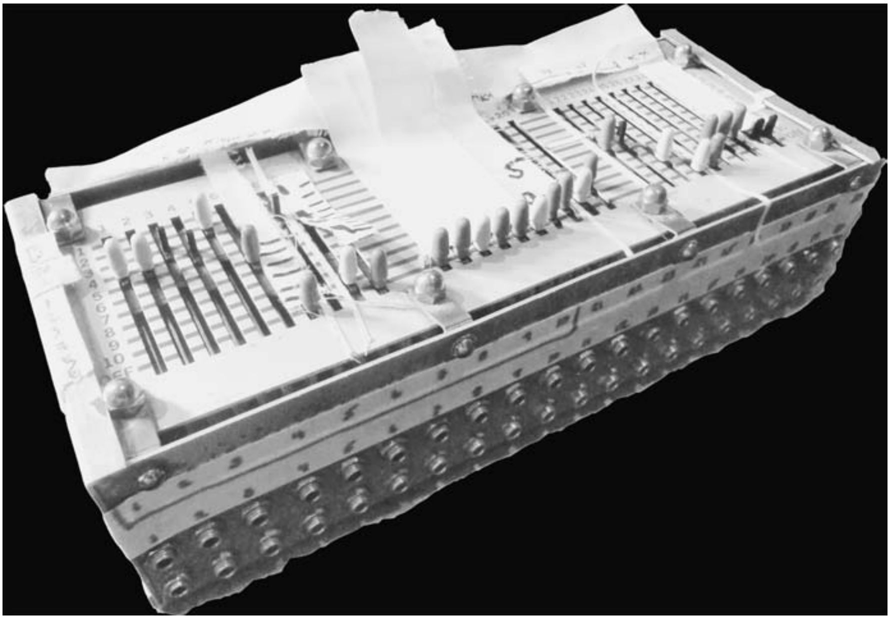


Figure 8.42 *Cherry Matrix Switcher 10 × 30*
DTC, no# | World Instrument Collection, Wesleyan University

for each of the 10 constants. This means that the two *Matrix Switchers* in the neatly drawn diagram of *Weatherings* are actually both output-biased, in spite of looking as if one was used in reverse since they have the mutual 10 ports on different sides. In fact, Tudor almost never used the instrument in the other direction.

Another material bias had to do with interface. Since the *Cherry Matrix Switcher* used a slider switch, in order to go from input 1 to 10 (when the instrument is output-biased), Tudor had to physically move through all the inputs in between. He could certainly mute the output channel while he did so, but in general, the proximity between two sources on the input side would have made the switching between them easier. In contrast, the proximity between processors on the output side of the *Matrix Switcher* could suggest the sharing of sources, although with much less certainty. This was determined more by what was meeting them on the other end.

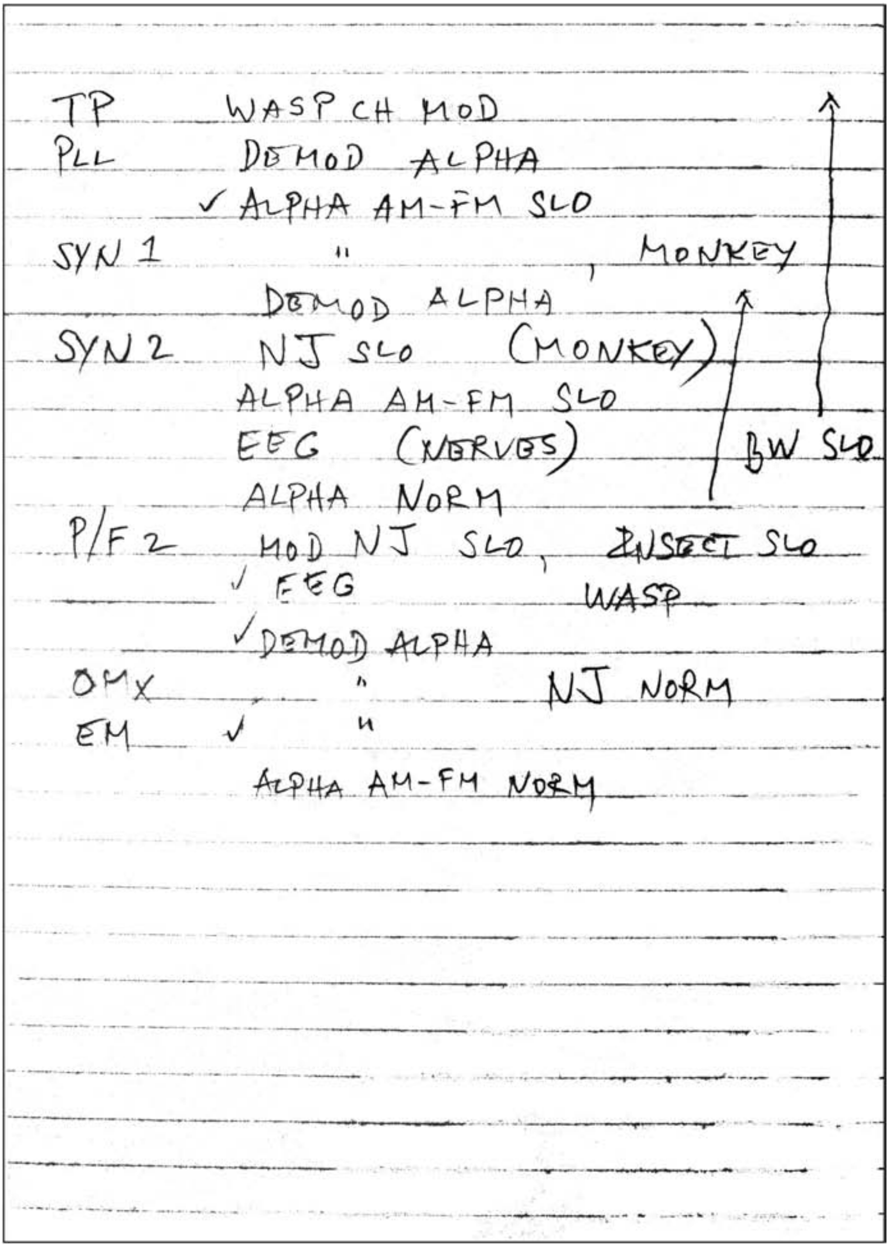
If they went into the other *Matrix* Switcher, proximity would again facilitate switching. The *TEAC Mixer*, on the other hand, had a stronger bias on how processors were ordered, as they needed to be paired together for the line and microphone inputs of each track. And the specific nature of this instrument was that it allowed the selection between the two inputs *but not both* (Figure 8.43). In other words, once the second *Matrix Switcher* was taken out, paired processors could not be used simultaneously. The pairing on the side of the mixer also became a matter of switching.

Figure 8.43 TEAC | *2A Mixer*
DTC, no# | World Instrument Collection, Wesleyan University

8

In *Weatherings*, however, there was yet another kind of material bias Tudor used to determine the coordination between instruments, which did not concern their strictly physical nature: the *character* of each *Pepsi Tape* and effects processor. Just as he had done with the instrumental loudspeakers of *Rainforest* in the past,[126] a note shows Tudor assigning specific sources to each processor—and not the other way around, confirming the observation that the *Matrix Switcher* was output-biased (Figure 8.44). Indeed, Tudor even writes down the same source multiple times, assigning it to different processors. The extant recordings reveal that these pairings of sources and processors remained largely unchanged throughout the performance. Each sound

[126] Analyzing a sketch related to the 1972 duo tour where specific *Pepsi Tapes* are paired with specific instrumental loudspeakers, Rogalsky observed: "Each source tape seems to be paired with a single object and not varied throughout its duration, which assists in keeping streams clearly audible" (Rogalsky, "Idea and Community," 180). He later offered a detailed examination of how Tudor paired fifteen *Pepsi Tapes* with the instrumental loudspeakers of *Rainforest* at the New Music for New Hampshire festival in June 1973: "Notes show careful exploration of his own sound resources with specific objects [. . .] Some signal sources appear in both the 'still' and 'sprinkler' columns, but predictably, Tudor's sounds did not always perform equally well with both objects. 'Alpha slo' is 'very good' with both, but while 'EEG' is 'excellent' when performed through the still, it is only 'OK' when heard through the sprinkler. 'Br. Wave' is 'good' with the sprinkler but just 'OK' with the still" (ibid., 228–230).



TP WASP CH MOD
PLL DEMOD ALPHA
✓ ALPHA AM-FM SLO
SYN 1 " , MONKEY
DEMOD ALPHA
SYN 2 NJ SLO (MONKEY)
ALPHA AM-FM SLO
EEG (NERVES) BW SLO
ALPHA NORM
P/F 2 MOD NJ SLO, INSECT SLO
✓ EEG WASP
✓ DEMOD ALPHA
OMX " NJ NORM
EM ✓ "
ALPHA AM-FM NORM

Figure 8.44 Tudor | *Weatherings*, coordination note for processors and *Pepsi Tapes* | Undated

DTP, Box 46, Folder 3| Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust character therefore persists. In other words, how material is "weathered," physically transformed through exposure to external influences, appears to have been largely composed in advance.[127]

In fact, *Weatherings* turns out to be one of the most structured music Tudor ever composed. Its 35- to 38-minute-long performance has an identifiable outline, always opening with the *Wasp Chewing Slow*, which after a couple of minutes is overlaid with *Wasp Chewing Normal*, then joined by *E.E.G. Modulated* around 5 minutes in, followed by *Demodulated Alpha Waves* before reaching 10 minutes. The next 10 minutes are filled with bursts of *Demodulated Alpha Wave* gated by the *Photocell Keys*, which after five minutes or so become interjected by another series of heavily flanged bursts. The high-pitched wobbly sound that always appears at the end is Tudor's favorite *Mosquito in Test Tube Normal*.

In general, the primary focus in *Weatherings (Nethograph)* remained on a scale greater than individual characters, in the structure that accommodated them and the common "themes" that bound them, as suggested by the title as a metaphor and by the subtitle as a neologism connecting the words "spin (netho)" and "writing (graph)": the process of weathering and rotation of material. Indeed, various processors not only modulated the sources but also rotated them. In particular, the cyclical sweeping effects of *Phaser/Flanger* and the *Synthespins* are prominent in the recordings. But rotation is no longer physical, like the cranking of handles on the *Amplified Barbeque Grill*, or the switching of loudspeakers surrounding the audience in a pavilion. It is rather a virtual simulation thereof, realized mostly as a matter of appearance. Although the CIE's joint project for developing rotating loudspeakers had just received a grant from the National Endowment for the Arts in 1977, Driscoll remembered in 2002 that "[t]he rotating loudspeaker project was something that David never wanted to get involved with."[128]

9

On December 3, 1978, three months after the premiere of *Weatherings*, Tudor presented a public talk at Media Study/Buffalo where CIE had been in residence since November 10. They were researching focused loudspeakers—not rotating—although Driscoll admitted forty years later that none of them had any clue that what they were doing was connected to *Island Eye Island Ear*.[129] Tudor generally did not talk much about what was on his mind, even to his closest collaborators. That is precisely why his presentation toward the end of the residency was an extremely rare occasion. Unfortunately, the recording of the event appears to have been lost, but a newsletter of Media Study/Buffalo published in January 1979 included a brief report on what had taken place:

[127] That said, Tudor, in his customary manner, did keep adding new equipment to his sound system. For instance, *The Silencer* was purchased on June 21, 1979, nine months after the premiere (Tudor, "Order for *The Silencer* to Musician's Supply [June 21, 1979]," Box 134, Folder 5, David Tudor Papers, GRI).

[128] Driscoll, quoted in Rogalsky, "Idea and Community," 345.

[129] John Driscoll and Phil Edelstein, "Conversation with You Nakai," New York, NY, June 19, 2018.

> *David Tudor spoke on "Altering Signal Sources In Real Time: transformations by electronic and non-electronic means, speech and other sound simulations; or, how to make the ordinary extraordinary." Explaining in detail the techniques fundamental to his work, Tudor traced the historical development of this personal style of electronic music-making, and argued for "output processing," the electronic enhancement of basic sound sources, as a means of heightening the aesthetic quality of musical material.*[130]

The language used, presumably taken from how Tudor actually spoke that day, reveals an analogy between the creation of multiple appearances from a given source and the technological enhancement of nature, which triggered reflection and heightened the experience of the visitors wandering through the island of sound beams or the forest of loudspeaking objects. But there was a strange mismatch too: while the act of reflection in *Island Eye Island Ear* and *Rainforest* was conditioned by experiencing *both* the "natural" source—the island or the instrumental loudspeakers—and their enhancement, *Weatherings* focused on presenting already processed sounds. If anything, Tudor's initial interest in output processing was to "mak[e] the sound outputs different enough that you could not recognize them as being generated by the same signal."[131] If the connection to the source is deliberately occulted, there would be no chance for reflective comparison.

In his lecture-demonstration in Buffalo, however, Tudor presented things still more differently:

> *Introducing "a sound that I hate," a recording of a grasshopper chewing a grape leaf, Tudor demonstrated how, by output processing techniques, that sound could be transformed into a striking musical event. A substantial portion of Tudor's presentation was taken up with an actual performance in which he demonstrated ways in which the techniques he had explained may be used musically, in an interaction with the acoustics of a space, to produce complex auditory illusions.*[132]

Tudor not only created complex illusions (as usual) but also showed how the illusion was created. Although presented as an explanation of his method, the way he explained it was itself a new method that had not been heard in his music before. Staging the process of transformation in real time brought about two significant changes in how a listener perceived the sound: (a) since it was presented to them in a lecture hall, the audience did not need to walk around to reflect on the differences, and (b) despite Tudor's explanation, the polarity between nature and its technical enhancement ceased to be the point, for it did not matter anymore whether or not the source was natural. What mattered was how it

[130] Media Study/Buffalo, "Newsletter, January 1979," Woody and Steina Vasukla archive, accessed September 1, 2019: http://www.vasulka.org/archive/4-30d/MedBufJan79(6000).pdf. Quoted in Rogalsky, "Idea and Community," 322; also available at davidtudor.org, accessed September 1, 2018: https://davidtudor.org/Articles/cie_buffalo.html

[131] Tudor, "Interview by Teddy Hultberg."

[132] Media Study/Buffalo, "Newsletter, January 1979."

went from being one thing to another as one listened. In a way, Tudor was not so much spilling the beans as putting on a new trick under the guise of revealing the old.

After being in the company repertoire for almost three years, the last performance of *Weatherings/Exchanges*—before its revival a decade later—took place at the Sadler Well's Theatre in London on June 18, 1981.[133] Three months before, on March 24, Cunningham had premiered a new choreography, again at the New York City Center, called *Channels/Inserts* for which Tudor once again provided music. The new piece was called *Phonemes*. As the name bespeaks, he had returned his focus to speech—a transformation which carried the imprint of his Buffalo lecture but was triggered, as usual, by a change of instrumentation.

Phonemes

1

On January 8, 1981, Tudor purchased a kit from PAiA Electronics called *The Drum*.[134] The straightforward name was a straightforward synecdoche deliberately mistaking the specific instrument with a general category of instruments. But the coordination between the part and the whole was in appearance only, for this was yet another electronic instrument simulating an acoustic instrument. It was a part disguising a whole it had never been part of. Also dubbed an "analog percussion synthesizer," this more formal second name spelled out its true pedigree—a family of synthesizers which, after more than a decade of experimental development by various makers, had become widely available as a commercial product around then.[135] The mechanism of disguise was quite versatile. *The Drum* synthesized drum-like sounds using one of two input triggers: (a) physical hit on the drum transducer, a piezo microphone which could be attached to any object to transform the applied force into an electrical signal, or (b) any sound which had already been transduced into an electronic signal by other transducers (microphones or pickups). The difference between the ways signals were generated did not make any difference on the receiving end. Whatever their pedigree, the triggers functioned as a virtual hit on the synthesizer to produce drum-like sounds.

[133] This performance was recorded by David Meschter and is archived as part of the David Tudor Papers: "*Weatherings*, Sadler Well's Theatre, London (June 18, 1981)," Box 1A, C11, David Tudor Papers, GRI.

[134] A cutout of a two-part article from the May and June 1980 issues of *Radio Electronics* describing the instrument in detail is found among Tudor's papers: Steve Wood, "Build This: The Drum . . . A Percussion Synthesizer (Part 1)," *Radio-Electronics* (May 1980), 49–52; Wood, "Build This: The Drum . . . A Percussion Synthesizer (Part 2)," *Radio-Electronics* (June 1980), 59–62 (Box 3, Folder 23, David Tudor Papers, GRI).

[135] The first attempt at controlling a rhythm box with external touch-sensitive pads was initiated by Felix Visser in 1967. The first commercial drum synthesizer *Syndrum* was released by Pollard Industries almost a decade later in 1976. The percussion synthesizer would become one of Tudor's favorite instruments throughout the 1980s. MCDC's list of equipment from April 1986 includes at least two others that Tudor owned: *Amdek Percussion Synthesizer PCK-100* and the *Cosmo Super Sound Drum* (MCDC, "Equipment list [April 1986]," Box 32, Folder 4, David Tudor Papers, GRI).

Figure 8.45 Tudor | *PAiA The Drum Analog Percussion Synthesizer*
DTC, Instrument 0117 | World Instrument Collection, Wesleyan University

To do this, *The Drum* first tracked the shape (peaks) of the incoming signal through an envelope follower with a controllable decay rate. This information was then used to determine three parameters of an entirely new signal generated inside the instrument: (a) frequency was determined first by a voltage-controlled oscillator which produced the signal; (b) amplitude was determined next by a voltage-controlled amplifier; and (c) the spectrum of a noise source, necessary to create a likeness to un-pitched components of percussion sound, was determined by a voltage-controlled filter. All modulations thus impressed, to a varying degree, the character of the trigger signal onto the newborn signal. That is to say, the instrument generated an analog of whatever was input, whose degree of likeness could be adjusted by the human performer—who by doing so impressed *his* own biases. With so many midwives involved, pedigree became a matter of act, not fact. This time, Tudor finished composing the kit synthesizer (Instrument 0227) around which he composed his new music premiered three months later (Figure 8.45).

2

Phonemes was in many ways a decendant of *Weatherings*: the input sources continued to be the *Pepsi Tapes*, almost all the effects processors overlapped, and the theme of rotation was still very prominent. David Meschter, who took over the job of sound engineer for MCDC from Fullemann in 1981, recalled in November 2017 that Tudor was quite fond of what he had done in *Weatherings* and wanted to continue the work in other ways.[136] But there were also differences, of course. In May 1988, while talking to Hultberg, Tudor reflected on the piece, first describing the general approach and then going over the specifics:

> *I use the principle of making the sound outputs different enough that you could not recognize them as being generated by the same signal, in all the later pieces. For instance, one of them was called "Phonemes," which was also a dance score for Merce Cunningham. There I took two sound modifiers. One of them was a vocoder which could chop sound into small pieces. The second device I took was a percussion generator, somewhat like a percussion synthesizer which permitted me to lengthen the attack to several seconds. So then, I thought, 'now . . . if I take short sounds and lengthen them and I use long sounds on the vocoder and shorten them, I have two processes which can overlap'. . . and so I began experimenting. Listening to the combinations, it reminded me of speech. The sounds were very short, so I called the piece "Phonemes."*[137]

Among other things, a radical reduction of material had taken place: the diversity of characters that animated the sources of *Weatherings* is categorized into a simple polarity between long and short sounds,[138] as is the variety of effects processors, which is now centered around two synthesizers. As a result, the multiple ways to coordinate the tapes and the instruments, which Tudor was seen working out in the previous piece, has become a matter of combination between two pairs. The focus is neither to reveal the nature of the material nor to proliferate disguises, but to stage a process of mutual transformation, a gradual switching of identities.

3

This character of *Phonemes* appears to have been influenced by how the project began. Cunningham had initially choreographed *Channels/Inserts* as a 32-minute videodance directed by Charles Atlas in January 1981. This was not the first time Tudor scored music for a dance on video. Four years earlier, in December 1976, he had collaborated once again with Farber on exactly that kind of work produced by the Fort Worth Art Museum and KERA-TV in Dallas, Texas. The set and costumes were designed by Robert Rauschenberg, another collaborator Tudor knew well. For this project, titled *Brazos River*, Tudor stuck to his principle of using virtual *Pepsi Pieces* when working with Farber. *Video Pulsers* used visual information from the video both as input source as well as

[136] David Meschter, "Interview by You Nakai," Astoria, NY, November 21, 2017.
[137] Tudor, "Interview by Hultberg."
[138] This categorization of sounds based on their length is reminiscent of quantitative meters in Roman and Greek prosody, as well as Tudor's differentiation between percussion-like instruments such as the piano (before it was amplified) which produce only short sounds, and wind-like instruments such as the organ or bandoneon which can produce long ones.

control signal of output: (a) RGB video signals were divided in frequency and processed through two parallel modulating networks based on feedback; (b) the two networks together output ten differently processed audio signals (à la *Pulsers*) to a matrix switcher controlled by ten one-color-sensitive photocells placed in front of the monitor playing back the same video source. The two modulating networks were essentially simplified analogs of *Toneburst* and *Pulsers*, one using the *Spectrum Transfer* and the other the *Prototype Pepsi Modifier* as central modulators. Feedback loops with phase shifters and equalizers were drawn around them.

Four years later, Tudor's focus had shifted. Music was now coordinated with visuals based on how the sound appeared to the human viewer and not to the one-color-sensitive photocells. Reviewers at the time described the short sounds that characterized *Phonemes* variously as "liquid gurglings and explosive sounds resembling of fireworks,"[139] or "full of warlike sounds suggesting sirens and bombardment."[140] But one particularly apparent likeness was left unmentioned: the irregular and discrete sounds of the dancers' footsteps which are very audible in the film, mixed almost at the same level as the music. That is to say, Tudor's music provided illusionary dance steps, while the sounds produced by dancers disguised the electronic pulses in turn.[141] In spite of being "composed without reference to the particulars of the choreography," *Phonemes* coordinated with *Channels/Inserts* through an overlap of sonic characters, creating a coherence that is deceptive in the viewer/listener's mind. As such, it also enhanced the concept that Atlas and Cunningham explored, which the latter described as "the possibility of placing the cast and the scenes in a way as to give the sense of dual events happening concurrently"[142]—an illusionary simultaneity between two separate events, which of course applies to the dual relationship between the dance and music as well. In the visuals, this effect was achieved by the use of smaller movements and cross-cutting techniques, inspired by the language of television, which was honored in the dual title of *Channels/Inserts*. Polarities were composed and decomposed, both in appearance only.

4

In keeping with the spirit of the work, it might be good to change our footing and first approach *Phonemes* from how it sounds. Anna Kisselgoff said it best in her review of the stage version of *Channels/Inserts* for the *New York Times* on

[139] Jack Anderson, "The Dance: 'Channels/Inserts,'" *New York Times*, March 8, 1987.

[140] Anna Kisselgoff, "Dance: Cunningham's 'Coast Zone,'" *New York Times*, March 21, 1983.

[141] On a number of occasions, Tudor explained that he mostly experienced Cunningham's dance as sound. For example, when he answered Eliot Kaplan's interview for the video documentary on Cage and Cunningham in the late 1980s: "Just listening to it happen in the space was really beautiful because there was extraordinary movement and then absolute stillness, and as a musician that's one of the ways that I experience dance, it's in the sounds they produced. It's not in my habit to look at dance while I'm performing but to listen to it at the same time. It's part of … I wouldn't say that it's part of my music but it's part of the experience of producing the music" (Eliot Kaplan, *Cage/Cunningham*, Cunningham Dance Foundation, 1991).

[142] Cunningham, quoted in the summary of the video: Merce Cunningham and Charles Atlas, *Channels Channels/Inserts*, Cunningham Dance Foundation, 1982.

March 21, 1983, when she described Tudor's music as "all purposefully dramatic."[143] *Phonemes* indeed appears to depict the drama of two characters who aim to transform into each other. The sounds are generally short, reminiscent of dancers' footsteps. A recurring pattern of background tones and rotational effects fabricate a virtual stage, so to speak, whose temporal constancy makes it easy to identify the sound characters despite their irregularity. How the two characters make an appearance and undergo mutual transformations over the course of performance—usually lasting between 27 to 33 minutes—is composed theatrically from start to end. That is to say, *Phonemes* is Tudor's version of program music if ever there was one. To generalize from recordings of different realizations, the drama proceeds more or less as follows:

(a) A minute or so of fart-like long tones modulated up or downward opens the curtains [very likely short sounds from the *SN76477 Complex Sound Generator* IC chip lengthened by controlling the decay rate of the envelope follower inside *The Drum*];
(b) The "short sounds" make an appearance as a fast, irregular array of shot-like pulses [*Longhorn Beetle Walking* chopped using a noise gate] which sometimes trigger, as if one of the shots had hit a mark, its own modulation in various ways. These are usually accompanied by a faint, relatively high-pitched recurring sound pattern in the background, which fabricates a virtual stage;
(c) The pulses are soon joined by another group of relatively continuous moving sound [*Modulated E.E.G.*], reminiscent of a noisy duck quacking its way through and around the dry and wet pulses;
(d) After ten minutes or so the effect of rotation moves more to the fore and starts affecting both the pulses and the duck, gradually making the one appear as the other and vice versa. The "basic sound manual" of MCDC from 1987 when *Channels/Inserts* was revived, indeed contains one specific instruction for performance: "At about minute 14, DT cues DM [David Meschter] to start pan manipulation. The type of signals that DT sends to the *Sound-A-Round* determines how the sound is to be panned."[144]
(e) Toward the end, the pulses are heavily modulated, creating a cloud of sounds moving in a pseudo-continuity.

The actors are limited, and the events are tightly staged. The two characters undergo many forms of modulation, but what governs their trajectory is not the concern for making sounds different enough to occult the connection to the original source. Instead, the very notion of origin is presented as illusionary since *characters are often introduced already in disguised form*—short sounds are shortened sounds. The perceived identity is simply a point of departure for the drama to unfold.

[143] Kisselgoff, "Dance: Cunningham's 'Coast Zone.' "
[144] MCDC, "Active Repertory 1987, Basic Sound Manual," Box 28, Folder 8, David Tudor Papers, GRI.

Paradoxically, the unconcern for the nature of materials reflects the nature of materials used. In *Untitled*, the three *Study Tapes* had stood in as a perfect substitute for the giant oscillator which produced them. But the *Pepsi Tapes* were not chosen for their connection to the nature of instruments; they were chosen for how they sounded and what they reminded the listener of. Like the trigger input to *The Drum*, the difference in how signals are generated does not make any difference in how they are synthesized on the receiving end. After all, as he listened to the tapes he had salvaged from Osaka, Tudor was reminded of the voice and not the physiological mechanism of walking longhorn beetles or flying mosquitoes.

5

Behind the apparent drama on stage, however, *Phonemes* suffered from a technical problem specific to program music. During the interview with Fullemann on September 3, 1984, Tudor compared the experience of performing this piece and *Toneburst*. With no-input feedback, "anything could happen because there was basically just an oscillation in a state of instability."[145] Which is also to say that nothing in particular needed to happen: "the sound materials aren't important at all because there aren't any."[146] With the theater of sound characters, the situation was quite the contrary, for what was needed was precise control to make materials appear as planned. But this did not go so well, as Tudor reminisced to his former sound engineer:

> *Now, "Phonemes" was a problem, because that is supposed to have a second input to it. And making that one appear . . . like, the principal input is sometimes a problem, so sometimes I have to wrestle with it to make it happen. And then a lot of variation is possible because of the fact that there is a second input, so there is a real choice you can make.* [. . .] *Well, the thing is that my focus is on the main input. I also control that, but how the second input interplays into that can make a lot of changes depending on what's available to me. Sometimes I make what seems to be the wrong choice, and I have to sort of correct the situation without removing what I've chosen. So, in other words I have to live with it. Oh, things can get real different; as a matter of fact, that piece now is at a point where it's difficult to remember the original version.*[147]

What Tudor means here by "second input" is not immediately clear. The ordinal ("second") brings to mind the "second device" he would describe to Hultberg four years later, by which he meant the percussion generator used to lengthen short

[145] Tudor, "Interview by Fullemann."
[146] Ibid. Tudor did have a rough outline of performance in mind, as Klüver and Martin's later article described (Billy Klüver and Julie Martin, "Sound into Image: The Collaboration between David Tudor and Sophia Ogielska," in David Tudor and Sophia Ogielska, *Toneburst: Maps and Fragments*, 1996). See footnote 83, Chapter 7 for details.
[147] Tudor, "Interview by Fullemann."

sounds. But the confession that the "second input" was difficult to make appear is puzzling, since *The Drum*, still alive and well among Tudor's instruments at Wesleyan, can indeed make short triggers long even today when activated.[148]

But as he spoke to Fullemann in September 1984, Tudor also had another problem: that of making the piece reappear in his mind in the way it initially sounded three years before. Fortunately, he kept a recording of an early performance of *Phonemes* at Sadler's Wells Theatre in London on June 20, 1981, just three months after the premiere (and two days after the last performance of *Weatherings*).[149] The music is almost identical to the one heard in the videodance. What is striking about this "original version," compared to later recordings of *Phonemes*, is the relative absence of long sounds. Aside from the ascending and descending fart-like tones in the opening scene, almost the entire performance is composed of various transformations of discrete pulses. Long sounds appear only in a few scenes as modified short sounds, creating the illusion of continuity either through fast repetition (from 17′30″, for instance) or rotational effects (notably from 18′30″ to 23′20″).

The only other long sound is long from the start: a faint, continuously wobbling *Brainwaves* tape which provides a sonic backdrop for the rapid punctuation of pulses. The appearance of this subtle character is highly choreographed, first entering to set the stage from 2′00″ to 5′40″, then returning in the last four minutes of the performance from 23′00″ to close the piece. But this particular sound is also a good reminder of the fact that the absence of long sounds could not have been due to their lack as source material. There were certainly many *Pepsi Tapes* whose sounds were continuous. In fact, some short sounds that appeared were long sounds shortened before making an appearance.

If long sounds as such or shortened in advance could be made to appear, and short sounds that make an appearance could be lengthened, there is only one type of long sound that is missing. The puzzle of the "second input" must be related to the process of lengthening short sounds *before* they appeared—"And making that one appear. . . ."

6

But that is not the only puzzle here. Following the reasoning above, the "principal input" can be assumed to be related to the process of shortening long sounds. But although this process is said to have worked relatively well, and the recordings confirm those words, just *how* it worked is a mystery in itself. For it is not clear what Tudor had in mind when he explained that the principal device used for shortening long sounds was a "vocoder." There are only two instruments that appear to match that name among the ones he owned back then:

148 This was confirmed in a joint research with Michael Johnsen at Wesleyan University in April 2018.
149 Tudor, "*Phonemes*, Sadler's Well Theatre, London (June 20, 1981)," Box 2A, C62, David Tudor Papers, GRI.

(a) ***Electro-Harmonix Talking Pedal***; and
(b) ***Electro-Harmonix Bass Balls***, a dynamic filter controlled by an envelope follower, which tracked the input signal's amplitude and used this information to sweep the peak frequency of the filter up and down, generating "very unique vocal-like sounds."[150]

However, neither the speech synthesizer (otherwise known as a wah-wah pedal), nor the dynamic filter (otherwise known as an "auto-wah"), would have done a good job of "chopping sound into small pieces," since their function is not to gate sounds but to filter their frequency content using the formants of human speech or the amplitude of input.

There are three other instrumental suspects in the sound system of *Phonemes* that match the description in terms of what they do, but not in terms of what they are called:

(c) ***Envelope Modification Unit (EMU)*** (Instrument 0267), a voltage-controlled amplifier kit sold by BNB Kits that could modify the envelope—attack, sustain, and decay characteristics—of any input signal (Figure 8.46). The 1979 catalog of the company found among Tudor's papers describes its features: "Each characteristic can be infinitely adjusted within the constraints of your instrument's intrinsic limits. It can shorten the envelope to produce a guitar being played with strings dampened by the hand effect without eliminating the rich harmonics as the hand does."[151] This instrument first appeared in *Weatherings* and then in many subsequent pieces, including *Phonemes*. Tudor studied how it worked, copying out its schematics and circling in red ink the sections in charge of controlling attack, decay, and sustain.[152] Described as "ENV. MOD. (GATE)" in a later matrix map,[153] he indeed appears to have used this instrument primarily to gate long sounds into shorter pulses. In fact, when activated it produces pulses colored with cymbal-like fizzing resonance that appear frequently in *Phonemes*—a character that, as Johnsen discovered, is not derived from the original design but from a faulty part in Tudor's build; a specific nature of this particular realization that would not be found in another copy of the "same" instrument.[154]
(d) ***Vox Repeat Percussion (VOX or VX)*** (Instrument 0257), which also appeared in *Weatherings*, chopped signals using a reverse sawtooth waveform to create a repeating percussion-like attack (Figure 8.47). Although it is uncertain when Tudor bought his copy, Vox began selling this instrument back in 1967. Its first appearance in Tudor's papers is in a diagram of *Pulsers* circa 1975.[155]
(e) ***Toneburst Generator***, which had continued to appear in *Weatherings*.

The narrowing down of suspects also narrows down the possible reasons behind the enigmatic wording: (1) perhaps Tudor regarded the "nature" of *EMU* or *Vox Repeat*

[150] "Bass Balls," Electro-Harmonix.com, accessed December 15, 2019: https://www.ehx.com/products/bassballs
[151] BNB Kits, "Catalog No. 791, 1979," Box 45, Folder 4, David Tudor Papers, GRI.
[152] Tudor also draws alternative modifications to make the 10 F capacitor in both the attack/decay and sustain section variable to shift the time constant in charge of setting the rise, decay, and sustain time, though this adjustment was never implemented.
[153] Tudor, "*Weatherings*, matrix map (undated)," Box 4, Folder 7, David Tudor Papers, GRI.
[154] This was confirmed during a joint research with Michael Johnsen at Wesleyan University in April 2018.
[155] Tudor, "*Pulsers*, diagram sketch," Box 3, Folder 23, David Tudor Papers, GRI.

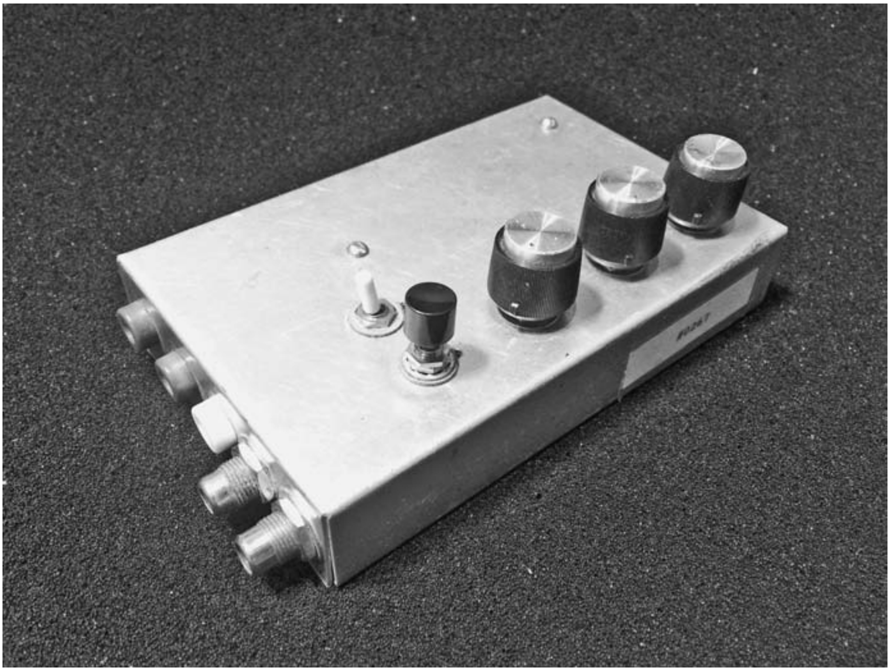


Figure 8.46 Tudor | *Envelope Modification Unit* (EMU)
DTC, Instrument 0267 | World Instrument Collection, Wesleyan University

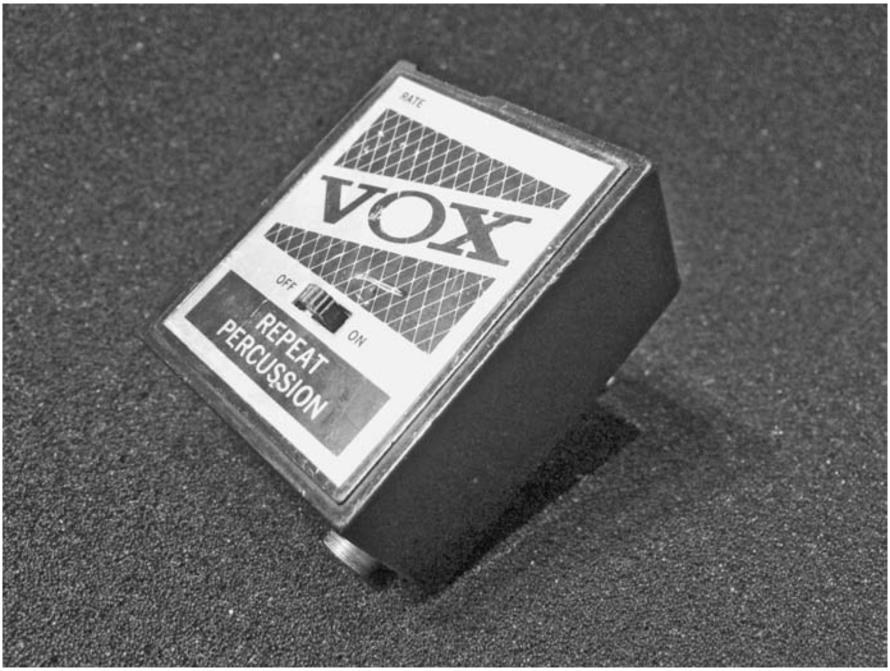


Figure 8.47 Vox | *Repeat Percussion* (VOX)
DTC, Instrument 0257 | World Instrument Collection, Wesleyan University

Percussion as a "vocoder" in spite of its actual name—except that chopping sounds is, again, not a natural thing for vocoders to do; (2) perhaps he was talking about the *Talking Pedal* or the *Bass Balls* and had found a way to shorten sounds with one of them—although this would still have been a difficult task for the primary input which he recalled as being much easier than the second; (3) perhaps there was another vocoder he owned that has gone missing over the years—which is unlikely since such an instrument does not appear in any of the matrix maps related to *Phonemes*. There is one other possibility, which, as ridiculous as it may sound, does coordinate with what appears to have been Tudor's concern around this time: (4) perhaps the company name "Vox" *reminded* him of the voice. After all, that was the name Tudor always wrote in the matrix maps to address the instrument.[156]

7

As if to enhance the mismatch between the nature of materials and their appearances into the domain of language, the two puzzles of "second input" and "vocoder" in *Phonemes* both revolve around the slippage between actual materials—instruments as well as sounds—and how Tudor talked about them. So the best place to search for clues to solving the two cases might be in the same slippage, which is to say, in how the concepts Tudor used to generalize and reduce the multiplicity of materials were materialized in actual performances. In fact, there is something very odd about the generalized diagram Tudor drew for *Phonemes* (Figure 8.48).

The operation of the sound system appears to be clear on the surface. The source inputs are: (a) two stereo tape recorders playing the *Pepsi Tapes*; and (b) a spike icon, which—judging from related matrix maps—refers to *SN76477 Complex Sound Generator* IC chip known for providing sound effects to early arcade video games.[157] Processors, most of them familiar by now, are paired as usual for selection at the *TEAC Mixer*. From the top, they are:

(1) *Electro-Harmonix Octave Multiplexer* and a switch;
(2–3) Two complementary filters, each with the option for keying;
(4) *Electro-Harmonix Polyphase*, a phase shifter whose filter was controlled by an envelope follower, and the *Talking Pedal*;

[156] As Shane Butler explains, "'vox' has two meanings that are not only different but, seemingly, mutually exclusive, designating either exactly that which he can write down, or exactly that which he cannot. Indeed, in English translation [. . .] we are obliged to impose two words—respectively, 'word' and 'voice'—where the Latin text has only one" (Butler, *The Ancient Phonograph* [Cambridge, MA: Zone Books, MIT Press, 2015], 96).

[157] Although the actual instrument has gone missing, a manual for Bullet Electronics SE-01 Sound Effects kit built around the *SN76477* has been found among Tudor's papers (Bullet Electronics, "SE-01 Sound Effects kit Manual," Box 46, Folder 11, David Tudor Papers, GRI); "76477" appears frequently as input source in *Phonemes*-related sketches and matrix maps of this period. Some of the videogame-like sounds that one hears in the recordings of *Phonemes*—including the ascending/descending tones that always open the piece—may have been produced by this lost instrument.

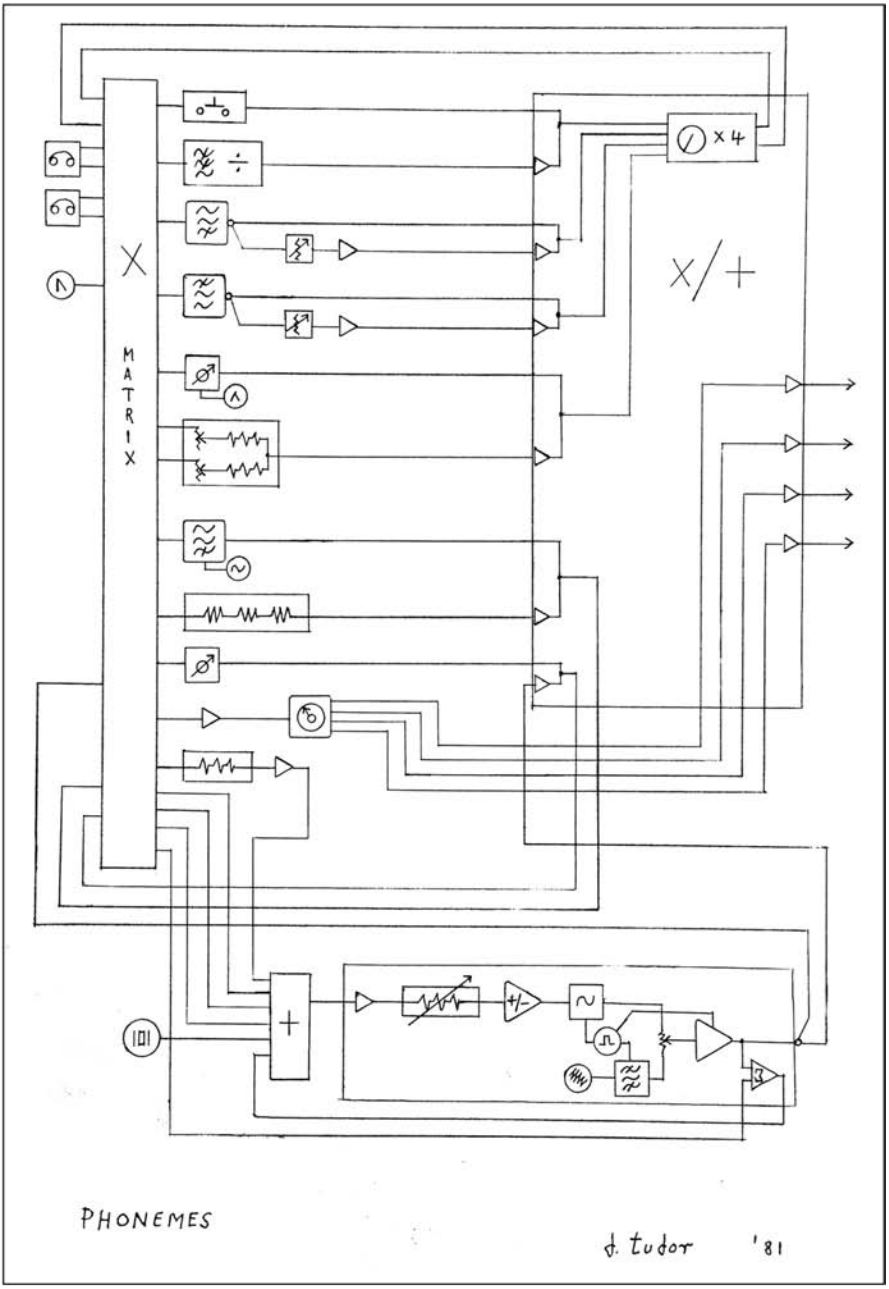


Figure 8.48 Tudor | *Phonemes*, generalized diagram | 1981
DTP, Box 3, Folder 23 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

(5) *Electro-Harmonix Bass Balls* and *Toneburst Generator*;
(6) Another phase shifter and *The Drum*.

There seems to be a vague logic of pairing one instrument that prolongs (or at least does not shorten) sounds with another that (at least supposedly) shortens them. All of them are fed back to the input of the *Matrix Switcher*.

In the lower part of the diagram, the signal processed through the *Vox Repeat Percussion* is sent directly to *The Drum* after being mixed with (a) three direct signals from the *Matrix Switcher*; (b) the input from a piezo microphone; and (c) the output of the auxiliary summing amplifier of *The Drum* (which is itself a mix of the output of the percussion synthesizer and a direct signal from the *Matrix Switcher*). The final mix is split four ways using a panning device and sent out through the four "bus" channels of the *TEAC Mixer* (which, like the public transport it is named after, picks multiple channels up and routes them as one). Tudor had asked Driscoll to modify these bus channels so that they could receive four external inputs with a switchable gain of 5 to bring the signal up to line level.[158] These extra inputs were most often used for panners to rotate the output across multiple loudspeakers, as it does here.

But the appearance of clarity is in appearance only, because the seemingly ordinary routing of signals hides one extraordinary connection in plain sight. This is the coupling between the *Vox Repeat Percussion* and *The Drum* in the bottom section. Since the former is used to shorten long sounds and the latter to lengthen short sounds, the result of their coordination is that *the shortened long sounds never make an appearance as such*. They are used only as triggers for *The Drum*—just like the input from the piezo microphone.

Now this suggests two possibilities for the puzzle of the "vocoder": (a) *Vox Repeat Percussion* is *not* the "vocoder" since its output can never be heard directly. In this case, the instrument Tudor was thinking about would have to be one of the other dubious instrumental suspects which either fits the name but not the function, or fits the function but not the name, and the mystery remains unsolved. (b) *Vox Repeat Percussion is* the "vocoder" *and* its output can never be heard directly. In this case, the "overlap" of two discrete processes Tudor described actually happens behind the stage. The principal event in *Phonemes* may have never made an appearance.

8

But there is something even more puzzling here. This strange coordination between the key suspect for the vocoder and the only candidate for the percussion synthesizer that Tudor drew in the generalized diagram *never appears in any of the matrix maps.* In all the actual set-ups, *Vox Repeat Percussion* is inserted in parallel with the other processors between the *Matrix Switcher* and the *TEAC Mixer. The Drum* just receives a direct output from the *Matrix Switcher* gated by a *Photocell Key*, or signals picked up by a piezo microphone. This suggests, again, two possibilities: (a) all the matrix maps

[158] Driscoll and Edelstein, "Conversation with Nakai," June 19, 2018.

which correspond to the generalized diagram have been lost; or (b) the generalized diagram does not correspond to any actual configuration. It is just an *appearance* Tudor wanted to present—not even a generalization of what he actually did. And the puzzle of "second input" could have very well been this coordination between the so-called vocoder and the percussion synthesizer, a coordination that only worked *in concept*.

In the generalized diagram as in his description, Tudor always appeared concerned with setting a *conceptual* scheme. When explaining *Phonemes* to Hultberg, he proceeded in an unusually schematic manner, creating a series of polarities in quick succession: there are two types of synthesizers, one for percussion and another for voice; there are two types of source sounds, long ones and short ones; the percussion synthesizer is used to lengthen short sounds, and the vocoder to shorten long sounds; the goal is to push this process of transformation until the outputs of the two synthesizers overlap and it becomes difficult to tell one from the other. The drama of characters is enacted through a series of oppositions laid out by language.

This realization triggers a reflection on the nature of the two puzzles. Both cases may have developed out of a single source: Tudor's efforts to push the two principal instruments of *Phonemes* beyond their physical nature to match the linguistic schemes he had deliberately set up. After all, if one took him at his word, it sounded like he wanted to force the vocoder to chop sounds instead of filtering them with formants to simulate speech and force the percussion synthesizer to prolong sounds instead of shortening them to simulate hits.

Tudor indeed had a notorious record of abuse when it came to synthesizers. To realize *Solo(s) for Voices No. 2* in 1967, he and Mumma had tried to "subvert […] the possibilities of both Moog and Buchla synthesizers";[159] during his residency at Mills College in 1968, he had discovered a way to kill the *Buchla* dead;[160] and when he set up the electronic music studio in Ahmedabad in 1969, he had overloaded the inputs of the *Moog* with the sole intention of un-coordinating the poor instrument he had carried all the way across the Pacific. Ten years later, when he unexpectedly cast a vocoder and a percussion synthesizer in the principal roles of his new music, Tudor may have been contemplating another way of subverting their possibilities that had to do more with "concepts" than feedback. After all, in September 1980—just three months before he purchased *The Drum*—Tudor had revealed to Massimo Villa and Stefano Bonagura what he thought about the synthesizer in the following way:

> *The synthesizer (which is more a "concept" than a real musical instrument) makes people believe that it is possible to produce every sound and that the only thing to do . . . is to learn to use it.*[161]

159 Mumma, "Email interview by Nakai," March 5, 2016.
160 Alden Jenks, "Email to You Nakai," March 13, 2015.
161 Massimo Villa and Stefano Bonagura, "David Tudor: nei meandri del possibile," *Fare Musica* (December 1980), 28 (Box 65, Folder 7, David Tudor Papers, GRI). As the interviewers were based in Rome at the time, this interview was probably taken in September 1980 when Tudor visited there to perform his *Laser Concert* with Lowell Cross at the Roman Forum on September 3 and 4.

Fighting concepts with concepts in a program music that focused on the illusionary basis of language—the drama of pseudo-phonemes that disguise one another—makes sense. And the two puzzles, in turn, may have been a corollary of the simple fact that the two synthesizers happened to be more "real" than Tudor thought in their resistance to his pushing. *Vox Repeat Percussion* offered a strange linguistic solution in this regard, oscillating between the name of the company and that of the instrument, just as *Untitled* had between the name of the series and that of the version.

9

Whatever the reasons may be, the actual result was that Tudor ended up with predominantly short sounds. It was what inspired the title: "The sounds were very short, so I called the piece *Phonemes*." In other words, what he had conceived was an *a posteriori* name that addressed, after the fact, the output of a system that did not work as conceptually intended. But the same sounds can of course remind the listener of something else. *Phonemes* actually sounds very much like percussion music, especially so in the original videodance version where it constantly overlapped with the running steps of dancers. The appearance of music in this way reflected the commercially assigned character of the two instruments cast in the principal roles: a *Percussion* Synthesizer and the Repeat *Percussion*.

At the same time, another nature particular to synthesizers also influenced the music in a more occult manner. For aside from their presence in the drama of *audible* sounds, they reintroduced an *inaudible* element that could not be perceived directly. The input to *The Drum* was not transformed immediately into a likeness of percussion sounds—it was instead converted into "control signals." The description of *Untitled* had proudly noted the absence of this type of ghostly material in the configuration: "No control signals, as such, were employed."[162] But now, aside from appearing in music as a character in disguise, a sound could once again become an instrument influencing the appearance of others without itself being seen or heard.

III. Likeness to Language

Imaginary Patois

1

In 1981, Tudor received a commission from the Calouste Gulbenkian Foundation in Lisbon, Portugal. He decided to use this opportunity to develop a concert version of *Phonemes* to be performed without the dance. The resulting music was premiered at the Espace de Projection of IRCAM in Paris, France, on March 19, 1982—just three months

[162] Tudor, "*Untitled*, description," Box 3e, Folder 3, David Tudor Papers, GRI.

before *Untitled* was revived in Amsterdam. The reluctance about titles manifested in the name of the 1972 piece had apparently turned into an enthusiasm in the ten years since, for the new piece received not one but two names that were separated by a slash, just like the Cunningham dance it had divorced itself from: *Likeness to Voices/Dialects.*

The two names were placed in the chronological order of their appearance, as revealed by an early handwritten draft of description which carries only the first one in abbreviation:

> l. to v.
> sound "translations," in 2 streams: vowel-like sound sources are electronically transformed to become percussive; percussive (or fricative) sounds are electronically transformed to become vowel-like. primary sound sources used in these transformations are frequency & amp-modulated alpha waves, & the beating of insect's wings. the performance combines groups of already-prepared sounds rotating at rapid speeds (up to 30 times per second), & with the interjection of electronic percussion elements performed live (in "real time").[163]

The outline of the drama remained more or less the same as in *Phonemes*, as did the theme of rotation. But Tudor had switched the polarity of "long" and "short" to that of "vowel-like" and "percussive (or fricative)," enhancing the focus on both speech and percussion. The categories no longer concerned the length of sounds, but rather what they sounded like, which is to say *character*. He was following the general distinction made in phonetics: "fricatives" are consonants made by the friction of air going through a half-closed mouth (like s, f, v); in contrast to more percussive "plosives" made by a sudden release of air after a complete stop with a closed mouth (like b, p, t).[164]

The description also revealed the true identity of the two principal characters: (a) *Frequency and Amplitude Modulated Alpha Waves*; and (b) "the beating of insect's wings," which probably refers to *Mosquito in Test Tube* or *Mosquitoes in a Water Jar*, the only *Pepsi Tapes* used that fit the description. A further distinction was made between two forms of material to be combined in performance: (a) groups of already prepared sounds rotating at rapid speeds; and (b) electronic percussion elements interjected in real time. The former obviously referred to something recorded in advance.

The commission from the Gulbenkian Foundation had in fact come through the Centre Européen pour la Recherche Musicale in Metz, which led Tudor to be a resident composer in the latter's electronic studio between February 23 and 27, 1982.

[163] Tudor, "Description for *Likeness to Voices*," Box 3, Folder 15, David Tudor Papers, GRI.

[164] In Rudolf Steiner's dialect, the former were "breath sounds" and the latter "impact sounds" (Steiner, *Eurythmy as Visible Speech* [Leominster, Herefordshire: Anastasi, 2015], 86). Tudor obviously knew this distinction, which he later employed when drafting the description for *Coefficient: Frictional Percussion and Electronics*, a live electronic percussion music he composed for Michael Pugliese in 1991: "A variable feed-back system between the two elements is influenced and changed by the performance of the frictional sounds by a percussionist. A distinction is made between those sounds produced by friction and those produced by impact" (Tudor, "Program note, *Coefficient: Frictional Percussion and Electronics*, S.E.M. Ensemble at Paula Cooper Gallery [February 26, 1991]," Box 81, Folder 4, David Tudor Papers, GRI).

During this residency, Tudor composed a 33-minute recording by mixing some of the *Pepsi Tapes*. This time the pre-recorded material was not a necessary evil like the three *Study Tapes* of *Untitled*, but a carefully composed foundation of the performance.[165]

Tudor appears to have written the above draft while he was in Metz producing the tape, as this was the only period when the music had just one title. When the commissioned work was premiered three weeks later on March 19, he played the tapes and performed percussion elements in real time. The description in the program note that day repeated the draft verbatim but added a second title: *Dialects*.[166] So it may have been that the two titles referred to the two layers of the music, the recorded tape called *Likeness to Voices* and the performance using that tape as material called *Dialects*. As if to reflect Tudor's focus on the appearance of sounds, neither in the draft nor the printed version was there any mention of the actual instruments used.

The second performance took place three months later, on June 2, at the auditorium of the Gulbenkian Foundation in Lisbon. After that, *Likeness to Voices/Dialects* was not performed until January 26 of the following year, when Tudor invited Driscoll to collaborate on a duo version for the Lovely Music Live festival at Marymount College in New York City. The piece now appeared as *Dialects (No. 2)* in the program note, along with a new sentence that explained what all these likenesses and their transformations amounted to: "the weaving of these two streams develops an imaginary 'patois.'" The unusual word which Tudor placed in quotes referred to a local dialect, usually considered inferior to the official language, although in most cases the many deviances from such neutral-like standard were themselves the result of one language being forced onto another through colonization. In other words, the term expressed the resistance of the local tongue through its material bias.[167] *Dialects* was thus portrayed as a product of defiance, albeit one that is imaginary.

Still, there was no mention of actual instruments. These would start to appear only after the summer of 1983. On the back of an envelope sent from *Who's Who in American Music* with the postal date "July 5, 1983,"[168] Tudor paired the two sources with their respective modifiers:

> beating of insect's wings/perc. gen.
> fm & am alpha/vocoder[169]

[165] Tudor, "*Likeness to Voices* [4 channel] (undated)," Box 13A, R58, David Tudor Papers, GRI.

[166] IRCAM, "Program for March 19, 1982," Box 79, Folder 10, David Tudor Papers, GRI.

[167] "Patois" is also how Jamaicans call their language, English with a West African bias. L. Emilie Adams explains, "English was originally a patois, like Afro-Jamaican. It was an 'ungrammatical' (i.e. 'new-grammatical') mixture of the Germanic language of the conquered Angles and Saxons and the Norman French language of their conquerors, with bits of Celtic and Latin thrown in. Similarly, the Jamaican patois is a 'new-grammatical' mixture of the languages of the conquered Africans and that of their English conquerors, with bits of Spanish and native American Arawak thrown in" (L. Emilie Adams, *Understanding Jamaican Patois: An Introduction to Afro-Jamaican Grammar* [Kingston, Jamaica: Kingston Publishers, 1991], 6).

[168] Tudor, "Draft for *Likeness to Voices/Dialects*," Box 3, Folder 15, David Tudor Papers, GRI. Below the draft, Tudor also wrote "10/9 WASH. aft.," which refers to October 9, Washington, DC. Tudor actually stayed in the nation's capital on that day to perform *Likeness to Voices/Dialects* on October 11 at the Washington Project for the Arts as part of the New Music America Festival.

[169] In the program notes, instruments only began to be mentioned from the performance at Wesleyan University on September 9, 1983: "the transformation devices used with both sources are a vocoder, and

He then scribbled beneath it the nature of the two *Pepsi Tapes*: "illusionary vowel & fricative sound sources." As if to create a negative of the pulverization of language that modified speech to create a likeness to music, Tudor's new music would use sounds that resembled speech to create a likeness to language.

2

One summer later in Stockholm, as Tudor sat down with Fullemann for an interview, the former sound engineer asked a straightforward question: what had served as the "motor" or "the mechanism for the starting point" of *Dialects*? He had just experienced his friend's new music the previous evening at the Moderna Museet. Tudor replied as follows:

> *The motor as you call it in this one is rotation. The piece's commission originated from the Gulbenkian Foundation, but the commission was through a studio, an electronic studio in Metz. And so I had to have a project not really knowing their studio. I decided to do my own thing. So, I knew that I was going to have to deal with multi-track and then I have this gadget which you've seen, that rotates four signals. So I laid down sixteen tracks, which amounts to four simultaneous sounds, all rotating, and then since I wanted to have a lot of multiple rotation, I used those tapes as one layer, and on top of that I had another rotating layer to be activated by myself in performance. That's its motor.*[170]

Very much like a real motor, the basic operation of *Likeness to Voices/Dialects* was rotation upon rotation, which followed the nature of the two principal instruments: the electronic studio in Metz which allowed Tudor to use work with up to sixteen tracks; and "the gadget" which allowed him to rotate up to four signals—a *Polyfusion Sound-A-Round Quad Panner QP-1* which he had purchased with the commission money on February 12, ten days before his departure to France.[171]

How Tudor composed the recording of *Likeness to Voices* can be glimpsed from two scores he created in Metz, which are found among his papers.[172] The first (score I) shows the four basic track layers (which were each quadrupled to form the sixteen tracks) upon which thirteen segments labeled A to N are laid out (Figure 8.49). The second (score II) reveals, through acronyms and abbreviations, the identity of each source as well as the name of the effects processor it was paired with (Figure 8.50).

a percussion generator" (Tudor, "Program note, Experimental Music: New works by Ron Kuivila and guest composer David Tudor, Wesleyan University [September 9, 1983]," Box 80, Folder 2, David Tudor Papers, GRI).

[170] Tudor, "Interview by Fullemann,"

[171] Tudor "Expense Report: Gulbenkian Commission (July 9, 1982)," Box 137, Folder 3, David Tudor Papers, GRI.

[172] Tudor, "Score for *Likeness to Voices*," Box 3, Folder 15, David Tudor Papers, GRI.

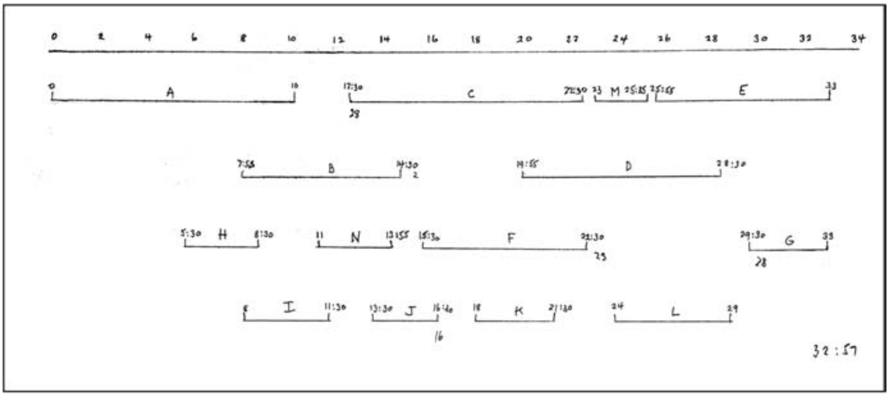


Figure 8.49 Tudor | *Likeness to Voices*, recording score I | 1982
DTP, Box 3, Folder 15 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

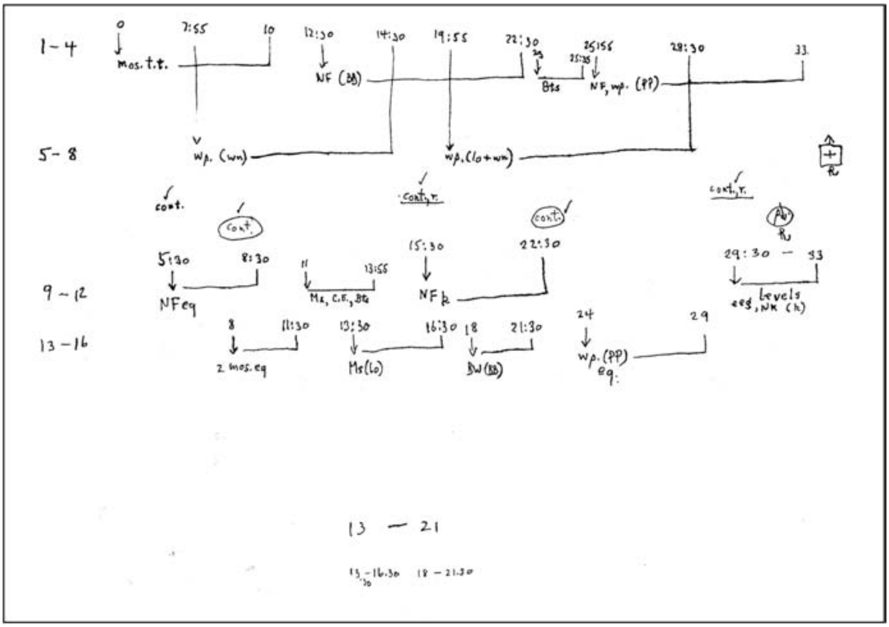


Figure 8.50 Tudor | *Likeness to Voices*, recording score II | 1982
DTP, Box 3, Folder 15 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

Most of the names have been deciphered:

A = *<u>mos. t. t.</u>* (*Mosquito in Test Tube*) 10′00″
B = *<u>wp.</u> (wn)* (*Wasp Chewing* [white noise?]) 6′35″
C = *NF (BB)* (*Nerves Firing* [*Electro-Harmonix Bass Balls*]) 10′00″
D = *<u>wp.</u> (lo + wn)* (*Wasp Chewing* [low + white noise?]) 8′35″
E = *NF, <u>wp.</u> (PP)* (*Nerves Firing, Wasp Chewing* [*Electro-Harmonix Polyphase*]) 7′05″

F = NF k (*Nerves Firing*, [*Photocell Key*]) 6′00″
G = eeg, NK (k) (*EEG* [*Photocell Key*?]) 3′30″
H = NF eq (*Nerves Firing* [equalizer]) 3′00″
I = 2 mos. eq (2nd *Mosquito in Test Tube* [equalizer]) 3′30″
J = Ms (lo) (*Mosquitoes in a Water Jar* [low]) 3′00″
K = BW (BB) (*Brainwaves* [*Bass Balls*]) 3′30″
L = wp. (PP) (*Wasp Chewing* [*Polyphase*]) 5′00″
M = Bts (*Bats*) 2′35″
N = Ms, C.E., Bts (*Mosquitoes in a Water Jar, Cat's Eye, Bats*) 2′55″.

The identified *Pepsi Tapes* can be largely categorized into animal-related, exterior sounds and brain-related, internal sounds (the former are underlined in the above list). Tudor appears to have composed a balance of sorts between the two, choosing exactly a double amount of animal sounds than brain sounds, with *Cat's Eye* serving as an overlap:

> Animal-related: *Wasp Chewing* (× 4), *Mosquito in Test Tube* (× 2), *Mosquitoes in a Water Jar* (× 2), *Bats* (× 2);
> Brain-related: *Nerves Firing* (× 3), *E. E. G.* (× 1), *Brain Waves* (× 1).

A similar balance is also observed in the assignment of effects processors, each of which appears twice, paired mostly with the same source. The theme of rotation is realized by two Electro-Harmonix pedals that had already appeared in *Phonemes: Bass Balls* dynamic filter and *Polyphase* phase shifter, both using an envelope follower which turned the amplitude of the input sound into a control signal for the internal filter responsible for creating the rotary effects—how loud a sound was influenced how it was rotated.

But the two scores are also something of a puzzle. For in spite of being announced in virtually every description as the principal character behind the vowel-like sounds, *FM AM Alpha Waves* is nowhere to be found here. Yet again, there is a slippage between the nature of material and Tudor's language describing them.

3

Given these scores, the task of matching them with the extant recording may appear easy. The tape of *Likeness to Voices*, which starts from the subtle flickering of *Mosquito in Test Tube* in rapid virtual rotation, sounds overall like a piece of voice percussion—a simulation of the human voice simulating percussion—with irregular and capricious lip buzzing, super-fast teeth clattering, and groaning long baritones and basses, all rotating in various speeds, some of them extremely fast. The progression of music indeed follows the timeline of the scores exactly. But the attempt to identify the sources Tudor wrote down becomes increasingly difficult as layers and effects accumulate. For one thing, although Tudor specified the pairing with a specific effects processor, the sources are actually modified with more than one instrument. "B = wp. (wn)" starting from 7′55″, for instance, is transposed an octave down using the *Octave Multiplexer* within a minute after its appearance, lengthened a minute later, and further treated with the *EMU* thirty seconds later, and so on. In a sense, this difficulty of identification is a matter of course since Tudor's focus was precisely in making distinctions based on the perceived identity of sources increasingly dubious by having them simulate each other. The switch from one tape to another that is so clear on paper is occulted in the recording by multiple layers of disguises. The listener has a difficult time telling one thing from another.

In the performance of *Dialects*, Tudor became that listener of *Likeness to Voices*, playing the tape and interjecting more layers of materials in response to what he heard. "I'm listening to the sound," he reminisced during the aftertalk of his concert at STEIM on June 16, 1994, describing how he performed the music more than a decade before. "And the next sound I produce because the previous one reminds me of something either resembling speech or going towards music."[173] In other words, the listeners of *Dialects* are listening to Tudor's listening.[174]

4

There is a generalized diagram for this performance processing, which carries the later date "1984" and does not carry the title *Likeness to Voices* (Figure 8.51). The symbols can be coordinated with actual instruments thanks to a note in which Tudor wrote out the correspondences (Figure 8.52).[175]

The coupling of processors has decreased from the five pairs in *Phonemes* to just two, all dominated by Electro-Harmonix instruments: (1) *Octave Multiplexer* and *Bass Balls*; and (3) *Polyphase* and *Talking Pedal*. The rest of the tracks on the *TEAC Mixer* each takes only one input: (2) *The Drum*, (4, 5) complementary equalizers, and (6) another Electro-Harmonix product, *Attack/Decay Tape Reverse Simulator*, which had separate controls for attack and decay, making it possible to chop as well as prolong signals.

In comparison to the scarcity of parallel processors, the lower half of the diagram has become more populated. Three input mixers and two additional output mixers have been added. Two of the input mixers connected in series are for *The Drum*, while the third is dedicated to a second *Percussion Synthesizer* (Instrument 0025). This new instrument was composed from an article written by Forrest M. Mims for the December 1981 issue of *Popular Electronics*.[176] It simulated the sound of percussion whose parameters could be controlled manually using a rotating control interface (Figure 8.53). The circuit was composed around a *4046 Phase-locked Loop* IC chip with the horizontal axis of the joystick

173 Tudor, "Aftertalk, STEIM (June 16, 1994)," Video, Private Collection of Molly Davies.

174 For an intriguing philosophical inquiry into the phenomenon of listening to listening, see Peter Szendy, *Écoute, une histoire de nos oreilles* (Paris: Éditions de Minuit, 2001); English translation by Charlotte Mandell, *Listen: A History of Our Ears* (New York, NY: Fordham University Press, 2008).

175 Tudor, "Symbol/instrument chart for *Dialects*," Box 110, Folder 4, David Tudor Papers, GRI.

176 Forrest M. Mims, "Experimenting with a Joystick," *Popular Electronics*, December 1981 (Box 47, Folder 13, David Tudor Papers, GRI).

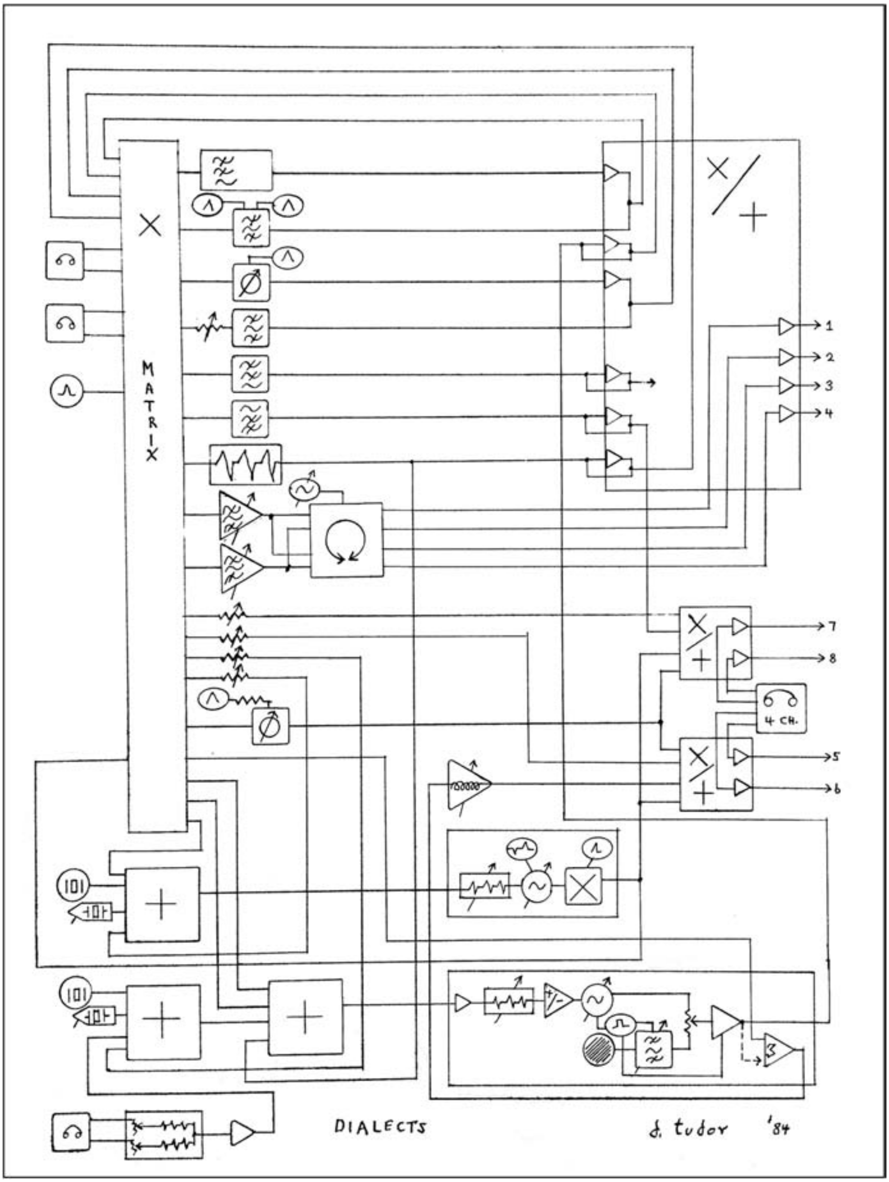


Figure 8.51 Tudor | *Dialects*, generalized diagram | 1984
DTP, Box 3, Folder 6 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust
Note: Tudor forgot to add the division symbol to the *Octave Multiplexer* icon at the top.

adjusting the control voltage for the voltage-controlled oscillator (VCO) section of the chip, and the vertical axis adjusting the gain of the *741 op-amp* connected to the VCO output. Thus, moving the joystick left and right generated different frequencies, while moving it up and down changed the gain. Tudor's symbol accurately shows the two sections of the instrument. The trigger for this synthesizer was a signal from one of the input

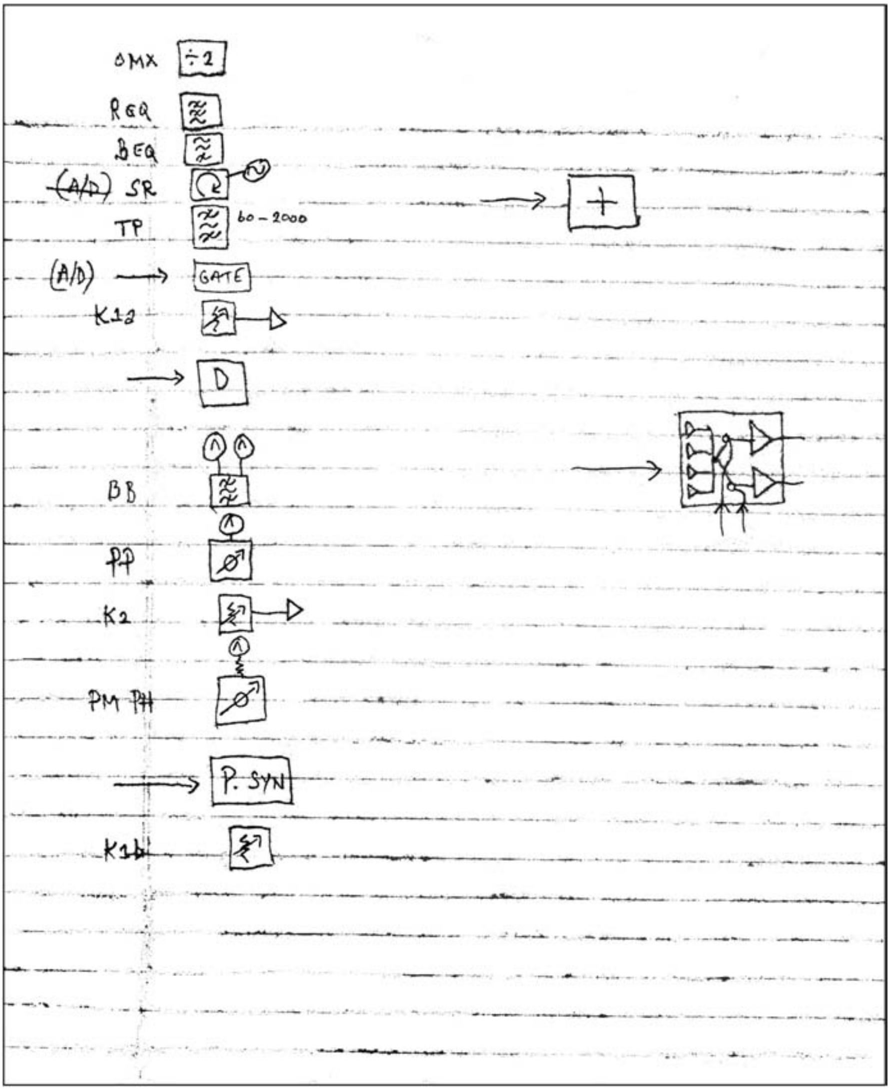


Figure 8.52 Tudor | *Dialects*, coordination note for symbols and abbreviations | Undated
DTP, Box 110, Folder 4 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

mixers summing two signals from the *Matrix Switcher*—one direct and one keyed—and two from piezo and air microphones.

The primary output of the entire sound system is sent to a pair of *t.c. electronic Dual Parametric Equalizers* before being rotated across four loudspeakers using the *Sound-A-Round*.[177] But there is also a secondary output going through the two 4-track output

[177] Aside from the manual control of panning with a joystick, the *Polyfusion Sound-A-Round Quad Panner QP-1* could automate the same control, setting the depth and speed with two knobs or a separate control voltage. Tudor's symbol reflects this function with a variable sine wave sign attached to the top of

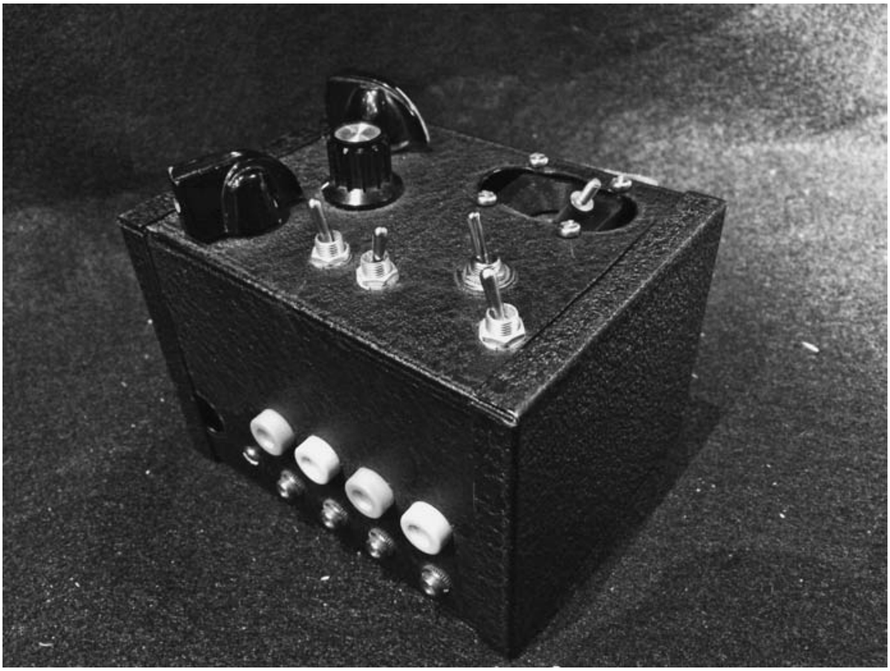


Figure 8.53 Tudor | *Percussion Synthesizer*
DTC, Instrument 0025 | World Instrument Collection, Wesleyan University

the larger square with a rotating arrow. The specific instrument Tudor owned was modified: he had asked Driscoll to make it go faster. As he explained to the participants of his workshop on September 28, 1985, Tudor wanted to do what he had initially planned doing at the *Pepsi Pavilion*:

> *This is one of the devices used by me to make the sound appear different. It is a device made to send the sound around to the four speakers and I have altered it. First of all I changed the speed so that it has a great range that goes up to 32 cycles per second so that I can obtain sound modulation with it. Because the speed which it is going through the loudspeakers becomes audible, and that frequency modulates the sound you are putting into it*. (David Tudor, "Workshop at Mobius, Art Center.")

The specific modulation he was after had to do with making long sounds short, as Tudor continued to explain to his students in the form of an object lesson:

> *You see, these things are designed by somebody. His idea is that if you move the sound too quickly from one speaker to another, the waveform will be cut off. So in other words it will sound chopped. So the idea is to smooth that transition from the exiting of one speaker to the entering of the next. So I had to go in the box and defeat that to get what I wanted, which was the chopping.* (ibid.)

The extant instrument at Wesleyan University preserves material traces of how the maker's idea was defeated: diodes are added in series with each control voltage so that there is less smooth transition between the outputs. Driscoll, who was the one who actually went inside the box, remembered in June 2018 that there was another modification he was asked to apply:

> *The other thing he always wanted me to do with the Sound-A-Round was to make it so he could easily flip it between a 1 to 4 and 4 to 1*. (Driscoll and Edelstein, "Conversation with Nakai," June 19, 2018)

The modified *Sound-A-Round* therefore synthesized the reversible *Stirrer* and the switchable pavilion loudspeakers, actualizing the theme of rotation that the two Electro-Harmonix pedals, *Bass Balls* and *Polyphase*, simulated virtually.

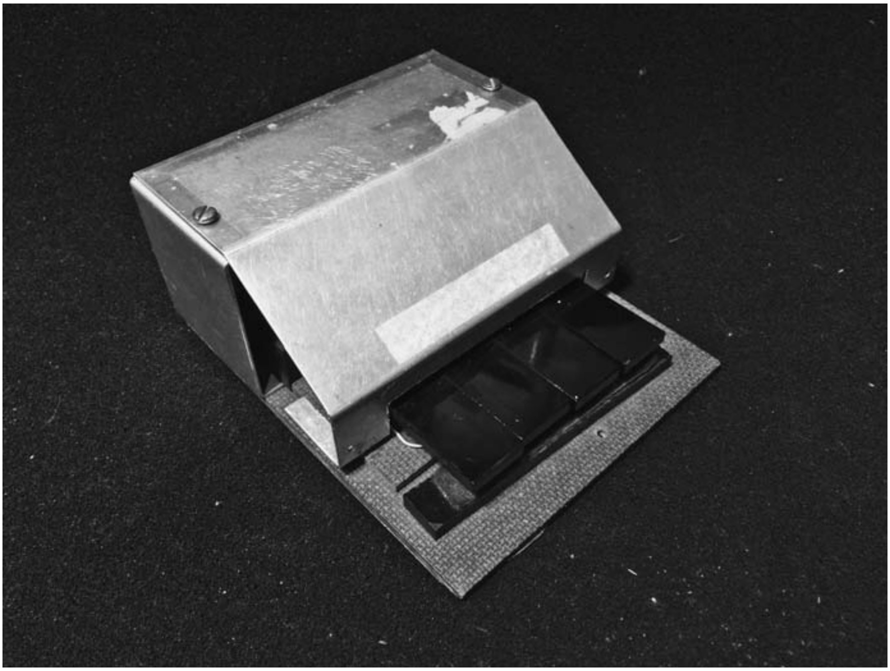


Figure 8.54 Anonymous | *Quad Key (4K)*
DTC, Instrument 0086 | World Instrument Collection, Wesleyan University

mixers that combines the *Likeness to Voices* tape with the output of the *Percussion Synthesizer*, along with signals from the *Matrix Switcher* processed through a high-pass filter, keyed gating, and *t.c. electronic TC XII Programmable Phaser*.[178] The output of *The Drum* is also sent there through a variable reverb (right-sided triangle with spirals and an arrow to indicate variability).

Most of the processors in this section were new, including the four parallel keys which Tudor drew using the same symbol as the *Photocell Keys*, and designated as "4K" or "Quad Key" in the matrix maps (Instrument 0086). This instrument of unknown origin indeed performed a gating function similar to Farley's touch-sensitive keys but without the photocells. Instead, four black phenolic keys were coupled with a flex sensor that responded to touch (Figure 8.54). It appears for the first time in a matrix map from February 1, 1984, when MCDC performed an *Event* in Seoul, Korea.[179]

[178] The *t.c. electronic TC XII Programmable Phaser* (PM PH or TC PH No #) was a versatile phase shifter which the Danish company boasted as giving the user "more possibilities of controlling, programming and choice of phaser-sounds than any other compact portable phase shifter on the market" (t.c. electronic, "TC XII Programmable Phaser manuals"). In addition to usual controls for width, depth, and speed of the phasing sweep, it featured a selection of 4, 8, or 12 phase-lag filters as well as program jacks that allowed it to work in different ranges of the sound spectrum. The instrument came in two versions, normal range and one octave lower bass range, but the two copies Tudor owned were both of the bass range type.

[179] Tudor, "Matrix Map, Seoul (January 31/February 1, 1984)," Box 3, Folder 8, David Tudor Papers, GRI. A day or two later, Tudor flew to Tokyo on his own to give a lecture at the SCAN gallery run by Fujiko Nakaya.

All in all, the input to *The Drum* has increased in number and variety, with the addition of more exterior inputs and a chopped signal from the *Electro-Harmonix Attack/Delay*. What appears to be the choppy *EMU* at the bottom of the diagram receives an independent tape input which it converts into yet another discrete trigger.[180] But *Vox Repeat Percussion* is nowhere to be seen, making the puzzle of "vocoder" more of a puzzle—even the vague linguistic connection has vanished. The main instruments are now two "percussion synthesizers," further distorting the neat polarity between percussion and voice that Tudor presented in the description. Like the absent *Modulated Alpha Waves*, the names he drops keep missing what they name.

5

Tudor's reminiscence about *Dialects* during the aftertalk at STEIM in June 1994, ended with a comment on the name of the piece and the particular realization that led to it:

> *I'm listening to the sound, and the next sound I produce because the previous one reminds me of something either resembling speech or going towards music. And I tried to come up with a title that would express that. So it turned out to be* Dialects *because I realized it isn't speech, it's something in between.*[181]

The polarity Tudor used to orient his listening of *Dialects* was no longer "vowel" and "fricative/percussive" that categorized the source materials of *Likeness to Voices*. Instead, what the illusionary speech sounds composed was either "music" or "speech"—the same opposition Cage had used to theorize the pulverization of language. But Tudor's source of inspiration was probably not his former collaborator. Thirty-six years before, on October 2, 1958, Tudor had written to M. C. Richards recommending a book in which Rudolf Steiner revealed his insight into the nature of language: "when you're thinking about language don't forget that everything springs from the sounds. do delve into 'eurythmy as visible speech'—it's very helpful &

It was during this stay that he purchased the *Playback Microphone Echo Adaptor EA-100* (Instrument 0453), the variable reverb in the diagram modifying the output of *The Drum* (although there is no receipt for the purchase, the manuals attached to the extant instrument show that it was bought in Japan, and judging from their appearance in the matrix maps, Tudor must have bought it between November 1983 and February 1984).

180 This symbol does not appear in the chart. My first guess was that this corresponded to the *Talking Pedal* since the speech synthesizer uses a dual variable resistor to sweep the filters up and down—but the instrument only has one input, and Tudor's note specifies the symbol of "TP" as a band-pass filter. My second guess was that this might be the choppy *EMU* since there seems to be no other symbol in the generalized diagrams for the instrument that appears in all the matrix maps of *Dialects*. There is also at least one matrix map where the *EMU* is coupled to a stereo tape output via a small mixer which mixes the two signals into one (Tudor, "Matrix Map [undated]," Box 3, Folder 8, David Tudor Papers, GRI). However, the *EMU* does not have a dual variable resistor.

181 Tudor, "Aftertalk, STEIM."

furthers that alchemical perception of words that's so important for poetry. you'll find it upstairs, I think."[182] Much later, as he found himself thinking about language, Tudor appears to have followed his own suggestion, taking a series of concepts Steiner had laid out in the same lectures to compose his pseudo-vocal music with synthesizers, which he regarded more as concepts than real instruments.

Like Emile Jacques-Dalcroze's Eurhythmics, which it resembles in name, the art of Eurythmy developed by Steiner aimed to visualize sound as bodily movement. However, the reasoning of the occult philosopher who thought and taught that "everything in the world is formed as a polarity"[183] proceeded through a series of binaries. At the center of this complex of polarities lay the most fundamental pair among them all: "music" and "speech." This was the opposition that split the whole art into "tone eurythmy" and "speech eurythmy," as reflected in the title of the two lecture series from 1924, *Eurythmy as Visible Music*[184] and *Eurythmy as Visible Speech*.[185] Steiner then subdivided "speech" into another polarity between "vowels" and "consonants," adding to each a metaphysical character:

> *Vowels have been wrested from the inner being of man. They are the direct expression of the feelings, of the inner life of the soul.* [. . .] *The consonants are adapted to the outer world. If you study a consonant, you will find that it is always an imitation of some process existing in the outer world.*[186]

In the fourth lecture of "The Inner Nature of Music and the Experience of Tone," given on December 2, 1922, this polarity between sounds that simulated exterior processes and sounds that revealed the inner nature of the speaker was connected to the polarity between the material body of instruments and the immaterial soul of the instrumentalist:

> *You can comprehend standard musical instruments, a violin or some other instrument, by looking at them fundamentally from the viewpoint of the consonants, by*

[182] Tudor, "Letter to M. C. Richards (October 2, 1958)."

[183] Rudolf Steiner, Lecture Dornach, December 2, 1923, *The Arts and their Mission*. CA 276, AP 1964, p. 79, quoted in *Eurythmy as Visible Speech* (Herefordshire, UK: Anastasi, 2015), 15.

[184] The German title *Eurythmie als Sichtbarer Gesang* was first translated as *Eurythmy as Visible Song* in 1932, and later changed to *Eurythmy as Visible Music* in 1977, finally becoming *Eurythmy as Visible Singing*. Ralph Kux explains why the term "singing (*Gesang*)" was chosen over "music": "The eurythmic artist . . . perceives instrumental music through the ear and straight away transforms it into an inwardly heard singing, and fashions this singing into visible movement. Consequently we can speak of a 'visible singing' and not of a 'visible music.'" (Ralph Kux, *Erinnerungen an Rudolf Steiner* [Stuttgart, Germany: Mellinger Verlag, 1976], 52; translated and quoted in Alan Stott, "Translator's Preface and Acknowledgments," *Eurythmy as Visible Singing*, Rudolf Steiner Archive online, accessed December 15, 2018: https://wn.rsarchive.org/Lectures/GA278/English/AMTRP1996/EuViSg_tpref.html).

[185] According to Steiner, the two components of this polarity, music and speech, had emanated from a common source: "The inner recitation differentiated itself, becoming on the one side speech that retained the artistic element, and on the other side the purely musical element, the wordless sounding of music that depends for its effect only upon pitch, and so on" (Steiner, *Eurythmy as Visible Speech*, 104).

[186] Steiner, *Eurythmy as Visible Music* (London, UK: Rudolf Steiner Press, 1977), 64–65. He repeats the same explanation in *Eurythmy as Visible Speech*, given four months later: "Pronouncing a vowel-sound, you feel that you express something coming from the inmost depths of your own being. [. . .] With the consonants we do not feel that the sounds arise from our inmost experience, but we feel that they are images of what is outside our own being" (*Eurythmy as Visible Speech*, 34–35).

> *picturing how they are built, as it were, out of consonants.* [. . .] *The vowel element is the soul playing on this musical instrument.*[187]

In using these concepts, Tudor added a series of modifications to the source material. For one thing, he extended the application of polarity, which Steiner kept strictly within the realm of speech, to the realm of physical objects. A list of materials for instrumental loudspeakers of *Rainforest* probably written when the music was revived in 1988 is a perfect example (Figure 8.55):[188]

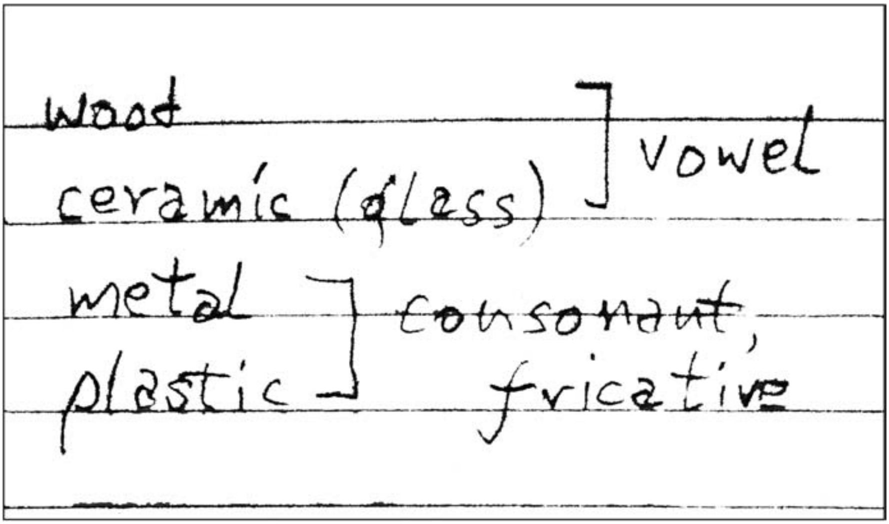


Figure 8.55 Tudor | *Rainforest*, notes | 1988

DTP, Box 111, Folder 5 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

This extension to materials throws anthroposophical conception of speech sounds into a terrible confusion. The objects made out of these materials were, after all, loudspeakers who spoke for themselves. So instead of revealing the inner nature of human speakers, "vowel" in Tudor's use is redefined as the voice of non-human speakers made out of wood or ceramic. But for humans, that vowel is also consonant-like, expressing the "images of what is outside our own being."[189] At the same time, "consonant" was itself vowel-like, since it too revealed "something coming from the inmost depths" of the loudspeaker made either of metal or plastic.[190] The polarities are kept, but the application runs amok.

[187] Steiner, *The Inner Nature of Music and the Experience of Tone* (New York, NY: Anthroposophic Press, 1982), 33–34.
[188] Tudor, "Note on *Rainforest* instrumental loudspeakers (1988)," Box 111, Folder 5, David Tudor Papers, GRI.
[189] Steiner, *Eurythmy as Visible Speech*, 35.
[190] Ibid.

But Tudor's modification went further. For he did not just keep the polarities, but always treated them as a matter of resemblance or illusion: "something either resembling speech or going towards music," "illusionary vowel & fricative sound sources." Instead of seeing an essential difference between the conceptual polarities, Tudor used them to tentatively bias and orient his listening, first to the sources that sounded either like vowels or consonants, then to the tapes made out of the sources that sounded either like music or speech, if only to stage their disguise into what they were not.[191] This utterly instrumental use of concept is also observed in the constant switching from one set of polarities to another—long/short, vowel/consonant, music/speech—in spite of the constancy of *Pepsi Tapes* they were supposed to sort out. As far as the matching between words and things go, a likeness may serve just as well, even a dubious one like "Vox" and vocoder.[192]

6

Once the concepts and the pre-recorded tapes were in place, what guided the performance was how the material *appeared* to a particular listener that was *David Tudor*. In this way, the feedback of the mind explored in *Island Eye Island Ear* had been turned into a method of performance. It was no longer the case of simply letting materials speak, as Tudor spoke in September 1981 about the *Rainforest* loudspeakers: "it's they who are doing it rather than some ghostly agent."[193] In the interview with Fullemann three years later, Tudor set a contrast with *Toneburst*:

> *in a piece like "Toneburst" I'm too busy to think, whereas "Dialects," performing it is like a thought piece, you know.*[194]

[191] This instrumentalization of concepts is reminiscent of the tradition of Pragmatism. William James summarized the "principle of pragmatism" by paraphrasing Charles Peirce's argument: "In an article entitled 'How to Make Our Ideas Clear' […] Mr. [Charles] Peirce, after pointing out that our beliefs are really rules for action, said that, to develope a thought's meaning, we need only determine what conduct it is fitted to produce: that conduct is for us its sole significance. And the tangible fact at the root of all our thought-distinctions, however subtle, is that there is no one of them so fine as to consist in anything but a possible difference of practice. To attain perfect clearness in our thoughts of an object, then, we need only consider what conceivable effects of a practical kind the object may involve—what sensations we are to expect from it, and what reactions we must prepare. Our conception of these effects, whether immediate or remote, is then for us the whole of our conception of the object, so far as that conception has positive significance at all. […] Theories thus become instruments, not answers to enigmas, in which we can rest" (William James, *Pragmatism* [New York, NY: Dover Publications, 1995], 18–21).

[192] As Tudor described to Larry Austin on April 3, 1989, the very possibility to transform materials and compose an imaginary patois was offered by language: "It would have to do with phenomena like … metamorphosis, where one shape … if you turn it inside-out, it changes into a completely other one. Music offers you the possibility that … well, language offers it to you. There's the possibility that consonants can become vowels, and vowels can become consonants. Now, not actually, but by dealing with the boundaries, dealing with the edges, you can approach transformations" (Tudor and Austin, "A Conversation").

[193] Kit Fitzgerald and John Sanborn, *re: Soundings*, Electronic Arts Intermix, video, 1983. The whole comment is as follows: "I guess it's my regard through materials and how they each have their own sound, and trying to make them sound so that you're aware that it's they who are doing it rather than some ghostly agent" (ibid.).

[194] Tudor, "Interview by Fullemann."

And when the "long sounds" started appearing, this particular listener was reminded of something very specific, as he reported to Hultberg another four years later:

> *That one features the longer sounds rather than simply the short sounds and that reminded me of listening to a foreign language that you can't possibly understand but you know that it is a language. So I called that one "Dialects."*[195]

A collection of sounds one cannot possibly understand, but that one knows is a language, has an *appearance* of language. That is to say, the sounds Tudor was listening to suggested *something beyond mere appearance*—a potential intelligibility as if it were an almost legible piece of a puzzle. This character of foreign language that Tudor called by the name of *Dialects* also bears a certain likeness to voices. For a "voice" is a name of sound that evokes "some ghostly agent" beyond its mere sonorous appearance, some agent characterized by the potential to speak and to speak more.[196] This excess is one way to explain why the voice is persistently coupled with language: they both *conceptually* enhance the actual appearance of sound.[197]

Like the benchmark of success in synthesizing speech at Bell Labs, the criteria of judgment always rest on the listener's end. But unlike a common language whose mechanisms can be communicated, the ghostly agent of voice or an unknown

[195] Tudor, "Interview by Hultberg."

[196] The potential for speaking more explains the curious case of voices that do not speak, as often told in the literature of psychology, psychoanalysis, or philosophy. In *Sound Unseen: Acousmatic Sound in Theory and Practice* (New York, NY: Oxford University Press, 2014), Brian Kane engages in an extensive criticism of such non-sonorous voices, including Martin Heidegger's "voice of conscious" that arrives to the subject as a silent wake-up call, or what he called the "psychoanalytic voice," an acousmatic silence—silence whose origin remains occult—that emerges between the analyst and the patient. In each case, Kane foregrounds the *techne* behind the staging of the non-sonorous voice, dissipating the illusion by revealing the mechanism. But some illusions do not go away so easily.

In *The Voices Within: The History and Science of How We Talk to Ourselves* (London, UK: Wellcome Collection, 2016), Charles Fernyhough presents a "dialogic thinking" model to examine the phenomenon of auditory hallucination, which departs from the long-held view of voices in the head as misrecognized inner speech. Instead, he considered these voices, particularly the non-sonorous ones, as "people" that one has internalized through social interactions in the process of growing up. If what we sense as voice is not so much a matter of sound but the presence of a person, the effects of non-sonorous voices can be explained in the following way: "Ultimately a heard voice is something that communicates, and an entity that communicates can be represented separately from its actual utterances. If I'm on the phone to someone and there's a pause in the conversation, I can still represent my interlocutor mentally even though I'm not hearing her voice. Voices are more than fragments of sensory perception or intrusions from memory, as Rachel Waddingham explained to me: 'They're kind of like people, really.' […] When an individual is hearing a voice, he or she is experiencing an intention to communicate. The term 'auditory verbal hallucination' starts to look like a misnomer. We should move on from our fixation on the auditory qualities of the experience, and focus instead on some neglected facts: that voices are entities that can be interacted with, that voice-hearers can often readily answer a question like 'How many voices do you hear?' and that they can even find them good company. These are strong signs that some voice-hearers experience their mental visitors as hallucinated people" (*The Voices Within,* 229–230). This is also to say that the voice's potential to speak is coordinated with the listener's own potential to speak more.

[197] This metaphysical tendency is observed, for instance, in Don Ihde's *Listening and Voice: Phenomenology of Sound* (Albany: State University of New York, 2007), which starts the section dedicated to the voice with a chapter entitled "The Center of Language," and later presents a pseudo-theological formulation: "In the beginning was voice and the voice was speech and speech was Language" (*Listening and Voice*, 185). Obviously, there have been many objections. In *Voice and Nothing More* (Cambridge, MA: MIT Press, 2006), Mladen Dolar criticizes "the total reduction of the voice as the substance of language," and reads the history of philosophy as a continuous effort to tether the

language retains its occult interiority, inaccessible to the listener. So the virtual image synthesized in one's mind can never be fact-checked with an actual entity.[198] The appearance of there being more than appearances *is*, therefore, the nature of voice or an unknown language. And just like the latter is any sound that sounds *like* a language to someone, a voice is ultimately any sound that sounds *like* a voice to a particular listener—a voice *is* a likeness to voices.

Listening to music that sounded like voice or language to him, Tudor no longer focused on the relationship between the appearance of sound and its actual source. Instead, what became central was the instrumentality of the voice whose appearance kept reminding the listener of illusionary characters and virtual patois that did not exist outside its own conceptual synthesis.[199] The nature of voice is outside itself, so to speak, a composition of a listener who would read beyond what is apparent. Intelligibility can neither be discarded nor be taken for granted. In this sense, the titles of vocal works—*Phonemes, Likeness to Voices/Dialects*—continued to name the primary musical instrument: the character of sounds synthesized by *David Tudor*. Of course, his idea about commercial synthesizers would then feed back to his own manner of operation: "The synthesizer (which is more a 'concept' than a real musical

voice to language (*Voice and Nothing More*, 19). A similar endeavor is conducted by Adrianna Cavarero in *For More than One Voice* (Stanford, CA: Stanford University Press, 2005), where she pursues what she calls "a vocal ontology of uniqueness" against the "devocalization of logos" that has long governed Western metaphysics. Cavarero wishes to recover the function of the voice to "manifest the unique being of each human being, and his or her spontaneous self-communication according to the rhythms of a sonorous relation" (*For More than One Voice*, 173). A history of the voice based on a speaker who is always already unique may bypass the center of language, but also tends to leave out the indeterminacy inherent in the coordination between the voice, the speaker, and the listener.

[198] Mladen Dolar borrows the metaphor of ventriloquism from Slavoj Žižek to explain this excess of the voice in relation to the actual speaker: "Every emission of the voice is by its very essence ventriloquism. Ventriloquism pertains to voice as such, to its inherently acousmatic character: the voice comes from inside the body, the belly, the stomach—from something incompatible with and irreducible to the activity of the mouth. The fact that we see the aperture does not demystify the voice; on the contrary, it enhances the enigma" (Dolar, *Voice and Nothing More*, 70). The problem with this approach is that it tends to simply venerate the ineffable unique nature of the voice that cannot be reduced to mechanisms. Kane's criticism focuses on the role of *techne* conditioning the "phantasmagoria," or the voice's appearance of irreducibility. But although Kane reveals that this appearance is actually produced by specific techniques, he also observes, following Žižek and Dolar, that the primary mechanism of phantasmagoria is the psychological formula of "I know … but nevertheless…" In other words, the illusion works not because of *techne*, but in spite of it. The excess of voice cannot be reduced to the mechanism of its production, as it is precisely an excess *from* that sort of mechanism. On the other hand, the fact that the voice does not appear reducible to *techne* does not mean that their excess cannot be analyzed. It simply means that the matter needs to be considered from the other side—the listener's end. As far as voices are concerned, the primary *techne* is not the actual mechanism of production but the appearance thereof. This is why a voice often passes unheard, why people have always needed to fight to have their voice heard, or how one hears voices where there are—as far as *techne* is concerned—none. This dependence of voice to coordinate with the listener is the source of its indeterminacy as well as excess. See also Nina Sun Eidsheim's brilliant summary of the problem in the introduction of *The Race of Sound*—where she makes a similar observation: "Voice's source is not the singer; it is the listener" (Eidsheim, *The Race of Sound*, 9).

[199] Even before the speech synthesizer started imitating the voice, the human speech-production mechanism always worked like a synthesizer, gating and filtering a noise source to generate a variety of sounds and likenesses to other sounds. That is to say, if a percussion synthesizer can synthesize sounds that remind the listener of speech, it is because the voice can synthesize percussion-like sounds to begin with. Voice is always a synthesized appearance. A listener can synthesize almost any sound as voice because a speaker can synthesize almost any sound with the voice. The sound of Tudor's pseudo-vocal music reminds the listener not only of sounds that sound like the voice, but of this fundamental versatility of the voice to sound like other sounds (footsteps, percussion, etc.). In short, *his music sounds like voices sounding like something else*.

instrument) makes people believe that it is possible to produce every sound and that the only thing to do is to learn to use it."[200]

A Likeness to Voices

1

During the STEIM aftertalk on June 16, 1994, just before he began explaining how he had performed *Dialects*, Tudor suddenly remembered a work of literature that had influenced his music from twelve years before:

> *"Phonemes," that was the first one, and then another one. There was an intermediary which I… I admired a book by Carson McCullers, I think that's her name? It was called "Likeness to Voices," and I entitled the piece "Likeness to Voices," but then I put a subtitle "Dialects."*[201]

Carson McCullers never wrote a book called *Likeness to Voices*. But there is another person who did. Published in 1963, *A Likeness to Voices* was a "speculative fiction" written by an author named Mary Savage.[202] Although her name has appeared more frequently as the third wife of the novelist Davis Dresser, who wrote popular detective novels under the pseudonym Brett Halliday, Savage was herself a writer of at least four novels, one cookbook,[203] and one autobiographical essay.[204] The publisher gave the following synopsis for the work Tudor appears to have admired:

> *When Stanley Withers loses his third job in five years, his wife decides it is time she took a hand. But the methods she uses and the assistants she employs are highly unorthodox, to say the least, resulting in a tale of modern witchcraft involving one of the most talented and trouble-prone cats ever to survive 2000 life cycles. Alternate chapters are narrated by said cat, "Rasputin" by name.*[205]

Because of this already synthetic, imitative nature, the voice has served as a model to many instruments in the history of music as Rebecca Cypess, among others, has researched: "[Giovanni Battista] Doni was neither the first nor the last to claim that an instrument could imitate the voice. Indeed, sixteenth century theorists seem to have considered the emulation of song a necessity for all instrumentalists" (Cypess, "'Esprimere la voce humana': Connections between Vocal and Instrumental Music by Italian Composers of the Early 17th Century," *Journal of Musicology* 27 (2010), 181). Even in the late 18th century, C. P. E. Bach would complain how keyboards had not yet learned to sing: "All other instruments have learned how to sing. The keyboard alone has been left behind, its sustained style obliged to make way for countless elaborate figures" (*Essay on the True Art of Playing Keyboard Instruments* (New York, NY: W. W. Norton, 1948), 30). These old complaints connect directly to more contemporary efforts to imitate the voice using electronics, as Don Lancaster reported in a 1975 article: "we can consider specific ways of synthesizing the sounds of given traditional musical instruments. Once we know how to accomplish this, we can go on to designing our own 'voices' for the instruments. (Imitating an instrument is called 'voicing')" ("Imitating Musical Instruments with Synthesized Sound," *Popular Electronics* [August, 1975], 37).

[200] Massimo Villa and Stefano Bonagura, "David Tudor: nei meandri del possibile."
[201] Tudor, "Aftertalk, STEIM."
[202] Mary Savage, *A Likeness to Voices* (New York, NY: Dell, 1965).
[203] Savage, *Savory Stews* (Garden City, NY: Doubleday, 1969).
[204] Savage, *Addicted to Suicide: A Woman Struggling to Live* (Santa Barbara, CA: Capra Press, 1979).
[205] Savage, *A Likeness to Voices*.

In the author's own description inserted as a preface, however, the same book was described somewhat differently:

> *This is a story about a cat and a man, the cat is wise and clever and very, very old. The man is unwise, innocent and young. Their lives are spent, necessarily, on different levels of communication and understanding. Faced with the same set of circumstances, they react deeply—and differently, each according to his separate understanding and habit of life. In the end, however, a single resolution is required for the satisfaction of each one's individual—and different—problems.*[206]

The novelist focuses on the contrast between the cat and the man, leaving the wife and the witchcraft out. This is truer to the appearance of the novel, whose chapters alternate between the viewpoints of Rasputin[207] and Stanley Withers who, despite their differences, are similarly blind to the "unorthodox" doings of Jessica, the former's owner and the latter's wife, in addition to being an extremely talented witch. Around her, other powerful sorcerers roam, albeit all in disguise: Jessica and Stanley's teenage son, who is a gifted wizard without knowing so; his high school history teacher, who appears to be spying on the family; Jessica's aunt, who always tries to interfere with her niece's marriage; and an esteemed psychoanalyst who lives in the neighborhood and tries to take Jessica's son under his wing. The man and the cat are drawn into the secret battle between these powerful characters, while attempting to each solve a more urgent and personal puzzle at all costs: Stanley must protect his wife and marriage from dark forces; Rasputin must regain his cat body that he loses at the beginning of the novel. These two separate cases call for a similar task: to understand the hidden mechanism at work behind appearances. So the husband and the cat-turned-into-a-squirrel both engage in an intense reading of whatever signs they can perceive—gestures, expressions, remarks—from Jessica and others. The readers follow their readings. What the characters don't know, and the readers know only partially, is that their readings are themselves influenced by the same witches they are trying to read, who in turn can read *their* thoughts much more accurately.[208] The desperate effort to read what lies behind appearances thus deviates the two protagonists from reading what is exposed in plain sight. In other words, the puzzle they think they are solving is in appearance only.

The theme of disguise runs throughout the novel, most apparently in Rasputin's adventure to recover his original appearance while being forced to live in the body of a squirrel. The same theme is also found running behind the stage, so to speak, in the witches' "extra sense of communication outside of the normal channels" that bypasses the voice and is therefore hidden from the readers as well: "They sat in silence for

[206] Ibid., 5.

[207] This greatly upset the novelist Avram Davidson to the extent that he did not even care to finish the book before writing one of the very few reviews Savage's book ever received: "I quit reading it when I discovered that part of it is written by the cat, for pity's sake. I do not review books written by cats. I would have mentioned this when I applied for the job, but I did not suppose the matter would ever come up. Cute cover by Si Coleman" ("Review of *A Likeness to Voices*," *The Magazine of Fantasy and Science Fiction* [November 1963], 71).

[208] "'I must say, Jessie, that I'm disappointed in you for not influencing more strongly in my favor. His present feelings are going to be a definite handicap to us.' 'I've tried—' Jessica protested weakly" (Savage, *A Likeness to Voices*, 100).

several minutes, but when Sybil spoke again, it was as though she were continuing a conversation which had heretofore been conducted without vocalization."[209] This ability to converse without using the voice, when directed toward Stanley and Rasputin, the devoted readers of appearances, becomes a silent instrument to modulate their thoughts and speech without being heard—a control signal that biases appearances without itself making an appearance.

The phrase "a likeness to voices," which lends Savage's novel its title, appears in a quote from *Malleus Maleficarum*, the most notorious book on witchcraft and witch-hunt written in 1487, which the author used as the epigraph of her Chapter Six:

> *Devils have no lungs or tongue, though they can show the latter, as well as teeth and lips, artificially made according to the condition of their body; therefore they cannot truly and properly speak. But since they have understanding, and when they wish to express their meaning, then, by some disturbance of the air included in their assumed body, not of air breathed in and out as in the case of men, they produce, not voices, but sounds which have some likeness to voices, and send them articulately through the outside air to the ears of the hearer.*[210]

Devils are thus like ancient speech synthesizers, disguising voices as terminal analogs only. The lesson appears to be loud and clear: the likeness to voices is a mere illusion that deceives—it is not to be trusted.

2

The novel is a puzzling piece of the puzzle. Its connection with Tudor's music is easy to speculate yet difficult to prove, almost like the voice itself. The alternating chapters and viewpoints remind the reader of the polarity between illusionary vowels and consonants; the play between dubious appearances and silent control signals is reminiscent of the deceptive drama of sonic characters; the references to the supernatural and the occult bring to mind Tudor's devotion to spiritualism. And yet, the most puzzling aspect about Savage's book is its very status as a piece of the puzzle: a reference that Tudor mentioned only once and only in passing, tagged with the name of the wrong author—which reveals something about the nature of Tudor's puzzle. Or rather, of my own reading of his materials.

Tudor's listening to a foreign language he cannot possibly understand may resemble Stanley and Rasputin's efforts to read the signs of sorcerers they actually have no way of knowing. But unlike the performer who reads deceptive appearances he himself excelled at composing, the man and the cat fear for their lives that their reading is an illusion fabricated by others. They are never the authors of the puzzle.

[209] Ibid., 74.

[210] Heinrich Kramer, *Malleus Maleficarum*; English translation available as *The Hammer of Witches: A Complete Translation of the Malleus Maleficarum*, trans. Christopher S. Mackay (Cambridge, UK: Cambridge University Press, 2009); quoted in Savage, *A Likeness to Voices*, 71.

Savage's novel in this way reveals a possibility that Tudor, as such author, never explicitly talks about: the appearance of intelligibility can itself be a red herring.

But this triggers a reflection. For the constant slippage between actual instruments and how Tudor talked about them in public, along with the plot of Savage's parable that Tudor confessed he admired—just in passing, yet knowing very well he was on record—all appear to suggest that the legible breadcrumbs may not be trusted. The puzzle may be in appearance only. My own effort to turn materials into puzzle pieces to make sense of things takes on the likeness of Stanley and Rasputin's desperate attempts to read more than just appearances. After all, Tudor was known as a wizard-like virtuoso whose particular genius was in creating extraordinary appearances out of seemingly ordinary materials. He had himself revealed just that in the subtitle of his talk at Media Study/Buffalo: "How to make the ordinary extraordinary."[211] And as much as Tudor loved solving and making puzzles, he was also known to have enjoyed creating false ones, as Cage recalled on July 30, 1992, just two weeks before he passed away:

> *But how [Tudor] composes is unknown, because he loves keeping secrets. He doesn't want people to know what he's doing. He said once—even as a performer—I want to have an instrument that no one else knows how to play.* [. . .] *One person at Black Mountain pestered him over lunch, asking questions, and David, never answering, finally said, If you don't know, why do you ask?*[212]

Driscoll told me a similar story: one day in the mid-1970s, Tudor, who was giving a workshop, left the room, leaving a hand-drawn schematic of a phase shifter circuit on the table. The curious students rushed to copy the material while their otherwise secretive instructor was away. Years later Tudor revealed to his friend that the circuit actually never worked.[213] The misleading allure of the nomographs for *Variations II* may also be recalled.[214] In *A Likeness to Voices*, after all their attempts to read the

[211] Behrman later reflected on Tudor's exceptional abilities as a pianist using the same word: "His interpretations were so brilliant that he had a tendency to make ordinary pieces extraordinary" (Behrman, "Remarks Read at the David Tudor Celebration at Judson Church," Box 67, Folder 6, David Tudor Papers, GRI).

[212] John Cage and Joan Retallack, *Musicage: Cage Muses on Words, Art, Music* (Middletown, CT: Wesleyan University Press, 1996), 298.

[213] I have heard this anecdote directly from Driscoll in a private conversation, but Rogalsky also documents it in a published paper: Rogalsky, "David Tudor's *Virtual Focus*," *Musicworks* 73 (Spring 1999), 21. Similar stories abound. For instance, Frederic Rzewski recalled in 1997: "David always had something hidden, inside those mysterious bags he always carried around. If you asked him what he had in there, he would just chuckle. His piano playing was like that too, sometimes, when he reached into the innards of the instrument, apparently searching for something, the 13th harmonic node of a particular string perhaps, you couldn't be sure he was actually preparing to make some startling sound, or merely using gesture to define the duration of that special silence, that knowing hush of expectation of the audience of cognoscenti that attended those one-of-a-kind concerts in 1950s New York. He might have nothing in his hand, but just when you decided he was bluffing he would hit you with a full house" (Rzewski, "Fax to *MusikTexte* [April 8, 1997]," Box 67, Folder 6, David Tudor Papers, GRI).

[214] When the legibility of mechanism is canceled, one is left with the voice which is itself pregnant with meaning, as Shane Butler writes: "reductive as it may aim to be of everything else, the symbolic can never quite succeed in reducing itself merely to its symbolic function; something more always remains. For the interpreter, this residue is mere noise—but this is only because she or he is listening to and for something

signs they detect end up misleading them, Stanley and Rasputin begin to distrust all appearances. It might be a lesson to be learned. Maybe I should stop reading then.

3

But for those who continue reading, Savage keeps her promise and does deliver the "single resolution" to all their problems in the end. This is revealed in a monologue by Rasputin, who has gradually learned to depend on something he distrusted at first:

> *maybe there's something to be said for Love, after all. A damned uncertain factor, and one I'd rather not have to depend on. But. BUT. I'd bet my last whisker that it's the reason Mrs. Withers is about to rebel. It's the one thing that the Old One would have left out of her calculations when she was grooming her niece as her successor. And it's the one thing that might transform her tame disciple into a wild onion.*[215]

The novel Tudor appeared to say influenced him while composing music that focused on the creation and confusion of appearances concludes on an unexpected note: when the reading of appearances reaches a dead end, the only resolution is love. The bond between Jessica and Stanley Withers saves the day because it is another form of occult correspondence, one that escapes the almighty sorcerers' reading as it escapes all kinds of reasoning. Unlike the conspiracy of witches and wizards who try to access resources using this or that magic, Savage depicts love as a singular coordination between two ghostly agents *in spite of* their mutual inaccessibility. Love remains on the periphery of all the calculations and manipulations while driving all the reasoning which it nonetheless eludes, and its consequences distort patterns that were thought to be legible, transforming everyone involved—all without itself making an appearance.

Tudor loved puzzles, which is to say he was strongly attracted to unknown mechanisms whose nature was hidden behind signs at the threshold of intelligibility. So he must have been delighted when the sound of his music took on the appearance of a foreign language he could not understand. But this was a foreigner only in character. Not reading it correctly may have ended in a bad performance, but he could simply start over the next evening. Then something happened which interrupted the single performer feedback of listening to an imaginary patois of one's own design.

4

On November 28, 1983, Jackie Matisse Monnier sent a letter from Villiers sous Grez in north-central France to David Tudor in Stony Point, New York. They had met

else. We shall instead call this hermeneutic noise the voice. The voice, let us say, is the real of the symbolic, which, even as it seemingly enshrines and enforces absence and alienation, is itself always present to us" (Butler, *The Ancient Phonograph*, 57)

[215] Savage, *A Likeness to Voices*, 115.

twenty years earlier in 1964 when MCDC made their stop in Paris during their first world tour. Julie Martin, who was close to both, reminisced:

> *They shared a love of food and cooking and many friends remember long hours, even long days of their form of social cooking that would result in an unforgettable Indian meal. Both also had love of using found objects—in Jackie's case cloth, bits of plastic, paper, paint etc.—and in David's, electronic components and gadgets he could use, and abuse, in his electronic setups. Jackie loved, as her daughter Caty remembers, "foraging" along Canal Street, where in the jumble of stores ranged side by side she could not only find bits of electric and electronic parts and wires, but also fabrics and plastics in many colors, shapes and sizes, from rigid Plexiglas to flexible vinyl.*[216]

But it was *Island Eye Island Ear* that brought the two together. Tudor wanted Monnier to fly her kites—something she had been creating since the late 1960s[217]—to reveal the nature of wind on *Knavelskär*. From the early 1980s, they developed a romantic relationship. The connection with Monnier reveals unknown aspects of Tudor's life through the letters she wrote and sent him. In the one she penned on that late November day, Monnier notified her partner about a package she had sent off the previous week to the same address:

> *Just to tell you I got your "artificial flowers" off to you last week thru the mail and I hope they arrive in Stony Point and are not too much trouble for you to get. The package is probably larger than they merit. They were for me a great day's work. It was interesting to see what I could do, thinking of your piece, with piano wire, pliers and my silver solder. I could have had them planted and shiny but I can do them once again if you wish. The ones you have will rust eventually as they are only piano wire. I hope you won't be disappointed by the forms. As you can see they are not "flowers."*[218]

Aside from the *Pepsi Tapes*, Tudor had been using external sources as auxiliary input since *Weatherings*—a remnant of the microphone input that had been brought into *Forest Speech* as the vocal illusion receded all the way back to the sound source. But it was not his voice that these microphones captured. Inputs designated as "SPDR" or "SPRG" start appearing in the matrix maps from the late 1970s, each abbreviation standing respectively for a metal brass "spider" toy and a metal "spring." Monnier's metal flowers made out of piano wire would similarly be used as an input trigger for *The Drum* in subsequent performances of *Dialects*: Tudor would bend a bunch and release them against the drum transducer, letting it rattle back and forth (Figure 8.56).[219]

Monnier worried about Tudor being disappointed by the appearance of what she had made, as they were not really "flowers." But Tudor's actual use of these pseudo-flowers disregarded their appearance. Instead, her instrument triggered a change of focus: to bring what had always been on the periphery of Tudor's pseudo-vocal music

216 Julie Martin, "Jackie Matisse in America," Klüver/Martin archive.
217 Ibid.
218 Jackie Monnier, "Letter to David Tudor (November 28, 1983)," Box 56, Folder 6, David Tudor Papers, GRI.
219 The plexiglass flower pot that now stores the metal flowers appears to have been made at a later point. A letter from Monnier dated January 27, 1989, informed: "Plexi Flower pot is in the works" (Monnier, "Letter to David Tudor [January 27, 1989]," Box 56, Folder 8, David Tudor Papers, GRI).

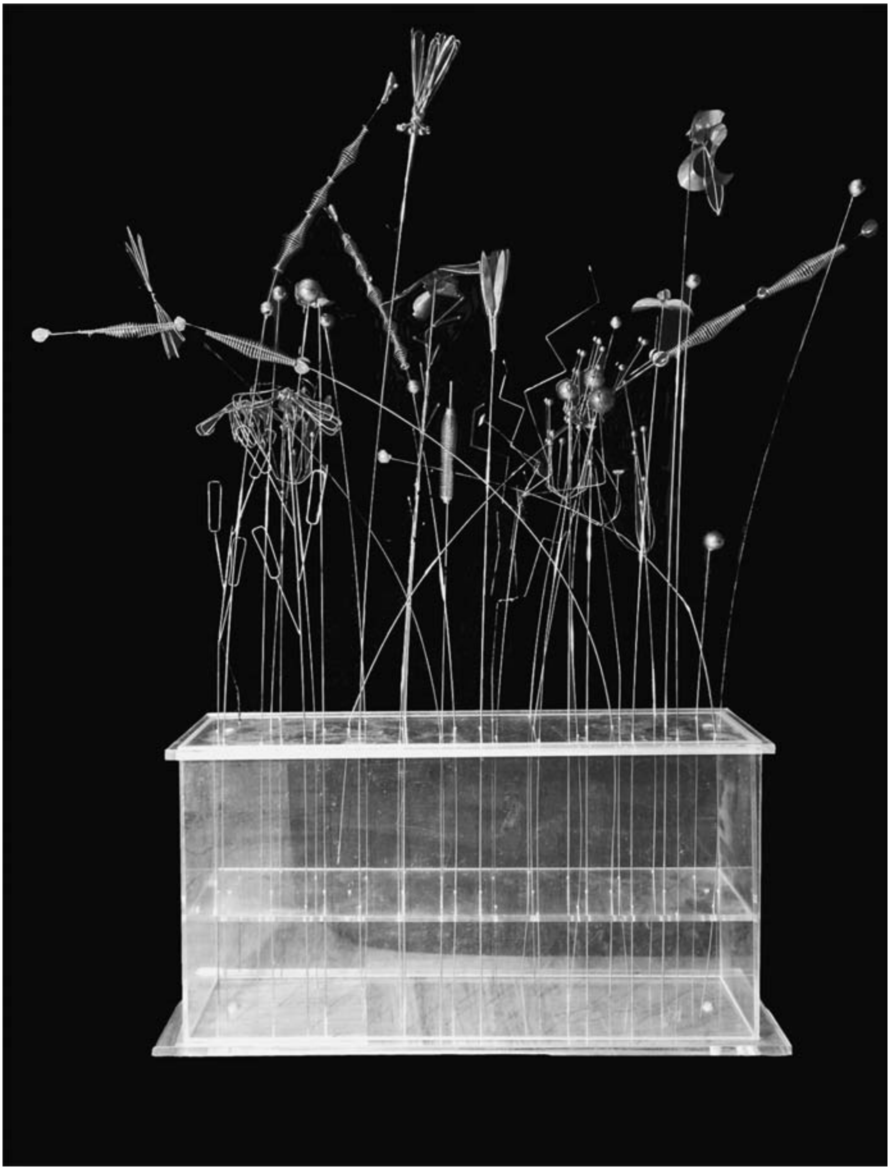


Figure 8.56 Jackie Monnier | *Artificial Flowers* for *Dialects*
DTC, no# | World Instrument Collection, Wesleyan University

back to the center. For behind the instrumental drama of illusionary voices and imaginary patois, one thing constantly distorted the neat conceptual polarities Tudor tried to lay out in language: the nature of his primary instrument, a percussion synthesizer performed remotely with external triggers. After the appearance of Monnier's flowers, the primacy of *Pepsi Tapes* and audible sounds that remind the listener of other matters quickly wilts, giving way to a revived interest in physical objects and inaudible control signals. It appears Tudor was not at all disappointed.

Chapter 9
Reflections

I. Positive

Fragments

1

On September 3, 1984, as his interview neared its end, John David Fullemann asked Tudor what his next project was going to be. There was an excitement in the answer:

> *Next one is going to be a real vocoder shebang . . . I have plans for that. I'm now working on some circuit boards I bought that look very promising. It takes a signal and filters into banks. There are sixteen stages and the first sixteen are all odd harmonics and the second are all even harmonics. And so I'm going to work on that with a pan situation. It'll be more complicated than that because it's going to be double . . . the inputs are going to be panned so it should turn out well.*[1]

Both the matrix maps drawn around that time and the chronology of work assembled later indicate that the plan Tudor describes here turned out to be *Fragments*, another music for MCDC, performed with a dance named *Phrases*. The premiere at the Municipal Theatre of Angers in France indeed took place on December 7 of that year, six months after the interview.

But *Fragments* is something of a puzzle in that nobody appears to remember its existence, let alone the details. Neither David Meschter, the company's sound engineer at the time, nor David Vaughan, the company's archivist for all times, could recall anything about the music Tudor made when I interviewed them separately, thirty-three years later, in 2017.[2] *Phrases* remained in the Company's repertoire for just over a year, until March 1986. So perhaps it was due to this brevity of performance that Tudor's music had failed to register in people's memories.

Among Tudor's instrument collection at Wesleyan University, there is only one "real" vocoder, which happens to be built from a kit that does appear to have been purchased circa 1984: *Powertran ETI Vocoder* (Instrument 0515). But this instrument separates speech signals into fourteen bands, not sixteen, and does not differentiate

[1] Tudor, "Interview by Fullemann," davidtudor.org.
[2] David Vaughan, "Interview by You Nakai," New York, NY, May 29, 2017; David Meschter, "Interview by You Nakai," November 21, 2017.

Reminded by the Instruments. You Nakai, Oxford University Press (2021). © Oxford University Press.
DOI: 10.1093/oso/9780190686765.001.0001.

between odd and even harmonics. Tudor's reply to Fullemann, which made the new project sound like a continuation of pseudo-vocal music, even a culmination of the series, does not coordinate with the fragments of material left.

2

As for recordings, there is only one: a 33-minute-long performance at the New York City Center on March 12, 1986—one of the very last realizations *Fragments*.[3] But the sound of music is far from being "a real vocoder shebang." The first five minutes consist entirely of discrete irregular clicking pulses with a prominent hum noise always in the background. Around four minutes in, the noise begins to rotate faintly while the pulses are colored with the familiar fizzing sound of the *EMU*. Shortly afterward, an additional layer of noisier and faster rumbling pulses appears, sounding very much like the *Wasp Chewing* tape featured prominently in previous pseudo-vocal music. The rotation disappears around 7′00″ and so does the fast rumble, but another layer of modulated, watery pulses emerges to perform a duo with the dry pulses (8′00″). The latter gradually increases its speed before exiting abruptly, leaving the watery pulses on their own (10′45″), only to return almost immediately, together with the hum noise, this time rotating faster and heavier. A distinct vocoder-like sound appears almost exactly at the middle point of the performance (15′30″). This character becomes more prominent later (19′00″), modulating the irregular pulses into a melodic sequence of rapidly ascending and descending tones (between F#2 and C#3). The tremolo hum noise still continues in the background, now joined by a very faint whooshing wind-like sound. Pulses are modulated further to produce liquid-like staccato tones reminiscent of other pseudo-vocal music (21′00″).

The rest of the performance follows a similar pattern. The continuous layers of discrete irregular pulses and hum noise are modulated with flanger/phaser-like rotation, occasionally interjected by a faint wind-like sound. The vocoder effect foregrounds one last time (25′30″), before stopping abruptly (28′00″) to let the swooshing sound in the background take over. Interestingly, what sounds like a modulated recording of *Pulsers* makes a sudden appearance in the final three minutes, which brings the performance to an end.

Overall, the presence of the vocoder is apparent, but the sounds, as well as the effects on sounds, are very discreet, many of them lying at the threshold of perception as if they were being played at a distance. The only extant recording of *Fragments* leaves a strange impression that it is a deliberately thinned-out remains of whatever input material was used. In a letter to Tudor written on June 23, 1984, two months before the Fullemann interview, Monnier had observed a transformation in her partner, with whom she had just spent five days together following the MCDC tour in Denmark and France. She imagined its cause to be the planning of his next music, which she described with an enigmatic wording one can only imagine came from Tudor himself:

[3] Tudor "*Fragments*, City Center of New York (March 12, 1986)," Box 2A, C57, Side B, David Tudor Papers, GRI.

> *I find you changed since last year and it is a pleasure to see.* [. . .] *Perhaps it is the thinking about the new piece you are going to make: the electronic piece with malady?*[4]

Fragments does indeed sound like a pathologically weathered fragment of a once healthy and full electronic music.

3

Like the recording, there is only one matrix map of *Fragments* that can be identified with any certainty, simply because it has the name of the dance written on it (Figure 9.1).[5] Fortunately, Tudor also wrote down the date: "2/86." Since MCDC performed *Phrases* only once in February 1986, this map is very likely related to that performance which took place on February 26 at the University of Texas, Austin. Fortunately again, this is just two weeks prior to the performance at the City Center when the only extant recording was made.[6] The list of instruments going in and out of the two *Matrix Switchers* and the *TEAC Mixer* has been redrawn in the form of a connection diagram to make the network topology clear (Figure 9.2).

The matrix map reveals that Tudor returned to the use of the two *Matrix Switchers* he had initially tried out in *Weatherings*. There are six primary processors, largely overlapping with *Dialects*, each going into the six inputs of the *TEAC Mixer* in the following order: *Vocoder* ("VCDR"), *Electro-Harmonix Attack/Decay* ("AD"), *E&MM String Damper* ("SD") (Instrument 0469), *Forrest M. Mims Percussion Synthesizer* ("P. SYN") (Instrument 0025), an option between the *Electro-Harmonix Octave Multiplexer* ("OCT") (Instrument 0300) and *Loco Box GE-6 6-Band Graphic Equalizer* ("LB EQ") (Instrument 0303)[7], and another *Bass Equalizer* ("B EQ"). All the effects processors either chop or prolong sounds or provide equalization.

Two output mixers differentiated as "ST" and "M"—presumably *Realistic 4-channel Stereo Mixer* (Instrument 0147) and *Realistic Stereo Mixing Console* (Instrument 0514), also appearing in other matrix maps as "R ST" and "R MC"—receive a second group of effects processors consisting mostly of phasers and flangers in charge of rotational effects: *t.c. electronic Chorus + Flanger* ("CH/FL"), *Ibanez FP-777 Flying Pan Phaser* ("FP"), *t.c. electronic TC XII Programmable Phaser* ("TC PH"), and *Electro-Harmonix Polyphase* ("PP"). They are mixed with the direct output from the first *Matrix Switcher*, and a keyed output from the second. The mixer ("M") also receives separate source material from a *Sony Walkman WM-D6* ("D6"), gated by *Vesta Fire*

[4] Jackie Monnier, "Letter to David Tudor (June 23, 1984)," Box 56, Folder 6, David Tudor Papers, GRI.

[5] Tudor, "*Phrases*, Matrix Map (February 1986)," Box 3, Folder 25, David Tudor Papers, GRI.

[6] By using this specific map as a clue, ten other maps have been identified as related to *Fragments*. Six of them, including the dated one, return to the use of two *Matrix Switchers*. The differences between them are not large, and at least two are unfinished sketches.

[7] There is a receipt for this box dated June 11, 1982 (Safe Sound, "Receipt for Loco EQ-6," Box 136, Folder 7, David Tudor Papers, GRI).

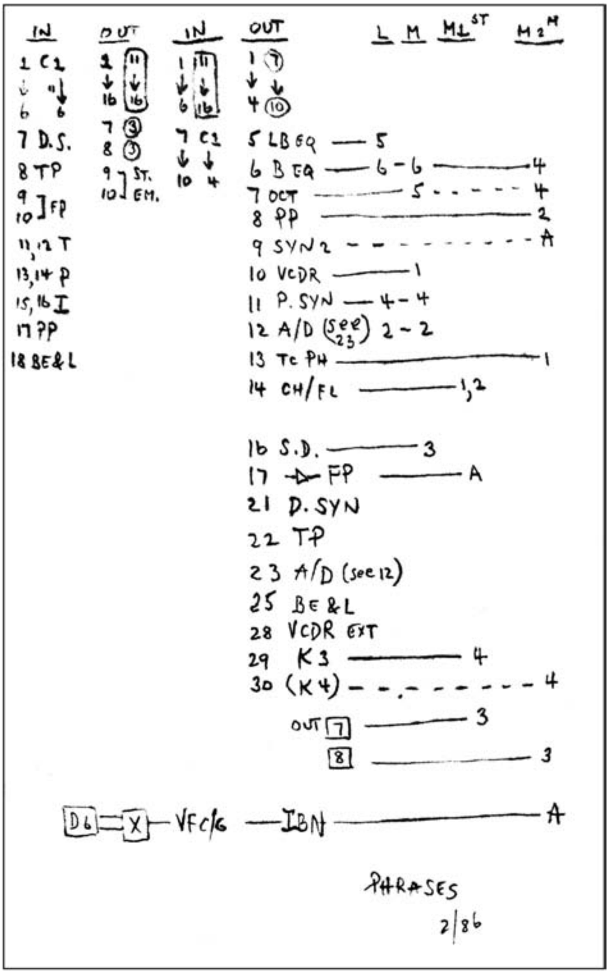


Figure 9.1 Tudor | *Phrases/Fragments*, matrix map | February 1986
DTP, Box 3, Folder 25 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

CG-1 Compressor/Gate ("VF C/G") (Instrument 0320) and filtered by *Ibanez PQ-9 Parametric Equalizer* ("IBN").

"FP" and "PP" are also part of the third group of processors that are inserted in the feedback path from the output of the second *Matrix Switcher* to the input of the first, along with a *Drum Synthesizer* ("D. SYN"), *Electro-Harmonix Talking Pedal* ("TP"), and *Guyatone PS-020 Bass Exciter/Limiter* ("B E/L"). In addition to these, the first *Matrix Switcher* also takes three tape inputs, as well as signals fed back from the cue outs of the *TEAC Mixer*. The first six outputs of the first matrix switcher are simply passed over to the input of the second, which also receives signals from the first four cue outs of the *TEAC Mixer*. The remaining four outputs of

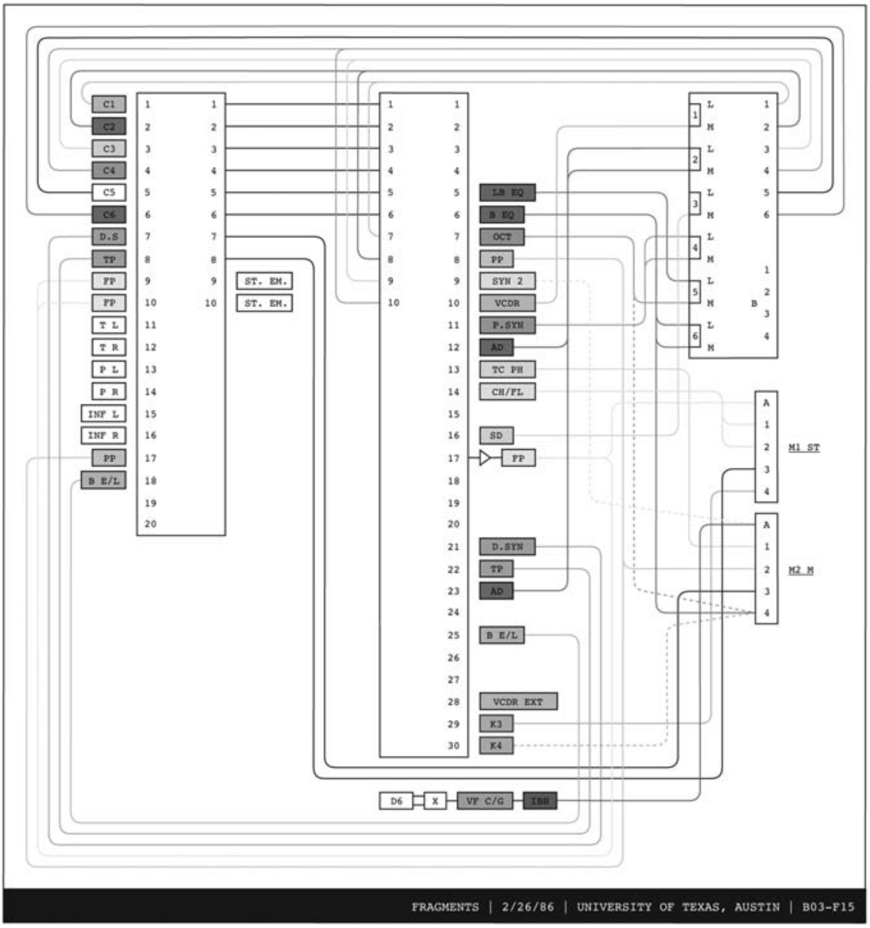


Figure 9.2 *Fragments/Phrases*, matrix map diagram
Created by You Nakai

the first *Matrix Switcher* bypass further processing, two of them going into the two output mixers, while the other two go through an unidentified processor designated as "ST. EM" (which appears in other matrix maps as "ST. EMP" connected to the *Sound-A-Round*).[8]

The effects of the gating instruments (AD, SD, or VF C/G), as well as the flanger/phaser types (TC PH, SD, or FP) are all audible in the recording. All in all, the instruments do align with the sound of music, but the analysis of the sound system does not offer any further insight into what Tudor was trying to do. A surprising clue is found elsewhere, however, in another music he was working on around the same time, for which there are more legible materials.

[8] For example, Tudor, "Matrix Map (undated)," Box 4, Folder 10, David Tudor Papers, GRI.

Hedgehog

1

On June 23, 1984, Tudor flew back to New York from Paris after a month in Europe touring with MCDC. Later that same day in Villiers sous Grez, Monnier wrote a letter to him, listing all the things they did together over the previous couple of days that had stayed in her mind: "To my memory this is some of what happened in those few days."[9] Among other matters of curiosity like Tudor dreaming of Templar knights, her letter reveals that following the last concert with the company on June 18 they drove from Paris via Lyon to Cadaques, a small fishing village by the Mediterranean in Catalonia, Spain. It was a favorite destination for Monnier: her mother Teeny Duchamp and stepfather Marcel Duchamp (who had each played chess with Cage at the premier of *Reunion*) often vacationed there, like so many other European artists throughout the twentieth century. Twelve summers before, Tudor had crossed the Pyrenees with Cage after performing *Untitled* and *Mesostics Re Cunningham* in Pamplona to visit the same village where Monnier was staying.[10]

Although she closed her letter of recollection with a disclaimer about forgetfulness—"I'm sure I've forgotten a great deal … of this crazy trip. And I wonder what you remember. By the time you get this you will have had so many other adventures you will have forgotten these"[11]—Monnier also included a reminder to herself, for there was one souvenir Tudor had purchased on their trip that did not fit in his bag:

> *David busy packing until all hours. many many packages disappear into 2 suitcases. I am left with one herisson (hedgehog) to send to New York.*[12]

In a postscript to another letter written three weeks later on July 15, Monnier reminded her correspondent and informed posterity that the name of the spiny mammal referred to something other than a new pet animal:

> *Did I tell you your chimney sweep is in the mail? It is called a "herisson" in French which means a "hedgehog" You will be receiving it by boatmail.*[13]

On March 14 of the following year, after spending two weeks with Tudor in New York, Monnier wrote once more about the "hedgehog" in another postscript to another letter, again reminding Tudor of its name. This time, however, she called it an "instrument" and revealed why he had bought it in the first place:

[9] Monnier, "Letter to David Tudor (June 23, 1984)."
[10] "when you and John came to Cadaques those years ago from Pampelona [*sic*] across the Pyrenees" (Monnier, "Letter to David Tudor [April 30, 1985]," Box 56, Folder 6, David Tudor Papers, GRI).
[11] Monnier, "Letter to David Tudor (June 23, 1984)."
[12] Ibid.
[13] Monnier, "Letter to David Tudor (July 15, 1984)," Box 56, Folder 6, David Tudor Papers, GRI.

> *Please remember the name of the instrument you brought back for "Rainforest" is "HERISSON" or "Hedgehog" for cleaning the chimney.*[14]

Thus, following the metal flowers for *Dialects*, another instrumental object traveled across the Atlantic from Villiers sous Grez to Stony Point: a circular metal chimney-sweeper with layers of concentric steel blades, whose name in France had been derived from the fact that the tool had a certain visual likeness to the mammal covered in spines (Figure 9.3).[15]

The first object Monnier sent was called "artificial flowers" for the same reason. The difference of appearance between her virtual "flowers" and real ones had made her worry. But Tudor's use of bending the bunch and letting them hit the drum transducer focused on the physical nature of the material—size, weight, number, flexibility, durability—that was even more different from real flowers than how they looked. And if this concern about the nature of material had resulted in bringing about the nature of *Dialects* as percussion music, the same concern regarding the metal hedgehog resulted in bringing about an unforeseen nature of *Rainforest* it was initially intended to be part of. In the end, the music turned out to be so different that instead of adding a new version to the series, it became a separate work.

2

On September 28 and 29, 1985, six months after Monnier's last reminder, Tudor premiered his new music at the Mobius Arts Center in Boston as part of their two-year Sound Art series organized by Richard Lehrman. As usual, the title of his music was taken from the name of the principal instrument: *Hedgehog*. Over the weekend, Tudor gave a concert each evening and conducted a workshop on Sunday afternoon. Both the workshop and the two concerts were recorded. These recordings not only document the sound of *Hedgehog* in action. Either on purpose or by accident, the tape recorder to run after the performance in the second evening and recorded almost 30 minutes of Tudor talking to audience members, casually answering their questions about the music he had just performed.[16]

Following the tradition of *Rainforest*, Tudor had hung the *Hedgehog* in the performance space, attaching two transducers to turn it into an instrumental loudspeaker. When an audience member pointed at the object after the show and asked, "So that's functioning as a speaker?" Tudor slightly corrected him: "It *is* a loudspeaker. Yeah,

[14] Monnier, "Letter to David Tudor (March 14, 1985)," Box 56, Folder 6, David Tudor Papers, GRI.

[15] Tudor later described the same object to Kyle Gann: " 'A hedgehog is just a metal broom, an instrument commonly used years ago by the chimney sweeps,' Tudor explains. 'I bought mine in France, at a hardware store. I've since found out that you can get them here, but you don't see them much anymore. Everything's done with plastic these days' " (Kyle Gann, "Music Notes: David Tudor, a legend in his own time," *Chicago Reader*, April 4, 1986 [Box 66, Folder 5, David Tudor Papers, GRI]).

[16] GRI's description of this tape being the recording of the first night is wrong since Tudor mentions the performance of "the night before" in his conversation.

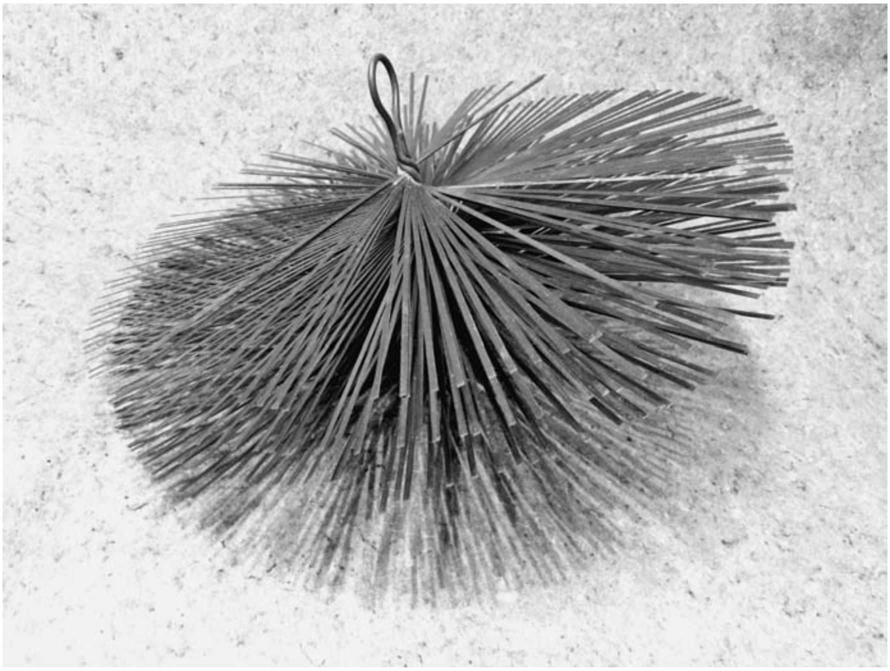


Figure 9.3 *Hedgehog*
Instrument 0462 | David Tudor Instrument Collection, Wesleyan University

those things underneath it are voice-coils and I'm driving *it* with sounds and that makes it vibrate."[17] In the talk before the performance on the previous night, however, he had stressed the difference with *Rainforest*: "This piece differs a lot from *Rainforest* because here, the sounds that I receive in the pickups, I chop them into very little pieces. Those pieces I then again treat them … and I send them back into the object and that gives a new view of things. So it's like a voyage for me to discover what it's trying to do."[18] One way to chop sounds was to use any kind of gating instrument after they went into the pickups, as he had done to shorten long sounds in the pseudo-vocal music.[19] But there was also another way to chop sounds that happened *before* they went into the pickups. This new method made use of the specific nature of the *Hedgehog*, as Tudor explained to another audience member who asked, "Why this particular piece of metal?":

> *Because something that vibrates too much, like this does, gives you a whole different kind of response. If I had this solid metal piece, then much more of the signals coming into it would have come across the pickups. But what I wanted was something that*

[17] Tudor, "*Hedgehog*, Mobius Art Center, Boston (September 29, 1985)," C73, David Tudor Papers, GRI.
[18] Tudor, "*Hedgehog*, Mobius Art Center, Boston (September 28, 1985)," C74, David Tudor Papers, GRI.
[19] "You see these pickups, there's three others in there, they pick up what it's producing, now especially producing continuous sound but there are little peaks in it, and then I have four what you call gates used here, and they take a little portion of that continuous sound and stop it immediately so those were making small things that sounded like percussion" (Tudor, "*Hedgehog* [September 29, 1985].")

> *I could attach loosely so that the most infinitesimal vibration would cause it to, you know, slap against it. So I have pickups which are very loosely attached and then they go, it clicks here, and then I equalize the sound so that they are very long and et cetera.*[20]

Attaching the pickups loosely may sound like a minor modification. But this slight change actually turned the whole principle of *Rainforest* inside-out, since slapping the vibrating *Hedgehog* transforms the instrumental loudspeaker from a mechanical filter to an audio-controlled percussion instrument. *Rainforest* had explored the resonant characteristics of the objects from within—perhaps best exemplified in the use of the stethoscope sometimes handed out to audience members to hear the interior sounds of the instruments.[21] But the object now became physically strikable from outside.

To put it somewhat differently, what Tudor did was to make the inaudible sound triggers of the percussion synthesizer in his pseudo-vocal music audible by enlarging the mechanism into a physical object that could literally be performed with sound—or pinged, to borrow an expression from the analogous use of sound as a probe in sonars. The many wobbly steel blades of the *Hedgehog* made it an ideal object for exploring this nature of instrumental loudspeaker as a giant percussion synthesizer. When yet another audience member asked, pointing at the same chimney sweep, "and what was this doing?" Tudor laughed and answered delightedly: "It was vibrating all the time! It's vibrating very slightly and the pickups here are loose so that *I'm not after the sound of the solid metal part*."[22]

Indeed, unlike any other version of *Rainforest*, the sound of *Hedgehog* heard in the two recordings is utterly percussive, a lively firework of irregular beats. As David Miller observed in his review of the Mobius concert: "The original source sound was characterized by its severe limitation: erratic staccato bursts of static-like sound, against a relatively faint, unpitched drone, like the sound of air escaping. The incessant modification of these sounds included multiplication and variation of the staccato rhythms and pitched differentiation of the drone."[23] This hissing drone layer is audible in the recording as well, setting the basic scale of recurring time—which is to say, tempo—through a constant rotation, again fabricating a virtual stage upon which the volatile percussion plays out. As a result, the rhythm of *Hedgehog* has a strong, visceral charm despite its complexity. This

[20] Ibid.

[21] This is something John Driscoll and Phil Edelstein continue to do, as when I performed *Rainforest IV* with them on July 20, 2014, at the Caramoor Summer Music Festival curated by Stephan Moore.

[22] Tudor, "*Hedgehog* (September 29, 1985)."

[23] David Miller, "David Tudor 'Hedgehog,'" *High Performance* 33 (1986), 88 (Box 66, Folder 4, David Tudor Papers, GRI). Miller concluded his review with the following insight: "Finally, without needing to justify *Hedgehog* in conventional musical terms, it did occur to me that elements analogous to harmony (the drone and its varying differentiation) and rhythm (the explosive patterns, however, (*sic*) erratic) were present throughout. The interaction of these two primary elements approached melodic shape at points, while the large structure of the piece was provided by occasional returns to the sounds in their original states. These returns provided resting places from which to venture forth again" (ibid.).

character brings to mind the lineage of no-input feedback music extending from *Pepscillator* which made people dance in the *Pepsi Pavilion*, to its virtual revival *Pulsers* which continued to explore the world of electronic rhythm. In fact, after the performance on the second evening, this likeness had inspired a question from an audience: "What's the difference between this piece and the *Pulsers* piece?" Tudor answered as if it were a matter of course: "Oh, in *Pulsers* the rhythms are regular. They change mostly in their speed."[24]

3

There are four matrix maps with the title *Hedgehog* which also happen to be all dated. They cover the only three times the piece was ever performed: September 28 and 29, 1985, and April 8, 1986. Two almost identical maps exist for September 29, which also largely overlap with the one drawn the day before (Figure 9.4 and 9.5).

The inputs from the four transducers "PROBE," "A. XDCR," "F.L. XDCR," and "PIEZO" each go into the first *Matrix Switcher* through a parametric equalizer. As Tudor had told the audience, there are three corresponding gating instruments waiting for them at the outputs 11 to 15 of the second *Matrix Switcher: Vesta Fire CG-1 Compressor/Gate* (Instrument 0320), *Next SE-100 Signal Gate* (Instrument 0275), and a stereo device called "SAE l" and "SAE r." This abbreviation stood for *Scientific Audio Electronics 5000A Impulse Noise Reduction System* (Instrument 0333), a noise gate made to remove the surface noise of records which also went by the nickname of "Click and Pop Assassin," according to the ads (Figure 9.6).[25] Tudor had purchased it a year earlier on November 7, 1984. One distinct nature of this instrument was described in the same advertisement as "a neat switch called an 'invert' switch, which lets you listen to what it's taking out."[26] That is to say, in addition to the usual function of suppressing noise below a certain threshold, this noise gate could invert that function and suppress all sounds *above* the set threshold. Instead of killing the clicks and pops, it would save them and kill everything else.[27]

[24] Tudor, "*Hedgehog* (September 29, 1985)."
[25] DAK Industries Inc, "Click and Pop Assassin," *Stereo Review* (November 1983), 109.
[26] Ibid.
[27] More accurately speaking, what the assassin kills or saves appears to be a virtual simulation of the input created by an internal envelope follower, which converts the alternate current clicks and pops into a series of direct current impulses. Michael Johnsen had not gone inside the instrument at the time of this writing but deduced its operation from listening tests and looking at the output signals on an oscilloscope. In the normal mode, these DC signals would be compared to the threshold voltage, and the ones exceeding it would be used as control signals for a voltage-controlled amplifier which thereby mutes the corresponding clicks and pops. The difference between the original AC signal and its DC simulation is minimal: "they sound almost the same and look almost the same." However, "short impulses are rich in harmonics, which means they offer wideband food to filters" (Johnsen, "Email to You Nakai," February 28, 2019). This virtual nature of the inverted signals also offers a nice food for thought concerning the concept of "negative music," as discussed in footnote 47.

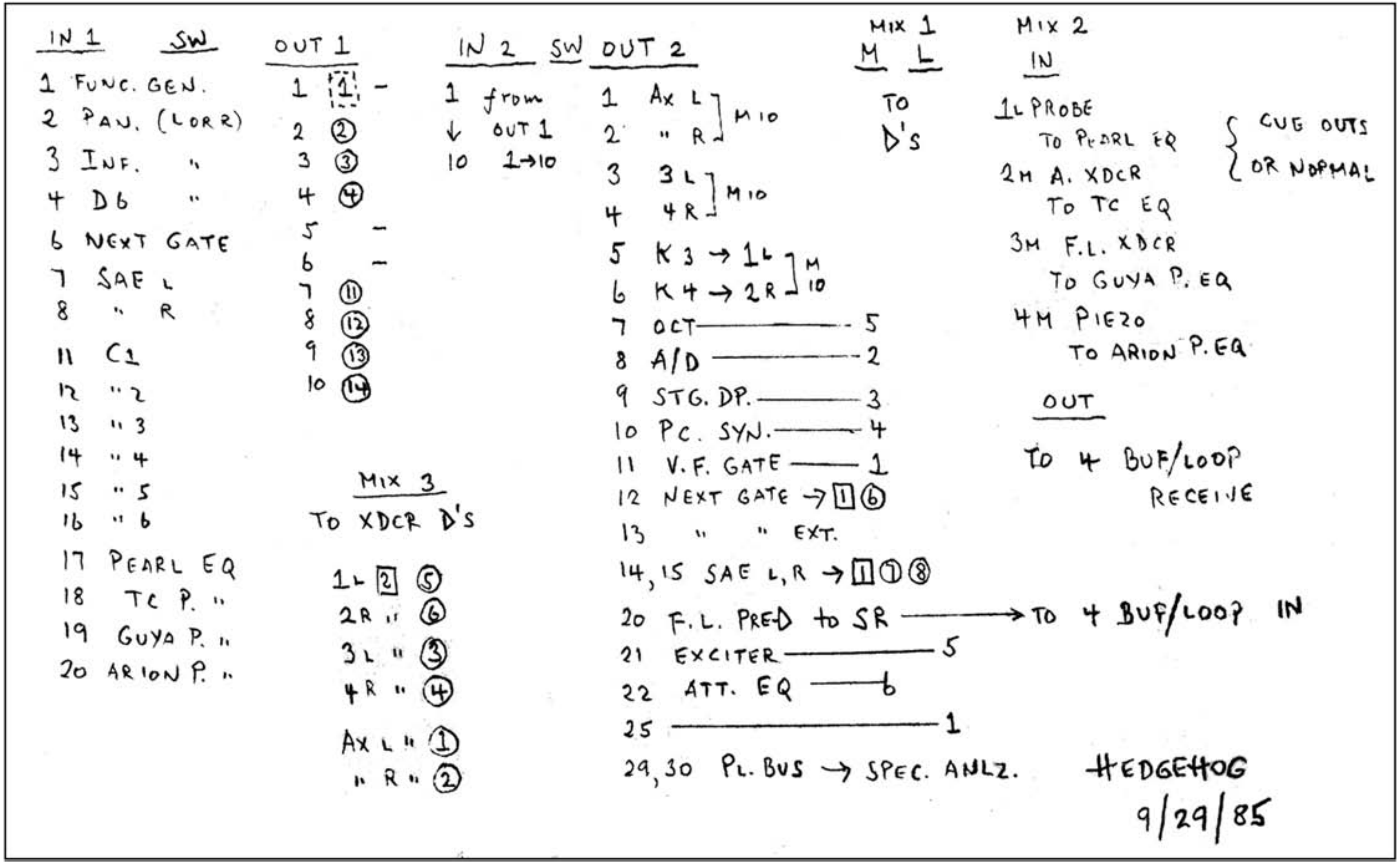


Figure 9.4 Tudor | *Hedgehog*, matrix map | September 29, 1985
DTP, Box 3, Folder 12 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

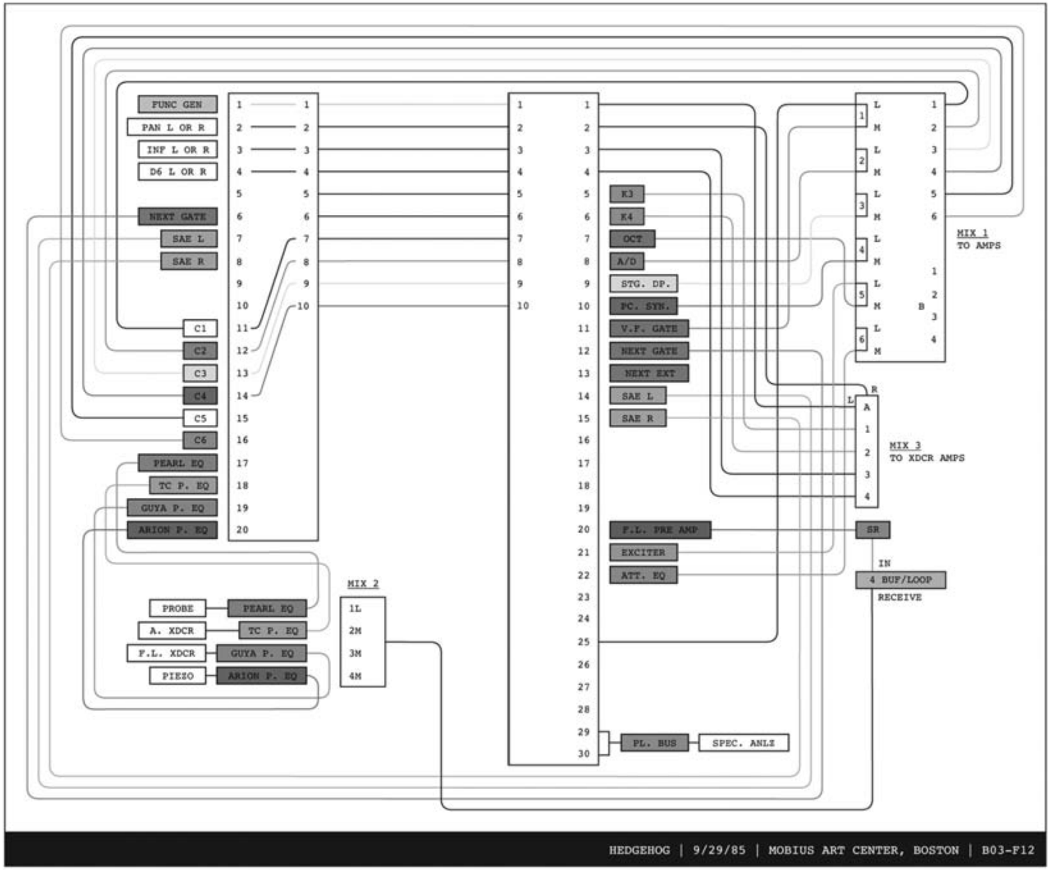


Figure 9.5 *Hedgehog*, matrix map diagram
Created by You Nakai

Figure 9.6 SAE | *5000A Impulse Noise Reduction System* aka *Click and Pop Assassin*
DTC, Instrument 0333 | World Instrument Collection, Wesleyan University

If one followed Tudor's words and coordinated the four noise inputs from the transducers going through the parametric equalizers to these four noise gates, the rest of the diagram can be read quite easily by placing the focus around the three mixers. (a) *Mixer 2* takes the ungated signals from the four transducers/parametric equalizers and sends them directly to the "receive" input of four *Vesta Fire Buf & Loop*, a loop selector allowing Tudor to select between one of these direct signals and one of the four modulated signals coming from the *Sound-A-Round* rotating the output 20 of the second *Matrix Switcher* (boosted by a preamplifier). (b) *Mixer 3* takes four direct and two keyed outputs from the second *Matrix Switcher* and sends them back to the amplifier of the transducer attached to the *Hedgehog*. (c) The six remaining effects processors all go into the *TEAC Mixer*: (1) either a direct output from the second *Matrix Switcher* or *Vesta Fire Compressor/Gate*; (2) *Electro-Harmonix Attack-Decay*; (3) *E&MM String Damper*; (4) *Percussion Synthesizer*; (5) either the *Guyatone PS-020 Bass Exciter/Limiter* or the *Octave Multiplexer*; (6) *Electro-Harmonix Attack Equalizer*. The *TEAC Mixer* takes these signals and either outputs them or feeds them back to the first *Matrix Switcher*. As there are no instruments between the two *Matrix Switchers*, the three tape inputs can be sent directly to the *Hedgehog* to trigger the whole feedback process. In addition, the *Fujitsu Ten Biyo QI-200SD Spectrum Analyzer* ("SPEC. ANLZ") (Instrument 0293) connected to the last two outputs of the second *Matrix Switcher*—after being boosted by *BOSS Headphone Amp HA-5 Play*

Bus ("PL. BUS") (Instrument 0473)—displayed the amplitude of the incoming signal across six frequency bands from 125 Hz to 8 kHz, allowing Tudor to visually monitor the movement of his music.[28]

4

In the talk with audience members after the second show, there was one particular question that was repeatedly asked: what did Tudor use as input? When Kyle Gann asked him the same question the following year, right before the third and last performance of *Hedgehog* at the School of the Art Institute of Chicago, Tudor evaded the question altogether: "It doesn't matter what goes into it. The end result doesn't resemble what is put into the object."[29] He was a little more engaging with his Mobius students but still kept running away from the question. When asked, "were some of the percussive sounds from the tapes?" he answered, "Umm, no, not really."[30] He then talked about the process being complex since "the tape is pulsed." When pressed further, he reluctantly confessed:

> *I had to have material that was very strongly pulsed and unpredictable, so what I did was I took tapes of biomedical signals, like barometers, or movements of the eye muscles. And then I put them through a device which* [. . .] *is made to remove things, but it has another go to it, to hear what you've removed. In other words, all I had were peaks. And actually, I could have used anything at all. It was just a matter of getting impulses that I could transform electronically.*[31]

In other words, he had processed some of the *Pepsi Tapes* using the "neat switch" which inverted the character of the *Click and Pop Assassin*. Tudor explained that this procedure was necessary "because I don't want the sound to be perfectly continuous."[32] The irregularity of rhythm which distinguished *Hedgehog* from *Pulsers* was thus first obtained at the level of source material using a noise gate in reverse. However, *Pulsers* had itself relied on a noise gate (squelch circuit) inside the *Prototype Pepsi Modifier* to create its regular rhythms. Perhaps for this inverted relationship, Tudor mentioned in passing the possibility of extracting a similarly irregular rhythm from the regular rhythm of *Pulsers*: "It's actually continuous oscillation and if you're lucky in that kind

[28] These observations coordinate well with Tudor's description of how he performed the piece: "There's four different pickups here, and like in the beginning I was rotating four different sounds which were coming off these speakers. Then later I concentrated on one sound or two sounds . . . you listen to what you do. Now for instance here [pointing to *Sound-A-Round*], which was receiving the sound that was to be swept around the room. I have in that five different sounds and I have the choice of making one sound rotate continuously or I can mix it with any of the 4 others, so that was fun" (Tudor, "*Hedgehog* [September 29, 1985]").

[29] Gann, "Music Notes: David Tudor, a legend in his own time."

[30] Tudor, "*Hedgehog* (September 29, 1985)."

[31] Ibid.

[32] To the question, "what made you choose biomedical?" Tudor answered, "because it's always very strongly pulsed. There's the big peaks, and it's easy once the original is in your hands to transform it, to make it be more of that" (ibid.).

of process, you turn the gain way down and you may get separate impulses like you get in this piece."[33] He was nevertheless quick to dismiss this method: "But usually it's a train of things that makes a rhythm."[34]

That train may have included the biomedical recordings from the *Pepsi Tapes*.[35] But no mention of such a source appears in the other two matrix maps Tudor drew for Mobius, one for each performance (Figure 9.7). Instead, what is scribbled in both is a surprising set of input sources: "SEA TAILS (L) INV." and "PULSERS (R) INV." The recordings Tudor inverted using the *Click and Pop Assassin* were those of his own music from the past, one of them being none other than the no-input feedback music that he had performed ten years before. The connection between *Hedgehog* and *Pulsers* that one perceptive listener in the audience sensed was, therefore, physically real—the former's rhythm was created by turning the latter's inside-out.[36]

5

A few hours before the concert on September 29, Tudor had given a workshop at the Mobius Art Center in which he talked about his music and received questions from the audience for 90 minutes, ending with that anthroposophical commentary on the polarity between sound and tone.[37] Fortunately there was a tape running, which recorded the event almost in its entirety. The talk had begun on quite a different note, with an anecdote about one particular recording of *Pulsers* from the mid-1970s which had accidentally revealed to Tudor the nature of his own music. The incident had occurred almost a decade before. Nonetheless, it appears to have been something that was on Tudor's mind around this time in the mid-1980s, as he had told the same story during his interview with Fullemann on September 3 of the previous year, shortly after his *Hedgehog* had arrived from France.

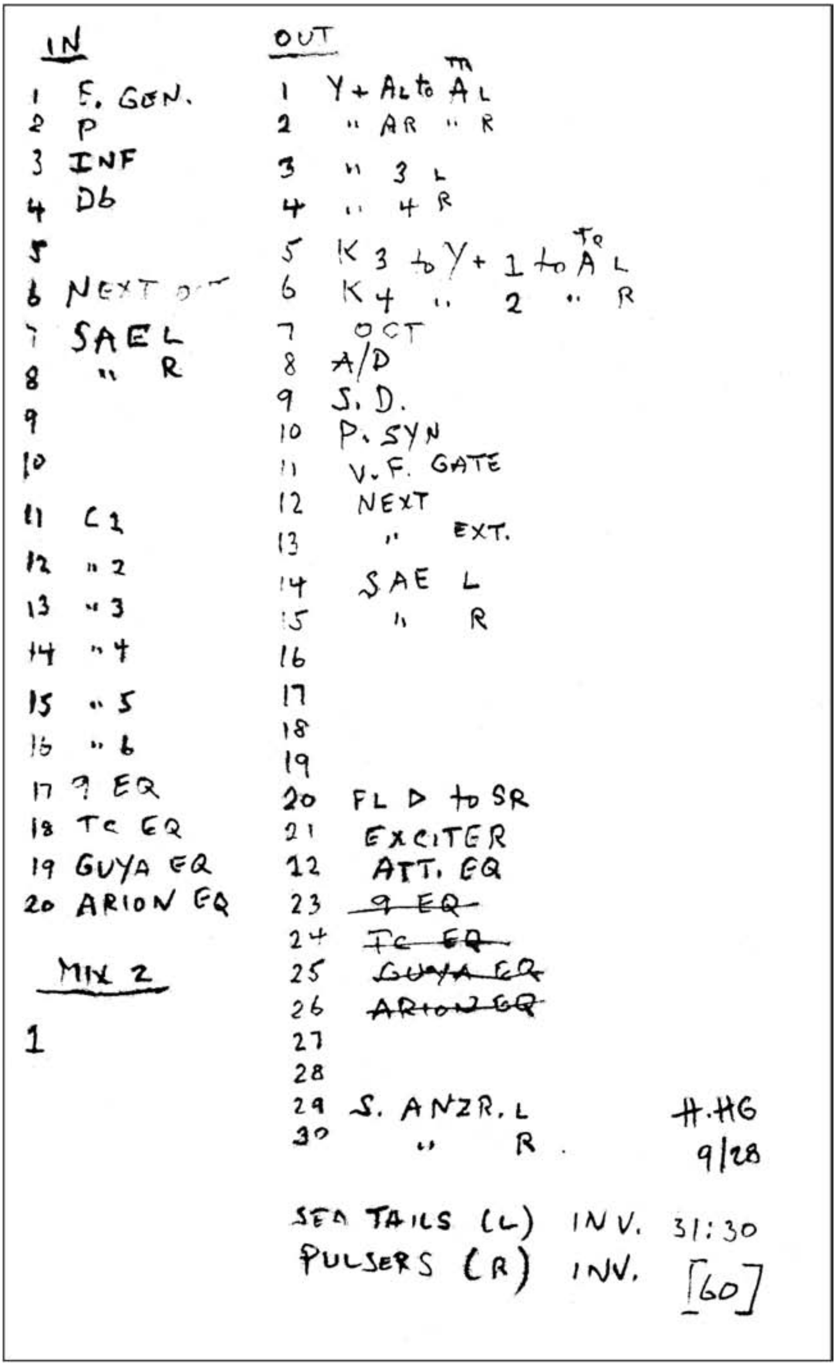
[33] Ibid.

[34] Ibid.

[35] Whether Tudor actually used the *Pepsi Tapes* for *Hedgehog* remains an open question, although the multiplicity of sources appears to go directly against what Tudor described to audiences as the basic idea of the piece: the creation of multiple appearances from a very limited number of sources, which of course has its roots in *Pulsers*. "The idea is to present it," he explained to an audience member. "To present it so that it disguises itself all over the place so that you don't realize that it is the same. It appears as if many things are there, but actually there may be one or there may be two" (ibid.). On the other hand, during the student workshop earlier that day when Tudor gave the same explanation in more detail, he did refer specifically to the *Pepsi Tapes*: "So I took a collection of tapes that I have been leaning heavily on for years that were all recorded in laboratories. And they are tapes of brain waves, eye muscle movements, and you know, biceps, and things like that, and not only from human beings but also from animals and insects. I had the opportunity to collect those in 1970 when I was programming a pavilion in Japan for Expo 70. So I got a lot of that material and I took that back. That kind of material already has very useful things for me because usually they are very very strongly pulsed through and there's a lot of peaks present. So I put them through this machine and of course the amount of … it's got a variable threshold so that you can get just a few impulses or you could get a whole stream of them. So that's really intrinsic to this performance" (Tudor, "Workshop at Mobius Art Center, Boston [September 29, 1985]," Box 2A, C75, David Tudor Papers, GRI).

[36] Also, in this way it broke the only prohibition Tudor had long set on *Rainforest*: "*Rainforest IV*, 1973, being coherent in its electronic principle, can accept any number of performers, and any kind of signal inputs (*excluding only composed musics*)" (Tudor, "Liner notes," *Rainforest IV*, Gramavision [GR-EB 1], 1980, LP; emphasis added).

[37] Tudor, "Workshop at Mobius Art Center."



IN		OUT	
1	F. GEN.	1	Y + AL to A L (TM)
2	P	2	" AR " R
3	INF	3	" 3 L
4	Db	4	" 4 R
5		5	K 3 to Y + 1 to A L (TO)
6	NEXT OUT	6	K 4 " 2 " R
7	SAE L	7	OCT
8	" R	8	A/D
9		9	S. D.
10		10	P. SYN
11	C 1	11	V. F. GATE
12	" 2	12	NEXT
13	" 3	13	" EXT.
14	" 4	14	SAE L
15	" 5	15	" R
16	" 6	16	
17	9 EQ	17	
18	Tc EQ	18	
19	GUYA EQ	19	
20	ARION EQ	20	FL D to SR
		21	EXCITER
MIX 2		22	ATT. EQ
1		23	~~9 EQ~~
		24	~~Tc EQ~~
		25	~~GUYA EQ~~
		26	~~ARION EQ~~
		27	
		28	
		29	S. ANZR. L
		30	" R.

H.HG
9/28

SEA TAILS (L) INV. 31:30
PULSERS (R) INV. [60]

Figure 9.7 Tudor | *Hedgehog*, matrix map | September 28, 1985
DTP, Box 3, Folder 12 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

The story goes that on March 21, 1976, Tudor gave what he thought was "one of the best performances [he] ever had" of *Pulsers* at the Sydney Conservatorium of Music in Australia.[38] At the time it was "virtually a new piece that I had been working on and I had performed it experimentally and they told me that they were going to record it."[39] So he sent the sound engineer both the line-level signal coming directly from the output mixer as well as the mic-level signal capturing sounds played out from the loudspeakers, telling him, "don't use the line or mix the line and the loudspeakers."[40] This instruction was followed only halfway: "the guy hooked up both line and mike and after five minutes he disconnected the mike so that recording was lost."[41] But Tudor of course did not mean that the recording was physically damaged or had gone missing. What was "lost" was the *appearance* of the music as experienced by him and the audience members in the concert hall: since the pulses produced by the *Prototype Pepsi Modifier* were extremely sharp, if one only took a line-level recording, "all you've got are clicks and pops."[42]

On both occasions when Tudor recalled this incident, he made it sound as if he had derived only one lesson about the nature of *Pulsers*: "Okay, I learned something which I hadn't really been aware of. The thing is that I learned finally that the particular loudspeakers which I use are part of the performance."[43] But this lesson is meaningful only if one wished to maintain appearances. It is a *positive* lesson concerning what one needs to make *Pulsers* appear as *Pulsers*, which dismisses the clicks and pops as being equivalent to silence just like Tudor explained to his workshop participants: "There's *virtually* nothing to listen to."[44]

However, as the well-known performer of Cage's *4′33″*, if there was something Tudor knew about silence, it must have been that it did not *actually* exist. Silence, in other words, is *virtual*—a matter of effect. The appearance of there being "virtually nothing to listen to" should have therefore triggered a second reflection, a *negative* lesson of the clicks and pops which inverts the first one, just like the workings of a noise gate in reverse. The line-level recording had made audible the virtual silences of *Pulsers*. Tudor remained himself silent about this, yet it is possible to read what he learned circa 1976 in how he used and talked about the effects of his new instrument a decade later. For immediately after describing the appearance of clicks and pops in the failed *Pulsers* recording, he likened the incident to the use of the *Click and Pop Assassin* in inverted mode:

> *something similar is going on here. Because part of the generation has already been prepared on tape and those are done by the machine here which was invented to*

[38] Tudor, "Interview by Fullemann."
[39] Tudor, "Workshop at Mobius Art Center."
[40] Ibid.
[41] Tudor, "Interview by Fullemann."
[42] Ibid.
[43] Tudor, "Workshop at Mobius Art Center."
[44] Ibid.

> *help you with your dirty records that are full of clicks and pops. So these machines may detect them and take them out. Now that's something that doesn't interest me at all. But what did interest me was that the person who marketed this put in it an inverted mode so you can hear what you are taking out. So I thought, okay, that's for me!* [laughs] *And sure enough, sure enough, it produces the clicks and pops that are already present.*[45]

This second lesson virtually inverts the polarity between intended appearance and unintended noise by making the latter appear deliberately. Just like the line recording of *Pulsers*, the neat switch of *SAE Impulse Noise Reduction System* revealed another music beneath what Tudor could hear: a "negative music," so to speak, of previously positive appearances.

6

The two primary characters that dominated the recording of *Fragments*, the continuous clicks and the prominent hum, turn out to be the deeds of the same *Assassin*. In fact, Tudor had purchased this instrument on November 7, 1984, which falls right in between the Fullemann interview in early September and the premiere of *Fragments* in early December.[46] What modified the initial plan of making "a real vocoder shebang" thus appears to have been a change of instrumentation. Tudor's collection of source materials archived at GRI includes a tape labeled "7 Mix SAE for *Phrases*" (C31B) which turns out to be a processed version of another tape labeled "*Pulsers Pepscillator* Delay Invert" (C178). Upon close listening to both tapes, the listener can hear an extremely faint layer of vaguely familiar sounds behind the sound wall of clicks and pops: first *Pulsers* and then *Pepscillator. Fragments* is the negative music of *Pulsers/Pepscillator* (Figure 9.8).

The faint sounds in the background were not signs that things were distant but that things had been turned inside-out; the neat switch flips the reality of the listener, making what was virtual actual and what was actual virtual so that one is listening to the music from the other side.[47] The fragment of modulated *Pulsers* that appears at the end brings the performance to a close by inverting back what had already been inverted from the beginning. Beneath the revived concern for the positive nature of materials that transformed an instrumental loudspeaker into a remote-controlled

45 Ibid.

46 DAK Industries Inc., "Receipt for *Click and Pop Assassin* (November 7, 1984)," Box 138, Folder 4, David Tudor Papers, GRI.

47 But the output signal of the inverted mode was not the clicks and pops themselves but their DC simulation. To be sure, it seems very likely from the way he describes the sounds that Tudor himself was either not aware of this fact or deemed it trivial enough to never bring it up in his explanations. For the analysis here, however, this fact adds yet another layer of reality: the negative music that the neat switch revealed was itself a simulation—the virtual silence was made actual in appearance only. In other words, *the flipping of polarity between virtual and actual realities was itself virtual.*

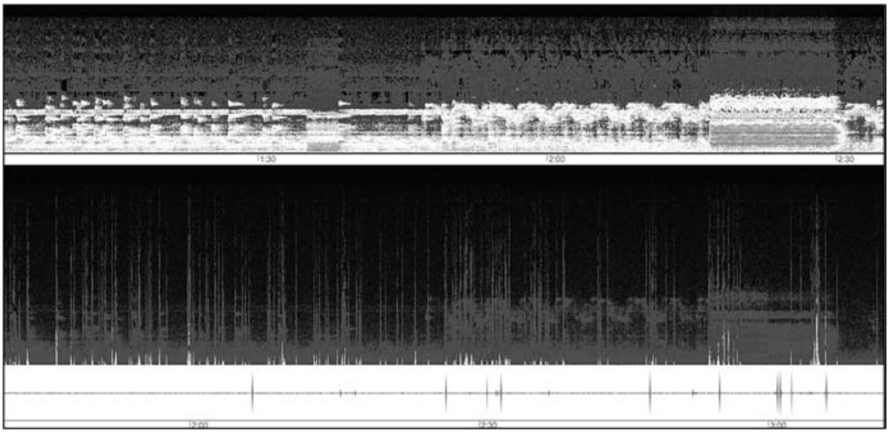


Figure 9.8 Sonogram of *Pepscillator* (C42B) (above) and its negative music used in *Fragments* (C178) (below)

percussion instrument, Tudor had developed another concern for a negative music that never makes an immediate appearance, neither in the materials nor in how he talked about them. Perhaps this was the "malady" he spoke of.

II. Negative

Wind

1

When Tudor told him about the "real vocoder shebang" project he was working on, Fullemann made an observation which the interviewee immediately confirmed.

> *F: So you are moving into something new, you're leaving the world of feedback a little bit behind, if I could see a trend?*
> *T: I'm doing something else, yes.*[48]

Tudor then proceeded to explain his current location, orienting himself once again with a set of polarities under which he contrasted the two parallel routes that led him there:

> *The feedback pieces have given me the whole thing about duration and rhythm. I mean, lots of things I can do in that realm, and "Rainforest" is complete harmonious*

[48] Tudor, "Interview by Fullemann."

> *coherence ... in lots of ways I can handle that. But now I really want to tackle the pitch elements, you know, and try and make something which is obviously tone.*[49]

The reasoning was suspiciously schematic: having mastered "rhythm" on one hand and "harmony" on the other, he now wished to deal with "pitched tone." "[T]hen it'd be simple ..." he mused, "any number of ways to put all those things together."[50]

Five years later, Tudor sat down for another interview on April 9, 1989, this time with Larry Austin, and talked about how he was interested in process of transforming one thing into another.[51] After bringing up the familiar example of consonants turning into vowels and vice versa, he added another polarity that had never appeared in connection to any pseudo-vocal music: "why not work on the transformation of rhythm into melody?"[52] The succession of pitched tones indeed forms a melody.

2

The schematic nature of Tudor's reasoning points to the usual source. Rudolf Steiner was among the many who regarded the triad of rhythm, harmony, and melody as the basic elements of music. On March 8, 1923, during the sixth lecture on "The Inner Nature of Music and the Experience of Tone," he connected these three elements, in the above order, to the three faculties of the human soul—willing, feeling, thinking—as well as the three parts of the human body—limbs, chest, head. He then told his Stuttgart audience that among the three, melody, because of its corresponding body part, had a special relationship to "concept"—namely, it prevented the latter from monopolizing the head by opening the gates to feelings originating from the chest: "It is as if you brought the heart into the head through melody."[53] Anthroposophically speaking, then, Tudor's focus on pitched tones could relieve his mind from the malady of conceptual polarities and synthesizers.

Toward the end of the same lecture, Steiner also specified the best instrumentation for each part of the triad:

> *The musical instruments basically are a clear reflection of the fact that music is experienced by the whole human being. The wind instruments prove that the head of man experiences music. The string instruments are living proof that music is experienced in the chest, primarily expressed in the arms. All percussion instruments—or*

[49] Ibid.
[50] Ibid.
[51] David Tudor and Larry Austin, "A Conversation," davidtudor.org.
[52] Ibid.
[53] Steiner, *The Inner Nature of Music and the Experience of Tone*, 66. As usual, Steiner explained this mechanism which supposedly relativizes the power of concepts, making a full use of concepts: "Melody contains something akin to mental images, but it is not a mental image; it clearly takes its course in the life of feeling. It tends upward, however, so that the feeling is experienced in the human head. The significance of the element of melody in human nature is that it makes the head of the human being accessible to feelings. Otherwise, the head is only open to the concept" (ibid.).

> *those in between string and percussion instruments—are evidence of how the musical element is expressed in the third part of man's nature, the limb system. Also, however, everything connected with the wind instruments has a more intimate relation to the melody than that which is connected with string instruments which have a relation to the elements of harmony. That which is connected with percussion possesses more inner rhythm and relates to the rhythmic element.*[54]

If these teachings were to be followed, the transformation of rhythm into melody should be reflected in a change of instrumentation: from percussion to winds.

3

During his conversation with Fullemann on September 3, 1984, Tudor described one particular project from his past as being instrumental to his current interest in pitched tone—unfortunately the work remained unfinished:

> *thinking about what I'm doing, I wish to God that some of the projects I have that are out there . . . that I could finish with them. 'Cause I'm sure for instance that what I did on that Island research, the things that two parabolic or other shaped antennae can do. If I had that for the work that I'm now doing I'd be further on, but I don't have it yet.*[55]

Tudor does not say why he needs the results of *Island Eye Island Ear* to explore melody, only that he needs it. However, around the same time, he had written a draft of an application for a fellowship to expand his current work in two ways: (a) to develop "the techniques of speech transformation" into group compositions; (b) to "work in the field of sonar techniques" to realize the goal of *Island Eye Island Ear*. He provided a concise formulation of the latter in the draft: "to enhance the perception of wind currents as a coordinating compositional factor."[56] Four years later, when he was interviewed in Grenoble on November 24, 1988, Tudor described the invisible bulk movement of air as being the primary instrument of his island project that only existed virtually in concept:

> *I think that the wind is wonderful to use in music. I have an environmental project that I have been thinking about for more than 10 years. I don't know when it will be realized. It uses fog and sound beams created by two antennae faced to one another. If you are here, you will hear it very loud, if you are there, you will hear it very weak. The wind transforms the sound. If it is really strong in one place, the wind comes and the harmonic content of the sound is displaced. The wind displaces the fog, dissipates it, and reforms it elsewhere. It's the same thing for the kites.*[57]

[54] Ibid., 74–75.
[55] Tudor, "Interview by Fullemann."
[56] Tudor, "Draft for grant application (undated)," Box 109, Folder 25, David Tudor Papers, GRI.
[57] Tudor, "Interview," *Revue et Corrigée* 2 (Spring 1989), 10.

So when Tudor referred to "the things that two parabolic or other shaped antennae can do" to Fullemann, he was probably thinking about the wind of *Knavelskär*—wind, which also happened to be the instrument whose nature was best coordinated with melody in Steiner's teaching.

4

In spite of how he made it sound, when Tudor spoke about his "island research" to Fullemann in September 1984, he had not given up on the project yet. On July 24, just a month before the interview, Tudor had written a letter to the National Endowment for the Arts asking for an extension of a grant to realize the work he had been trying to realize for ten years. After listing excuses for the delay, he offered a prospect:

> *However, a combination of my having time this year to work on "Island Eye Island Ear" and the now possibility of finding an appropriate island in the Thousand Islands area of the St. Lawrence River lead me to request this extension until December 31, 1985.*[58]

This plan, like all the others, did not materialize. The most giant instrument in the world was to remain only a speculation during Tudor's lifetime. By 1985, the only possible future for *Island Eye Island Ear* seemed to lie in realizing the idea virtually with more scaled-down materials. A likeness had to suffice. Tudor had indeed been doing so for some time with the giant instrumental loudspeakers of *Rainforest*. In talking about both works, he stressed the importance of actually experiencing the sound of one location being "enhanced" through its "transformed reflection" elsewhere in the environment. There was a "coherence that is deceptive" synthesized in the mind of the reflective listener who hears one sound first and then its reflection.

But there is more to reflection than just reminiscence. As Tudor moved away from the "complete harmonious coherence" of *Rainforest* to focus more on melody and wind, and as he developed a concern for negative music whose apparition did not depend on the listener's movement in space, what seems to have returned is another mode of reflection that he had initially explored on *Island Eye Island Ear* whose proposed title was in fact *Reflections*.[59] In addition to being an act of reminiscence coordinating what one saw and heard across time and space, reflection is also an act of extrasensory perception that reads positive appearances as a negative of something that does not directly meet the eye or the ear—just like when one "sees" wind, because it is moving a tree.

As a matter of fact, this was exactly the kind of observation Monnier reported to a curator at the Whitney Museum of American Art in New York in a letter written on April 15, 1986: "If there is not enough movement through the ambient air, I may want to bring in fans but I do not think this will be necessary as I saw the top leaves of your trees moving."[60]

[58] Tudor, "Letter to the National Endowment for the Arts (July 24, 1984)."
[59] E.A.T., "Report on Experiments for 'Knavelskär' Project (August 8, 1974)."
[60] Monnier, "Letter to Susan (April 15, 1986)," Box 26, Folder 2, David Tudor Papers, GRI.

She was referring to her recent visit to the museum in preparation for a concert presenting two fruits of collaboration. One was a new version of *Sea Tails*, a film she had made with Tudor and the video artist Molly Davies three years before in 1983. The other was a new piece by Monnier and Tudor which focused on wind, a natural instrument of choice for the couple whose relationship had grown out of the island project. Perhaps Tudor had realized that melody, like Nakaya's fog, could be sculpted negatively. But this time the concert would take place indoors. The very nature of wind would change, as Monnier added in her letter: "Your heating and air conditioning system is important."[61]

Reflections

1

On September 17, 1986, Tudor and Monnier presented *9 Lines, Reflected*, their first performance as a duo, at the Whitney Museum of American Art. In an undated draft written not long before the performance,[62] Tudor described the work very concisely:

> An environment of "translated" kite tails, designed by J.M. & ultrasonically transduced so as to activate an electronic system, realized & performed by D.T.[63]

The origin of this collaboration was another collaboration that was performed on the same day: *Sea Tails*, whose recording had already appeared in an inverted form a year before as the secret ingredient to *Hedgehog*. "Our work started with a score done for a film of underwater kites," Tudor reminisced to Teddy Hultberg in May 1988.[64] For two weeks in mid-February 1983, Davies had filmed Monnier's kites swimming near Nassau in the Bahamas, swayed not by air but by sea currents of the Atlantic Ocean. Tudor, who was invited to provide the music, accompanied them on this trip and recorded underwater sounds. While the other two dived and filmed, he stayed on the boat, dropping microphones sealed in baby food jars filled with mineral oil. "He never saw anything he recorded because as Jackie said, 'David never put his head underwater,'" Davies recalled. "But then, we were never sure if David could swim."[65]

For the three-week-long premiere at the Georges Pompidou Center in Paris from June 3 to 27, 1983, Monnier edited the film to be shown on six monitors arranged in three columns following a format of simultaneous projection she had been working on for some time. For the new "Sound Totem version" presented at the Whitney Museum three years later, three monitors displaying the films were installed inside

61 Ibid.
62 Tudor writes the full title *9 Lines, Reflected*, which only appears to have been used after April 15.
63 Tudor, "Draft sketch for *9 Lines, Reflected* (undated)" Box 26, Folder 5, David Tudor Papers, GRI.
64 Tudor, "Interview by Teddy Hultberg," davidtudor.org.
65 Molly Davies, "On Making *Seatails* (unpublished manuscript)," private collection of Molly Davies.

a 2.80-meter plexiglass structure made by Monnier with water running down on all four sides. In a note she wrote for the occasion, Monnier described the sounds Tudor collected as "the so-called 'silence' under the sea," connecting them with the virtual silence of clicks and pops: negative music that is already there but occulted from normal—or simply hydrophobic—perception.[66]

When *Sea Tails* was completed, Tudor took the next lead:

> *Then I thought: "wouldn't it be nice if we could make a sound environment outdoors with the kites in the air," so my mind started to work on that proposition . . .*[67]

The basic idea was simple: to directly coordinate his sound beam and Monnier's kites that had been considered only in parallel during the island project. The easiest way to do this was to point the sound beams to the kites moving in reflection to the wind so that the way sounds are modulated reflected that reflection. He had already discovered a useful substitute for his instrument: "It was obvious to me that radar was the way to go."[68] Among other things, this meant that the beam itself would become inaudible to human ears.

2

An acronym of "RAdio Detection And Ranging" coined by the United States Navy in the early days of the Second World War, radar is an instrument that perceives objects using ultrasonic radio-waves or microwaves. The mechanism is based on reflection: a transmitter sends out a high-frequency and therefore directional signal above the human hearing range which, upon hitting a moving object, is reflected back to the receiver sharing the same antenna. Since the object changes its position, the reflected sound wave takes slightly more or less time to reach the receiver, resulting in subtle shifts of frequency known as the Doppler effect. In other words, the difference between what is sent and what returns contained information about the spatial relationship between the antenna and the object.

Once back in the instrument, the slightly shifted frequency interferes with the original frequency to produce a lower beat frequency that can be heard by human ears—a process of demodulation through heterodyning similar to the one carried out by Mumma's *Beat Frequency Oscillator*. The remaining signals on the radio-frequency level are then filtered out. This was necessary not because signals outside the human audible range did not matter, but on the contrary, because signals inaudible to the human ear could nonetheless be heard by the instrument. As Tudor must have read in the manual of the copy he owned: "If higher frequencies are allowed to pass, the unit is prone to false triggering from, for example, mains-operated lighting, especially

[66] Monnier, "*Sea Tails*: Sound Totem version," Box 26, Folder 2, David Tudor Papers, GRI.
[67] Tudor, "Interview by Teddy Hultberg."
[68] Ibid.

fluorescent lamps."[69] The radar, that is, could detect the movement of the same light-emitting material whose sounds Tudor had amplified blindly back in 1964.

The method of hitting a physical object remotely with (ultra)sounds brings to mind how Tudor performed *Hedgehog*—another Monnier-related piece. But there are three differences that radar introduced: (a) sound was now inaudible to the human ear; (b) it did not cause objects to move but simply reflected the way they were moved by other forces; and (c) these reflections were used as control signals. These characteristics also clarify how Tudor and Monnier's new collaboration differed from *Island Eye Island Ear*. Whereas audible sound beams reflected the *movement* of wind as modulation of its own appearance, inaudible radar beams turned into control signals reflected not only the movement but also the *role* of wind to modulate appearances without itself making an appearance. Simply put, the radar did to music what the wind did to kites.

3

On February 1, 1985, when the work was still in progress, Monnier wrote an excited letter to Tudor reporting, "Radar is useful! If they can use it to measure distances in space, we must be able to use it for the kites out of doors. . . ."[70] But that possibility was quickly dismissed by the bias of actual resources—instrument and money—that was available. As Tudor explained to Hultberg three years later:

[69] "The Maplin RTX3," Box 49, Folder 6, David Tudor Papers, GRI. In *Echoes of Bats and Men*, a book Tudor owned, Donald R. Griffin wrote about a similar oversensitivity in early sonars that led to an unexpected use of the same device: "By the 1950s, however, echo sounders had been perfected to a level of realizability where they have become almost essential for safe navigation. They even became so sensitive that they began to indicate 'false bottoms' between the ship and the true bottom. 'Finding' two or three extra ocean bottoms above the real one was a rather disconcerting discovery, but after a time the fishermen who used echo sounders began to notice that some of the 'false bottoms' were really echoes from schools of fish. Still later, mysterious layers of faint echoing, or sound scattering, were noted almost everywhere in deep oceans at several hundred feet below the surface. These have been called the deep scattering layers and they were later found to migrate up and down with dawn and dusk. This fact provided the clue to their identity. Oceanographers had already discovered by systematic netting operations that large populations of shrimp and other small marine animals live at depths where sunlight barely penetrates. This depth is greater at noon than at midnight; hence there is a massive vertical migration of these animals upward during the evening and down again at daybreak. The physical records of the deep scattering layers turned out to match the known behavior of these animals. Once this additional fact was established, the echo sounder became a valuable tool for biological research, for now the timing of the vertical migrations could be studied with great precision" (Donald R. Griffin, *Echoes of Bats and Men* [Garden City, NY: Anchor Books, 1959], 110–111). On April 25, 1986, Tudor performed the only realization of a piece named *Electronics with Talking Shrimp* at the Clocktower, New York, in which he used four microphones, each connected to a noise gate (*SAE Click and Pop Assassin* [two channels], *Vesta Fire CG-1 Compressor/Gate*, and *Next SE-100 Signal Gate*) and the *Quad-keys* to pick up and modulate the sounds of toy shrimp which could make sounds using a small pneumatic mechanism—a miniature-scale organ, so to speak, which inverts the process of enlarging instruments with an added spicing of pseudo-voice and underwater themes. The system is also reminiscent of *Hedgehog*, whose third performance, after the two consecutive ones at the Mobius Art Center, had taken place just two weeks before, on April 8. The toy shrimps appear in Rogalsky's list as "Singing Shrimp" (Instrument 0239) but are nowhere to be found today.

[70] Monnier, "Letter to David Tudor (February 1, 1985)," Box 56, Folder 6, David Tudor Papers, GRI.

> *Well, it turned out that the radar system that I had access to was not sensitive enough for a kite-like situation. So now I'm working with another kind of radar which is much more sensitive. At the moment, I can only do short range transmission because, well, it is very expensive to use high power levels.*[71]

So they decided to create an indoor miniature of what was not possible outdoors, which was already a simulation of what had been too difficult to realize on an island. *Rainforest* had also been simulating the same line of ideas in miniature for some time. But compared to the instrumental loudspeakers that were at least chosen for their own nature, Monnier's object was carefully designed to reflect the nature of something else it simulated:

> *I asked Jackie if she had some kind of mobile that would resemble a kite. She began to develop sculptures which she calls lines and they hang vertically and contain structural elements which resemble kites.*[72]

Monnier made nine of these "*Lines*" for the Whitney performance, pieces of light aluminum of different dimensions that Tudor later likened to "miniature kites without tails."[73]As opposed to stationary instrumental loudspeakers which required the audience to move around, these pseudo-kites were designed to be constantly moved by the wind in order to constantly move sound in reflection. Accordingly, the simulation this time focused not so much on what could only be heard in reminiscence but on what could not be heard at all.

On April 15, 1986, just over a year after reporting the usefulness of radar to Tudor, Monnier wrote a letter to the Whitney Museum offering a tentative name for the new collaboration based on the kite-like mobiles she had been making: "The second piece for David's concert could be called 'Nine Lines' temporarily. He'll certainly have another name for it later on . . ."[74] However, in another letter she wrote to Tudor the following day, she scribbled down a slightly different name: "the radar piece, which for the moment I've called '9 Lines Reflected.' "[75] Monnier urged her partner to think of a better alternative: "You must think of how to baptize the above new piece—It deserves another name."[76] In the end, her title was kept. She had not only altered the meaning of reflection through her pseudo-kites but had also come up with a good name for what they were doing.

At the Whitney, the nine *Lines* were hung from two steel fishing cables with three smaller supporting cables running across, all attached to the columns above the door of the museum. The weight of each *Line* was calculated precisely to balance their susceptibility to the two invisible forces it mediated: the wind which it reflected, and

71 Tudor, "Interview by Hultberg."
72 Ibid.
73 Tudor, "*9 Lines,* draft description," Box 26, Folder 5, David Tudor Papers, GRI.
74 Monnier, "Letter to Susan (April 15, 1986)."
75 Monnier, "Letter to David Tudor (April 16, 1986)," Box 26, Folder 2, David Tudor Papers, GRI.
76 Ibid.

the radar beam which reflected it.[77] Tudor directed two microwave doppler-radar transceivers at the *Lines* to detect their movement "occasioned by air currents already present in the room,"[78] as he put it in an undated draft—hence Monnier's note on the heating and air conditioning system. In the same draft, he also wrote down how the instruments should be positioned. He wanted the two radars and related instruments on the ledge above the entrance, " 'invisible' to the space" like the waves they transmitted.[79] The signals generated there would be routed down to a table which served as "the control station" for the performer, who remained visible.

4

Tudor drew a generalized diagram for *9 Lines, Reflected*, showing the spatial relationship between the pseudo-kites and the radar system (Figure 9.9). Aside from two ultrasonic transceivers, one suspended from the ceiling and the other mounted on the wall, he used a microphone to pick up the sound of at least one kite "with a swivel mechanism," which was transmitted wirelessly to the audio processing system. The processed signal was output from the surrounding loudspeakers as well as from a reflector antenna suspended in the upper corner of the space which appears to have created a pseudo-sound beam received by another antenna at ground level, where Tudor placed another microphone to feed the sound back to his processors.

But there are no surviving matrix maps of his sound system or recordings that reveal what the performance at the Whitney actually sounded like. The most puzzling element is how the reflected signals from the radars were used, something that the generalized diagram does not indicate and is impossible to detect from the few remaining black-and-white photographs. In a letter written on October 16, a month after the performance, Monnier also lamented the lack of documentation:

> *I have scolded myself all week for my lamentable failure at getting our work correctly photographed in color. I really did trust the Whitney. There was so much else to do. Now I know one must really do it oneself. I somehow eclipsed it. Never again.*[80]

Following the concert, Monnier stayed in New York until October 6, during which time she and Tudor started planning for their second performance in Munich, Germany, to be presented as part of the Klang-Aktionen festival in November. There was a change in the title. For some reason, the word "reflection," which appeared to

[77] As Monnier informed the presenters on June 6: "The elements on the lines are light enough to move in the ambient air gently but enough so that David can do his piece. […] Each line with its elements will weigh no more than 100 grams (under 4 ounces). Total weight would not exceed 36 ounces" (Monnier, "Letter to Susan and Jeanette Vuocolo [June 6, 1986]," Box 56, Folder 6, David Tudor Papers, GRI).

[78] Tudor, "*9 Lines*, draft description."

[79] Ibid.

[80] Monnier, "Letter to David Tudor (October 16, 1986)," Box 56, Folder 6, David Tudor Papers, GRI. In the same letter Monnier reported: "I'm reading my first Steiner book in Eng, but is not *Theosophy* as I had hoped for they were out of it. The book is called *Philosophy, Cosmology and Religion* and I find the English translation makes his ideas much more accessible so I am greatly enjoying myself" (ibid.).

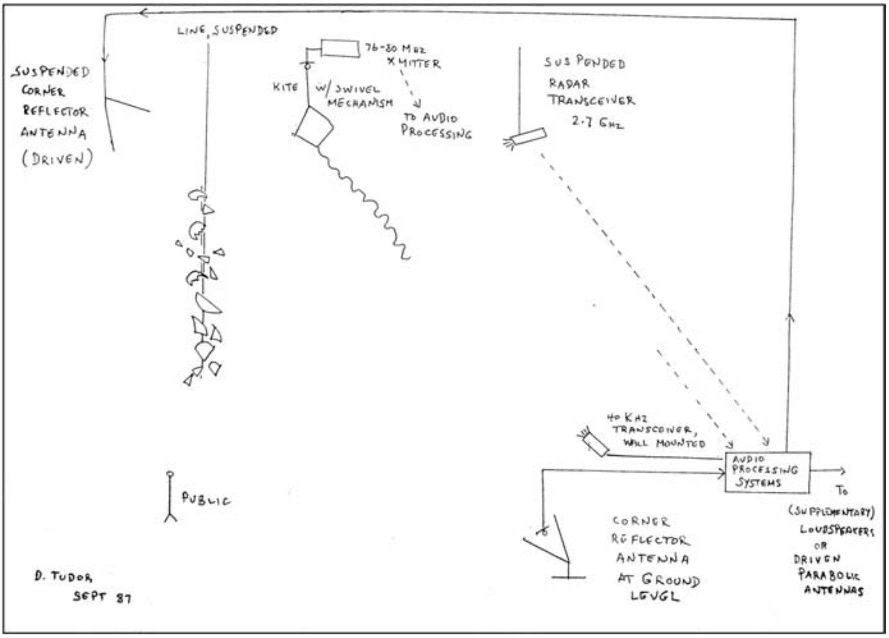


Figure 9.9 Tudor | *9 Lines, Reflected*, diagram | September 1986
DTP, Box 3, Folder 22 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust
Note: Tudor misspells the year as "87."

bring together the workings of both the pseudo-kites and the radars, was taken out, and the work now received a name that only addressed Monnier's part of the collaboration: *Line & Cluster*. Three matrix maps with the same title have been found. All of them are dated, but the dates turn out to be much earlier than November 8 when the performance was actually given[81]—one is from September 24 and two from October 4. In other words, these maps were all drawn while Monnier was still in New York.

Among the list of instruments there are only two that can receive external control signals: *The Drum* and the *Percussion Synthesizer*. For some reason, Tudor had reverted back to the use of two synthesizers from *Dialects*. *The Drum* indeed already appears prominently on the black and white photograph of Tudor's setup that was used for the postcard flyer of the Whitney concert (Figure 9.10). What is more surprising than the constancy of instruments, however, is the nature of control signals that went into them. No radar device appears in the *Line & Cluster* maps. Instead, the primary inputs are tape sources, which in two maps—both from October 4—are specified next to the abbreviated names of cassette tape players: *D6 (Sony Walkman WM-D6) = Dialects B; INF (Infinity Intimate Walkman) = Sea Tails, Pulsers; 800 (Sharp RT-W800 Cassette Deck) = Sea Tails 2* (Figure 9.11).

[81] It was performed in a joint program with new works by John Cage: *ASLSP* (1985), *Postcard from Heaven* (1982), *Ryoanji* (1985), and *Music for Two* (1984) ("Program for Klang-Aktionen 1986," Box 80, Folder 7, David Tudor Papers, GRI).

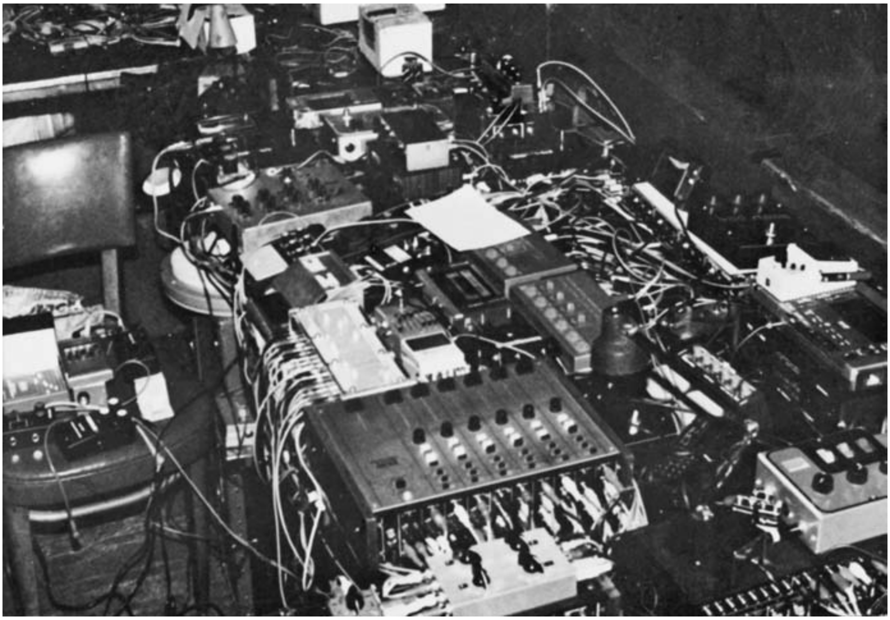


Figure 9.10 *9 Lines, Reflected*, Tudor's setup from postcard flyer | 1986
DTP, Box 80, Folder 7 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

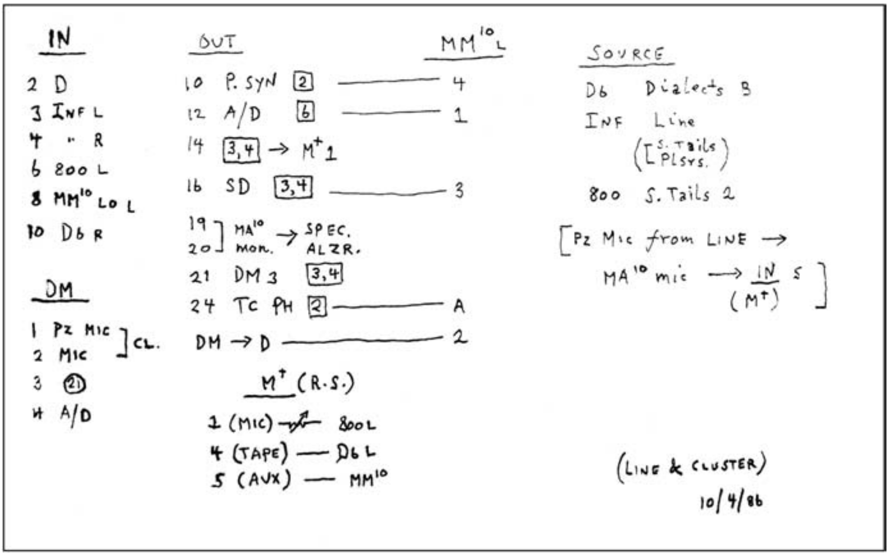


Figure 9.11 Tudor | *Line & Cluster*, matrix map | October 4, 1986
DTP, Box 3, Folder 16 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

Tudor was using his negative music instead of radar signals. Perhaps the problem of sensitivity and its trade-off with expensive high-power levels was still unsolved. Perhaps that was why the word "reflected" had disappeared from the title, as it no longer applied to Tudor's part of the performance. Or perhaps the tapes were just tentative substitutes for the radar signals which could not be tested properly in New York without the pseudo-kites installed in the actual space. In any case, the inverted negatives of Tudor's past music yet again stood in for an absent input. After all, both negative music and radar signals did share the same functional role of informing the listener about something that could not be perceived directly from appearances, only reflected upon.

5

Two years later, Tudor and Monnier presented a new version of their collaboration, renamed once again as *Lines & Reflections.* Two sets of performances took place, first a 70-minute version at The Kitchen in New York on February 28, 1988, as part of the Imaginary Landscapes Festival curated by Nicolas Collins; then an a (pseudo-) installation version at the Kunstakademie in Düsseldorf three months later, where Tudor performed for eight hours every day over the course of three days between May 18 and 20, as part of the Rheinisches Musikfest. For this occasion, Tudor wrote a description:

> Lines & Reflections
> A concert/environment conceived in collaboration with Jackie Monnier.
> Jackie Monnier's "Lines" are hung vertically with reflective forms, forms reminiscent of the artist's kite-tails, swaying following air currents in space.
> The movement of these visual elements, sensed via radar & ultrasonic transceivers provides control signals to a variety of sound generating circuits, implemented & performed by D.T., using four differing systems & their composite variations.
> The performance collaboration takes place in air: objects moving in space, influencing sound waves & their frequencies; an interaction between two disciplines results in a visual work participating in the creation of a sound-space.[82]

Only one matrix map has been found with the corresponding name and a date that matches the Düsseldorf performance (Figures 9.12 and 9.13).

Tudor used two pairs of instruments to detect the movement of Monnier's *Lines*. In the matrix map, one is specified as "Radar" ("R1", "R2") and the other as "Ultrasonic" ("US1", "US2"). Both were kits sold by Maplin Electronics for home security and worked in a similar manner. *RTX Radar Doppler Intruder Detector* was built around a microwave transceiver module that transmitted a signal of 12 MHz and had an adjustable range between two and ten meters. *Ultrasonic Intruder Detector* transmitted

[82] Tudor, "*Lines & Reflections*, description," Box 26, Folder 5, David Tudor Papers, GRI.

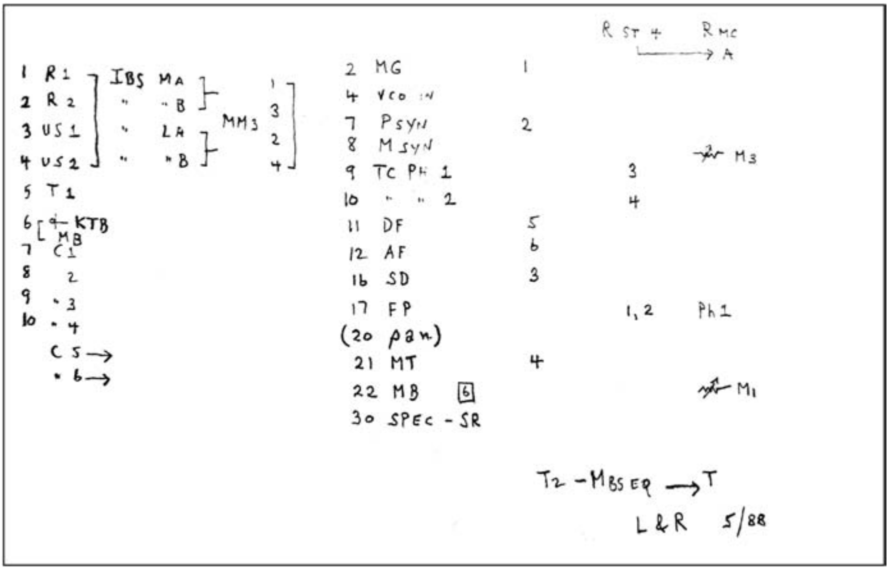


Figure 9.12 Tudor | *Lines & Reflections*, matrix map | May 1988
DTP, Box 3, Folder 17 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

a signal of 40 kHz with a range of up to six meters. Three days after the concert in Düsseldorf, Tudor was interviewed by Hultberg and explained how he was using these instruments: "I take audio frequencies from the devices and those I use to trigger modulating equipment. In a sense, it's very much like the principle of altering the output to disguise it."[83] According to Matt Rogalsky, who later tested the same pair of instruments in 1996, "The sonar units provide a very nice backdrop [. . .] with very low and high-mid whooshes, and the radar offers more low end."[84]

There are several ways to make sense of the modulating equipment these inputs triggered. From their placement on the output side of the *Matrix Switcher* they can be divided into six groups:

(a) *D&R Electronics Multigate* ("MG")
(control signal) Voltage-Controlled Oscillator input (for one of the synthesizers)
(b) *Percussion Synthesizer* ("P. SYN"), *Minisynth* ("M. SYN"), *t.c.electronic TC XII Programmable Phaser* ("TC PH 1," "TC PH 2"), *Boss Dynamic Filter* ("DF"), *Ibanez Auto Filter* ("AF")
(c) *String Damper* ("SD"), *Ibanez FP-777 Flying Pan* ("FP")
(d) (panner), *Mu-tron III Envelope Filter* ("MT"), *Shin-ei Mute Box Envelope Filter* ("MB")
(out) *Spectrum Analyzer* ("SPEC")—*Sound-A-Round* ("SR")

83 Tudor, "Interview by Hultberg."
84 Matt Rogalsky, "David Tudor's *Virtual Focus*," *Musicworks* 73 (1999), 23.

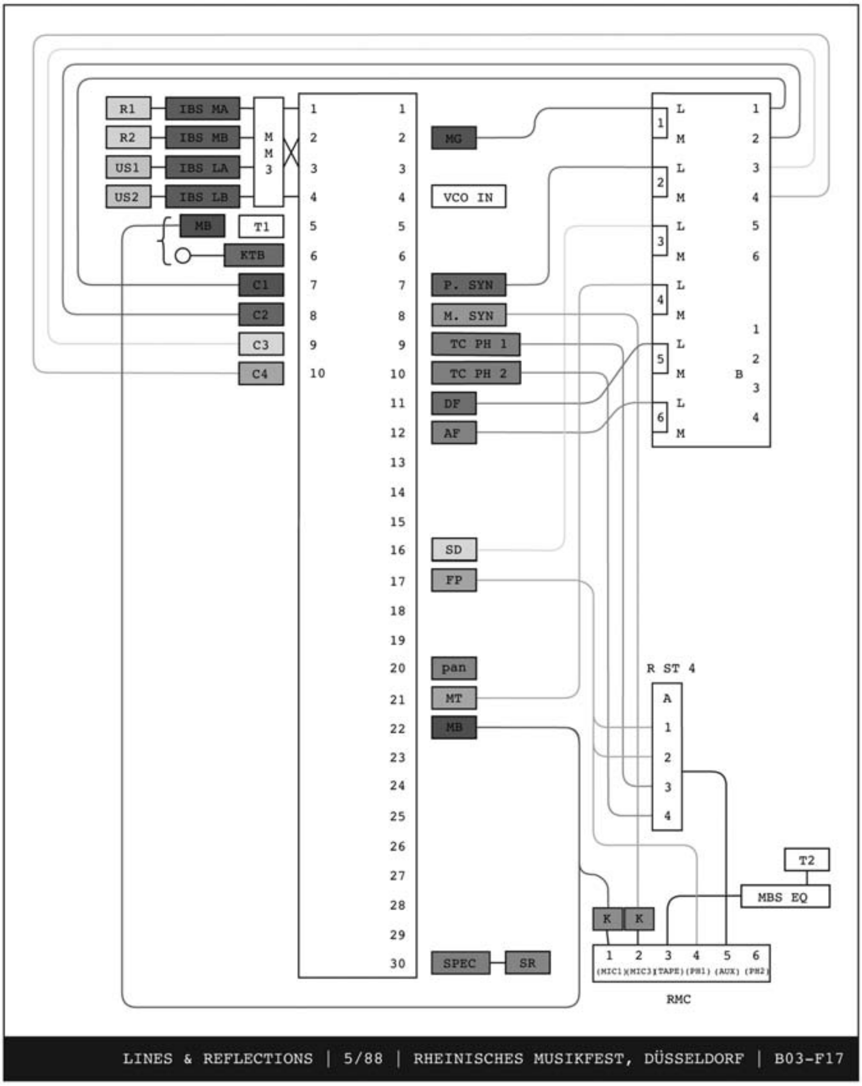


Figure 9.13 *Lines & Reflections*, matrix map diagram
Created by You Nakai

From their distribution to the input side of the three *Mixers*, they can be divided into three groups (their group letter is attached to each instrument):

(1) *TEAC Mixer*: MG (a), P. SYN (b), SD (c), MT (d), DF (b), AF (b)
(2) *Realistic 4-channel Stereo Mixer* ("R ST 4"): TC PH 1+2 (b), FP (c)
(3) *Realistic Stereo Mixing Console* ("RMC"): MB+K (d), M. SYN+K (b), T2 (*Tape 2*), FP (c), R ST 4.

A certain logic appears from these two groupings. But since the character of instruments play a significant role, the new effects processors must first be briefly introduced.

6

Perhaps reflecting the two pairs of radars used to capture the movement of Monnier's *Lines*, Tudor's selection of instruments was based on a coupling of instruments with similar functions: two gating devices to chop sounds (*Multigate, String Damper*), two PLL-based synthesizers to produce sustained tone (*Percussion Synthesizer, Minisynth*), two types of phasers (*Programmable Phaser, Flying Pan*), two pairs of envelope/dynamic filters (*Dynamic Filter, Auto Filter, Mu-tron III, Mute Box*), and even two panners.

Sound Choppers (a): *D&R Electronics Multigate*

This was a sophisticated noise gate that Tudor purchased in Paris on May 26, 1987, just a year before the performance of *Lines & Reflections*. The "Multi" in its name advertised versatility. Aside from the usual job of attenuating unwanted signals below an adjustable threshold, it could do many other tricks, such as frequency-dependent setting of threshold level to automatically adjust the gating to a signal of a particular frequency range. In Tudor's later description, "the gate can be 'tuned.' both as to frequency and duration."[85] Among all its multiple talents, however, one in particular must have attracted him: the "DUCK" button, which inverted the working of the *Multigate*, just like the neat switch of the *Click and Pop Assassin*.[86]

Sound Chopper (b): *E&MM String Damper*

Already seen in *Fragments* and *Hedgehog*, this was a kit instrument designed by Paul Williams and published in the May 1984 issue of *Electronics & Music Maker*. A cut-out of this article has been found among Tudor's papers.[87] As its name spelled out, the *String Damper* intended to electronically simulate the effect of damping guitar strings with hand. As if that was not clear enough, the box that Tudor owned had an additional label with a second name written in someone's hand describing not what it wanted to simulate but what it actually did: "Sound Chopper."

85 Tudor, "Liner notes," *John Cage: Music for Merce Cunningham*, Mode Records (Mode 024), 1991, CD.
86 The manual explains the use of the DUCK button in the following manner: "This function is especially useful in environments where a singing-voice has to come above the backing music. This can be done automatically by sending the music through the MULTIGATE's audiopath, making the attenuation a few dB's by the range control and sending the voice signal into the key-AC input (key switch into on-position). The effect is, when the voice triggers the MULTIGATE (coming above the adjusted threshold level), the music will decrease by some dB's which were set by the range control. The envelope of the decreasing music is accordingly to the att.del, attack, hold and release controls. The duck function is also useful for an easy threshold setup. By pressing the duck switch you hear the audio that will be deleted from the original audio signal. After this, release the duck switch again and you will hear only the audio signal without the part you have just listened to" (D&R Electronics, "Multigate Manual," 13 [Box 49, Folder 4, David Tudor Papers, GRI]).
87 Paul Williams, "DO-IT-YOURSELF The String Damper," *Electronics & Music Maker* (May 1984), 92–94 (Box 48, Folder 4, David Tudor Papers, GRI).

PLL-Synthesizer (a): *Forrest M. Mims Percussion Synthesizer*

This joystick instrument had already appeared in *Dialects, Fragments*, as well as *Hedgehog*. As observed before, it used a *4046 Phase-Locked Loop* chip connected to a rotating interface to control the parameters of percussion sound it simulated. Now it has a new companion.

PLL-Synthesizer (b): *Minisynth* or *Mini Musical Synthesizer*

Another kit instrument similar to Forrest Mims's, which was first published in Dick Smith's *Funways into Electronics Volume Three* in 1983, and then reprinted in the February 1986 issue of *Radio Electronics*.[88] Like its significant other, this synthesizer also used a voltage-controlled oscillator controlled by a *4046 Phase-Locked Loop* chip, which detected the frequency of the input signal and created a matching single-pitched signal, a simulation of the original with reduced harmonics and noise content—precisely useful for Tudor's goal of dealing with melody. This new tone could then be halved or doubled in frequency, or modified with a tremolo effect.

Phaser (a): *t.c.electronic TC XII Programmable Phaser*

A versatile phase shifter that had already appeared in *Dialects*. As discussed previously, the instrument came in two versions, normal range and one octave lower bass range, but the two copies Tudor owned were both of the bass range type.[89]

Phaser (b): *Ibanez FP-777 The Flying Pan*

Already seen in *Fragments*, this was another versatile phase shifter that could also control stereo panning. Tudor had purchased this instrument in Copenhagen on June 1, 1984, slightly before he embarked on the trip to Cadaques with Monnier during which he would find *Hedgehog*.

Envelope Filters/Auto-wahs (a): *Boss FT-2 Dynamic Filter/Ibanez Auto Filter*

Like the *Electro-Harmonix Bass Balls* that appeared frequently in Tudor's pseudo-vocal music, envelope filters or dynamic filters are automated wah-wah pedals that adjust the internal filter not by the physical movement of the foot pedal but by the volume of the input signal which is detected with an envelope follower and turned into a control signal. Popularized by funk music, there were a variety of these in the market around this time. Four of them appear here, each coupled with another to form two pairs. *Boss FT-2 Dynamic Filter* and *Ibanez Auto Filter* were two similar instruments that Tudor was fond of. He owned at least two copies of the first and at least two of the second.[90]

[88] Dick Smith, "Build This Mini Music Synthesizer," *Radio-Electronics* (February 1986), 75–78 (Box 48, Folder 7, David Tudor Papers, GRI). The same folder contains notes Tudor made when composing the instrument.

[89] See footnote 178, Chapter 8 for more details on this instrument.

[90] He had bought his first *Dynamic Filter* on July 20, 1987 in London, and his first *Auto Filter* on December 2, 1985, in New York ("Receipt for *Boss Dynamic Filter*," Box 140, Folder 16; "Receipt for *Ibanez Auto Filter*," Box 139, Folder 7, David Tudor Papers, GRI).

Both came with knobs or sliders and switches to adjust the sensitivity of input, the frequency range of the filter, as well as selecting between "up" and "down" mode, which determined the direction that the cutoff frequency of the filter was swept according to the volume of input. according to the volume of input.

Envelope Filters/Auto-wahs (b): *Mu-Tron III Envelope Filter/Shin-ei Mute Box*

The acronym "MT" referred to Mu-Tron or Musitronics, a manufacturer who built several instruments Tudor owned. The one used here was probably *Mu-Tron III Envelope Filter*,[91] advertised as "the world's first envelope filter" when it was released in 1972. As the most famous instrument of this kind, it triggered the birth of many cheaper instruments that simulated its effects. In fact, the *Ibanez Auto Filter* was dubbed "mutron killer," but that was not the only virtual Mu-Tron Tudor owned. *Shin-ei Mute Box*, below the *Mu-Tron III*, was yet another envelope filter very similar to the one above—in fact, a cheaper clone of the more expensive instrument. The output of this *Mute Box* is returned to input 6 of the *Matrix Switcher*, which it shares with a microphone directly attached to one of Monnier's *Lines*, suggesting that it was predominantly used to filter the real-time collision sounds of the pseudo-kites moved by the wind.

The coupling of instruments is reflected in how they are grouped. On the side of the *TEAC Mixer*, only one processor goes into each of the six channels, so there is no option of switching. One instrument from each group is chosen, except for the two envelope/dynamic filters in group b which are assigned to the two last channels, where Tudor had always placed two complementary equalizers in his pseudo-vocal music. These two filters also do not feed back to the *Matrix Switcher* as all the other ones. The remaining instruments all go into the other two mixers. *Realistic Stereo Mixer* receives the rotating outputs from the three phasers, which is then sent to the auxiliary input of the *Realistic Stereo Mixing Console*. The latter also receives sustained pitch signals from the *Minisynth* and *Mute Box* gated by two *Photocell Keys*, a direct output from the *Flying Pan*, and a source tape. Thus, while the *TEAC Mixer* receives all the instrument types except the phasers, the *RMC* receives all the instrument types except the choppers, which it replaces with the manual option of key gating.

(1) TEAC: **MG** (a), *P. SYN* (b), **SD** (c), *MT* (d), *DF* (b), *AF* (b)
(2) R ST 4: TC PH 1+2 (b), FP (c)
(3) RMC: *MB*+**K** (d), *M. Syn*+**K** (b), T2 (*Tape 2*), FP (c), R ST 4
(choppers in bold, PLL-synthesizers in italics, phasers are underlined, and envelope filters are underlined and in italics).

[91] The only extant Mu-Tron pedal in the Wesleyan collection is the *Bi-Phase*, which appears frequently in matrix maps from the late 1980s. It is, however, an unlikely candidate here since the *Bi-Phase*, as the name indicates, was a dual phase shifter with two separate sweeping filters, which meant it usually received two inputs, not just one. Tudor also owned a *Mu-Tron III Envelope Filter* which he purchased on the same day as the *Multigate*, which has gone missing, yet seems to be a better candidate for the acronym (Stars Music One, "Receipt for Pedal Mu-tron III [May 26, 1987]," Box 141, Folder 1, David Tudor Papers, GRI).

What the "four differing systems" Tudor wrote about in his description is not so clear. Perhaps he was thinking about the first four processors going into the *TEAC Mixer*, or perhaps the four categories of modulating instruments: gates, phase-locked loops, phasers, and envelope filters.

In any case, the composition of the sound system is reflected in the overall soundscape heard in the six-part, four-hour recording from the Düsseldorf performance: high whooshing sounds from the ultrasonic detector detecting the movement of pseudo-kites in the air mixed with heavy dragging sounds which are the recordings of the same *Lines* made in advance, chopped, prolonged, modified, and rotated, and filtered using the reflections of their movement during performance, itself reflecting the invisible movement of air currents in the space.[92] Perhaps this was the music of melodies sculpted negatively by wind that Tudor had sought for. But there is something else going on in the music which cannot be analyzed as easily as instruments on diagrams.

7

On April 3, 1989, one year after the performance of *Lines & Reflections*, Tudor sat down with Larry Austin in Denton, Texas, for an interview. Five years had passed since he was interviewed by Fullemann. He spoke more fluently about the transformation in his music and appeared more confident of its outcome. But the way he explained what he was doing was not so straightforward. At first, it sounded like he was giving a general description of his approach, repeating the principle of "it is they who are doing it":

> *I've always felt that there's a point where a piece seems to be alive, that is, living. And that's the point where I know the composition is finished, even though I might have designed the procedures so that it could change, you know. But there's a point where the composition is alive, and it doesn't need anymore . . . culture.*[93]

[92] The two tape inputs, one going into the *Matrix Switcher* and another into the *RMC Mixer*, were selected from a collection of six recordings now archived as part of the David Tudor Papers at GRI, each labeled succinctly:

Box 2A, C78: no description
Box 2A, C79: K? Line with multigate
Box 2A, C80 side A: Line (second recording)
Box 2A, C80 side B: with multigate
Box 2A, C81 side A: Radarmania
Box 2A, C81 side B: Line.

C80A and C81B are recordings made by attaching contact microphones to the *Lines*. They sound like metal wires clanging at a slow speed. C80B is C80A processed using *Multigate*, which chops the sound, only letting the ones above the set threshold go through, adding a particular sparkling ring to it. C79 sounds very much like the clicks and pops of negative music, perhaps produced by using the *Multigate* in reverse. C78, lasting a little short of 20 minutes, is a mix of *Line* sounds and a layer of heavy breath-like hiss which is actually the negative music of *Pulsers* (C47). C81A is from an unknown source called "Radarmania," which is a fast rumbling bass sound, melodious and rich in harmonics, sounding like an 8-bit videogame sound effect gone wild. All of these sources are very audible in the recording of the Düsseldorf performance (Box 2A, C82-85).

[93] Tudor and Austin, "A Conversation."

But this time, the explanation was actually a remembrance of things past. For he immediately continued:

> *Nowadays, I'm changing my mind about that.* [laughing] [. . .] *lately, I'm seeing that 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. I always compose around the periphery, you know.*[94]

When Austin asked him to clarify what he means, Tudor began to talk about metamorphosis, "where one shape . . . if you turn it inside-out, it changes into a completely other one."[95] But the example he went on to give was not about the metamorphosis of his mind; it was that of vowels to consonants, and then of rhythm to a melody. The examples themselves were metamorphosing—as if Tudor were performing what he was talking about. Austin naturally tried to get back to what he thought they were talking about, yet Tudor again raised the level of abstraction:

> *LA: You mentioned this concept of composing, where you could "turn your mind inside out." Is that the project that you're consumed with right now?*
> *DT: My radar piece has taught me new possibilities and that's . . . I'm going to continue with that. And as far as the ideas transforming "inside-out," you see, I started with this idea that the . . . that sound could be obtained from sculptural material or actually from anything through reflections. But the thing that is turning my idea about how to form the piece "inside-out," because, you see, I was starting from materials, and now I'm already working with waves which don't exist. Do you understand that?*
> *LA: Yes, they're not material?*
> *DT: They're not material. In comparison to the principles in "Rainforest," it's bodyless.* [laughter] *No . . . and I found that, if you can make waveform patterns interfere with one another, well you . . . I obtain results which astonish me . . . I've been trying to get, you know, space to sing by itself, and this is the first time I have succeeded. So, I'm quite excited.*
> *LA: So that the acoustical characteristics of a space will create the difference . . .*
> *DT: . . . will make a melody, yeah?*[96]

Five years since he took aim at the pitch element, Tudor had finally found a way to create a melody. But this was a melody in no ordinary sense. It was something that the space sang by itself, as a result of making immaterial and bodyless waves mutually interfere, turning the initial "idea" of obtaining sounds from materials through reflections inside-out.[97] He appears to have discovered a way to bypass objects altogether.

[94] Ibid.
[95] Ibid.
[96] Ibid.
[97] Ron Kuivila suggested an influence from Alvin Lucier's *Outlines of Persons and Things*, which similarly aimed to "make the inaudible audible" through the phenomenon of acoustic shadows—modulation of sound caused by physical obstruction of sound waves (in this case a high-pitched pure tone) using objects. According to Kuivila, Lucier performed this work composed in 1976 at one MCDC *Event* which Tudor attended and appeared to be impressed by the results (Kuivila, "Private conversation with You Nakai," Middletown, CT, April 22, 2017).

In an early draft of the program note for *Lines & Reflections*, Monnier had attached an enigmatic addendum on the back of the page as a personal note to her partner. It recorded a shift that took place during the performance:

> *The sound, master of the space, wants to make us feel the actual limits of the space and the air which fills it, in which it exists feeding off the movement of visual objects as fish feed off the sea bottom or as birds gobble insects in midflight. Then simultaneously it flails out in tone and rhythm making us actually hear SPACE. Is it because we are made to realize its limits? This is a collaboration between two artists working with air: one with objects in space, the other with sound waves and frequencies having fun together.*
> *For David from Jackie*[98]

The trigger for turning focus inside-out is described as the flailing out of sound in tone and rhythm. Perhaps this was the effect of waveform patterns interfering one another. But unlike the influence of winds that could be reflected upon while tracking the coordination of mudular instruments and even while listening to the performance in recordings, the melody sang by the space is difficult to hear without actually being there. There are several melodic elements in the recording, most notably the fast singing of high whooshing sounds coming from the radar and the rumbling low sounds of the "Radarmania" source tape. But although these can be heard as something that happened *in* the space, they are not the song *of* the space. The polarity between material and immaterial, between body and bodyless, is itself grounded in the physical specificity of the listener who can perceive one thing and not the other. For the radars themselves, even the fluorescent light may have been movement. Which is to say there is a paradoxical trade-off at work: the more bodyless the principles become, the more they seem to require an actual body situated in space and time to process and synthesize the results. The limits of space can be realized only by actually being limited in space (Figure 9.14).

Seeing Tudor's materials as a puzzle to be solved assumes that everything can be turned into signs that are legible from afar. But just like William H. Hawke's old advice which changed the young organist's life, there is a difference between doing something in the mind's eye and actually doing it. On December 5, 1978, during CIE's Media Study/Buffalo residency, Tudor had told something to the same effect to the interviewer of a local radio station: "I think that we're already creating an audience which appreciates the fact that it's unique and there's no other way that they can hear it, except to be there."[99]

[98] Monnier, "Hearing Space, Draft of Program Note for *Lines & Reflections*," Box 26, Folder 5, David Tudor Papers, GRI.
[99] WBFO, "Interview with David Tudor, John Driscoll, Ralph Jones, and Martin Kalve of Composers Inside Electronics, 'Plastic' [title of show] with host Mark Fruehauf," December 5, 1978, private collection of John Driscoll.

Figure 9.14 Tudor and Monnier performing *Volatiles and Sonic Reflections* | Jack Tilton Gallery, New York | March 1990
Photographer unknown | Klüver/Martin Archive | Courtesy of Experiments in Art and Technology

Virtual Ground

1

On June 16, 1988, MCDC premiered a new work at the Volksbühne in Berlin with the title *Five Stone*. The music was a composition of the same name by Cage, performed by

Tudor along with two other musicians of the company: Kosugi Takehisa and the young percussionist Michael Pugliese. The dance was the first part of a two part-choreography that Cunningham was making in order to fulfill two separate commissions. In early August, when the company was at the Avignon Festival, the second part was added to *Five Stone*, whose title must have delighted Tudor: *Wind*. The two parts, each lasting approximately 30 minutes, together composed *Five Stone Wind*. There was a contrast of movement between the two parts in the dance: "Most of the phrases in the first part were slow, but in the second part the dance increased in virtuosity, complexity, and rapidity."[100] Cage's material did not assign any such contrast to the music. What he had composed was just a series of flexible time brackets. The three performers were each given a different degree of bias. Cage worked closely with Pugliese for his percussion part, instructed Kosugi only to join for the second part, and told Tudor nothing: "I did not in any way give details to David Tudor or Kosugi for the realization of their parts."[101]

Nevertheless, through Pugliese's acoustic instruments—clay pot drums that Cage's friend Martha Otis Wright had made after African "Udu" drums—and Tudor's electronic ones, the music turned out to be "basically percussive in nature," as the latter described in 1991 when the recording was released.[102] The recorded music indeed presents a sparse soundscape delineated by extensive regions of silence, the usual effect of Cagean time brackets, punctuated with Pugliese's nine clay pots—eight of which were pre-recorded, with the percussionist playing the remaining one live—and Kosugi's pizzicatos on an amplified violin and bursts from the bamboo flute, both modulated electronically.

Left to his own devices, Tudor mapped the two parts of the piece onto his usual binary: *Five Stone* would focus on discrete short sounds and *Wind* on continuous long sounds. In his liner notes, he revealed what source material he used and how he composed the contrast:

> *The sounds are derived from recordings of earth-vibrations (not earth-quakes) passed through an electronic "gate." The gate can be "tuned," both as to frequency and duration. The resulting sounds are further treated by other electronic components, which produce a variety of timbres. In the second part of the work,* Wind, *the action of the gate is sometimes reversed, controlling the release of the sounds rather than the attack, allowing the sounds to have a more continuous character.*[103]

The polarity between short and long sounds is now established by the action of the electronic gate controlling the traffic of signals, which is to say by the DUCK button on the *D&R Multigate*. What allowed this effective materialization of concepts was a particular nature of the source material Tudor used.

[100] "Five Stone Wind (1988)," Merce Cunningham Trust, accessed December 15, 2019: https://www.mercecunningham.org/the-work/choreography/five-stone-wind/
[101] Cage, "Liner notes," *John Cage: Music for Merce Cunningham,* Mode Records (Mode 024), 1991, CD.
[102] Tudor, "Liner notes," *John Cage: Music for Merce Cunningham,* Mode Records (Mode 024), 1991, CD.
[103] Ibid.

2

One day in the mid-1980s, Tudor buried two hydrophones in the ground outside his house in Stony Point. "Probably about four feet down or something," according to Rob Miller who worked as the sound engineer of MCDC at the time,[104] although Driscoll and Edelstein thought it must have been closer to the surface as "David was not good with tools."[105] As he had done several years earlier when he fished for underwater sounds, Tudor was again probing the "so-called silence" of a world occulted from daily terrestrial life; except this time, instead of taking a trip to the Bahamas, he went fishing in his backyard. "He covered them in the earth and he recorded that stuff," Miller reflected, "What that made was a trigger track."[106]

There are eight tapes titled "Earth Vibes" among Tudor's collection, which appear to be all variations of a single source modified in speed.[107] The sound is overall similar despite the modification. The most prominent character is an irregular and sporadic series of explosion-like sounds with a lot of resonance. The time in between the explosions is filled with a frail and unstable rattling rhythm that sounds like a boat rocked by gentle waves, or the *Wasp Chewing* tape. Occasionally, a faint wind-like sound passes in the background, as if it were blowing somewhere outside—a reminder that one is listening underground. According to Driscoll, Tudor's garden was pestered by groundhogs so the explosive sounds may have been caused by the animals in action.

But there is another character in these recordings, a sound that is always present yet easy to overhear: a constant background hiss. It is this sound on the periphery of focus that is brought to the fore when the action of the *Multigate* is reversed. The DUCK button reveals a continuous sound beneath the intermittent attacks of earth-vibration. Which is also to say that the negative music of the earth-vibrations tape which Tudor made appear in the second part of *Five Stones Wind* happened to *sound* very much like the subject matter of that section. No longer an imperceptible source of reflection, wind now makes an appearance as a character. But the sound of underground earth-vibrations also has a likeness to the wind *in concept*, as an occult matter that can only be captured through reflection—or, a noise gate used in reverse. In the absence of objects flying up in the air, Tudor focused on the

[104] Rob Miller, "Interview by You Nakai," Skype, August 17, 2017.

[105] Driscoll and Edelstein, "Conversation with Nakai," June 19, 2018, New York, NY.

[106] Miller added, "it was just basically a ghost track" (Miller, "Interview by You Nakai"). This term arose from the likeness he observed between what Tudor was doing and what he had seen Morton Subotnick do with precomposed control signals which he called by that name. In works like *Until Spring* (1975), Subotnick developed a method of creating recordings of control voltages on two-channel, quarter-inch tape which were used to control an array of processors and planners. Since the taped signals never make an appearance as such, he called them "ghost tapes."

[107] One regular ("Earth Vibes, regular, undated," Box 17A, R107, David Tudor Papers, GRI), one slow, (Box 21A, R168) two regular stereo (Box 25A, R221; Box 5A, C216), one slow stereo (Box 17A, R106), two left slow/right normal (Box 5A, C215A; Box 5A C214), and one labeled "backup" (Box 9A, DAT3).

nature of his material extracted from under the ground, as if to topologically invert the former. And a likeness to wind appeared from beneath the sounds recorded beneath the ground.[108]

3

On March 20, 1990, approximately a year after the premiere of *Five Stone Wind*, Tudor premiered another new work at the City Center in New York which once again made use of his radar and ultrasonic system. This time the collaborator was not Monnier but Cunningham. The inaudible probing waves were therefore pointed at the dancers on stage moving not according to the wind but to Cunningham's new choreography called *Polarity*. Quite appropriately for the last piece in a series of works that focused on the virtual dimension of music, from negative music to melodies sculpted by the wind through reflection, Tudor's contribution was named *Virtual Focus*.

To approximate the dancers to Monnier's moving *Lines*, Tudor requested their costumes to include strips of metallic material and for metal screens to be placed behind the backdrop:

> *What we are looking at is the 3M Scotchlite Reflective fabric #8930, gray, to be used as trim on costumes for* Polarity. *The fabric was selected by David Tudor because of*

[108] Tudor had already used the same source material in another series he was working at the time. As usual, there is a confusion of names and categories: *Web for John Cage*, a concert piece commissioned by the WDR and performed in Cologne, Germany, on February 14, 1987; *Webwork*, music for MCDC's choreography *Shards* premiered at the City Center in New York City on March 4 of that same year; *Web for John Cage II*, performed five times between November 17, 1987, and April 19, 1989. The constancy of source material results in a certain likeness between the *Web* series and *Five Stone Wind*.

On April 23, 1989, the *New York Times* published a review of the very last performance of *Web for John Cage II*. The reviewer Allan Kozinn was obviously not content with Tudor's music, but he described what he was able to perceive in some detail:

> *The instrument on which Mr. Tudor played was a brass and gold spider web, with a dangling crystal spider. The web was amplified, and the sounds it produced when touched or otherwise manipulated were sent through electronic signal processing equipment.*
>
> *For 71 minutes, Mr. Tudor tapped the web and fondled the spider, and used a selection of brushes and a sponge to make the device yield different kinds of sounds. These ranged from harshly percussive to gentle, nondescript, whooshy sounds, with a few varieties of howling feedback.*
>
> *The performance was in two layers: one version of it was played on tape, while Mr. Tudor embellished the taped sounds with live additions. The sounds Mr. Tudor produced on his web were neither attractive nor compelling, and the road he traveled with them seemed not to lead anywhere in particular.*

(Allan Kozinn, "Electronic Homage to John Cage," *New York Times*, April 23, 1989).

Kozinn of course did not take note of the earth-vibration tapes for they were occulted in a ghostly manner. According to Miller's recollection on August 17, 2017, the sources were used as control signals for this piece: "It was acting as a trigger because he had envelope followers, so if a trigger hits an envelope follower, and that waveform is sent to another place to allow something else to happen" (Miller, "Interview by Nakai"). As control signals, they modified signals from another source which, just like the *Hedgehog*, was a *positive* object with a very apparent synecdochical connection to the music named *Webwork*: a brass and gold spider web with a dangling crystal spider. Which is to say that just like Tudor's sudden reluctance when asked about the identity of the actual source material feeding into the *Hedgehog*, the primary instrument may have been a visual decoy to distract inquiry into the negative side of matters. The spider and its web did indeed manage to capture the critic's attention. This instrument is currently nowhere to be found.

> *its radar reflective properties and will be incorporated into the costume design by Bill Anastasi. The radar reflective properties are important because Mr. Tudor will be bouncing radar waves off the dancers and electronically processing the radar waves to make the sound score.*[109]

In performance, Tudor appears to have decided on the spot which dancer to focus on. A note on the score for *Polarity*, very likely written by him and addressed "To: Critics" explained, using a term that he almost never used: "Like a feedback system, any interference in the path of the frequency transmission creates a signal, which activates the music. The results are the product of *chance operations*."[110]

4

The sound system revealed by several matrix maps identified as *Virtual Focus* is extremely simple (Figure 9.15). The sonic reflections and source tapes could be modulated by five processors, which, aside from the first, were all envelope filters—the same ones that had appeared in *Lines & Reflections*:

> *Drawmer DS201 Dual Gate* (also equipped with a DUCK function)[111]
> *Dynamic Filter*
> *Auto Filter*
> *Mu-Tron Envelope Filter*
> *Shin-ei Mute Box Envelope Filter*

This stripped down and extremely filter-biased parallel processing is reflected in the sound of music heard in the recordings.[112] The most prominent character of *Virtual Focus* is the constant rotation of wind-like sound. The *Dual Gate* appears to have been used predominantly in the DUCK mode. What is heard reminds the listener of the second part of *Five Stone Wind* in both mechanism and appearance: a negative music that sounds like the wind. The signal produced by inverting the actions of the noise gate is processed by the four envelope filters which emphasize specific frequencies over others according to the volume of the same signal. They are then rotated across multiple loudspeakers surrounding the

[109] "Email from JM to MM (January 25, 1990)," Box 209, Folder 2, Merce Cunningham Dance Foundation archive, NYPL.

[110] Tudor, "To: Critics, Re: Score for *Polarity* (March 20, 1990)," Box 3e, Folder 5, David Tudor Papers, GRI. Emphasis added.

[111] This instrument is not among the Wesleyan instruments, but Tudor owned a catalog, which is now archived in the David Tudor Papers at GRI (Box 48, Folder 2).

[112] A recording of *Virtual Focus* performed at Théâtre de la Ville in Paris on October 6, 1990 is included in *The Art of David Tudor* (disc 6) (New World Records, 2013), and *Music for Merce* (disc 7) (New World Records, 2011). There is another recording at GRI titled "Polarity - last perf., Paris" and dated "10/5/90"—which might be October 5, 1990, the day before the other recording, or May 10, 1991, the last time the piece was performed, except this took place in Los Angeles (Box 5A, C212).

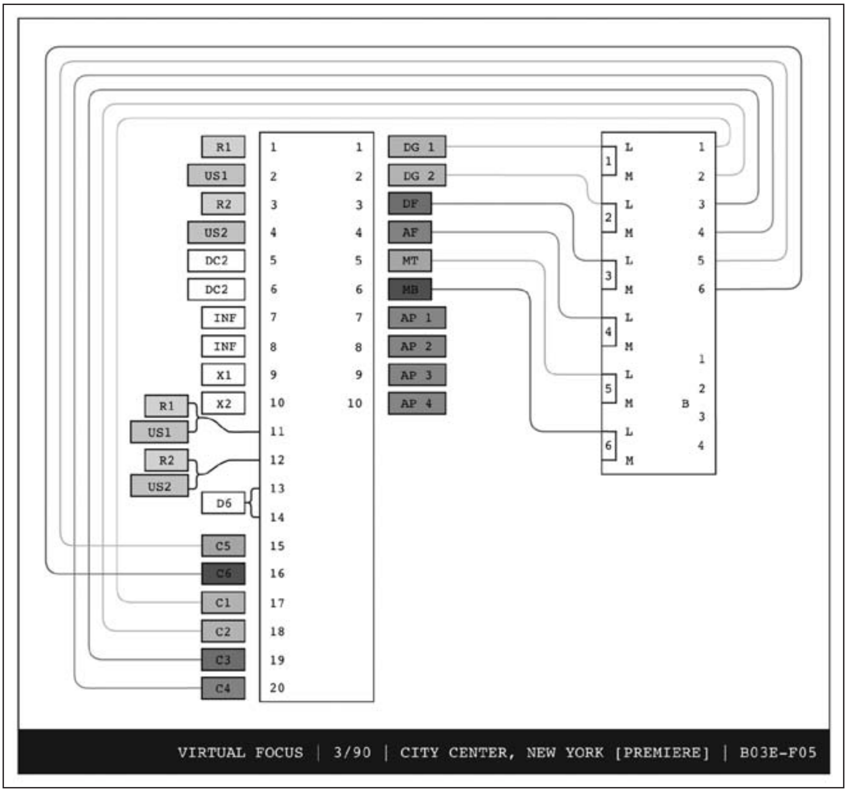


Figure 9.15 *Virtual Focus*, matrix map diagram
Created by You Nakai

audience using the *Auto Panner*. The result is a persistent rotation of wind-like sound that serves as a sonic screen or ground on which the movement of dancers is registered as disturbances to its virtual consistency. Only once in a while, a reflection of movement will pass through the ground to the side of the listener as a positive sound.

In other words, when focusing solely on Tudor's *Virtual Focus*, Cunningham's ever-appropriately titled dance *Polarity* appears only negatively, as modulations in the fabric of the music's own prefabricated reality. The giant virtual ground created by the rotation of sound vibrates in reflection to the movement happening on the other side of reality—like the vibrations of earth beneath the ground. The soundscape is therefore an inversion of *Lines & Reflections*. The wind is no longer something to be reflected from the appearance of how objects move; it is itself an appearance that reflects how objects move, or more accurately, Tudor's focus on how objects move. The listeners are now perceiving things from the side of the wind. Consequently, it is not wind but the movement of physical objects influencing the appearance of wind that now appears virtual. As Tudor's title suggests, what is virtual is a matter of focus.

5

But focus cannot be bodyless. As an act of choosing one thing over others, focus is always grounded on a body that must make that choice because it is situated in a specific time and space. The switching between the polarities of real and virtual hinges on the body that serves not only as an instrument to coordinate different scales of reality, but also as a means to stop those scales from multiplying endlessly. Like in the single performer feedback of *Bandoneon!*, the actuality of the observer's body is the reason why synecdochical structures found in Tudor's music were always only two- or threefold: an oscillator in an oscillator in an oscillator, at most. It was also what set the limit(s) of feedback on the instrumentalized islands.

This role of the body as a switcher as well as a limiter was at the basis of Steiner's view on the microcosm and macrocosm, itself inherited from Neo-Platonism and its traditions.[113] But there was another author who may have influenced Tudor more on this matter: Antonin Artaud, from whom he had learned some valuable lessons for being an actor. The playwright also happened to be responsible for coining the term "réalité virtuelle" to describe the workings of theater, in the third chapter of *Theatre and Its Double*—the same book Tudor read in 1950 when struggling to perform Boulez's *Second Piano Sonata*, which he then recommended to M. C. Richards, who later translated it into English, thereby introducing the term "virtual reality" to the Anglophone world. The emphasis is in the original translation:

> *All true alchemists know that the alchemical symbol is a mirage as the theater is a mirage. And this perpetual allusion to the materials and the principle of the theater found in almost all alchemical books should be understood as the expression of an identity (of which alchemists are extremely aware) existing between the world in which the characters, objects, images, and in a general way all that constitutes the* virtual reality *of the theater develops, and the purely fictitious and illusory world in which the symbols of alchemy are evolved.*[114]

The point of the chapter entitled "Alchemical Theatre" is of course to claim a distinct reality for the mirage. The added adjective, as in the case of *Virtual Focus*, was not there to criticize the fabricated nature of reality, but to invert the normal distinction between what is real and what is not. It was a neat linguistic switch that worked on the mind of readers to flip their focus onto the actuality of theater in relation to which all else now appeared virtual. Like the symbols of alchemy, the virtual reality of theater creates reality as an *effect*—a matter of act that needs to be processed all the more by an actual body within a specific time and space. In other words, it is precisely the kind of mirage that Tudor excelled in creating as a *virtuoso*—a word meaning "possessor of virtues," which happens to also be the original meaning of *virtual*: "there's no other way that they can hear it, except to be there."

[113] For an informative survey of Neo-Platonism, see Michel Foucault, *The Order of Things: An Archaeology of the Human Sciences* (New York, NY: Vintage, 1991). For a detailed study of the effects of Neo-Platonism on music, see Gary Tomlinson, *Music in Renaissance Magic: Toward a Historiography of Others* (Chicago, IL: University of Chicago Press, 1994).

[114] Antonin Artaud, *Theatre and Its Double*, 49.

6

For Tudor, however, this actual body was beginning to fail. On January 18, 1988, a month before the premiere of *Lines & Reflection* at the Kitchen, he was hospitalized for emergency medical care at the Good Samaritan Hospital in Suffern, New York, near Stony Point, after falling and breaking his hip.[115] On October 3 of the same year, he visited the Rockland Neurological Associates in Spring Valley, New York, for a neurological consultation about Transient Ischemic Attack, a temporary blockage of blood flow to the brain which caused a brief stroke-like attack known as a "mini-stroke"—a serious warning for more severe ones.[116] A month later, on November 10, he was at Montvale Diagnostic Imaging in Montvale, New Jersey, receiving an MRI brain test, including a Doppler ultrasound study of carotid arteries in the neck responsible for carrying blood from the heart to the brain.[117] The same technology he had used to detect the bodyless flow of air to reflect upon the super-sensible was now directed at his own body to detect the imperceptible but physical workings of his brain, the body part Steiner had associated with melody and wind. Long years of drinking alcohol were taking their effect. The excessive exposure to the influence of substances was beginning to weather Tudor's physical self.

According to Miller's recollection, it was through his involvement in radars that Tudor became interested in neural networks:

> *I think he became inspired by how the radar interacted with his other black boxes and from that he derived the idea of neural networks, especially by the time we'd gotten to Radar No.3. And this was before neural networks was a known entity.* [. . .] *That was not something he read in* Scientific American.[118]

But it may have been something he read elsewhere. On March 28, 1988, two months after he fractured his hip and as the signs of mini-strokes were appearing, Tudor ordered a book from the Electronics Book Club, whose title was abbreviated in the order form as "Artificial Neural Networks."[119] This was probably *Experiments in Artificial Neural Networks* by Ed Rietman, which had just been published that same year from TAB books, the publisher of many other books in the Electronics Book Club. The concern in *Virtual Focus* overlaps with Artificial Neural Networks if Tudor was thinking about ways to externalize the functions of one particular instrument that had always been a constant in his music: *David Tudor* himself. After all, reading Artaud had once reminded him of robotics.

[115] Good Samaritan Hospital, "Receipt from (March 10, 1988)," Box 142, Folder 6, David Tudor Papers, GRI.
[116] Rockland Neurological Associates, "Receipt (October 3, 1988)," Box 142, Folder 4, David Tudor Papers, GRI.
[117] Montvale Diagnostic Imaging, "Statement of Account (November 10, 1988)," Box 142, Folder 4, David Tudor Papers, GRI.
[118] Miller, "Interview by Nakai."
[119] Electronics Book Club, "Order Form (August 3, 1988)," Box 142, Folder 4, David Tudor Papers, GRI.

Chapter 10
Neural Syntheses

Universal Instrument

1

From September 16 to 24, 1989, a festival to celebrate the work of Merce Cunningham was held at UC Berkeley. On the fourth day was a panel discussion titled "A Kind of Anarchy" assembling the musicians of MCDC during which Tudor reflected on his approach from "the other side." Then, for the last three days, the company performed at the Zellerbach Hall on campus. One of these performances was attended by an engineer and technical writer from nearby Palo Alto named Forrest Warthman. Although he did not know much about modern dance or experimental music, Warthman happened to be sitting in the first row, with a clear view of the stage as well as the musician's pit. As the performance proceeded, his focus moved from the dancers to the musicians. He was captivated in particular by an elderly figure who sat surrounded by a great number of modular electronics, most of them commercial effects processors and others seemingly homemade, all connected with many wires and cables. "I became fascinated with the possibilities that that kind of arrangement of instruments suggested to me," Warthman reminisced twenty-four years later.[1] During the intermission, he approached the musician, whose name he had checked in the playbill as David Tudor. After introducing himself, Warthman proposed on the spot to compose a single computer system that could solve by digital means the problem of having too many instruments and wirings. The musician's reply was that it was "an interesting idea."[2]

Three weeks later, Warthman visited New York with a more detailed proposal for the new instrument. The meeting took place at an apartment of a friend of Tudor's in SoHo, with John Driscoll and Phil Edelstein from CIE also present. Warthman explained to them his idea for a universal instrument with a single user interface. Tudor's first reaction was to ask for more: "why would it do just audio, let's include the lighting system, and then the other physical devices. . . ."[3] He appears to have recalled his bandoneon piece from twenty-three years before: a single instrument activating and controlling audio, visuals, and other forms of output. Fortunately, Warthman had happened to bring along just the right person to the meeting.

[1] Forrest Warthman, "Interview by You Nakai," Skype, October 8, 2013.
[2] Ibid.
[3] Ibid.

Reminded by the Instruments. You Nakai, Oxford University Press (2021). © Oxford University Press.
DOI: 10.1093/oso/9780190686765.001.0001.

Warthman could not recall how he met him, but Ron Clapman was an engineer at Bell Labs working on the development of the Private Branch Exchange (PBX) telephone system, a computer system that could switch calls between local telephone sets inside a company and the external public telephone network. In other words, he was trying to solve the same problem that the research facility of the world's largest telephone company he worked for had been preoccupied with for years: how to connect multiple inputs and outputs in the most efficient and flexible manner.[4] The various instruments composing the TEEM system of *9 Evenings*—the relay switches, the *Program Drum*, the *Program Switching Matrix*—were by-products of similar research into complex routing that Clapman's predecessors engaged in their day job.

Once back in California, Warthman drafted the first project proposal with Clapman, entitled "A Performance Computer: Design Definition." In a letter written on October 22 and attached to the draft, Warthman informed Tudor that they "tried to remember our conversation with you as best we could."[5] This document reveals the initial conception of the system: a complex yet flexible signal router, which is to say a matrix switcher. As Warthman later recalled:

> *In an early phase, Ron Clapman of Bell Labs and I explored designs using PBXs and pen-on-screen interfaces to switch a broadband matrix of analog and digital signals, including not only audio but video and performance-hall control signals. This led us to think about parallel processors with rich feedback paths.*[6]

The "design objectives for the system" section of the draft laid out prerequisites such as "switch any inputs to any outputs," "combine any inputs into any output," "feedback any outputs to any inputs," or "show the operator the status of all outputs and queued events."[7] These ideas are again reminiscent of the versatility sought for the TEEM system. The proposal even included the use of a light pen for input to control the routing of signals, although the *Proportional Control System* was never mentioned. The accompanying letter simply reported that "Both Billy Klüver and Fred Waldhauer seemed interested to [*sic*] seeing what we were doing."[8]

In contrast to this focus on signal routing, the only mention of a sound source was in relation to the necessity for the computer to memorize a library of recordings: "store

[4] David A. Mindell gives a fascinating account of Bell System's development of the telephone network across the United States and the technological problems that had to be solved along the way, which gave birth, among other things, to negative feedback, amplifiers, and single-side band modulation (David A. Mindell, *Between Human and Machine: Feedback, Control, and Computing before Cybernetics* [Baltimore, MD: Johns Hopkins University Press, 2002])

[5] Forrest Warthman, "Letter to David Tudor (October 22, 1989)," Box 27, Folder 5, David Tudor Papers, GRI.

[6] Forrest Warthman, "Liner Notes," David Tudor, *Neural Synthesis Nos. 6–9*, Lovely Records (CD1602), 1995, 2 CDs.

[7] Warthman, Clapman, Tudor, "A Performance Computer: Design Definition (October 22, 1989), Box 27, Folder 5, David Tudor Papers, GRI.

[8] Warthman, "Letter to Tudor (October 22, 1989)."

of large amounts of performance source material, with high-speed access to specific segments."[9] This model reflected the nature of Tudor's music at the time: pre-recorded sources going through multiple processors in parallel before being sent out from multiple loudspeakers. Warthman's "Performance Computer" was essentially an integrated matrix switcher equipped with internal memory, as shown in the architecture diagram attached to the draft (Figure 10.1).

2

Several months after drafting the first proposal, however, the project "took a fundamental turn," according to Warthman's own words.[10] In early 1990, he attended a conference on computer architecture and saw Mark Holler, an engineer from Intel, give a paper on the new *80170NX Electrically Trainable Analog Neural Network* (ETANN) IC chip his team had developed. The integrated circuit was designed to simulate the neural activities inside the human brain and allowed parallel processing of analog signals.

In the standard "von Neumann" model computers, the central processing unit (CPU) fetches program codes and data stored in a memory device, processing them serially, one task at a time. The parallel architecture of neural networks replaces one complex CPU with many simple interconnected processors which simulate the activity of "neurons." The input to each neuron is multiplied by a predetermined numerical weight, and when the sum of these weighted inputs reaches a predetermined threshold, the neuron fires an output signal as a "synapse." The *ETANN* chip had 64 neurons, each with 128 analog inputs whose weight could be programmed individually. This resulted in a performance of two billion connections (multiplication-and-sum operations) per second.[11] In Warthman's eyes, therefore, what Holler was describing "seemed a perfect basis for an audio-signal router."[12] After the presentation he approached Holler and asked him if he could "use the *ETANN* to route and modify natural or electronically synthesized audio signals."[13] Holler gave him a chip to experiment. Thus, two years after Tudor ordered the book "Artificial Neural Networks," his custom-made universal instrument was to be based on an electronic circuit that imitated the working of neural networks to create a virtual analog of the human mind.

[9] Warthman, Clapman, Tudor, "A Performance Computer."
[10] Warthman, "Liner Notes," *Neural Synthesis Nos. 6–9.*
[11] Allan Chen, "Neural Networks: Computing's Next Frontier," *Microcomputer Solutions* (March–April 1991), 4.
[12] Warthman, "Liner Notes," *Neural Synthesis Nos. 6–9.*
[13] Chen, "Neural Networks," 6.

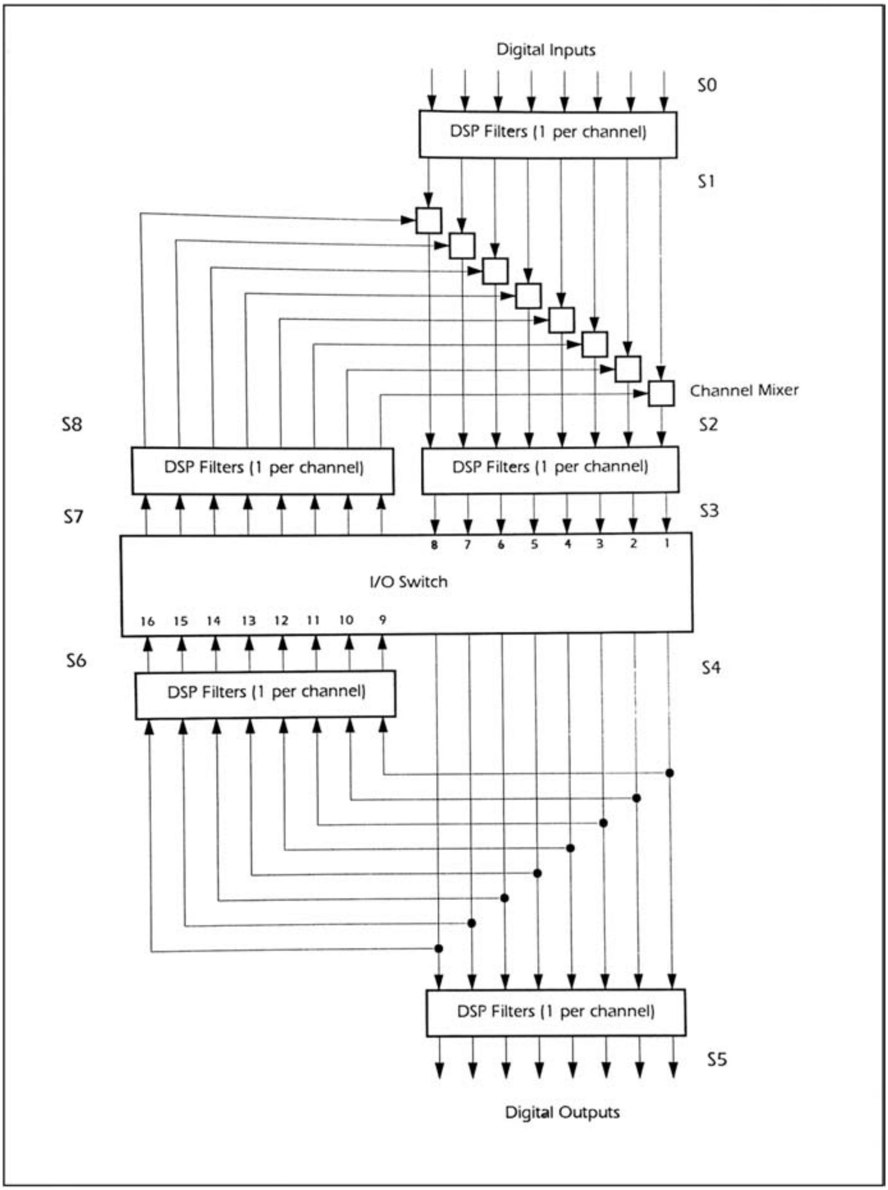


Figure 10.1 Forrest Warthman and Ron Clapman | Logical Architecture of "Performance Computer" | October 1989
Courtesy of Forrest Warthman

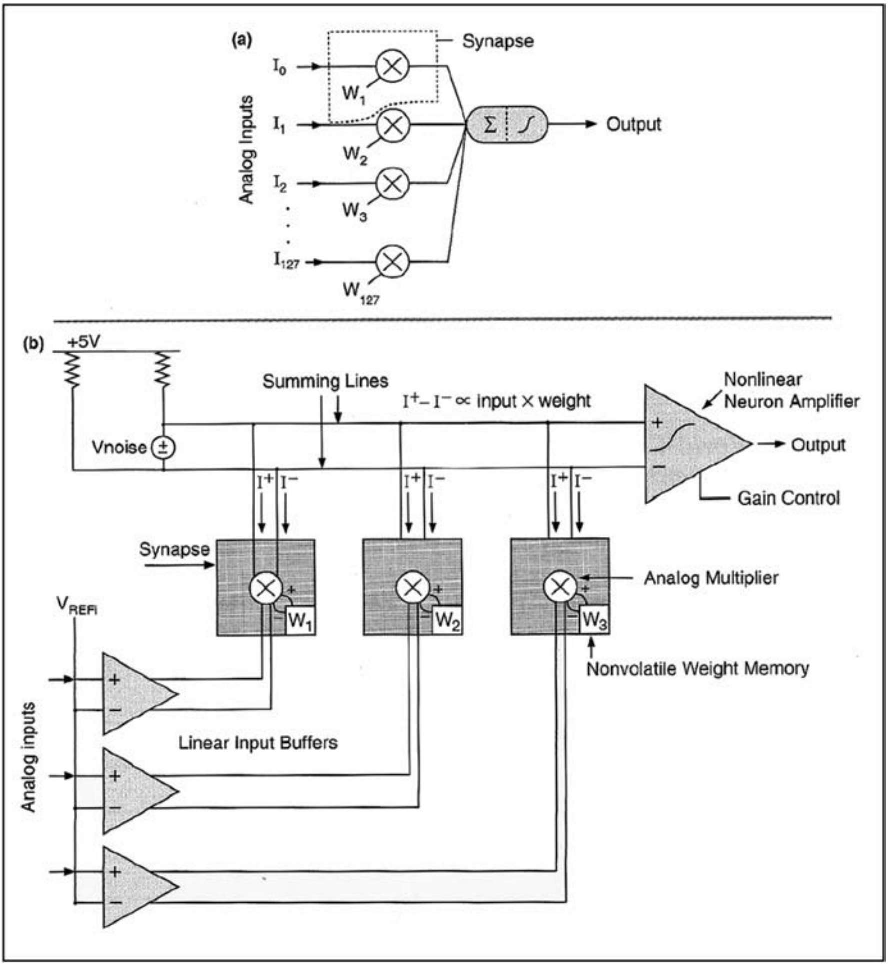


Figure 10.2 Thorson, Warthman, and Holler | The architecture of one of the neurons: (a) Neuron function, and (b) its electrical analog | *Dr Dobb's Journal* (February 1993)
Courtesy of Forrest Warthman

3

But as Warthman and Holler started experimenting, the nature of the actual chip led them to reconsider the instrument they were designing. They later recollected the details in an article published in the February 1993 issue of *Dr. Dobb's Journal*.[14] In order to simulate neural networks with electronic circuitry, the function of neurons had to be materialized in one way or another using electronic components. Holler's

[14] Mark Thorson, Forrest Warthman, and Mark Holler, "A Neural-Network Audio Synthesizer," *Dr. Dobb's Journal* (February 1993), 52.

chip used amplifiers and multipliers to compose this "electrical analog": synapses became an array of multipliers, each multiplying the input signal with a programmable volatile weight; neurons became non-linear op-amps which summed the parallel output products of the multipliers (Figure 10.2).

The physical nature of the *ETANN* chip was therefore 64 groups of 128 multipliers whose products were summed by one of the 64 op-amps. This made Warthman view the neural network chip as a potential source of signal generation rather than a mere switching device. As Tudor knew very well, if they were amplifiers, they could be made to oscillate through feedback: "It was a non-deterministic switching of inputs to outputs, but the fact that you could connect inputs to outputs was very interesting," Warthman looked back on October 8, 2013. "And I did not know what kind of signals might be generated with Mark's neural network chip, but I thought it was very interesting."[15]

So he and Holler added feedback paths from the output of the chip to its input to create what were essentially multiple, interconnected oscillators. The diagram of how the chip was used shows two 64 × 64 arrays of synapses. One is the input array, and the other, the feedback array. The output of the 64 neurons in the input array could be fed back in three ways: (a) internally on-chip to the feedback array; (b) via circuitry outside the chip but still inside the instrument; or (c) brought out externally to the console to drive multiple audio channels outside the instrument (Figure 10.3).

There were two ways to activate oscillation. If an additional phase-shifting band-pass filter circuit was inserted in the feedback path, the instrument became a sinusoidal oscillator producing sine waves. However, if the output was directly connected to the input, it turned into a relaxation oscillator producing non-sinusoidal output. As described in their 1993 article, this second type of feedback generated a specific kind of oscillation characterized by "abrupt switching transitions followed by an RC decay back toward a switch point. The abrupt transition has the sound of a pop. [. . .] The waveforms generated are often similar to those of the action potentials or spikes in biological neurons."[16] Since the instrument could now generate signals on its own, they decided to call it the *Neural Network Synthesizer* (Instrument 0459) (Figure 10.4).

4

As "a large collection of individually simple interconnected processors operating and co-operating in a parallel distributed fashion,"[17] the neural network model was indeed a miniature analog of the web of modular instruments dedicated to parallel

15 Warthman, "Interview by You Nakai."
16 Thorson, Warthman, and Holler, "A Neural-Network Audio Synthesizer," 62.
17 Peter M. Todd and D. Gareth Loy, eds., *Music and Connectionism* (Cambridge, MA: MIT Press, 1991), ix.

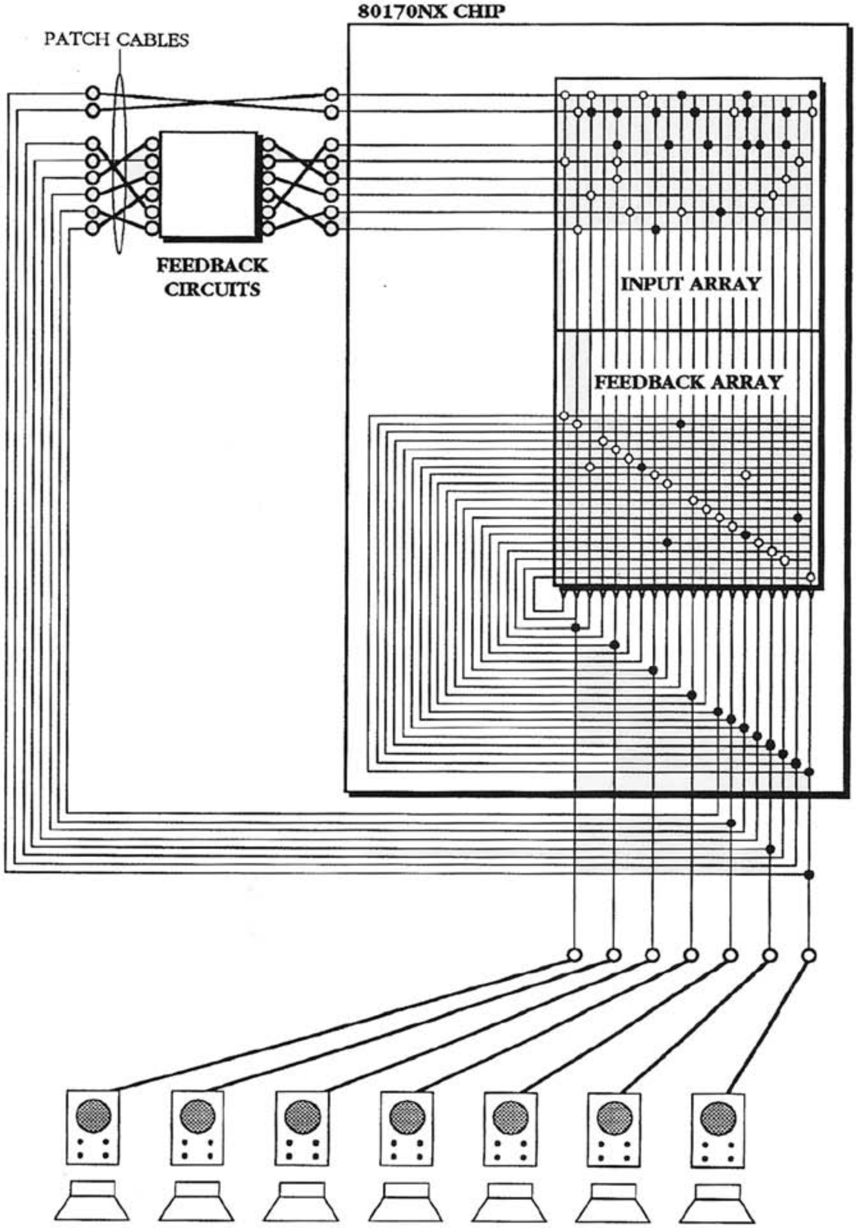


Figure 10.3 Thorson, Warthman, and Holler | Synthesizer architecture diagram | *Dr Dobb's Journal* (February 1993)
Courtesy of Forrest Warthman

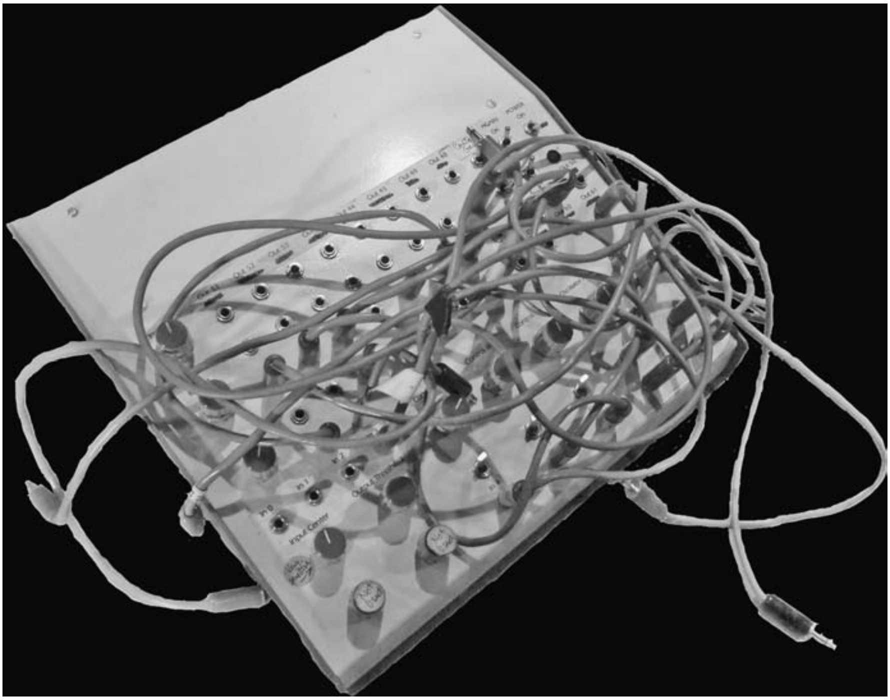


Figure 10.4 Thorson, Warthman, and Holler | *Neural Network Synthesizer*
DTC, Instrument 0459 | World Instrument Collection, Wesleyan University

signal processing that Tudor was using at the time. But the actual realization of that model using the *ETANN* chip rather coordinated with what Tudor was doing much earlier than that. On September 29, 1985, he had explained to his workshop participants at the Mobius Art Center that his previous efforts to make giant oscillators was based on the discovery that "I could induce oscillation by working with phase with loops of feedback having a change of phase. And all you need, *virtually*, is an amplifier."[18] Five years later, Tudor would discover that the nature of his new universal instrument is actually a myriad network of amplifiers which could be made to oscillate similarly through feedback.

Indeed, when the *Neural Network Synthesizer* was ready to be tested, what delighted Tudor was the unpredictability of sounds it generated due to the complexity of its internal network. "He used whatever random noise he could find," Warthman recalled in October 2013. "That's all he was interested in: getting some really random sounds. The greater the diversity of the sounds, the better."[19] In particular, the thermal noise on the summing lines connecting the multipliers to the amplifier was the major

[18] Tudor, "Workshop at Mobius Art Center, Boston (September 29, 1985)," Box 2A, C75, David Tudor Papers, GRI; emphasis added.
[19] Warthman, "Interview by Nakai."

source of indeterminacy. When the synthesizer was set at the threshold of oscillation, that noise would intermittently trigger the network to oscillate for only a few cycles, producing short, fragmentary patterns.[20] In order to fight this noise, Warthman, Holler, and Mark Thorson, Holler's colleague who had joined the project belatedly, decided to use nine parallel chip inputs for each audio input, thus increasing the signal strength at the summing lines. Since the level of noise did not change, this method improved the signal-to-noise ratio by a factor of nine.[21] But Tudor had other thoughts about the instrument: he regarded the thermal noise as part of its nature. Warthman recalled that the input from Tudor during the process of developing the synthesizer revolved mostly around this single issue, which was also shared by Cage, who came to take a look at the instrument: "Almost all of his inputs had to do with preserving the randomness that was generated by the synthesizer. He and John shared this comment. They were not interested in any predictable behavior. […] What they were interested in, were random sounds."[22]

The focus on randomness, the instrument's capacity to never fall into predictable patterns, however, went directly against what neural networks are designed for: to recognize patterns. As Warthman explained, "The idea in all neural networks is that you present test patterns to the neural network system, and if it provides an output that you expect it to provide, you save those values so that you can repeat that pattern recognition."[23] In other words, neural networks operated on the principle of training. By fortifying connections that align well with a particular "example," each network biased itself into an analog of the pattern it was exposed to, which could then be used to recognize or simulate other patterns.

That was the idea most people followed when the general application of neural network to music started to gain attention in the 1980s, around the same time Tudor appears to have become interested in them. The focus was on creating models of selected aspects of human musical behavior—perception and judgment—through the neural network's learning abilities. These "behaviors" existed outside of the networks themselves, as something accumulated and stabilized over long time. In other words, unlike the fleeting fighter planes whose future trajectory Norbert Wiener tried to predict, it was from past musical traditions that "target values," the correct examples the system had to learn to produce by itself, were derived. In doing so, they were simulating history.

For example, *Music and Connectionism*, an anthology of papers exploring the connection between neural network models and music, originally published in the *Computer Music Journal* at the end of 1989, is full of "examples" that reveal the destination of neural network systems as the composition of likeness to pre-acquired

20 Thorson, Warthman, and Holler, "A Neural-Network Audio Synthesizer," 62.
21 Ibid., 58.
22 Warthman, "Interview by Nakai."
23 Ibid.

aesthetics:[24] "More often, we know what we like without really knowing exactly why we like it. In this case, a neural network approach is attractive."[25] Or, neural networks can "[e]mulate our judgments about the presence or absence of objectionable rhythmic sequences in an entire musical piece."[26] In spite of the absence of a CPU, neural networks were always conceptualized as subservient to the human user who stood outside of the system—as the true CPU, so to speak—imposing a "desired behavior" on the instrument; precisely the form of engagement Tudor, along with Mumma, had denounced long ago in favor of seeing machines as other characters.

5

Tudor, by his own nature, was not interested in any of this. "The neural network chip was designed so that it could be trained to recognize patterns. That was the original purpose of Intel developing the chip. David made no use whatsoever of that capability, to my knowledge," Warthman continued his reminiscence on October 8, 2013. "He was not interested in recognizing patterns. He wanted to generate unique sounds."[27] Even when Holler later developed a second *Neural Network Synthesizer* which could preserve some connection patterns, Tudor deemed this unnecessary for his music, as he told Collins during the aftertalk at STEIM on June 16, 1994: "they gave me the processor that weights the chips. So now I'm in a situation where I can record what's been done. [. . .] And so far I haven't been able to do that. My position was that I didn't really need to do that, because it's a completely analog technology."[28]

Most neural networks discussed in *Music and Connectionism*, for example, existed as digital simulations running on a von Neumann–type computer. But the nature of the *ETANN* chip, in Tudor's observation, was derived from the fact that it was analog. In other words, the simulation had its own material bias. This discouraged the assigned role of pattern recognition in two ways. For one thing, realization always entailed indeterminacy, as he explained to Collins in June 1994: "It isn't very precise, because the neural technology is analog. It isn't digital. If it were completely digital, you could expect the same results the next day."[29] At the same time, the actual way the *ETANN* chip materialized a neural network—myriad parallel amplifiers—could not be reduced to the generalized function of neural networks. Analog material was not precise *yet* specific: lacking accuracy in relation to external efforts of control, while revealing the "specific principles which exist" that Tudor had long sought in the instruments he used. In other words, it had a *character* of its own. So naturally for Tudor,

[24] Another nice example is Niall Griffith and Peter M. Todd, eds., *Musical Networks: Parallel Distributed Perception and Performance* (Cambridge, MA: MIT Press, 1999).
[25] Todd and Loy, *Music and Connectionism*, 6.
[26] Ibid., 9.
[27] Warthman, "Interview by Nakai."
[28] Tudor, "Aftertalk, STEIM (June 16, 1994)," Video, Private Collection of Molly Davies.
[29] Ibid.

given *his* patterned approach to instruments, the proper use of the *Neural Network Synthesizer* was not to make it reproduce exterior examples but to make it reveal its own interior mechanism. Accordingly, the nature of mind shifted from recognizing old patterns to producing something new, as Tudor told an audience member after his concert at STEIM: "It's like a generator which has its own mind. Somehow I can't control it. I love it!"[30]

Still, Warthman lamented the fact that the *Neural Network Synthesizer* did not make use of the pattern recognition capabilities of the *ETANN* chip. As if to make up for this loss, he located the missing learner in the human performer coordinated to the instrument: "The chip itself is not used to its full potential in this first synthesizer. It generates sound and routes signals but the role of learner, pattern-recognizer, and responder is played by David, himself a vastly more complex neural network than the chip."[31] *David Tudor* indeed responded to the *Neural Network Synthesizer* with his own mind, but his response also went directly against the role expected of him.

Neural Syntheses

1

After experimenting extensively with his new instrument, Tudor began adding several devices around it. The source input went into the *Matrix Switcher* which routed the signal to several effects processors. The related matrix maps list familiar components from this period, starting from the noise gates and envelope filters. Also included was a *Zoom 9002 Multi-Processor*, from which Tudor used—according to what John D. S. Adams, who assisted him for most of the project, recalled in April 2014—a patch called "SFX" (Special Effects) with a step pitch shifter that "created a random shift of tones," which "would be different each time you put a signal in."[32] Tudor thus appeared to repeat the usual procedure of adding parallel processing channels to modify the output of a giant oscillator in multiple ways and create polyphony in disguise—a pattern from his own past going all the way back to *Toneburst* and *Pulsers*. Contrary to these previous examples, however, the processing he applied was minimal this time. "For purposes of my musical vocabulary, I further modified the signals that came from the synthesizer," he explained during the aftertalk at STEIM. "But I don't give very much in that respect. I very soon, after working with it, realized that I didn't have to do very much."[33]

[30] Ibid.
[31] Warthman. "Liner Notes," *Neural Synthesis Nos. 6-9*.
[32] John D. S. Adams, "Interview by You Nakai," Skype, April 9, 2014. The manual describes the effect in the following way: "This gives random, stepped sample&hold [*sic*] for sequencer and arpeggio type effects" (Zoom, "Zoom 9002 manual," Box 50, Folder 3, David Tudor Papers, GRI).
[33] Tudor, "Aftertalk, STEIM."

2

The first piece using the *Neural Network Synthesizer* was a duo for Tudor and Kosugi, titled *Neural Network Plus*. It was premiered at the Paris Opera on November 12, 1992, as music for Cunningham's new dance, quite appropriately choreographed using LifeForms, a computer software that allowed him to digitally program movement using three-dimensional human animation. The title of the resulting dance was taken from the key used to commit the choreographed phrase to the computer's memory: *Enter*.

Unlike LifeForms, the *Neural Network Synthesizer* produced sounds on its own. But unlike past examples of no-input feedback systems which, once activated, kept oscillating and generating music, this one only produced sounds once in a while and only for a moment. As Tudor explained, "The main problem was to excite the neurons to speak."[34] It had the potential to do so, but whether it actually did so was indeterminate to the extent that Tudor often could not get any sound out of it. Unlike "Enter," commands did not result in a determinate operation—one could only hope to influence. Although Tudor had wanted random sounds, the situation turned out to be too random to realize a public performance.

Facing this problem, Tudor recalled an "example" from his own past: twenty years before, he had come up with a simple method to deal with the utter complexity of his sound system for *Untitled*. So in the week leading up to the premiere of *Neural Network Plus*, Tudor set up his synthesizer in the orchestra pit of the Paris Opera and began recording the sounds it made whenever it happened to do so. As Adams recalled twenty-two years later: "We had a residency at the Paris Opera and that's where he produced the source materials—in the pit, while we were preparing for the premiere."[35] Three 30-minute recordings were made on November 12 and another three the following day, making a total of six input sources.

However, Tudor approached these pre-recorded materials in a peculiar manner. "After the premiere, he did make a few more source tape recordings so he never became familiar with the sounds," Adams continued his reminiscence in April 2014. "This was key, to not 'memorize' the source tapes so you would instinctively anticipate certain types of sounds."[36] Indeed, two more recordings were made when MCDC performed at City Center in March 1993. Later that year, when Tudor and Adams stayed at the Banff Centre for Arts and Creativity in Canada during late October and early November to record a solo version of the piece titled *Neural Synthesis*, four more source tapes were made by mixing sources from existing recordings, and two more were recorded anew. By the end of 1993, the tapes amounted to a total of fourteen. Tudor's own complex neural network thus worked hard to defy the very ability of the

[34] Ibid.

[35] D. S. Adams, "Interview by Nakai." Adams continued, "we recorded each pass and we did that twelve times in preparation for the piece" (ibid.). However, I have only been able to find six source tapes made at the Paris Opera.

[36] Ibid.

human brain to memorize patterns that neural networks aimed to simulate with electrical analogs.

3

Yet it was also impossible for Tudor *not* to remember the source material, especially if the processing was subtle. As Adams recalled:

> *You can't help but start to learn the material after a certain number of performances. Tudor knew that certain source tapes had a certain quality.* [. . .] *he had basically six channels of source material coming in that he could choose from at any moment in time, and he kind of knew that if he wanted to really create something loud and more dense* [sic]*, he could go for this source that was playing. Or if he wanted something more sparse and periodic, and maybe a bit more percussive, he knew that this tape that was playing back, he could go for that and that would give him a sparse and more open quality material.*[37]

Each material indeed had a different character. The sporadic, repetitive sound patterns were in general composed of gallop-like rhythms with discrete, distorted tones that suggested a melody, and occasional sweeping tones that interrupted the flow. A sequence would start abruptly and go on for just a second, or in longer cases for a couple of minutes, before stopping or transforming into another pattern. Silences are many, in particular Source 5 has almost a minute of silence twice toward the beginning (2′11″ and 4′00″), and Source 6 is mostly subtle pulses throughout.

The identity of each tape was thus stored in Tudor's "vastly more complex neural network" but with a deliberate effort to subvert the role of pattern-recognizer. The retrieval of material therefore became indeterminate, just like the *Neural Network Synthesizer* itself. *David Tudor* thus simulated the unpredictable nature of his instrument with his own neural network, forming once again an instrumental synecdoche.

4

But the indeterminacy of Tudor's mind not only concerned the identification of source tapes; it also involved the identification of the music itself. When he began performing the solo version of his synthesizer music after the premiere of *Neural Network Plus*, Tudor was reminded of a difficult puzzle that stemmed directly from the indeterminacy of live performance: how to coordinate the polarity between the uniqueness of each specific realization and the constancy of materials that he could not help but remember no matter how hard he tried. In practical

[37] Ibid.

terms, the problem came down once again to the slippage between the name and what is named. To decide what to call his new solo music, Tudor recalled yet another example from his past. Fifteen years earlier, perhaps following the even earlier example of Cunningham's *Events*, he had numbered *Weatherings (Nethograph)* for each performance. This practice lasted for eight months, from the premiere on September 27, 1978, to the performance at Maison de la Culture de Rennes on May 29, 1979, at which point the piece had become *Weatherings (Nethograph #10)*.

Drawing on this memory, Tudor began numbering each performance of *Neural Synthesis*. He proved himself to be a slightly better counter this time. After performing *Nos. 1* to *5* in New York, Miami, Berlin, and Stockholm, he recorded *Nos. 6* to *9* at Banff in November 1993. But half a year later, when he performed *Neural Synthesis* at STEIM on July 16, 1994, Tudor had to admit to the audience that because of the imperfection of his memory, he had missed the count at some point: "Nic tells me that this is *Neural Synthesis No. 8*, but my engineer tells me it's *No. 12*. So I've lost track."[38]

5

In his liner notes to the Lovely CD of *Neural Synthesis Nos. 6–9*, Warthman looked back at the four years of development of the *Neural Network Synthesizer* which had started from the idea of creating a universal "Performance Computer," and had ended in creating an instrument that existed virtually in the form of tape recordings: "The unfolding of our ideas was an adventure in discovery and like all real adventures it led to unexpected places. What began as an effort to integrate the proliferation of electronic devices in David's performance environment ended in the addition of yet another device."[39] The attempt to generalize Tudor's procedures by studying the examples from his past was diverted by the nature of materials actually used, which inspired Warthman to think otherwise. But the project led to somewhere unexpected for Tudor as well. Although he appeared to make no use whatsoever of the capability of the *ETANN* chip to recognize patterns, its specific nature had triggered him to reflect on examples from his own past.

Reminded by the Instruments

1

Gordon Mumma often reminisced about the exceptional nature of Tudor's mind, which appeared to be packed with all the music he had performed throughout the

[38] Tudor, "Aftertalk, STEIM."
[39] Warthman, "Liner Notes," *Neural Synthesis Nos. 6–9*.

years. Like the organ that biased Tudor's musical imagination throughout his life, these influences from the past remained as ghostly control signals, only sometimes becoming manifest. Mumma was a lucky witness on several of those rare occasions. In a recent memoir from 2013, he wrote about accompanying his friend on excursions to churches with historic organs while touring Europe with MCDC:

> *When access to the instrument was possible, he would put on his thin leather-soled organ shoes, which he carried along in a little bag. He would begin by feeling out the instrument, testing the locations and sonorities of the stops and working the pedals for their physical responses. Then from memory he would launch into segments of the organ repertoire chosen according to the time and place of the instrument.*[40]

Twenty years before, in 1993, Mumma had written about another occasion that had stayed in his memory. One early afternoon in the late 1960s, during another MCDC tour, he walked into a theater of an upstate New York college where they were scheduled to perform and heard the sound of the piano. The lights were still unlit, so Mumma could not figure out who was playing the instrument right away, but even in darkness he could more or less recognize the music that was being played: Debussy's *Études,* Rachmaninoff's *Études-tableaux*, "a sentimental dance-pattern that I recognized as from Louis Moreau Gottschalk," and then some fragments from Messiaen's *Catalogue d'oiseaux*.[41] As he approached the orchestra pit, he finally recognized the pianist. It was Tudor, recalling his past: "I realized he had been playing 'by touch,' alone in the darkness and rummaging through his memory for music he'd probably not played in a decade or more."[42]

Twenty-some years later, when Petr Kotik organized a concert of *Atlas Eclipticalis* with *Winter Music* at Carnegie Hall on October 29, 1992, Tudor performed the music from thirty-five years before that he had not played in more than a decade.[43] Christian Wolff, who attended the performance which went on for 90 minutes, later reminisced:

> *After the concert he remarked that he had had trouble reading his music (his eyesight was bad after a heart attack) and that sometimes he had to just go ahead and play*

[40] Mumma, "With Tudor the Organist," in *Cybersonic Arts*, 145.

[41] Mumma, "A Visit to Mount Olympus with David Tudor," in *Cybersonic Arts*, 245 (originally published as "David Tudor: A Historical Reminiscence," *20th-Century Music* 3 [1996], 6–7).

[42] Mumma, "A Visit to Mount Olympus with David Tudor," 246. "I asked about the work I hadn't recognized, the piece after the Rachmaninoff. He said, 'Oh, was I playing Rachmaninoff? Don't ever tell anyone about it. I also played some Charles-Valentin Alkan; you really should know his music.' I never heard David play this repertory again. It was a unique experience—a visit to Mount Olympus. Many years later I asked him if he remembered that early afternoon in upstate New York. He replied, 'Oh, really? I thought I'd put that aside years ago' " (ibid.).

[43] The last occasion Tudor performed *Atlas Eclipticalis* with *Winter Music* was probably on June 10, 1979, at the Beethovenhalle in Bonn during the John Cage Festival organized by Tage Neuer Musik ("Program Note, John Cage Festival," Box 79, Folder 4, David Tudor Papers, GRI).

> *without reading the music. He figured out, he said, what he had to play by ear and his memory of what the music was supposed to sound like.*[44]

By the time Jack Vees interviewed him three years later in the summer of 1995, however, Tudor's memory was beginning to fail. Names and words that Vees mentioned would trigger a vague reminiscence, but accurate retrieval was in many cases no longer possible. His recollection was fragmentary, un-coordinated bits and pieces of anecdotes that would suddenly surface and then disappear. And when he could not recall, Tudor would ask the people around: "The name *Variations II* crops up in my head. There's got to be a reason for that. Maybe you know it."[45] Even questions that only he could have answered had to be processed through external channels. The conversation on July 12 had begun with Vees asking Tudor if he remembered a very specific detail from his childhood: whether he went over to his piano teacher's house or she came over to his house. To the question, "is there anything that kind of sticks out in your memory?" Tudor replied by asking his assistant Adams if he could recall in his stead: "No. I'd have to search my memory to see whether I was independent or not. Do you remember it?"[46] Adams of course did not.

2

But Adams did remember other things. The concert at STEIM was the last performance of *Neural Synthesis* given by Tudor. His health continued to decline. But the number of performances he had realized until then had turned into "examples," for Adams was able to commit to his memory how the piece was performed after assisting Tudor for several years. Shortly after the STEIM performance, Tudor asked Adams to perform *Neural Synthesis* on his behalf for the MCDC residency at the Joyce Theatre in September. During the performance, Tudor sat in the audience seat, listening. Afterward, Adams went up to him and asked what he thought:

> *I was so nervous. It is possible that he might have hated it. Anyway, he didn't hate it, but he looked at me in my eyes, and he said, "perform it not like I would perform it, but perform it like you would perform it." And that was pretty much all he said—to not try to imitate him but to allow your own musicality to come forth, to let it be your own.*[47]

Tudor's concise advice went against the neural network model of learning through previous examples. The lesson had to be sought elsewhere. Six months after Adam's

[44] Wolff, "'. . . how he made all the difference': Thinking of David Tudor," in *Cues*, 382.
[45] Tudor, "Interview by Jack Vees (September 18, 1995), 241 g," *Oral History of American Music*, Yale University Library, 38.
[46] Tudor, "Interview by Jack Vees and John D. S. Adams (July 19, 1995), 241 a," *Oral History of American Music*, Yale University Library, 1.
[47] D. S. Adams, "Interview by Nakai."

performance, on March 28, 1995, Rogalsky asked Tudor about his thoughts on how a "proper performance" of a live-electronic music piece that has no score might be communicated. Tudor's response was again concise: "my approach was always to encourage the [*sic*], that the objects should teach you what it wants to hear."[48] Rogalsky pressed on, pointing out that, "in *Rainforest* and in your other works too if somebody else is going to do it then they really have to take on the role of being a composer as well as a performer so there is a responsibility for composition that rests in those pieces as well."[49] Tudor yet again replied as a matter of course: "Oh I always thought it was a nice piece because it would teach itself. It teaches itself."[50] In other words, the necessary weight and bias on each node of the neural network of the performer could be largely determined through physical coordination with actual instruments.

3

But he also appears to have had other thoughts. Later that year, on August 6, as he talked with Vees for the third time, there was one topic Tudor was able to partially retrieve from memory:

> *When I did the* Five Piano Pieces, *Artaud was constantly in my mind,* [. . .] *because of what Bussotti told me, I think it was in a letter,* [. . .] *that he was writing the piece for David Tudor the instrument. And that immediately told me what the work was about.*[51]

It was a reminiscence of a reminiscence from more than thirty years before. What had triggered his memory was the interviewer's effort to change the subject. For some time, they had been talking about Boulez's *Second Piano Sonata* and the influence of Artaud on Tudor's now legendary realization. Then Vees attempted to generalize the discussion: "in general when you're working on music what comes to mind?" He first asked about sources other than Artaud—"when you worked on Boulez, [. . .] did you keep going back to a certain resource to help you make sense out of them, other than Artaud?"[52]—and then composers other than Boulez—"let's let Boulez sit by the side for a second."[53] For some unknown reason, perhaps simply following the alphabet,

[48] Tudor, "Interview by Matt Rogalsky," Tomkins Cove, NY, March 28, 1995. http://davidtudor.org/Articles/rogalsky_inter2.html; also in Rogalsky, "'. . . in rehearsals, or preparation, or setup, or from one performance to another': Live Electronic Music Practice and Musicians of the Merce Cunningham Dance Company," MA thesis, Wesleyan University, 1995, 171.
[49] Ibid.
[50] Ibid.
[51] Tudor, "Interview by Jack Vees (August 6, 1995), 241 e," *Oral History of American Music*, Yale University Library, 28.
[52] Ibid.
[53] Ibid.

the next composer Vees brought up was Bussotti. "When you worked on the Bussotti piece [. . .] is there anything about that piece or his music that stands out in your mind as its distinguishing feature or what you relate to in it?"[54] This transition, however, silenced Tudor literally for one minute. After a very long contemplation, it was Tudor who brought Artaud back into the conversation:

> [extremely long pause] *Right now I don't know where to send you to. I just need to tell you that you're hitting the right nerve, because I don't right now make the right connection, but there was when Bussotti presented me with this work* [. . .] *Even ten years ago I could have made the connection much more readily. When I did the* Five Piano Pieces*, Artaud was constantly in my mind. . . .*[55]

Vees had hit the mark by sheer chance. There happened to be an unexpected coordination between Boulez and Bussotti that was not about their names sharing the same letter of the alphabet but had something to do with the influence of Antonin Artaud. Yet Tudor's neural network in 1995 could not recall what it could have recalled in 1985. So the conversation on Artaud that day ended with a description of not what was on Tudor's mind back in 1958, but what was on his mind as they spoke:

> *There's some article, there's somewhere I have talked about this before. There's something very . . . something very obscure that's cropping up in my mind. I've got to . . . I've got to track it down.*[56]

The mentioned article, if it indeed existed, has not been found. But this "obscure" thing might have already cropped up in his mind fifteen minutes earlier, for in attempting to explain the connection between Artaud's ideas on theater and the new music he was performing in the 1950s, Tudor had described, for the first time in a public interview, his interest in a character that the playwright and actor had created for himself: Artaud Le Momo.[57] One may recall how the lesson Tudor derived from Artaud's study of the mime appeared to connect to the mute tappings of keys in Bussotti's *Piano Piece for David Tudor 1* circa May 1959. But in August 1995, Tudor's mind proceeded to connect miming to something quite unexpected: "and part of the idea was that David Tudor could be . . . part of his, umm, my, technique was . . . robotics."[58]

[54] Ibid.
[55] Ibid.
[56] Ibid., 29.
[57] Ibid., 27.
[58] Ibid. Transcribed by You Nakai from the actual tape recording of the interview.

4

Miming and robotics indeed focus similarly on the body as a physical instrument. In 1959, for the thirty-three-year-old Tudor, this could have simply meant playing the role of a musical instrument through other people's materials, an endeavor that culminated in 1966 with Stanley Lunetta's *Piece for Bandoneon and Strings*, which quite literally made a puppet out of *David Tudor*. In 1982, for the fifty-six-year-old Tudor, it may have linked to his particular listening process that drove the drama of pseudo-phonemes and seemingly unknown languages. Even in 1990, for the sixty-four-year-old Tudor, the specificity of the body situated in time and space had served as the primary instrument for inverting reality through virtual focus. But in 1995, Tudor's reflection on Artaud appears to have been influenced by a different concern altogether—the malfunction of his own body. For if the body was indeed an instrument, the coordination between miming and robotics points toward the possibility of creating an instrumental analog, a virtual body which functions in the absence of the real one.

In other words, Tudor's reminiscence on that particular August day about what he learned from Artaud appears to have been triggered by the difficulty of reminiscing, of establishing the "right connections." What he was trying to recall was something that could have solved the problem of him not being able to recall things well. But unlike "virtual reality," "robot" was not a term that Artaud used, except for perhaps once when he described being reduced to "a walking robot" by God in an essay written in 1925.[59] Tudor may have been influenced by something else.

On June 10, 2015, Ron Kuivila recalled an interaction he had with Tudor around this time where robotics was again the topic:

> *When I got pulled into the neural synthesis project in 1994, DT expressed strong interest in the possibility that it would become fully autonomous. He went on to invoke Paik's robot and comment that it would be wonderful if the neural project ended up implemented as a robot.*[60]

Nam June Paik had created a large family of humanoid figures from multiple television sets and old radios over the years, but the robot that was on Tudor's mind in 1994 was probably the earlier radio-controlled *K-456* that the human artist built thirty years before as the first non-human performance artist and named after Mozart's piano concerto. It roamed the streets of New York City to "kill the pop-art," as Paik claimed in the announcement of *Robot Opera* sent on November 26, 1964, which Tudor as usual kept

[59] Antonin Artaud, "On Suicide," in Jack Hirschman, ed., *Artaud Anthology* (San Francisco, CA: City Lights Books, 1963), 57.
[60] Ron Kuivila, "Email to Sam Hart, Charles Eppley, Michael Johnsen, and You Nakai," June 10, 2015.

safely among his papers.[61] Which is to say that Tudor appears to have wished not simply to automate the instruments in the form of a sound installation, but also to automate the instrumentalist who would perform the music live. Perhaps he imagined the robot to be taught by the instruments. In any case, something or someone had to play *his* role.

5

But what was the role that Tudor played? The many puzzle pieces that have been coordinated so far may reveal a portrait of sorts. One may recall, for instance, that Tudor's first encounter with Artaud had been triggered by the difficulty he faced in realizing Boulez's *Second Piano Sonata*. The material was so unforeseen in 1950 that he could not find a pattern using past examples, as he looked back twenty-two years later:

> *My training had been as a musician of precision—first as an organist, then as a pianist, playing all the classical works—but encountering Boulez for the first time meant my training for the work of Schoenberg wouldn't do at all. Boulez had written no counterpoints, no second voices, and you couldn't subordinate any voices at all, as there was nothing leading, nothing on which the music centered itself.*[62]

Reading Artaud inspired him to switch his focus and approach the same material differently:

> *Then I realised I was now in a different situation, in the presence of a different type of musical continuity than I was used to, and all of a sudden I was able to play it. I recall this as a definite breaking point, as the moment I became aware another kind of musical continuity was possible. . . .*[63]

The material had not changed at all, but Tudor as an instrument had a new realization. Like on a Möbius-strip, he was now seeing things from the other side. Rather than feeling time, he breathed and watched it. Like the neat switch of the *Click and Pop Assassin*, coordination with new material had reconfigured Tudor's perception of that material. And the transformation stayed with the lesson learned: ". . . and from then on I began to see all other music in those terms."[64]

But there would be other object lessons, as when Tudor subsequently "became" the *Music of Changes*:

> Music of Changes *was a great discipline, because you can't do it unless you're ready for anything at each instant.* [. . .] *I had to learn how to be able to cancel my*

[61] Nam June Paik, "Announcement of Robot Opera (November 26, 1964)," Box 57, Folder 11, David Tudor Papers, GRI.
[62] Tudor, "From Piano to Electronics," 24.
[63] Ibid.
[64] Ibid.

> *consciousness of any previous moment, in order 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.*[65]

In other words, Tudor had become free through self-induced amnesia, outsourcing the puzzle of no-continuity generated by Cage's coin toss to the physical operations of a stopwatch and his own breathing. Once again, the coordination with actual materials had reconfigured the instrument to enable a realization. Upon reflection, it might be tempting to see a general pattern here.

6

The effort to achieve the unforeseen in music centered naturally around the issue of memory—or an effective disposal thereof. Cage often preached an art of constant forgetting, as he wrote in his diary in August 1966, soon after he began calling what Tudor was composing "sound systems," for lack of a better word:

> *Those musical conventions assume I recognize relationships. They give no exercise to my faculty to reach the impossibility of sufficient auditory memory to transfer from one like event to another the memory imprint (Duchamp paraphrased).*[66]

But Cage's own memory was sufficient to repeat a very similar claim four years later, as he conversed with Daniel Charles to whom he also reported the rather belated news of Tudor's becoming a composer of his own:

> *one must strain to reach the impossibility of remembering, even when experience goes from an object to its double. In contemporary civilization where everything is standardized and where everything is repeated, the whole point is to forget in the space between an object and its duplication. If we didn't have this power of forgetfulness, if art today didn't help us to forget, we would be submerged, drowned under those avalanches of rigorously identical objects.*[67]

And if art was the art of oblivion, Tudor was a natural-born artist: "It is in David's nature not to repeat what has been done—because he must always go forward."[68]

Tudor kept changing indeed. It was as if he were applying the lesson of *Music of Changes* not only inside specific performances—"a whole hour at a time"—but also outside of them, as he moved from one piece to another, forgetting each time so that each realization was alive. This was what stayed strongly impressed in Cunningham's

[65] Ibid.
[66] Cage, "Diary: Emma Lake Workshop," in *A Year from Monday*, 22.
[67] Cage, *For the Birds*, 80.
[68] Ibid., 70.

memory about his collaborator's music, as the choreographer looked back across almost five decades of their friendship during Tudor's memorial service on August 27, 1996:

> *I remember a program he gave at Steinway Hall, in the 50's. He played Cage, Feldman, Brown, Wolff, Stockhausen, I think Pousseur. Each piece had a distinct character and difference in sound and shape, a phenomenal feat with music so new.*[69]

Nevertheless, it was not so much the sheer power of forgetfulness that made this feat possible. It was rather Tudor's focus in realizing the distinct nature of each material, which in turn would remind him of something he did not already know. And to prevent this pattern from turning itself into an example to be trained into, Tudor must have remembered a simple fact: that each material was different *in different ways*. But this is a very difficult realization to generalize.

If each difference is different, then memory becomes coordinated to the specific material biases of each situation. And as a corollary, the very act of forgetting and remembering becomes indeterminate. Just as coordination between instruments was neither a matter of absolute control nor sheer chance but that of influence and bias, there is neither absolute amnesia nor perfect memory, but only the imperfection of the mind that needs to be constantly reminded anew by this or that coin, this or that organ, this or that sketch, this or that phrase, this or that question, this or that sound, this or that person.

Throughout his life, Tudor appears to have engaged with the thresholds of memory based on this indeterminacy of the mind. On the enhanced island, in the resonant rainforest, and throughout the drama of vowels and consonants, instruments were used to trigger the listener's memory so that sounds became synthesized tentatively in their reflection.[70] "In that way you don't forget the sound; it lives with you in different ways."[71]

[69] Cunningham, "Statement delivered at David Tudor's Memorial Service (August 27, 1996)," Box 67, Folder 6, David Tudor Papers, GRI. He also told a similar recollection to Holzaepfel on July 31, 1989: "I remember those programs in Steinway Hall that David gave when he played pieces by John, Earle, Morty. And I have such a vivid impression of every single piece being different. Absolutely every single piece had its character. It was just amazing. He gave a very distinct quality to each piece" (Merce Cunningham, "Interview with John Holzaepfel, 31 July 1989, New York City," quoted in Holzaepfel, "The Roles of David Tudor in the Early Repertory of the Merce Cunningham Dance Company," in David Vaughan, ed., *Merce Cunningham: Creative Elements* [New York, NY: Routledge, 2013], 48).

[70] Another example would be *Sea Tails*, which Nancy Perloff has examined in detail, paying particular attention to the role of memory: "In *Sea Tails*, shrimp, splashes, waves that resonated at particular moments in the ocean depths detected by Tudor's underwater microphones have been recorded, amplified, filtered and mixed, then played back in a performance space in conjunction with films showing underwater kites continually transformed by light and swirling waters. Distinct sounds and images return in varied forms as memories. We encountered them at the beginning of the piece, and we encounter them again and again, knowing we've seen and heard them before, but not being able to pinpoint where or when. This substitution of memory for repetition is vital to the collaborative working together of the different media in *Sea Tails*" (Perloff, "Hearing Spaces: David Tudor's Collaboration on *Sea Tails*," *Leonardo Music Journal* 14 [2004], 35).

[71] Tudor, "Interview by Billy Klüver (November 24, 1978)," 1; in E.A.T., "*Island Eye Island Ear*: A Sound and Cloud Environment on Boulder Island (January 11, 1979), Appendix I," Box 21, Folder 8, David Tudor Papers, GRI.

In this way, tone is what the sound as an instrument reminds the listener. Music may thus always reflect the spiritual—yet it is not this general observation, but the actual reflections it generates that inspire others. Like a passage Walt Whitman composed one day circa 1855, and that Tudor copied out another day some hundred years later, to remind himself and others yet another day in the future:

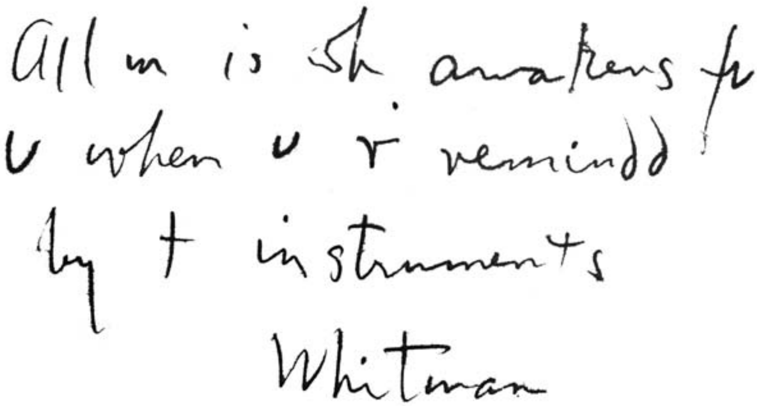

All m is wh awakens fr
u when u r remindd
by t instruments
Whitman

Figure 10.5 Tudor | Copy of a fragment from "A Song for Occupations" | undated
DTP, Box 101, Folder 10 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

All music is what awakens from you when you are reminded by the instruments,
It is not the violins and the cornets, it is not the oboe nor the beating drums, nor the score of the baritone singer singing his sweet romanza, nor that of the men's chorus, nor that of the women's chorus,
It is nearer and farther than they.[72]

[72] Walt Whitman, "A Song for Occupations," in *Leaves of Grass* (New York, NY: Simon & Brown, 2017).

Out

Maps and Fragments

1

One day in the spring of 1994, David Tudor visited the house of Sophia Ogielska and Andy Ogielski, to whom he had been introduced several months earlier through their neighbors Billy Klüver and Julie Martin. Andy Ogielski was at the time working for Bell Communications Research, the descendant of Bell Labs, where he had been developing a new computer with multiple neural network chips. Klüver was on a mission, as Andy reminisced twenty-four years later: "Billy was either tasked by David Tudor, or on his own . . . they were looking for neural network chips. They were a rarity in those days, Intel had just produced one [. . .] and another chip was built in Bell Labs."[1] As usual, Klüver and Martin were trying to help Tudor through their connections. This time it was not another island they looked for, but another neural network chip.

What captured Tudor's attention that day, however, was not the electronics to develop his synthesizer music further. Sophia Ogielska was a visual artist who had studied mathematics in graduate school. And through her interest in the notion of "process," she was at the time working on a project where she deliberately immersed herself in one specific composer's influence in order to transfer his approach to painting. On September 24, 2018, something I asked triggered her memory: "It was never mentioned because I didn't think it was important. You are the first to ask this question. So what really happened, I started doing a series of paintings in the 1990s, early 90s, 91 or so, before I met David, basically and absolutely influenced only by John Cage."[2] Her method to simulate Cage's methods was meticulous and exhaustive: "I read every freakin' book John wrote, I read every interview, I read related books."[3] She even read the entire *Theory of Harmony* by Arnold Schoenberg—which she "didn't understand well—or probably at all"[4] —simply because Cage had mentioned or written something about his former teacher's book somewhere. In other words, she had taken a very Tudor-like approach to study a collection of materials that Tudor knew very well.

[1] Sophia Ogielska and Andy Ogielski, "Telephone Interview by You Nakai," September 24, 2018.
[2] Ibid.
[3] Ibid.
[4] Ibid.

Perhaps because of this, their solutions also shared certain likenesses: Sophia's paintings were "always human size," square panels composed of 60 to 100 modular small paintings that could be rearranged.[5] The analogy to his own modular instruments appears to have been evident to Tudor, for when he saw the multiple finished and unfinished works in her studio, he immediately began to *perform* them: "He was re-arranging those pieces. And he would marvel at how the higher structure would appear by accident almost."[6] Sophia's work presented itself as material to be used. But besides the modifiability of components, she had also conceived of the panel as a "map" that could be traveled by the gaze: "you were able to enter from any direction, it didn't matter if it's upside down or sideways."[7] As a flexible routing system with multiple inputs and outputs, the "map" was also analogous to the neural network chip Tudor had come to talk about, except magnified in scale to "human size." It also resembled the *Neural Network Synthesizer* in its operation: rearranging modular components to generate an unforeseen higher order. "You couldn't plan it in advance," Sophia stressed. "If you would plan it in advance, it would first of all be boring because you would always know what will be at the end."[8] Indeed, even if Tudor had planned something in advance, his visit that day took an unexpected turn. Instead of another circuit with a mind of its own, he had found another human collaborator. He would make the last work of his life with her, which turned out to be a visual work—at least by all appearances.

2

Tudor, as usual, did not take immediate initiative. "He didn't tell me what to do next, he was waiting for what I would bring."[9] So after discussing the matter with Klüver and Martin, Sophia decided to send him a trigger signal—"to ask David for his diagrams."[10] Tudor had himself hinted the way: "It was the one physical thing besides components, he said, which you could put your hands on."[11] She did not specify what or how many. However, Tudor chose only one: the "Performance Processing" diagram of *Untitled*. As far as Sophia remembered in September 2018, "there was no talk even about other diagrams."[12] Tudor had two ideas for what to do with the diagram: (a) he wanted it to be "human size," like Sophia's paintings; and (b) he wanted to perform around it.

These two inputs inspired Andy to make a suggestion: "it was sort of rather natural to say, 'okay, let's make a transparency.' So I went into my office, and […] printed this 'Performance Processing' diagram on dozens and dozens of clear transparency

[5] Ibid.
[6] Ibid.
[7] Ibid.
[8] Ibid.
[9] Ibid.
[10] Ibid.
[11] Ibid.
[12] Ibid.

sheets."[13] Reminiscent of Cage's materials composed long ago as puzzles for him, Tudor's diagram could now be superimposed. But that was not what they did:

> *Not superimposing but making little sculptures, like a fan that is taped together, so it looks like one is casting the shadow of another. It was a little-distorted shadow because they were sort of glued together or pinned together in different respects. So each shadow was a little different and that was very intriguing for David.*[14]

They had gone straight to making three-dimensional objects, little sculptures which Andy also called "little prototypes."[15] Perhaps after years of working with lasers and kites, Tudor felt two was too small a dimension. But more likely, his focus was not on any particular dimension but on the relationship between one dimension and another. For their use of transparencies to make sculptures was related to shadows, a two-dimensional silhouette cast by a three-dimensional object blocking the light. That is to say, they had gone 3D simply to create its negative portrait in 2D.[16] The little prototypes indeed created interesting shadow effects, but they had a problem related to the nature of what they were: prototypes, a miniature mockup of an idea. And scale turned out to be critical for the endeavor.

3

One day in January 1995, Sophia decided to do something different. She took a huge projector along with the transparencies of *Untitled* and drove to Tomkins Cove, where Tudor had moved the previous spring from Stony Point, following a series of strokes. When she got there, she placed one transparency on the projector and blasted it on the wall of his living room, "just out of curiosity, to see how he would react."[17] React, he did:

> *He stood in front of this wall and stopped talking. It suddenly got bigger than human size. I have photographs of it. (Figure O.1) David literally stood in front of it and started pointing at certain components, one after another, in different ways, and again in different ways, and then thinking again, walking around, and coming and pointing.*

[13] Ibid.
[14] Ibid.
[15] Ibid.
[16] There could have been a chain of influence from Monnier, who may have relayed the influence from her stepfather Marcel Duchamp, an artist famously concerned about shadows because they reflected a higher order: "Since I found that one could make a cast shadow from a three-dimensional thing, any object whatsoever […] any three-dimensional object, which we see dispassionately, is a projection of something four-dimensional, something we're not familiar with" (Pierre Cabanne, *Dialogues with Marcel Duchamp*, translated by Ron Padgett [New York, NY: Da Capo Press, 1971], 40). For a nice survey on the role of shadow in the history of art, see Victor I. Stoichita, *A Short History of the Shadow* (London, UK: Reaktion Books, 1997).
[17] Ogielska and Ogielski, "Interview by Nakai."

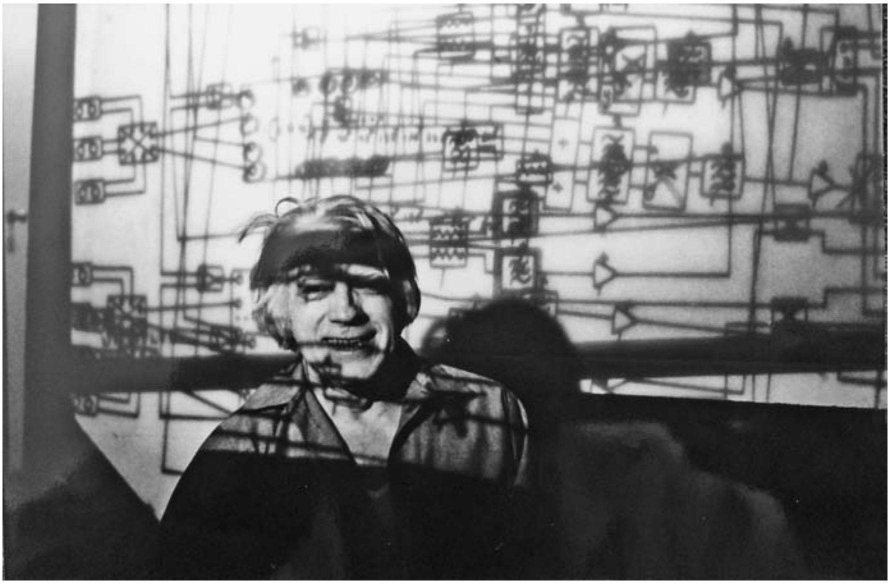


Figure O.1 Tudor with the blown-up and superimposed projection of Untitled diagrams | January 1995
Photo: Sophia Ogielska | Courtesy of Sophia Ogielska.

> *I should have filmed it, it would have helped everybody probably, but I didn't. And it was endless. I was asking if he was playing a silent concert and he said, what do you think, of course.*[18]

As with Sophia's modular paintings, the specific scale in relation to the human body had again triggered Tudor to interact. This time the modular components were his own, so even if the instruments were 2D icons and symbols projected on the wall, Tudor could perform them, hearing the music virtually in his mind. He had always told people that he could imagine the music perfectly when reading a score. "The different physical exertion that you use to play forte is quite specific," he would reflect just six months after this silent concert, "and since I could hear it in my mind's eye, I didn't need to do it actually."[19] He was trying to retrace the reasoning that his organ teacher made all those years ago when he suggested to his young student that he should go back to the piano. But for the silent concert, the "different physical exertion" used to play *Untitled* was something Tudor had already developed by actually doing it. He had been trained, as it were, so he could re-enact the physical coordination even with an image far removed from the actual instrument,

[18] Ibid.
[19] Tudor, "Interview with David Tudor by Jack Vees and John D. S. Adams (July 19, 1995), 241 a," *Oral History of American Music*, Yale University Library, 5.

such as a wall projection of a drawing printed on a transparency that was copied from a diagram depicting instruments in schematic form. What mattered more than the difference between the 2D representation and the 3D object it represented was the difference of size between the actual representation and the actual human body. As with Cage's transparency material, physical scale mattered. And "human size" also happened to be the standard against which giant instruments were always measured.

Perhaps what was not so standard in comparison was Tudor's scale of time. The concert that only he could hear "lasted literally a good few hours, maybe more," Sophia recalled. "Eventually, I left him, with the projector and everything, and I sat in the car in front of his house like a good half an hour, out of curiosity to see if he was still going to do it—he did it. And at last I got so bored that I left."[20] When she came back the next morning, she still found him performing the virtual instrument (Figure O.1).

4

Now that the materials were magnified to a slightly larger size than the human body, the project quite literally moved inside the diagram, switching the level of focus from the entire sound system to that of individual components and how Tudor used them in performance. As Sophia looked back a quarter century later, "Components did not appear from the very beginning. Instead, they came from this silent performance."[21] The collaborators then came up with an interesting idea: they decided that the diagram should be used as material to create another type of diagram which documented not only the spatial coordination between instruments but also the temporal coordination between the instruments and Tudor—in other words, how they were performed. So instead of just rendering 3D to 2D, they would try to render 4D to 2D, by using a 2D rendition of 3D they already had as material. The resulting composition would be something akin to a tablature, a type of notation that instructs the user not which sounds, but which instrument to play, when, and how. The only unusual feature was that it was enlarged to human size: a giant tablature.

Sophia had made an important observation as she watched Tudor perform silently for hours: *he was not using all the components in the diagram*. There were some boxes that he did not touch at all, like the *8Ø Multioutput Phase Shifter* splitting the phase of the incoming signal into eight different degrees before sending them off to the modulator section. When she asked him why that was, Tudor simply replied: "because they are not necessary."[22]

At Sophia's request, he marked the ones he was actually using with colored pens over the transparencies, and these were copied out as separate units. This procedure

[20] Ogielska and Ogielski, "Interview by Nakai."
[21] Ibid.
[22] Ibid.

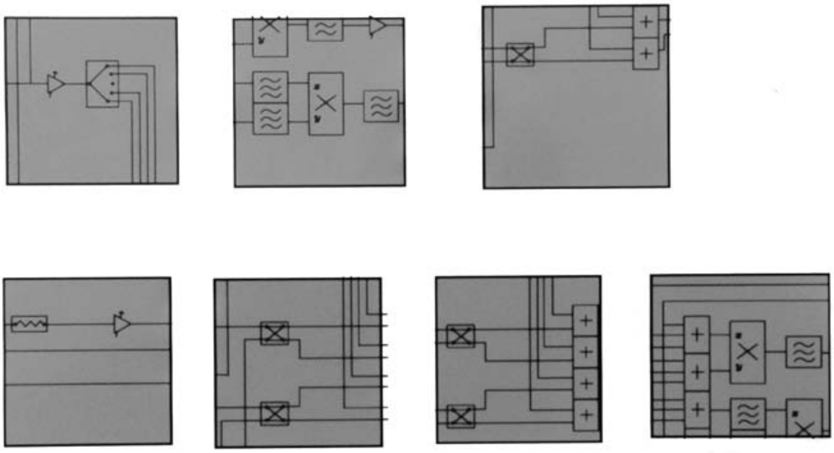


Figure O.2 Sophia Ogielska and David Tudor | Selection of "short-time operation" units (in red) | 1995
Sophia Ogielska's Private Collection | Courtesy of Sophia Ogielska and Andy Ogielski

divided the instruments in a different way than the diagrams (Figure O.2). For example, he had used the *Audio Multicoupler* (receiving the three tape inputs and the fed-back signal from the modulator section) in various ways, as the principal mixer and router with different gain settings. So he multiplied the icon of the instrument—which was a dual device already—to 12 figures, and added arrows to indicate the degree of gain control. In contrast, the four instruments in the Formant Shifter network were always used as one unit, so their icons were trimmed together. Beneath the multiplicity of instruments on the "Performance Processing" diagram was another layer of multiplicity only revealed during performance.

Following a suggestion of a friend, Sophia and Tudor named the selected 23 figures "ideograms"—a written character symbolizing the idea of something and not the sounds to be produced by the reader.[23] In this case, each idea was a unit of use in performance. Tudor then categorized these ideograms into three groups: (a) *short-time operation*, which was anything controlled by switches; (b) *long-time operation*, which was anything controlled by a potentiometer; and (c) *frequency-selective components*. "Further differentiation will be confusing," he told Sophia.[24] Instead of further differentiation, he added a new dimension: color. According to Sophia's recollection, Tudor already knew the exact correspondences from the start: "This is very bright red, this is

[23] Ibid.
[24] Sophia Ogielska, "February 1995 notes," quoted in Billy Klüver and Julie Martin, "Sound into Image: The Collaboration between David Tudor and Sophia Ogielska," in David Tudor and Sophia Ogielska, *Toneburst: Maps and Fragments*, 1996, 7.

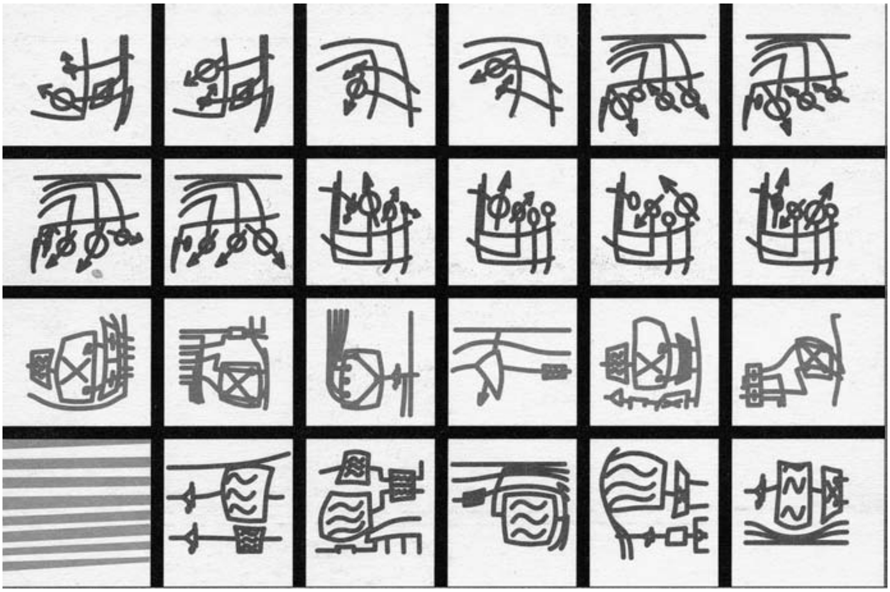


Figure O.3 Ogielska and Tudor | *Ideograms* | 1995
Sophia Ogielska's Private Collection | Courtesy of Sophia Ogielska and Andy Ogielski

very bright blue, and this is green"[25]—*short-time operation, long-time operation*, and *frequency-selective component*, respectively. In the first group were the modulators and the channel reversers; *Audio Multicoupler* was the only instrument in the second group; filters obviously were all green (Figure O.3).

5

Around the same time, another coincidence recoordinated the project to Andy Ogielski's research. Aside from developing the Neural Network Computer at Bell Communications Research, Sophia's husband was spending summers at the Marine Biology Laboratory in Woods Hole, Massachusetts, to work on vestibular systems: "that's the subsystem of the inner ear," he explained to me on September 24, 2018, "which is very close to hearing, involved in the keeping of balance."[26] Embedded in the last section of the human auditory system, also known as the "*labyrinth* of the ear," where Steiner believed physical sound became metaphysical tone, this biological mechanism did not de-materialize incoming vibrations, but

[25] Ogielska and Ogielski, "Interview by Nakai."
[26] Ibid.

coordinated and oriented the body which received them—a function that recent studies have likened to "an internal GPS for the body."[27] To register the movement of the body from the inside, the vestibular system uses two kinds of instruments: three semicircular canals that detect the rotation of the head, and two otolith organs that detect linear accelerations. Their numbers reflect the dimensions of movement that the system has to render into signals: head rotation is in three and linear acceleration in two.

To model such system, Andy was working on a computer graphics software that could manipulate and transform two-dimensional images in three-dimensional space, showing the effects of one dim ension in another, similar to how Tudor and Sophia bent and folded the transparencies to make their little prototypes. But since the operation was now done virtually inside a computer program, the light that created the shadows was gone, along with the hands or pins that held the transparencies together. What one saw was only the result of the modification. 3D had turned into an imperceptible source of influence that could only be reflected upon through perceivable effects, just like inaudible signals moving the lasers at the *Pepsi Pavilion*, or the invisible wind moving various materials on *Knavelskär*. The image had no visible shadows, but was itself a shadow of a higher dimension.

In the process of testing his software, Andy imported the diagram of *Untitled* into the program and showed the collaborators how the ideograms could be manipulated on screen. Then they were free to do it on their own. Sophia remembered a specific effect that was caused by the forced tethering of 3D to 2D: "What happened was that it was distorted on a three-dimensional surface, but then it was projected in two dimensions because we didn't have means to do it in three dimensions. So shape becomes very interesting."[28]

After the modulation was all done, the ideograms were combined into a panel following one of the many ways Tudor performed them, creating what they called a *Map*. By March 1995, an almost completed first *Map* with the caption "Work in Progress" was made. Four more would follow. Like Sophia's paintings and Tudor's matrix switchers, they could be entered at any point and moved around through any of their multiple paths. In spite of the fact that they had used only one diagram—"Performance Processing" of *Untitled*—for all the *Map*s, Tudor wanted to call the whole project *Toneburst*. The reason, he explained to Sophia, was simply that the name sounded better.[29]

[27] "Vestibular System: Your Child's Internal GPS System for Motor Planning and Attention," Integrated Learning Strategies, accessed December 15, 2019: https://ilslearningcorner.com/2016-04-vestibular-system-your-childs-internal-gps-system-for-motor-planning-and-attention/

[28] Ogielska and Ogielski, "Interview with Nakai."

[29] Ibid.

6

Following their experiments with transparencies, Tudor wanted the ideograms to be printed on translucent sheets. Most of all, this was to bring back the shadows of the little prototypes that had been eliminated in the process of virtualization: "He said shadow was important. He insisted on this because it was sort of repetition I guess."[30] As a reflection of another dimension, the shadow of ideograms was a shadow of a shadow, a visual trigger to activate the same kind of neural synthesis across scales and dimensions that Tudor had pursued over the years by composing a chain of sonic reflections in *Rainforest* and *Island Eye Island Ear*, or by using inaudible sound and wind-sensitive volatiles in his collaborations with Monnier.

But although such reasoning uses language to quickly generalize matters, the actual process of materializing shadows carried, as usual, very specific problems of its own. For one thing, printing solid colors on translucent material did not create colorful shadows, only gray ones. The same was true if one colored them with regular paint. So Sophia found a special type of translucent paint which could be applied to their translucent film. Because of this process, the surface of the film was now physically irregular with dried paint. "And all was painted because David wanted shadows."[31]

On the whole, color was used in two different ways. The first two *Maps* were all black, but they were combined with two sets of *Ideogram Clusters*, five to six acrylic strip mobiles of 2.43 meters (96 inches) in length, which cast colorful shadows on the monochrome panel. In the other three *Maps* made later, color was integrated.

Ogielska hoped to make more but time was running out:

> *Everything went into the production a little earlier than I had wished. We wanted to make a more colorful* Map*, etc., more elaborate ones. But David insisted. His health was deteriorating. And it was for us a sort of deadline because he really wanted to see everything.*[32]

The deadline was physical: Tudor was gradually losing his sight as the project developed. Sophia was with him the day he called Merce Cunningham to let the choreographer know that he had come to the full realization that he could not perform anymore. He conveyed his "wish" that Kosugi should be the next director.[33] Tudor's last appearance with MCDC was in March 1995, during the two-week residency at the City Center in New York they had presented every year since 1979. It was in that same month that the prototype of *Map 1* was produced. But his hands stopped working, and legs soon followed. Sophia remembered how Tudor retained his

[30] Ibid.
[31] Ibid.
[32] Ibid.
[33] Ibid.

memory and curiosity much longer, but physical balance and coordination—his vestibular system—were failing.

In the end, in spite of the rush, the work arrived too late. By the summer of 1995, when Jack Vees started interviewing him, Tudor had already become blind. He never got to see the *Maps* when they were completed. "Now that I can't see," he joked to Sophia, who later told Klüver and Martin, "I'm a visual artist."[34] There was a plan to exhibit *Toneburst: Maps and Fragments* at the Zilkha Gallery in Wesleyan University in the fall of 1996. For the opening on September 11, Tudor asked John D. S. Adams to perform in his stead the music that had now become *Toneburst*, using edited materials from the three *Study Tapes* of *Untitled*. Andy remembered driving Tudor up to Wesleyan sometime after he had lost the ability to see because he wanted to "listen to the space" to prepare for the performance.[35] The concert, however, became yet another output he could not experience. David Tudor passed away on August 13, 1996, one month short of the opening.[36]

7

When I talked to her over the phone twenty-two years later, one of the things Sophia recalled was that during the collaboration, before they realized time was running out, she and Tudor talked about "time" a lot.[37] As a giant tablature, these *Maps* were not "maps" in the ordinary sense (nor "matrix maps," for that matter), a visual diagram showing the coordination of components without showing in what order they are to be read. The spatial sequence of ideograms instead represented temporal sequence. In other words, even when they were exhibited as three-dimensional objects, the *Maps* still conveyed information about a higher dimension. The reflection of shadows, as well as the modification of each ideogram, made visible the compression of 3D into 2D, which served as a reminder to reflect on the compression of 4D into 3D/2D.

A quarter of century later, the same interdimensional compression is used everywhere in so many digital map applications which add a temporal dimension to the 2D or 3D representation of space by using GPS (Global Positioning System), a technology that detects the real-time position of the user—a giant vestibular system of sorts. Which is to say that in order to incorporate time, the viewer has to coordinate with the system. Like Sophia's modular paintings that

[34] Quoted in Klüver and Martin, "Sound into Image," 8.

[35] Ogielska and Ogielski, "Interview with Nakai."

[36] The finished works were eventually exhibited at Wesleyan, including two 96" × 96" black-on-clear *Maps*, fourteen colorful translucent *Fragments* of varying dimensions, two 96" long *Ideogram Clusters*, with recordings of Tudor's performances of *Untitled* playing continuously. Three original diagrams for *Untitled* were also exhibited.

[37] Ogielska and Ogielski, "Interview with Nakai."

Tudor immediately set out to perform, the *Maps* expect people to perform them by tracing the many possible paths with their gaze. "We talked a lot about how to make this happen in those *Maps*, and it became a sort of a labyrinth which if you are patient enough you will trace this way or another."[38] Like the 1959 material that Christian Wolff designed to draw the pianist "into labyrinthian complications," or the piano pieces that Sylvano Bussotti wrote around the same time for the "Minotaurus of the pianistical mythology," a *labyrinth* is a three-dimensional puzzle that requires the physical investment of the user to be solved in time. Like the part of the ear that goes by the same name where material sound became immaterial tone and different dimensions are mediated to keep the balance of the body, what matters is coordination. "It was like a puzzle," Sophia paraphrased, "somehow you have to participate."[39]

8

Once you do, the *Toneburst Maps* can indeed be read. *Map 1* (Figure O.4), for instance, is actually composed of two sequences which are neatly divided into the modulation network section (A) and the output processing section (B) of the "Performance Processing" diagram.

Sequence A (Figure O.5) preserves the dual networks in the original diagram, starting either from the top two sections of the *Quad Multi-Input Mixer* connected to the giant *Spectrum Transfer* network, or the distributor at the end of the Formant Shifter network. Each network is repeated twice and modulated in a wavy-form, emphasizing the modulators first and then the filters.

Sequence B (Figure O.6) preserves the three parallel output processing channels, starting either from the *Audio Multicoupler*, now decomposed into a collage of three ideograms, or the *Signal Selector in Reverse* and the bottom two sections of the second *Quad Multi-Input Mixer* going into the output mixer.

The two sequences are positioned in various sizes, directions, and modulations, some of them connecting to another, others abruptly cut. This gives a clue to the user of how the map can be tracked. But there are other things that are more difficult to read than symbols and icons: the actual way the ideograms are modified using Andy's software, or the colorful shadows casted on them when the work is actually installed. These effects are puzzling because they are effects that have been processed by the specific material bias of *David Tudor*.

When he selected the colors for the ideograms, Sophia asked why he chose those colors. He answered as a matter of course: "Oh, because that's how it

[38] Ibid.
[39] Ibid.

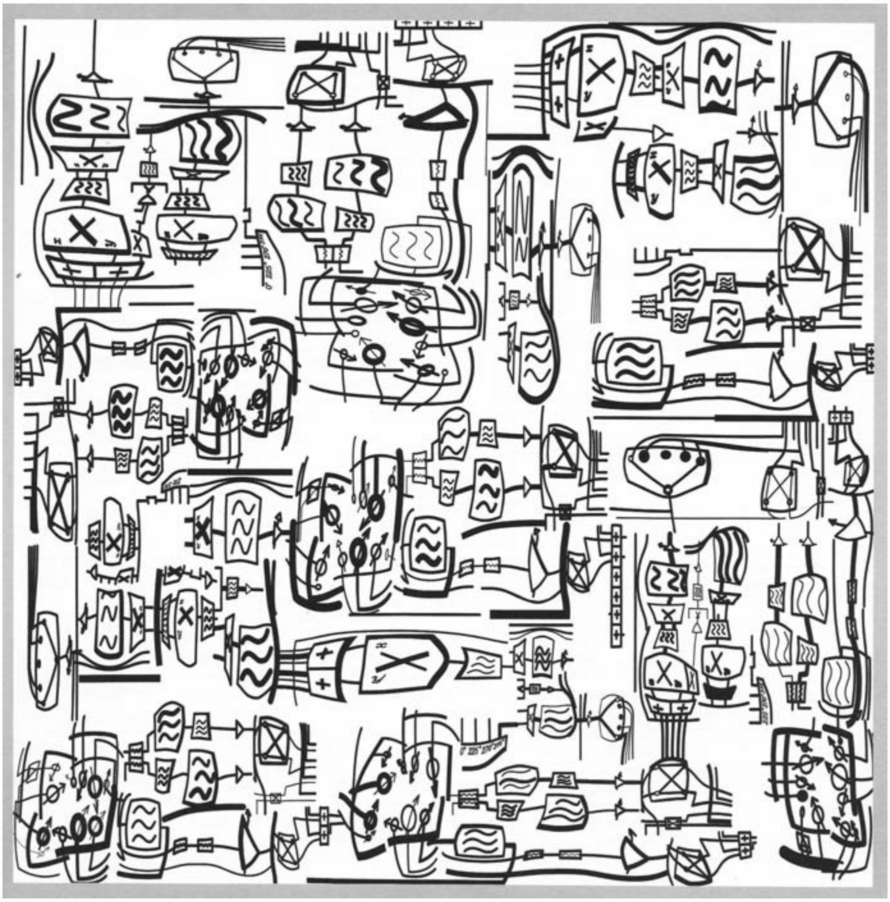


Figure O.4 Ogielska and Tudor | *Toneburst Map 1* | 1996
Sophia Ogielska's Private Collection | Courtesy of Sophia Ogielska and Andy Ogielski

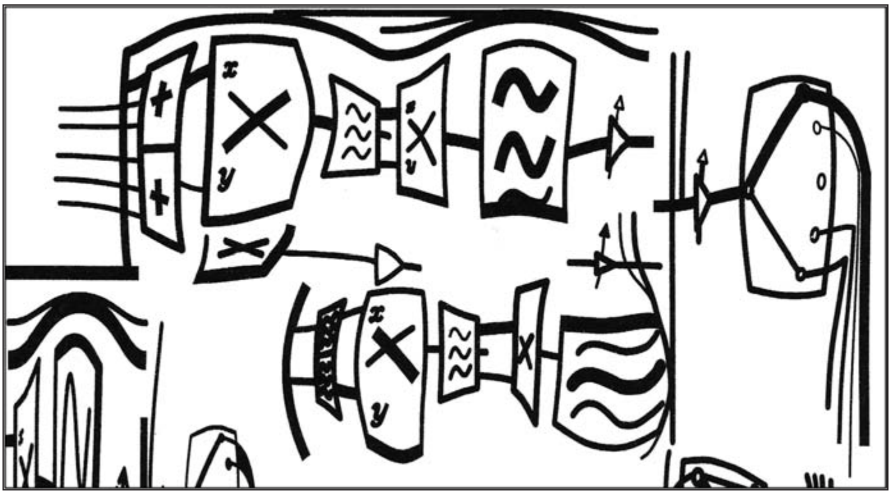


Figure O.5 Ogielska and Tudor | *Toneburst Map 1*, Sequence A
Sophia Ogielska's Private Collection | Courtesy of Sophia Ogielska and Andy Ogielski

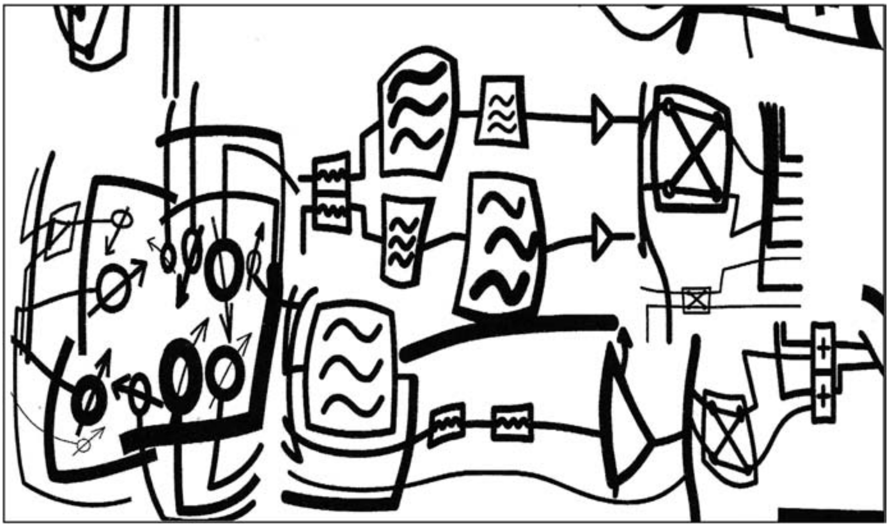


Figure O.6 Ogielska and Tudor | *Toneburst Map 1*, Sequence B
Sophia Ogielska's Private Collection | Courtesy of Sophia Ogielska and Andy Ogielski

sounds."[40] By all accounts, *David Tudor* appears to have had synesthesia, a physical condition where stimulus in one sense is routed and perceived as another—where what usually is a side effect becomes a norm. As Sophia continued to reminisce: "The shapes triggered a sound, color would trigger a sound, and also smell, I think. We cooked a lot together, and he was always reacting 'ahhhh, it sounds good!' " And as they subjected the ideograms to virtual 3D space, Tudor alone kept hearing sound: "He literally was saying 'that doesn't sound good,' or 'that sounds good.' So we twisted a little bit less until it sounded good."[41] Seeing the same images, Sophia instead placed her focus on how they looked.

Throughout all those years of visualizing sound in public, Tudor must have also been sonifying what he was seeing in private. After all, when he looked back in May 1972 on his experience some years before, he had said precisely that to Victor Schonfield: "Since that time I have come to the point where I don't need to hear the sound anymore, but only to look at it because I can tell what it would sound like from seeing it."[42] In the conversation with audience members after the performance of *Hedgehog* in September 1985, he had revealed what was on his mind as he performed: "I want certain colors and I want certain different densities of occurrences in time. When I'm performing I think a lot of colors."[43] It was feedback that only he may have known.

[40] Ibid.
[41] Ibid.
[42] Tudor, "From Piano to Electronics," 26.
[43] Tudor, "*Hedgehog*, Mobius Art Center, Boston (September 29, 1985)," C73, David Tudor Papers, GRI.

But this also defines the limit of my own participation. For I definitely do not hear any sounds when I look at colors or modulated ideograms. The specificity of my own body, biased in quite different ways from Tudor's, prevents me from reading the materials further. Back in 1995, however, Tudor had a collaborator. And one of the things he had told her was that *Untitled* was always based on three tape sources which he described as "constant input from previous performances"—material from outside the closure of no-input feedback circuit.[44] When Sophia wanted to add another color on the palette as *her* input to the work, Tudor assigned it to the multiple lines coming out of the tape source that he had added more than two decades before when he realized the physical impossibility of realizing a pure no-input performance. He asked Sophia what color she wanted. Yellow was her choice (Figure O.7).

9

Sophia did something in return. When it became clear that the large *Toneburst Maps* could not be realized in a timely manner, she created smaller size fragments from the larger panels in development and applied the four colors she and Tudor had chosen. She wanted her collaborator to at least see a prototype miniature, a virtual simulation of the work he may not be able to experience. Unfortunately, these *Fragments,* as Sophia called them, also did not make it in time. When they were delivered, Tudor had already lost his vision. But the translucent paint used to realize the colorful shadows Tudor insisted on seeing (or hearing) generated an unexpected side effect which allowed him to perceive the physical addenda in the absence of sight:

> *That's also a reason we made these* Fragments *because I could bring a piece of this polycarbon with this film on it and David could trace the shape*.[45]

Like the negative music from 1984 with the same name, *Fragments* worked as an instrument for listening to sounds from the other side. This time Tudor listened, not through the *Click and Pop Assassin* working in reverse, but with his fingers tracing the surface texture of ideograms that the translucent paint had altered by accident almost. "For me, touch is very important," he had confessed at the end of the aftertalk at STEIM.[46] Like a puzzle piece, *Fragments* revealed a higher order that was imperceptible, yet could be synthesized in the mind through one instrument or another (Figure O.8).

[44] Ogielska and Ogielski, "Interview with Nakai."
[45] Ibid.
[46] Tudor, "Aftertalk, STEIM (June 16, 1994)," Video, Private Collection of Molly Davies. He was talking about how much of a difference a particular instrument made: "I had the control of a kind of an attenuator that was continuously variable by touch"—by which he probably meant the *Quad Keys* (0086) with piano-like black phenolic keys and a pressure-sensor to make it do what the piano could not.

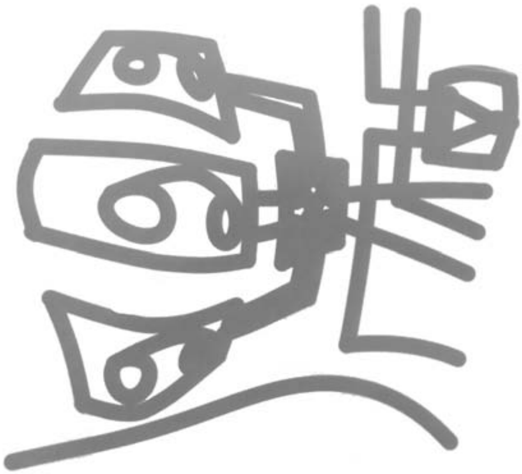


Figure O.7 Ogielska and Tudor | *Ideogram* (tape sources, in yellow)
Sophia Ogielska's Private Collection | Courtesy of Sophia Ogielska and Andy Ogielski

Figure O.8 Ogielska and Tudor | *Toneburst Fragment 9* | 1996
Sophia Ogielska's Private Collection | Courtesy of Sophia Ogielska and Andy Ogielski

10

In the end, it matters little whether Tudor actually left behind a puzzle or not. Whatever the intention may have been of the person who lived it, a life inevitably takes on the appearance of a puzzle for anyone who tries to read it (including, or rather especially, one's own). And like the gaze that travels across the *Toneburst Map*, reading is an act of choosing one sequence over others, conditioned by a specific body in a specific time and place. In other words, the only way to enact an atemporal universe of possibilities, whether written on paper, printed on transparencies, or scattered across many archives and memories of people around the world, is for someone to use the materials in a particular order. In so doing, the user tries to justify the specific continuity that results, like the composer who once attributed the no-continuity of events to the throwing of coins. But this is also to say that, just like any realization, a book that tries to show the way around a labyrinth ends up creating its own labyrinth.

Like the voice, the appearance of a puzzle might very well be in appearances only, something projected by the reader of materials. But like the random trigger signal that serves to activate the process of oscillation, it did have a role to play. For it was this appearance that led me to discoveries I had not foreseen, answers to questions I only began to ask in retrospect. And in this sense, the entire trajectory of my research turned out to be grounded in something paradoxical: not so much the products arrived at nor the processes taken to get there, but the *side effects* generated along the way—matters that initially appeared out of focus, perceived only as a by-product. Revelations always came from the periphery, composing sequences I did not anticipate, and biasing what followed.[47]

Yet, although encounters were certainly not planned in advance, their seeds had been planted for a long time, as I realized on my first visit to the Getty Research Institute where I stumbled across Tudor's materials by accident almost. For if there is one thing that is absolutely certain about this book, it is that it could not have existed if David Tudor did not deliberately leave an incredible amount of materials and take great pains to preserve as much detail of what he did as he could—without telling

[47] Tudor's last composition was *Soundings: Ocean Diary*, the music for MCDC's choreography *Ocean*, which was also a posthumous collaboration with Cage who had started working on the piece before his death in 1992. For this music, Tudor focused on what he called "peripheral sounds"—sounds recorded as a by-product of the effort to record a certain sound. He revealed this little-known fact during a brief exchange with Kosugi as they set up the piece in Amsterdam on June 23, 1994. This conversation was fortunately captured on film by Molly Davies, who was following her friend and former collaborator with a video, trying to make a documentary on him: "I wanted to have a lot of peripheral sounds related to the activities of collecting the sounds," Tudor can be heard explaining in the footage. "So far they think I'm interested in mammals and they send me sounds of mammals, but I'm not particularly interested in the sound of mammals. […] I'm more interested in sounds that chop in the act of trying to record a sound." He goes on to give another example of what he was asking others to record for him: the sounds of an ice field when it breaks up. When Kosugi replies jokingly, "I think I'm going to do it in my own refrigerator," Tudor laughs and implicitly reminds him that it needs to be done *actually*: "that's what John Cage would do!" (Molly Davies, *David Tudor's Ocean: From Another Point of View*, private collection of Molly Davies).

other people about it. As with so many other instruments he composed, it appears he "hoped to influence" things from afar.[48]

11

On October 23, 1987, Tudor appeared in another Merce Cunningham–related symposium, this time at the Southern Methodist University in Dallas, Texas. The topic of the day was Black Mountain College, and the list of panelists included his former partner M. C. Richards, whom he had met at the same summer school thirty-six years before. At one point in the discussion, the moderator asked Tudor a question about foreseeing the future in relation to the now-legendary theater event which had taken place at the same school in the summer of 1952 under the influence of Artaud: "Did you feel the importance of that evening in that dining hall like you were making history that evening?" Tudor replied:

> *My relationship to that question, I don't mean your question, but the question of what you are doing is going to be history is that one thing leads to another, and I knew that was going to happen when I was doing that because that work had come out of something else that I was also involved in with John.*[49]

One year later, on November 9, 1988, a day before he visited the Montvale Diagnostic Imagery to receive a Doppler ultrasound test of carotid artery with high-frequency sound waves turned to his direction, Tudor asked Marc Farre, the

[48] Toward the end of writing this book, I read a brilliant review of Quentin Meillassoux's book *The Number and the Siren: A Decipherment of Mallarmé's Coup De Dés* (New York, NY: Urbanomic/Sequence, 2012) written by a teenager named Rice Pekinpah, which criticizes the philosopher's attempt to read the famous poem *Un coup de dés jamais n'abolira le hasard* written in 1897 by Stéphane Mallarmé, as a "puzzle" to be deciphered. In his book, which likens itself to a detective story, Meillassoux claimed that he had *either* solved the puzzle by discovering a secret number (707) at the center of the enigmatic poem, *or* that his counting was wrong in which case the other numbers resulting instead of 707 would be totally meaningless, revealing the fact that the puzzle was in appearance only. For Meillassoux, this indeterminacy between utter significance and utter insignificance was a "wager" that Mallarmé made, the act of letting chance—the very theme of his poem—determine whether posterity would solve the work or not. The 14-year-old Pekinpah argued instead that the philosopher had tamed chance to his benefit, and tha t the real chance lay not in the question of whether the puzzle is solved by him or not, but in the likelihood that the puzzle may be solved in more ways than one; that other numbers may be just as meaningful as the one Meillassoux discovered, or that someone other than him may have solved it instead. According to Pekinpah, Meillassoux did not think about these other possibilities because the philosopher was biased to believe that the puzzle can be solved by pure detective work—that in his reading of materials he was letting the materials lead the way to the truth, and that in doing so, he was bypassing all arbitrary processes of interpretation. What is forgotten, however, is the *rhetoric*—the performance of language—that Meillassoux employs to convince the readers that this is in fact the case. The solving of the puzzle, in other words, is a *matter of act*, rather than of fact. (Rice Pekinpah, "The Rhetorics of Detective M.," in *Matters of Act (A)* [New York, NY: Already Not Yet, 2016]).

[49] Tudor, "Merce Cunningham Symposium at the Southern Methodist University (October 23–24, 1987)," Merce Cunningham Dance Foundation Collection, Rodgers and Hammerstein Archives of Recorded Sound, New York Public Library.

manager of MCDC, to write a "memorandum" on his behalf. It was addressed to Cunningham, Cage, the Cunningham Foundation's executive Art Becofsky, and its European representative Benedicte Pesle:

> *David Tudor has asked me to help him conceptualize and initiate this project, and has approved the wording of this memo. David desires an important overhaul and analysis of his career to date as musician, composer and member of Merce Cunningham Dance Company. This proposal is an attempt to clarify what practical steps need to be taken to accomplish this.*[50]

There was a tone of urgency:

> *Though explicit, it does not address the important issues of timetable, cost, and ultimate administrative responsibility. It is hoped, nonetheless, that this methodical breakdown will help facilitate the quick execution of this desire, to the benefit not only of DT, but also of the Cunningham Dance Foundation and the large number of people worldwide who are interested in his important work, past and present.*[51]

The memorandum then divided the necessary work into five steps: (a) archival assembly, (b) archival analysis, (c) process of recapture, (d) public access, and (e) administrative coordination. Despite calling itself one of the "basic chronological steps," the last step was extratemporal:

> *Even as this project involves various different parties, David Tudor's musical affairs past and present need to be coordinated and overseen by one person.*[52]

Since he himself was occupied with performing for the company, Tudor suggested Barbara Mayfield for this role, his good friend who had supported him over the years:

> *David feels that Barbara, in close association with CDF and Artservice International, is best suited to look after the complex set of issues that affect his work, both within the scope of the Company and without, forever intertwined as they are. He hopes that the Foundation will help bring this wish to fruition.*[53]

In the end, the Foundation did not.[54] But instead, a month later, on December 18, a doctoral student in musicology at the City University of New York with "a particular

[50] Marc Farre, "Memorandum (November 9, 1988)," Box 26, Folder 11, David Tudor Papers, GRI.
[51] Ibid.
[52] Ibid.
[53] Ibid.
[54] Art Becofsky sent a reply to Tudor on January 13, 1989, apologizing for the long delay and offering his support, yet explaining the need to obtain approval from the board as far as company business is concerned: "I wanted to let you know that I stand ready to make whatever proposals necessary to the Finance

interest in the historiography of post-war music"[55] wrote to Tudor to let him know about the endeavor he was about to embark on: "I will, beginning in January, undertake a major research project at CUNY regarding your role in that music."[56] Cage had already shown him the memorandum. "Needless to say, I was excited by the prospect that you, too, are interested in an enterprise of the kind I have described, and I would be delighted to speak with you further about this."[57] The student introduced himself as John Holzaepfel, who, along with many others, would work for years to bring many of the scattered fragments together so that the "continuity" Tudor cared for could be retraced and his music revived, so that we may remind ourselves of something different for a change. As Tudor said, one thing had led to another.

Committee of the Board of Directors to get funds appropriated to get started. Sometimes the finding of funds for new projects takes some time, but the sooner we get started, the better. I'll need to get a sense of the amount of monies necessary, and I'll have to enlist the support of one of the development staff members to help find some ear-marked funds for the project" (Art Becofsky, "Letter to David Tudor [January 13, 1989]," Box 26, Folder 11, David Tudor Papers, GRI).

55 Holzaepfel, "Letter to David Tudor (December 18, 1988)," Box 26, Folder 11, David Tudor Papers, GRI.
56 Ibid.
57 Ibid.

Acknowledgments

or Dramatis Personae
(in more or less the order of appearance)

Acknowledgment sections in books are like end credits of movies in that most readers—with the obvious exception of those who feel they might be mentioned there—don't actually care to read them. Their existence is a matter of formality. And yet, if there is anything I have learned from watching recent superhero movies with Aevi, it is that the long list of real-life *dramatis personae* may hide a surprise or two, or even reveal something extra about the work just experienced, if one did not leave the theater so hastily.

To start from the very beginning, I must first thank Trisha Brown and Yvonne Rainer for triggering the whole endeavor without knowing so. A similar act of accidental midwifery was performed by Yelena Gluzman, Ellen C. Covito, and Kenjiro Okazaki, who have each influenced how I think (or perhaps more importantly, how I don't).

The entire trajectory of this project which started with an accident was fraught with accidents. One of the most fortunate among them was being accepted to the music department of New York University. I am particularly indebted to Stanley Boorman for his warm mentorship since the day I arrived there in September 2009. Only after finishing the book almost a decade later, I realize that Stanley's challenging and often bewildering responses to my writing over the years have turned the project into a study of history (at least in appearance). The fact that this world-renowned scholar of medieval/Renaissance era musical manuscripts has supervised this research, in addition to the most fundamental research on John Cage's music—by James Pritchett, obviously—should testify to the extraordinary breadth of his scholarship. Among the other members of the faculty, Elizabeth Hoffman, Jaime Oliver, Martin Daughtry, Jason Stanyek, Suzanne Cusick, and Michael Beckerman each provided, at different times, much needed help and encouragement.

Outside of the department, I sought the advice of Joel Chadabe and got plenty of anecdotes, and briefly learned the ABCs of electronics with Douglas Repetto at the Computer Music Center of Columbia University. When I finally got to Wesleyan University, it was Ron Kuivila who took good care of me with his quick mind and quicker eloquence that anyone who knows Ron knows. Ron was always kind to ask his grad students to accommodate me in one place or another. After the first couple of visits, Michael Johnsen became my dear travel companion, so the number of people they had to accommodate became two. That was only possible because Hallie Blejweski kindly let us use her apartment anytime we were in town, in addition to organizing dinner

parties and driving us around. Although I had met Matt Wellins first as another fellow traveler to Wesleyan, he also became a generous host when he later enrolled there.

I am grateful to all the people who have shared their memories of David Tudor with me in person, over Skype, or via email. In more or less the order I met them, they are: Gordon Mumma, John Driscoll, Phil Edelstein, John David Fullemann, Christian Wolff, Pauline Oliveros, Toshi Ichiyanagi, Forrest Warthman, Fujiko Nakaya, John D. S. Adams, Rosaly Roffman, Ritty Burchfield, Nicolas Collins, Anthony Gnazzo, Alden Jenks, John Bischoff, Lowell Cross, David Behrman, Sören Brunes, Joe Kubera, Rob Miller, Alvin Lucier, David Vaughan, Molly Davies, David Meschter, Tony Martin, Carol Plantamura, and Barbara Mayfield. I spoke with Takehisa Kosugi but he did not wish to be interviewed, telling me that he thought Tudor's music should die with Tudor, an opinion I respected (although the fact that he told me this right after performing *Untitled* disguised as *Toneburst* himself was a bit puzzling). I waited until I reached the very end of the manuscript to interview Andy Ogielski and Sophia Ogielska. I thank them for sharing with me their story, as well as their kind permission to use one of Sophia's beautiful *Fragments* for the cover of this book.

Julie Martin does not appear on this list because I had already met her back in 2006 when I began working with the Trisha Brown Dance Company. Throughout the long course of this research, I often visited Julie's house in New Jersey, still near Bell Labs, which is also home to one of the most incredible personal archives of experiments in art and technology she and Billy Klüver collected over the years. This study would not have been possible without her generous sharing of materials, as well as the sheer speed with which she puts her thoughts into action (and her car through the streets of New Jersey, sometimes in the wrong direction). She also read the entire manuscript and gave me essential feedback in her sharp capacity as an editor ("Don't say 'Tudor's practice'—artists don't practice, they just do!"). In September 2019, I was lucky enough to accompany Julie on her revisit to *Knavelskär* after forty-five years, and I thank Anna Lundh, Jacob Kierkegaard, and Tobias Kirstein for the invitation.

But Julie also deserves a very special thanks in regard to the most critical phase of the project. Throughout the extremely long and stressful process of obtaining all the necessary copyright permissions, dealing from day to day with rights holders who would ask for absurd amounts of money, others who would not reply for weeks or months, and still others who somehow seemed to have disappeared off the face of the earth without leaving a trace, I often found myself at the verge of releasing the entire manuscript (which was already completed as far as I was concerned by January 2019) anonymously online. If it were not for Julie's constant encouragement and support, this book may not have been written by You Nakai or published by Oxford University Press.

Another person I must thank specifically is Gordon Mumma, who has been most supportive of my endeavor since the first time I met him in New York in March 2011. Over the years I sat down with him for extensive hours in San Francisco, Vancouver, and New York to talk about the music and instruments he and Tudor used to make. In May 2018, Gordon and his partner Michelle Fillion kindly invited me to their house in the Bay Area, which is also home to his astonishing personal archive of recordings, photographs, and films of music and other activities he has been involved in his long career (including a priceless collection of audience riot tapes). As a by-product of this visit, his Cybersonic instruments, which had been stored in a nearby storage space, have now found a new home at Wesleyan University alongside Tudor's and David Behrman's. Gordon and Michelle also introduced me to Jonathan Goldman who had written an excellent paper on Tudor's relationship to the bandoneon. I have borrowed Jonathan's ingenious concept of "musical synecdoche" and enhanced it a bit, and I hope he is okay with that.

Matt Rogalsky has always been very generous at sharing the tremendous amount of work he has done over the years on Tudor's electronic music, including the feat of cataloging all the instruments at Wesleyan, from which this research benefited immensely. John Driscoll and Phil Edelstein of Composers Inside Electronics, to whom I was introduced by Matt, have continuously supported my inquiry into the past of their dear friend and teacher in so many ways. From quite early on, they treated me not as a scholar but as a collaborator, which I appreciated very much. For one thing, they invited me to join CIE to perform Tudor's music (*Rainforest I* and *IV*, and *Microphone*) with them; for another, John and I began co-interviewing people (Ritty Birchfield and David Behrman). Our work together is carried further beyond this book, as when I helped Phil prepare a version of *Weatherings* for a performance with the Lyon Opera Ballet in November 2018.

Through John and Phil, I was introduced to many other collaborators and friends of Tudor. Stan Ries, who had been taking photographs of CIE since the 1970s; Stephan Moore, the former sound engineer for the Merce Cunningham Dance Company (and to whom I am especially grateful for sharing with me several important materials); Thom Holmes, the author of *Electronic and Experimental Music*, helped me identify one photograph of Tudor manipulating the Buchla Box that I first came across in his book. We thought it was taken by John Bischoff, which turned out to be not true, but in any case, connecting with John also helped me reach Alden Jenks and Anthony Gnazzo. And it was Paul DeMarinis who reminded me over a barbecue dinner in his backyard in May 2018 about the connection between occult philosophy and Michel Foucault's description of the Renaissance episteme.

But as far as influences from the alignment of celestial bodies go, this book would not have existed without my encounter with Michael Johnsen, his encyclopedic knowledge of electronics, and a very articulate mind that can break down complex phenomena into simple descriptions that even I could swallow. My friendship with Michael is one of the most valuable by-products of this research for me. Most of the identification of circuits and instruments presented here are a product of my collaboration with him, and I am extremely grateful for his generosity for letting me use many things we discovered together. Just about everything I may have gotten right about electronics is the result of me asking him; everything that I may have gotten wrong is whatever I forgot to ask. Since there was no room in the main text to account for our work together, I'll give just one typical example of how we went about

connecting the puzzle pieces. During our correspondence in November 2014, I brought up an enigmatic acronym that I kept seeing in Tudor's sketches from the mid-1970s: "D/G." I had already identified the corresponding symbol, which was drawn as two circles traversed with arrows pointed at opposite directions, but neither of us had any good idea about what the two letters stood for ("Deleuze and Guattari" was the joke). As we sat together during our subsequent visit to Wesleyan University in February 2015, Michael mentioned that from the shape of the symbol, it looked like the instrument we are looking for is some kind of complementary phase shifter. At that moment I realized that the two letters were not taken from the start of a word, but the end: lea"D" and la"G." Since both terms begin with the same letter, Tudor obviously needed another way to differentiate them. The only remaining task was to find the corresponding instrument, which we found within an hour, with the tiny labels "D" and "G" attached to the panel.

Another one of our joint research trips to Wesleyan in May 2015 was generously funded by the David Tudor Trust, and I thank Mimi Johnson for giving us that opportunity, as well as her kind permission to use Tudor's diagrams for this publication at no cost, which also convinced the Getty Research Institute to let go of their usual fees.

Many other people helped me along the way. I am grateful to Mats Lindström for showing me around Stockholm and introducing me to Sören Brunes; Philip Thomas for confirming my observations on escapement control and his support of my work (sorry I had to drop that scholarship); Emily Dolan for her wonderful seminar of Critical Organology at NYU which, along with her writings, were instrumental in reminding me about the role of musical instruments; Rebecca Y. Kim for her help in Earle Brown–related matters; Gayle Young, for her help in Hugh Le Caine and René Farley–related matters; Christopher Shultis, Michael Gallope, Brigid Cohen, and Julia Robinson for their encouraging words when I needed them most; David Bernstein and Maggi Payne for taking care of my visit to Mills College.

I also thank David for introducing me to John Holzaepfel, the famous Tudor scholar with whom I began corresponding in November 2014 after he saw me give a paper on the *Pepsi Pavilion* at the American Musicological Society's annual meeting. Every email I received from John confirmed his well-known concern for thoroughness that I had taken as a model for my own approach. He has always been extremely kind about sharing his knowledge and resources, which has helped me stop feeling like a sudden ignorant intruder to the beautiful garden he has carefully kept in order all these years. John also read the entire manuscript and gave me the most detailed and encouraging comments I could wish for.

It took me some time to meet John in person, which happened finally during the three-day conference "Over, Under, Around, and Through the Music of David Tudor," organized by Ron Kuivila at Wesleyan University in March 2016. Aside from Ron, who also organized other conferences and events and gatherings at Wesleyan, several people have invited me to present materials from the book. I thank Carol Parkinson from Harverstworks for putting together the event on *Toneburst: Maps & Fragments* (November 2016, Issue Project Room); Marina Mcdougall for inviting

me to the symposium *Interspatial: E.A.T., Cybernetic Serendipity, and the Future of Creative Collaboration* (September 2013, Exploratorium); Deidre Loughridge for accepting my proposal to "From Bone-Flute to Autotunes: A Conference on Music & Technology in History, Theory and Practice" (April 2014, UC Berkeley); Adam Harper for chairing the session at the "Hearing Landscapes Critically" conference (January 2015, Harvard University); James Mooney for his wonderful conference "Alternative Histories of Electronic Music" in London (April 2016, Science Museum); Takuma Ishikawa for curating my lecture in Tokyo (July 2017, Musashino Place); Tinken Laurantzon and Dag Blakkisrud of the Anthroposophical Society of Oslo for asking me to present a lecture on the influence of Rudolf Steiner on Tudor (September 2018, Anthroposophical Society of Oslo); Ben Piekut for inviting me to participate in the discussion on what comes "After Experimental Music" (February 2018, Cornell University); and Emily Payne, Floris Schuiling, and Eliane Fankhauser for their excellent gathering on "Material Cultures of Musical Notation" (April 2018, Utrecht University). An early version of Chapter 5 has appeared in the *Journal of American Musical Instrument Society* 43 (2017), and I thank the editors for giving me permission to further develop the article for this book.

My research certainly would not have been possible without the help of various archives and archivists in the world. At the Getty Research Institute, it was Virginia Mokslaveskas, along with the kind staff of the special collections room, who always accommodated my visit, and I appreciated the constant support from Nancy Perloff, the curator responsible for purchasing Tudor's materials back in 1996. I thank Paul van Emmerik for his astonishing online resource "A John Cage Compendium"; Suzanne Keyte at the Royal Albert Hall Archive; Olle Fernau at the Fylkingen Archive in the Swedish Performing Arts Agency (Statens musikverk) Collection; Tina Hogan at Trinity Church, Swarthmore; Dexter Dine and Petr Kotik at the SEM Ensemble Archive; the Oral History of American Music at Yale University; and Joshua Peach at the Robert Rauschenberg Foundation. I am also grateful to Staatliches Institut für Musikforschung for organizing the screening of "Musik im technischen Zeitalter" when I was living in Berlin and giving me a copy of the film afterward. Many of my analyses would have not been possible without the incredible online repositories Rudolf Steiner Archives (https://www.rsarchive.org/) and American Radio History (https://www.americanradiohistory.com/). Special thanks to Tatsuo Nakagawa for putting me in touch with the De Sa family.

A series of scholarships over the years have enabled this project financially: Getty Research Institute Library Research Grant (2009), NYU Fulbright Scholarship (2009–2011), NYU McCracken Fellowship (2009–2014), GSAS Dean's Dissertation Completion Fellowship (2014–2015), Patricia Dunn Lehrman Fellowship (2013), Global Research Initiatives' grant to stay at NYU Berlin (2014) and NYU London (2015), and postdoctoral fellowship from the Society for the Promotion of Sciences (2016–2018).

But the most important learning took place outside the academia, through the music, dance, theater, haunted musical mansions, picture books, and other works I made with others over the years. I thank Kay Festa, Earle Lipski, Jay Barnacle, Ai

Chinen, and Dee Ali of *No Collective* and *Already Not Yet* for all the ideas and performances we conceived and fabricated together (nocollective.com, alreadynotyet.org). The post-dance choreographer Lindsey Drury was my most significant and observant collaborator throughout the process of research who set me thinking about the body in its multiple dimensions and scales. Part of the book was written during *No Collective*'s two-week residency at the Kinosaki International Arts Center with *Zen-Go* (Megumi Kamimura and Shinichi Takashima) in February 2018 where we explored the problem of habit as a problem of dance, seeing a person's patterned behavior and mindset as an *archi-choreography* set to one's body (most times unconsciously), an idea which extended the notion of material bias to human beings. I also thank the curators Maki Hashimoto and Yuichiro Yoshida for letting me stay an extra week to work on the manuscript when we first visited the Center in September 2017.

Many ideas germinated in conversation with friends, especially with Dima Pevzner, Masami Tomihisa, Esther Neff, Brian McCorkle, David McCarthy, Humi Kobayashi, Akio Mokuno, Matthew Gantt, and Leah Morrison in New York; Yoshihito Mizuuchi and Pika (*Afrirampo*) in Osaka; Yelena Gluzman in San Diego. I learned a great deal about narrative from Roland Albrecht's *Museum der Unerhörten Dinge*, Bill Morrison's *Dawson City: Frozen Time*, and Marilyn Strathern's *Partial Connections*. Ellen C. Covito's *Composed Improvisations* and *Improvised Compositions* were the initial triggers that set me thinking about Tudor's distinct approach to indeterminacy and the issue of specific bodies in performance (ellenccovito.com). Cody Eikman's *Moving Instruments* and *Lost Instruments* helped me expand my initially narrow conceptualization of what musical instruments can be.

I am grateful to Norm Hirschy at OUP for his prescient interest in my early manuscript without which this book would not have been possible, and his patient support as I postponed one deadline after another without which my life would not have been possible. I also thank Dorothy Bauhoff for her excellent proofreading of this very long book, and Prabhu Chinnasamy for coordinating everything in the production phase.

My parents, Yoshinori and Yoko, as well as my grandparents Reiko, Shizuo, and Teruko, have always supported what I am doing without knowing what it actually is (which is sometimes the best form of support one can ask for). Yelena, Chuck, Gen, Polina, and Tolya have taken good care of Aevi at different times, which allowed me to focus on other things in life like the writing of this book.

Last but certainly not least, the most important dramatis personae of all are the three individuals who currently influence and brighten all the corners of my life: my partner Non, an expert puzzle-solver of her own who teaches me every day that kindness really works, and who also happens to be the most interesting video artist I know (https://noriko-koshida.net/); our little baby We, or Oui (for francophones), who was born in the same year as this book; and my ten-year-old son Aevi, my in-house editor and personal critic, who is the reason this book exists, with whom and for whom it was written. I love you all very much.

APPENDIX A

Notable Realizations

(Note: Other notable events in David Tudor's life are inserted in square brackets.)

1950 March 11: ***Battle Piece*** / Stefan Wolpe / Composer's Forum concert, Columbia University, New York

December 17: ***Second Piano Sonata*** / Pierre Boulez / Carnegie Recital Hall, New York

1951 July 5: ***Music of Changes (Book 1)*** / John Cage / University of Colorado Boulder, Boulder, Colorado

1952 January 1: ***Music of Changes*** [Premiere of complete version] / Cage ; ***Intersection 2*** / Morton Feldman ; ***For Prepared Piano*** / Christian Wolff / Cherry Lane Theatre, New York

May 2: ***Water Music*** (presented as ***66 W. 12***) / Cage ; ***Extensions 3*** / Feldman ; ***For Piano*** / Wolff / The New School for Social Research, New York

August: ***Theatre Piece No. 1*** / Cage et al. / Black Mountain College, Asheville, North Carolina

August 29: ***4′33″*** / Cage / Maverick Concert Hall, Woodstock, New York

October 12: ***Concert for Prepared Piano and Chamber Orchestra*** / Cage / Cooper Union, New York

August 21–22: ***Untitled Solo, Banjo, Septet*** / with Merce Cunningham / Black Mountain College, Asheville, North Carolina

1953 April 14: ***4′33″*** [NYC Premiere] / Cage / Carl Fischer Concert Hall, New York

1954 April 28: ***4 systems*** / Earle Brown ; ***Intersection 3*** / Feldman / Carl Fischer Concert Hall, New York

[Early July: Moves to Stony Point with M. C. Richards, Cage, David Weinrib, and Karen Barnes]

October 17: ***34′46.776″ for a Pianist*** simultaneously with ***31′57.9864″ for a Pianist*** (performed by Cage) / Cage / Donaueschingen Music Festival, Donaueschingen, Germany October 20: ***34′46.776″ for a Pianist*** / Musik der Zeit, Nordwestdeutscher Rundfunk, Funkhaus, Kleiner Sendesaal, Cologne, Germany

Late October: ***34′46.776″ for a Pianist*** simultaneously with ***45′ for a Speaker*** (performed by Cage) / Composers' Concourse, London

December 15: ***Klavierstücke I–VIII*** [Premiere of ***VI–VIII***] / Karlheinz Stockhausen / Carl Fischer Concert Hall, New York

1955 October 23: ***Music for Piano 4–19, Music for Piano 21–36/37–52*** (the latter presumably first performance) (with Cage) / Cage / Music and Musicians of the Village, New School, New York

1957 January 12: ***Winter Music*** (with Cage) / Cage / Brooklyn Academy of Music, Brooklyn, New York

April 22: ***Klavierstuck XI*** / Stockhausen ; ***Bewegungen*** / Bo Nilsson / Carl Fischer Concert Hall, New York

December 15: ***Duo for Pianists*** (with Cage) / Wolff / Harvard-Radcliffe Music Club, Cambridge, Massachusetts

1958 March 15: ***Variations I*** (with Cage) / Cage / The Woman's College of the University of North Carolina, Greensboro, North Carolina

May 15: ***Concert for Piano and Orchestra*** / Cage / The 25-Year Retrospective Concert of the Music of John Cage, Town Hall, New York

September 9: ***Quantitäten*** / Nilsson / International Frienkurse fur Neue Musik, Darmstadt, Germany (during the lecture "Communication" by Cage)

September 14: ***Quantitäten*** / Recording at Westdeutscher Rundfunk, Cologne, Germany

October 5: ***Quantitäten*** / As part of music for *Nightwandering* by Cunningham / Royal Swedish Opera, Stockholm, Sweden /

October 14: ***Music Walk*** (with Cornelius Cardew) / Cage / Galerie 22, Düsseldorf, Germany

1959 June 7: ***Quantitäten*** / The Village Gate, New York [US Premiere]

June 9: ***Indeterminacy: New Aspect of Form in Instrumental and Electronic Music with Concert for Piano and Orchestra*** (with Cage) / Cage / Columbia University, New York

July 23: ***Indeterminacy*** / Recording at Cue Recording Studios for Folkways Records

August 29: ***Piano Piece for David Tudor (2, 3, 5)*** / Sylvano Bussotti / International Frienkurse fur Neue Musik, Darmstadt, Germany

October 28: ***For Pianist*** / Wolff ; ***Piano Piece for David Tudor (2, 3, 4)*** / Staatliche Hochschule für Musik, Cologne, Germany

December 10: ***Solo for Piano*** with ***Fontana Mix*** (Music for *Antic Meet* by Cunningham) / Cage / Bennett School for Girls, Millbrook, New York (with Cage and MCDC)

1960 February 25: ***Music for Amplified Toy Pianos*** / Cage / Eastern Michigan University, Ypsilanti City, Michigan

March 7: ***Theatre Piece*** (with Cunningham, Carolyn Brown, Arline Carmen, Frank Rehak, Don Butterfield) / Cage / Composers' Showcase, Circle in the Square, New York

March 28: ***Piano Piece for David Tudor (1, 2, 3, 4, 5)*** / Living Theatre, New York

April 11: ***Music for Piano No.2*** / Toshi Ichiyanagi ; ***Poem*** (with Cage, Cunningham, and James Spicer) [NY premiere] / LaMonte Young / Living Theatre, New York

[May 16: Interview with Tudor and Cage by Gordon Mumma and Ed Burroughs for WUOM Radio / Ann Arbor, Michigan]

September 15: ***Cartridge Music*** (with Cage) / Cage / Radio Bremen, Bremen, Germany

October 6: ***Cartridge Music*** with ***Solo for Voice 2*** (with Cage, Cornelius Cardew, Hans G. Helms, Nam June Paik, Benjamin Patterson, William Pearson, Kurt Schwertsik) / Mary Bauermeister Atelier, Cologne, Germany

1961 March 24: ***Variations II*** [Premiere] / Cage ; ***Piano Concert for David Tudor*** / Richard Maxfield / Artist's Choice Concert, The New School, New York

April 20: ***Cartridge Music*** (with Cage) [US premiere] / Composers' Showcase, Museum of Modern Art, New York

June 20: ***Variations II*** (with Jasper Johns, Niki de Saint-Phalle, Robert Rauschenberg, Jean Tinguely) / American Embassy, Paris, France

August 3: ***Atlas Eclipticalis*** with ***Winter Music (Electronic Version)*** / Cage / International Week of Today's Music, Theatre La Comedie Canadienne, Montreal, Canada

September 6: ***(To Henry Flint) (April 1960)*** / La Monte Young / ***Incidental Music*** / George Brecht / International Frienkurse fur Neue Musik, Darmstadt, Germany

1962 [September 30–November 5: Japan tour]

1963 January 21: ***Variations II*** with ***Fontana Mix (for amplified piano)*** with ***Variations III*** (with Cage) / Musik im Technischen Zeitalter, Technical University of Berlin, Germany

March 15: ***Book for 3*** (with von Biel and Egon Mayer) / Michael von Biel / Artists' Choice Concert, The New School, New York

May 25: ***Music for Piano No.4*** / Ichiyanagi / Oldenburg palace, Oldenburg, Germany

July 17: ***Variations IV*** (music for *Field Dances* by Cunningham) / Cage / UCLA, Los Angeles (with MCDC)

August 21: ***Variations II*** with ***Variations III*** (with Cage) / Six concerts of the Avant Garde, Judson Hall, New York

September 3: ***26'1.1499" for a String Player*** with ***34'46.776" for a Pianist*** (with Charlotte Moorman, presented as ***34'46.776" for a Pianist and a String Player***) / Cage / Six concerts of the Avant Garde, Judson Hall, New York

September 9–10: ***Vexations*** (curated by Cage) / Eric Satie / Pocket Theatre, New York

1964 February 9: ***Atlas Eclipticalis*** with ***Winter Music (Electronic Version)*** (with New York Philharmonic, conducted by Leonard Bernstein) / Lincoln Center, New York

March 21: ***Duet for Cymbal*** (music for *Paired* by Cunningham) / Cage / Wadsworth Atheneum, Harford, Connecticut (with MCDC)

March 30 & April 6: ***Duo for Accordion and Bandoneon with possible Mynah Bird Obligato*** / Pauline Oliveros / Tudorfest, San Francisco Tape Music Center, San Francisco, California

April 1 & 8: ***Music for Piano No. 4 (electronic version)*** / Ichiyanagi / Tudorfest, San Francisco Tape Music center, San Francisco, California

June 24: ***Event No. 1*** / MCDC / Museum des 20 Jahrhunderts, Vienna, Austria

September 10: ***Electronic Music for Piano*** / Cage / Moderna Museet, Stockholm, Sweden

September 13: ***Fluorescent Sound*** (as music for *Elgin Tie* by Rauschenberg) / Moderna Museet, Stockholm, Sweden

October 11: ***Duet for Cymbal*** / Kunstakademiets Festsal, Charlottenborg Palace, Copenhagen, Denmark

[October 13–December 12: MCDC Asia Tour]

November 27: Evening of Cage/Tudor / Sogetsu Hall, Tokyo, Japan

1965 January 16: ***Variations IV*** (with Cage) / Cage / An Avant Garde Concert, San Francisco Museum of Art, San Francisco, California

April 3: ***Pandorasbox, Bandoneonpiece*** [US Premiere] / Mauricio Kagel / SUNY Buffalo, Buffalo, New York

July 23: ***Variations V*** [Premiere] (with MCDC) / Cage et al. / Lincoln Center, New York

July 30: ***Variations IV*** (with Cage) / "Sound System by David Tudor"/ Sundance Festival, Bridgeton, Pennsylvania

September 19: ***Talk 1*** / Cage et al. / ONCE AGAIN Festival, Ann Arbor, Michigan

November 8 & 10: ***Light Piece for David Tudor*** / Oliveros and Tony Martin / San Francisco Tape Music Center, San Francisco, California

November 11: ***Applebox Double*** (with Oliveros, presented as *Duo for Amplified Appleboxes*) / Oliveros / San Francisco State College, San Francisco /

1966 January 21: ***Solo(s) for Voice 2 (Electronic Version)*** (with Carol Plantamura) / Cage / SUNY Buffalo, New York

March 26: ***Variations VI*** (with Cage) / Cage and Tudor / Fine Arts Foundation, Hartford, Connecticut

March 28, 1966: ***Applebox Double*** (with Oliveros) / Once Festival, Ann Arbor, Michigan

May 6: ***Solo(s) for Voice 2 (Electronic Version)*** (with Lucier and Oliveros) ; ***Wave Train*** (with Lucier and Oliveros) / David Behrman ; ***Music for Solo Performer, 1965*** (with Lucier) / Alvin Lucier / Third Annual Presentation of Experimental Music, Case Institute of Technology, Cleveland, Ohio

May 13: ***Musica Instrumentalis*** / Lowell Cross / Special Avant-Garde Concert, The Art Gallery of Toronto, Toronto, Canada

August 6: ***Mesa*** / Gordon Mumma / Nuits de la Fondation Maeght, IIe Festival International de Musique et d'art Contemporains, Saint-Paul, France

Mid-August: ***Variations V*** / filmed for North German Television, Hamburg, Germany

October 14 and 18: ***Bandoneon! (a combine)*** / Tudor / 9 Evenings: Theatre & Engineering, 69th Regiment Armory, New York

1967 March 30: ***Music for Solo Performer*** (with Larry Austin) / Lucier / UC Davis, California

April 15 & 16: ***Fontana Mix (version for bass drum and electronic circuits)*** with ***Solo for Voice 2*** (with Cross) / Mixed Media Concerts, Isaacs Gallery, Toronto, Canada

July 25: ***Activities for Orchestra*** [Premiere] (with Cage, Mumma, Ichiyanagi, and MCDC) / Ichiyanagi / Ravinia Festival, The Murray Theater, Chicago, Illinois

December 6: ***Music for Bandoneon and Strings*** / Stanley Lunetta / First Festival of Live-Electronic Music: Concert IV, UC Davis, California

1968 January 16: ***Variations VI*** (with Martin Bartlett, Charles Boone, Anthony Gnazzo, William Maraldo, Edward Nylund, Judy Ohlbaum, Ivan Tcherepnin and Ron Williams) / Mills College, Oakland, California

March 5: ***Reunion*** (with Mumma, Behrman, Cross, Cage, Duchamp and Teeny Duchamp) / Cage et al. / Sight Sound Systems, A Festival of Art and Technology, Isaacs Gallery, Toronto, Canada

March 9: ***Rainforest*** as music for *RainForest* by Cunningham (with Mumma and MCDC) / Tudor / SUNY Buffalo, New York

April 16: ***Book for 3 (with amplified barbecue grills)*** (with the members of the Tape Music Center) / Mills College, Oakland, California

May 10: ***Video III*** / Cross and Tudor / UC San Diego, California

May 13: ***Variations III*** (with Cage, Cross, Anthony Gnazzo, Charles Boone, Ivan Tcherepnin, Alden Jenks, etc) / Cage / Mills College, Oakland, California

1969 January 18: ***The Music of Conlon Nancarrow*** (with Mumma) / Brooklyn Academy of Music, Brooklyn, New York

March 4: ***In Memoriam: NIKOLA TESLA, Cosmic Engineer*** as music for *Canfield* by Cunningham (with Mumma and Cage, and MCDC) / Oliveros / Nazareth College, Rochester, New York

May 9: ***Video/Laser I*** / Cross and Tudor (with Carson Jeffries) / Mills College, Oakland, California

May 16: ***HPSCHD*** (with William Brooks, Neely Bruce, Philip Corner, Ronald Peters, Yuji Takahashi, Antoinette Vischer, etc) / Cage / University of Illinois, Urbana, Illinois

[November 28–December 9: Ahmedabad Electronic Music Studio setup, produces ***Monobird*** tape]

1970 January 5: ***For 1, 2 or 3 People (baroque organ version)*** as music for *Tread* by Cunningham (with MCDC) / Wolff / Brooklyn Academy of Music

February 19–April 25: ***Pepsi Pieces*** / Pepsi Pavilion, Osaka, Japan (opened March 15)

June 5: ***First Week of June*** as music for *Signals* by Cunningham (with Mumma, Cage, and MCDC) / Theatre de France, Paris, France

June 17: ***Activities for Orchestra*** (with Mumma, Cage, and MCDC) / Ichiyanagi / Maison de la Culture, Amiens, France

1971 May 14–15: Music using *Pepsi Tapes* for *Survey* by Viola Farber / American Theatre Lab, New York

1972 February 1: ***Landrover*** as music for *52/3* by Cunningham (with Mumma, Cage, and MCDC) / Brooklyn Academy of Music, Brooklyn, New York

May 5: ***Rainforest*** with ***Mureau*** by Cage / Pro Musica Nova, Bremen, Germany

May 8: ***Untitled*** with ***Mesostics Re: Merce Cunningham*** (with Cage) / Pro Musica Nova, Bremen

May 18: ***Rainforest*** with ***Mureau*** (with Cage) / Tage Neuer Musik, Rheinisches Landesmuseum, Bonn, Germany

May 22: ***Rainforest*** with ***Mureau*** (with Cage) ; ***Untitled*** with ***Mesostics Re: Merce*** *Cunningham* (with Cage) / Royal Albert Hall, London, UK

[Late May: Interview by Victor Schonfield/ London, UK / Later published as "From Piano to Electronics"]

[May 29: Interview with Tudor and Cage by KPFA Radio / Brussels, Belgium]

June 5: ***Rainforest*** with ***Mureau*** (with Cage) ; ***Untitled*** with ***Mesostics Re: Merce*** *Cunningham* (with Cage) / Basler Theater, Basel, Switzerland

July 2: ***Untitled*** with ***Mesostics Re: Merce Cunningham*** (with Cage) / Pamplona, Spain

July 11: ***Rainforest*** with ***Mureau*** (with Cage) / Akademie der Kunst, Berlin, Germany

August 30: ***Monobird*** with ***Bird Cage*** (with Cage) / Bayerischer Rundfunk, Munich, Germany

September 7: ***Monobird*** with ***Bird Cage*** (with Cage) / 6th Festival of Arts, Shiraz-Persepolis, Iran

December 9: ***Monobird*** with ***Bird Cage*** (with Cage) [US Premiere] / SUNY
1973 Albany, New York

February 16: ***Free Spectral Range I*** / Cross and Tudor / The University of Iowa, Iowa City, Idaho

May: ***Microphone*** / Recording at the Center for Contemporary Music, Mills College, Oakland, California

June 12–14: ***Free Spectral Range II*** (***Laser Bird*** and ***Laser Rock***) / Cross, Tudor, and Jeffries / The University of Iowa, Iowa City, Idaho

July 7: ***Sliding Pitches in the Rainforest in the Field (Rainforest IV)*** (with John Driscoll, Phil Edelstein, Linda Fisher, Bill Viola, and Ralph Jones) / New Music in New Hampshire (June 21–July 8), Chocorua, New Hampshire

[November 27: Six-hour discussion with Raymond Wilding-White on the realization of graphic scores and related problems which would become "10
1974 Selected Realizations" / Chicago, Illinois]

[Early February: Fractures left wrist in Ahmedabad, India]

March 8: ***Rainforest*** (with Driscoll, Fisher, Viola, and Jones) / Everson Museum of Art, Syracuse, New York

April 20 & 21: ***Event 109 + 110*** aka ***Photocell Action*** (with MCDC) / Tudor and Tony Martin / Westbeth Artists Housing, New York
June 7 & 9: ***Microphone*** as music for *Dinosaur Parts* by Viola Farber (with Viola Farber Dance Company) / Westbeth Artists Housing, New York
[July 7–19: ***Island Eye Island Ear*** research/ Knavelskär, Sweden]
October 5: ***Microphone*** as music for *Dinosaur Parts* by Farber (with Viola Farber Dance Company) / Chicago, Illinois
October 10 & 11: ***Microphone*** as music for *Dinosaur Parts* by Farber (with Viola Farber Dance Company) / The College of St. Catherine & Walker Art Center, Minneapolis, Minnesota
October 13: ***Pulsers*** as music for *Events* by Farber (with Viola Farber Dance Company) / Guthrie Theatre, Minneapolis, Minnesota

1975 February 14: ***Rainforest*** (with Driscoll, Fisher, Viola, and Jones) / York University, Toronto, Canada
March 8: ***Toneburst*** as music for *Sounddance* by Cunningham (with MCDC) / Center for the Performing Arts, Detroit, Michigan
April 19: ***Rainforest*** (with Driscoll, Fisher, Jones and Kalve) / The Kitchen, New York
October 19: ***Rainforest*** (with Driscoll) / Modern Art Museum of Fort Worth, Texas
November 18: ***Rainforest*** (with Driscoll, Edelstein, and Viola) / LACMA, Los Angeles, California

1976 March 21: ***Pulsers*** (with recorded violin improvisation by Kosugi Takehisa) / Sydney Conservatorium of Music, Australia
May 21–23: ***Free Spectral Range III*** / Cross and Tudor / Universidad Nacional Autonomo de Mexico, Mexico DF
June 12, 13, 15 & 16: ***Rainforest*** (with Driscoll, Edelstein, and Viola) / Walker Art Center, Minneapolis, Minnesota
October 20–26: Composers Inside Electronics / Festival d'Automne à Paris, France
December 10–26: ***Video Pulsers*** as music for *Brazos River* by Farber and Rauschenberg / KERA-TV, Dallas, Texas

1977 January 7: ***Pulsers*** / The Kitchen, New York
March 20: ***Forest Speech*** (with Kalve) / Barnard College, New York
May 14, 16 & 17: ***Free Spectral Range IV*** (***Laserburst***) / Cross, Tudor, and Jeffries / Kultur-Forum, Bonn, Germany

1978 April 10: ***Pulsers 2*** / New York University, New York
September 23: ***Forest Speech*** (with Composers Inside Electronics) / The Kitchen, New York
September 27: ***Weatherings (Nethograph) No.1*** as music for *Exchange* by Cunningham (with MCDC) / City Center Theater, New York
[November 24: Interview by Billy Klüver on *Island Eye Island Ear*]
[November 12–December 11: Composers Inside Electronics residency / Media Study/Buffalo, Buffalo, New York]
December 3: ***Altering Signal Sources in Real Time*** (lecture) / Media Study/Buffalo

1979 March 1: Xenon performance (uses ***Monobird*** source tape) / Xenon, New York (one day after canceled performance at Artists for New York organized by E.A.T.)
June 9: ***Atlas Eclipticalis*** with ***Winter Music*** (with Rzewski, etc.) / Cage / Beethovenhalle, Bonn, Germany
October 5 & 6: Josef Matthias Hauer / Tudor and Joe Kubera / The Kitchen, New York

1980 January 20–February 3: ***Rainforest*** (with Jones, Kalve, Viola, Edelstein, Driscoll) / Akademie der Künste, Berlin
July 31: ***Variations II*** / Cage / Cage Festival, Rome, Italy
August 1: ***Solo for Piano*** / ***Cartridge Music*** (with Rzewski) / Cage Festival Rome, Italy
August 29: ***Laser Concert*** (***Video/Laser III***) / Cross and Tudor / Venice Biennale, Venice, Italy
September 3 & 4: ***Laser Concert*** (***Video/Laser III***) / Cross and Tudor / Massenzio 80, Roman Forum, Rome, Italy
[Early September: Interview by Massimo Villa and Stefano Bonagura / Rome, Italy / Later published as "Incontri: David Tudor: nei meandri del possible"]
September 10: ***Laser Concert*** (***Video/Laser III***) / Cross and Tudor / Ars Electronica, Linz, Austria

1981 March 24: ***Phonemes*** as music for *Channels/Inserts* by Cunningham (with MCDC) / City Center, New York
September 20–October 4: ***Rainforest IV*** (with Composers Inside Electronics) / Soundings, Neuberger Museum of Art, Purchase, New York

1982 February 24–27: ***Likeness to Voices*** / recording at Centre Européen pour la Recherche Musicale, Jouy-aux-Arches, France
March 19: ***Likeness to Voices/Dialects*** [Premiere] / IRCAM, Paris, France
June 2: ***Likeness to Voices/Dialects*** / Gulbenkian Foundation, Lisbon, Portugal
June 5–13: ***Rainforest IV*** (with Composers Inside Electronics) / Holland Festival, Amsterdam, Holland
June 9: ***Untitled*** / Holland Festival, Amsterdam, Holland
June 22 & 24: ***Variations II*** / ***Solo for Piano*** / Cage / Holland Festival, Amsterdam
September 11: ***Variations II*** / ***Solo for Piano*** / Philadelphia Museum of Art, Philadelphia, Pennsylvania
[October 4: Interview by Austin Clarkson on Tudor's relationship with Stefan Wolpe / Stony Point, New York / Later published as "Composing the Performer: David Tudor Remembers Stefan Wolpe"]
October 29: ***Sextet for Seven*** as music for *Quartet* by Cunningham (with MCDC) / Théâtre des Champ-Elysées, Paris, France
November 20: ***Variations II*** / ***Solo for Piano*** / Washington Performing Arts Society, Washington, DC

1983 January 26: ***Dialects No. 2*** (with Driscoll) / Lovely Music Uptown, Marymount Manhattan College, New York
[Mid-February: Nassau trip for *Sea Tails*]
June 3–27: ***Sea Tails*** (installation) / Jackie Monnier, Molly Davies and Tudor / Centre Georges Pompidou, Paris, France
October 31: ***Sea Tails*** (performance) / Theater am Turm, Frankfurt, Germany /
September 9: ***Likeness to Voices/Dialects*** / Wesleyan University, Middletown, Connecticut
October 11: ***Likeness to Voices/Dialects*** / New Music America Festival, Washington Project for the Arts, Washington, DC

1984 Early February: Lecture on ***Sea Tails*** / SCAN Forum, Tokyo, Japan

February 15: ***Dialects*** / Metropolitan Museum and Art Center, Miami, Florida

August 30–September 2: ***Sea Tails*** (installation) / Moderna Museet, Stockholm, Sweden

September 2: ***Dialects/Likeness to Voices*** / Moderna Museet, Stockholm, Sweden

[September 3: Interview by John David Fullemann / Stockholm, Sweden / "… performing is very much like cooking: putting it all together, raising the temperature," davidtudor.org]

December 7: ***Fragments*** as music for *Phrases* by Cunningham (with MCDC) / Angers, France

1985 March 5: ***Fragments*** as music for *Phrases* by Cunningham (with MCDC) [US Premiere] / City Center, New York

September 28 & 29: ***Hedgehog*** / Mobius Art Center, Boston, Massachusetts

1986 March 12: ***Phonemes*** as music for *Channels/Inserts* (revival) by Cunningham / City Center, New York (with MCDC)

[April 7: Interview by Bruce Duffie / Chicago, Illinois / "Presenting David Tudor: A Conversation with Bruce Duffie," bruceduffie.com]

April 8: ***Hedgehog*** / Art Institute of Chicago, Chicago, Illinois

April 25: ***Electronics with Talking Shrimp*** / Clocktower, New York

September 17: ***Sea Tails (Sound Totem version)*** / Monnier, Davies and Tudor / ***9 Lines, Reflected*** / Monnier and Tudor / Whitney Museum of American Art, New York

November 8: ***Line and Cluster*** / Monnier and Tudor / Kulturzentrum Gasteig, Munich, Germany

November 17: ***Line and Cluster*** / Staadstheater, Munich

1987 February 14: ***Web for John Cage*** / WDR, Cologne, Germany

March 4: ***Webwork*** as music for *Shards* by Cunningham (with MCDC) / City Center, New York

[July 26: Interview by Peter Dickinson on John Cage / London, UK / Later published in *CageTalk: Dialogues with and about John Cage*]

September 6: ***Haiku (with Electronic Web)*** / Cage / Cage and Colleagues, Japan American Theatre, Los Angeles, California

November 2 (or 6): ***Electronic Web (**aka **Web II)*** / Rensselaer Polytechnic Institute, Troy, New York

November 17: ***Web for John Cage II*** / Munich, Germany

1988 [January 18: Breaks hip and is hospitalized at Good Samaritan Hospital until January 29]

February 28: ***Lines and Reflections*** / Monnier and Tudor / Imaginary Landscapes, A Festival of Electronic Music, The Kitchen, New York

March 1: ***Rainforest*** as music for *RainForest* (revival) by Cunningham (with Takehisa Kosugi and MCDC) / Joyce Theatre, New York

[May 17–18: Interview by Teddy Hultberg / Düsseldorf, Germany / "I smile when the sound is singing through the space," davidtudor.org]

May 18–20: ***Lines and Reflections*** / Rheinisches Musikfest, Kunstakademie Düsseldorf, Germany

May 26: ***Variations II*** / ***Web for John Cage II*** / Kölner Gesellschaft für Neue Musik, Stadtgarten, Cologne, Germany

June 16: ***Five Stone*** for *Five Stone* by Cunningham (with Kosugi, Michael Pugliese, and MCDC) / Cage / Freie Volksbühne, Berlin, Germany

July 30: ***Five Stone Wind*** for *Five Stone Wind* by Cunningham / Cage / Avignon Festival, Avignon, France

[November 24: Interview by Olivier Masson and Franck Roméro / Grenoble, France / Later published in *Revue et Corrigée* 2 (Spring 1989)]

December 9: ***Web for John Cage II*** / Heidelberger Festival, Heidelberg, Germany

1989 February 18: ***Five Stone Wind*** for *Five Stone Wind* by Cunningham [US Premiere] / Walker Art Center, Minneapolis, Minnesota

[April 3: Interview by Larry Austin / Denton, Texas / "A Conversation," davidtudor.org]

April 19: ***Web for John Cage II*** / Alternative Museum, New York

September 19: "A Kind of Anarchy: Merce Cunningham and Music" symposium / UC Berkeley, California (with Cage, Kosugi, Mumma, and Pugliese)

1990 March 20: ***Virtual Focus*** as music for *Polarity* by Cunningham / City Center, New York

March 29–31: ***Volatiles with Sonic Reflections*** / Monnier and Tudor / Jack Tilton Gallery, New York

October 16: ***"Virtual Focus"*** (private collection of Barker-Mill) / Performance, Barker-Mill residence, Southampton, England

October 26: ***Volatiles with Sonic Reflections*** / Neue Musik Munchen-Klang-Aktionen 90, Black Box, Munich, Germany

1991 February 26: ***Coefficient: Frictional Percussion and Electronics*** (with Michael Pugliese) / Tudor (written for Michael Pugliese) / Paula Cooper Gallery (SEM Ensemble event), New York

March 12: ***Weatherings*** as music for *Exchange* (revival) by Cunningham / City Center, New York (with MCDC)

May 17: ***Coefficient: Frictional Percussion and Electronics*** / Rheinisches Musikfest, Bürgerzentrum Alte Feuerwache, Cologne, Germany

1992 [January 26: Interview by Julie Martin / Stony Point, New York]

March 19: ***Phonemes*** as music for *Channels/Inserts* (revival) by Cunningham (with MCDC) / City Center, New York

[August 3: Interview by John Holzaepfel / Stony Point, New York / Later published as "Reminiscences of a Twentieth-Century Pianist: An Interview with David Tudor," *Musical Quarterly* 78, no. 3 (1994)]

[August 12: John Cage passes away]

September 4: ***Concert for Piano and Orchestra*** (with Ensemble Modern) / Cage / Anarchic Harmony Cage 80, Old Opera House, Frankfurt, Germany

October 29: ***Atlas Eclipticalis*** with ***Winter Music*** (with SEM Ensemble) / Cage / A Tribute to John Cage, Carnegie Hall

November 17: ***Neural Network Plus*** as music for *Enter* by Cunningham (with Kosugi and MCDC) / Palais Garnier, Paris, France

1993 February 27: ***Neural Synthesis No. 1*** / Willow Place Auditorium, Brooklyn, New York

March 9: ***Neural Network Plus*** as music for *Enter* by Cunningham [US Premiere] / City Center, New York

May 18: ***Concert for Piano and Orchestra (two piano version)*** (with Joe Kubera and SEM Ensemble) / Cage / Konrad Wolf Saal, Berlin, Germany

May 19: ***Atlas Eclipticalis*** with ***Winter Music*** (with SEM Ensemble) / Cage / Konzerthaus, Berlin, Germany

May 21: ***Neural Synthesis No. 4*** / Konrad Wolf Saal, Berlin, Germany (curated by SEM Ensemble)

[September 8: Interview by Joel Chadabe / Tomkins Cove, New York / davidtudor.org]

October 14: ***Five Stone Wind*** / Fylkingen, Stockholm, Sweden

October 15: ***Neural Synthesis No.5*** / Fylkingen, Stockholm, Sweden

October 26–November 6: ***Neural Synthesis No. 6–9*** / recording at Banff Centre, Banff, Canada

1994 May 3: ***Neural Synthesis No.10*** (presented as ***No. 3***) / Mills College, Oakland, California

May 18: ***Soundings: Ocean Diary*** with *Ocean 1-95* by Cage/Andrew Culver as music for *Ocean* by Cunningham / Cirque Royal, Brussels, Belgium

June 15: ***Or Four People*** (with Kosugi, Nicolas Collins, and Wolff) / Wolff / Groningen, Germany

June 16: ***Neural Synthesis No. 12*** (?) / STEIM, Amsterdam, Holland [setup, performance and aftertalk filmed by Molly Davies]

[June 23–27: Setup of *Soundings: Ocean Diary* filmed by Molly Davies as ***David Tudor's Ocean: From Another Point of View***]

June 27–30: ***Soundings: Ocean Diary*** with *Ocean 1-95* by Cage/Andrew Culver as music for *Ocean* by Cunningham / Amsterdam, Holland

[November 2: Interview by Matt Rogalsky / Tomkins Cove, New York / davidtudor.org]

1995 January: "Silent concert" of ***Untitled*** / Tomkins Cove, New York

March 7: ***Untitled 1975/1995*** as music for *Sounddance* (revival) by Cunningham (with MCDC) / City Center, New York

[March 28: Interview by Matt Rogalsky / Tomkins Cove, New York / davidtudor.org]

[July 12, 19, August 6, September 18, October 11, December 6: Interview by Jack Vees / Stony Point, New York / *Oral History of American Music,* Yale University Library]

1996 July 30: ***Soundings: Ocean Diary*** (performed by D. S. Adams, Kosugi, and Behrman) with *Ocean 1-95* by Cage/Andrew Culver as music for *Ocean* by Cunningham / Lincoln Center, New York [US Premiere]

[August 13: David Tudor passes away]

September 12–October 23: ***Toneburst: Maps and Fragments*** / Zilkha Gallery, Wesleyan University, Middletown, Connecticut (September 11: performance of ***Toneburst (Untitled)*** by John D. S. Adams)

APPENDIX B

Rainforest Amplifiers

1

Among the many instruments in the David Tudor Collection at Wesleyan University there is a series of black phenolic boxes housing transistor amplifier kit boards:

(1–2) Instrument 0463 and 0465 use a Round-hill Associates *AA-100 Audio Amplifier* (Figures B.1–4);

(3) Instrument 0466 uses an unidentified amplifier very similar to the *AA-100 Amplifier* (Figures B.5 and B.6);

(4) Instrument 0464 uses an *EG-2004 Push-pull Audio Amplifier* (Figures B.7 and B.8);

(5–6) Instrument 0230 and 0467 use a *Lafayette 99-9037 Push-pull Audio Amplifier* (Figure B.9–12);

(7) Instrument 0189 uses two *"×1000"* Amplifier that had already appeared inside a plastic case in *Bandoneon!* (Instrument 0188) (Figures B.13 and B.14).

The first three instruments are particularly interesting. In all of them, no apparent modification has been made to the amplifier kit itself. The *AA-100* is a five-transistor solid-state amplifier with a gain of over 70 db (Figure B.15). It offers two input impedances—50 Ω (low impedance) and 100 kΩ (high impedance)—and two output impedances—8 Ω (to drive low impedance devices like loudspeakers) and 500 Ω (to drive higher impedance like modulators, etc.). What Tudor did was to simply extend the terminals on the board to the surface of the black phenolic boxes as an array of banana jack ports so that he could access the inputs, outputs, and power connections from outside the instrument.[1]

Although the two instruments with the *AA-100 Amplifiers* (Instruments 0463 and 0465) are different in terms of the color of the banana jacks, they are identical in terms of how the jacks are placed, with six ports on one side and four on the other (Figures B.16, B.17, B.18, and B.19). Among the six ports on one side, four of them are connected to the input terminals of the board (two for each of the low and high impedance input transformers) and the other two to power connections. The four ports on the other side of the box are connected to the output terminals (two for each of the low and high impedance output transformers). The third instrument with a similar amplifier (Instrument 0466) has five banana jacks on one side and four on the other with similar connections: four input terminals from two input transformers plus one terminal for power connection, and four output terminals from two output transformers.

[1] Rogalsky also took note of these three instruments, since they appeared in a 1971 photograph of equipment used for a performance of *Rainforest* in Bloomington, Indiana (Rogalsky, "Idea and Community," 137). He guessed correctly that these were the sources of "unpredictable oscillations" heard in recordings of *Rainforest*, though at the time, he was unable to identify the kit boards.

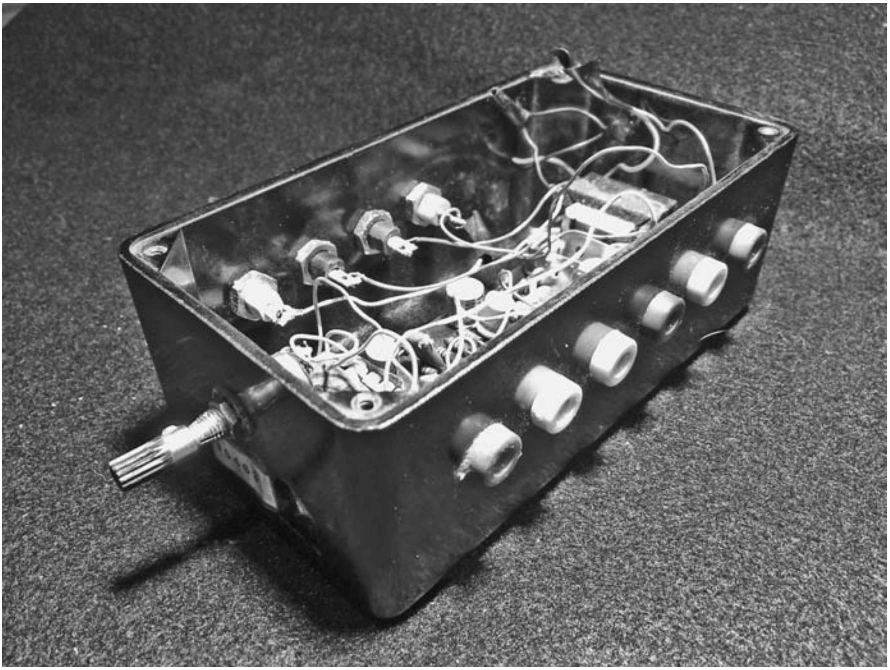


Figure B.1 Tudor | *Round Hill Associates AA-100 Amplifier*
DTC, Instrument 0463 | World Instrument Collection, Wesleyan University

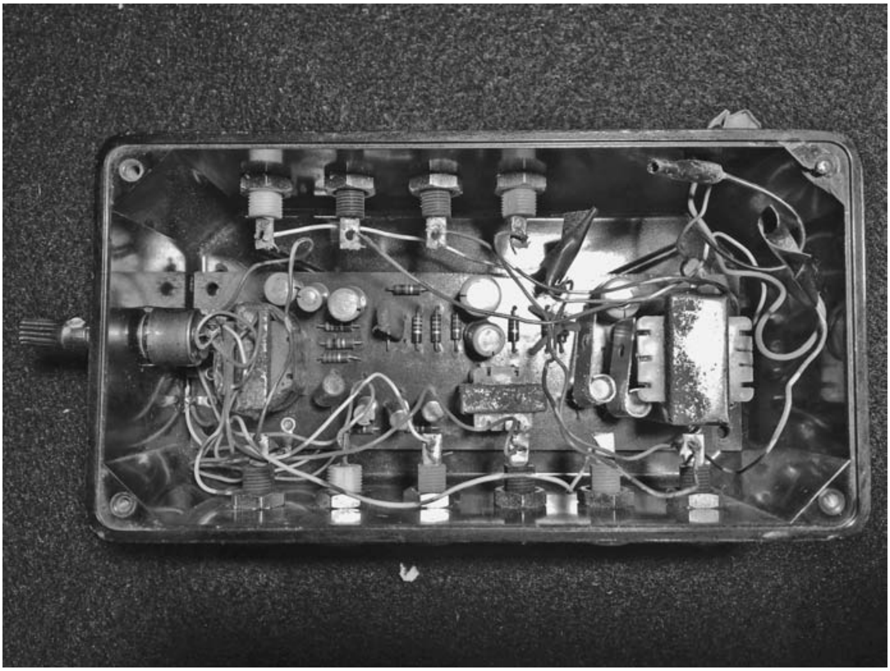


Figure B.2 Tudor | *Round Hill Associates AA-100 Amplifier (interior)*
DTC, Instrument 0463 | World Instrument Collection, Wesleyan University

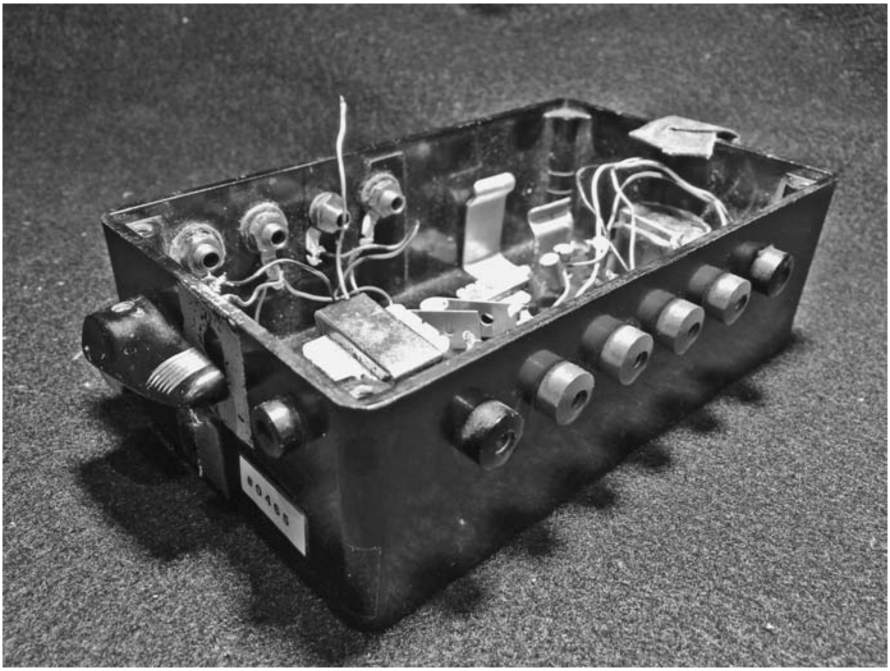


Figure B.3 Tudor | *Round Hill Associates AA-100 Amplifier*
DTC, Instrument 0465 | World Instrument Collection, Wesleyan University

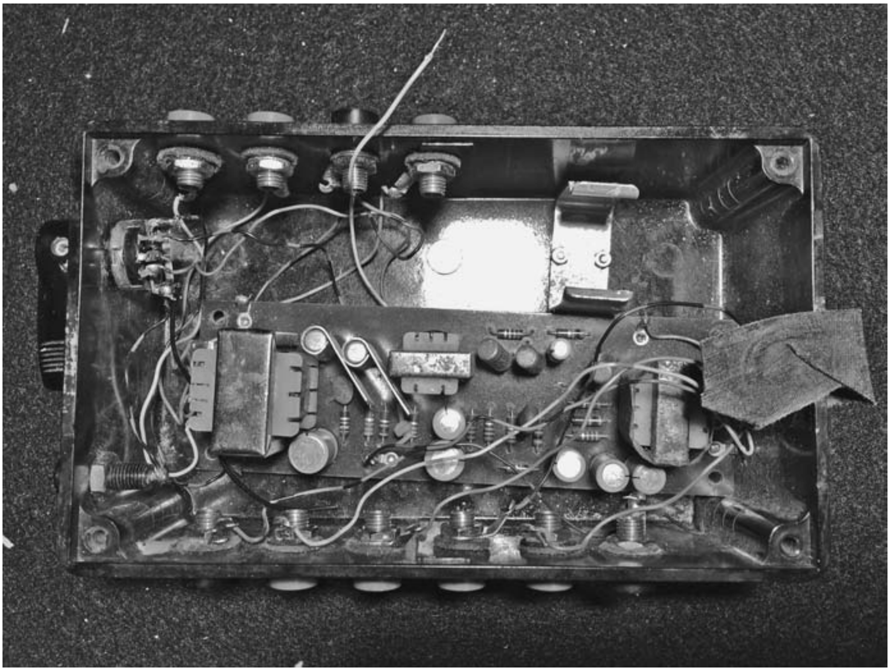


Figure B.4 Tudor | *Round Hill Associates AA-100 Amplifier* (interior)
DTC, Instrument 0465 | World Instrument Collection, Wesleyan University

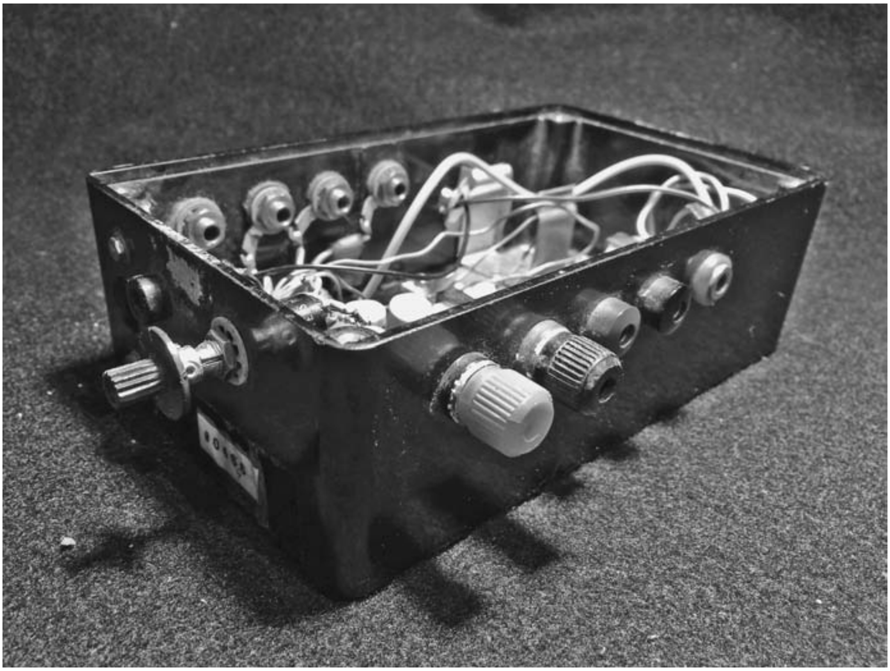


Figure B.5 Tudor | Unidentified amplifier
DTC, Instrument 0466 | World Instrument Collection, Wesleyan University

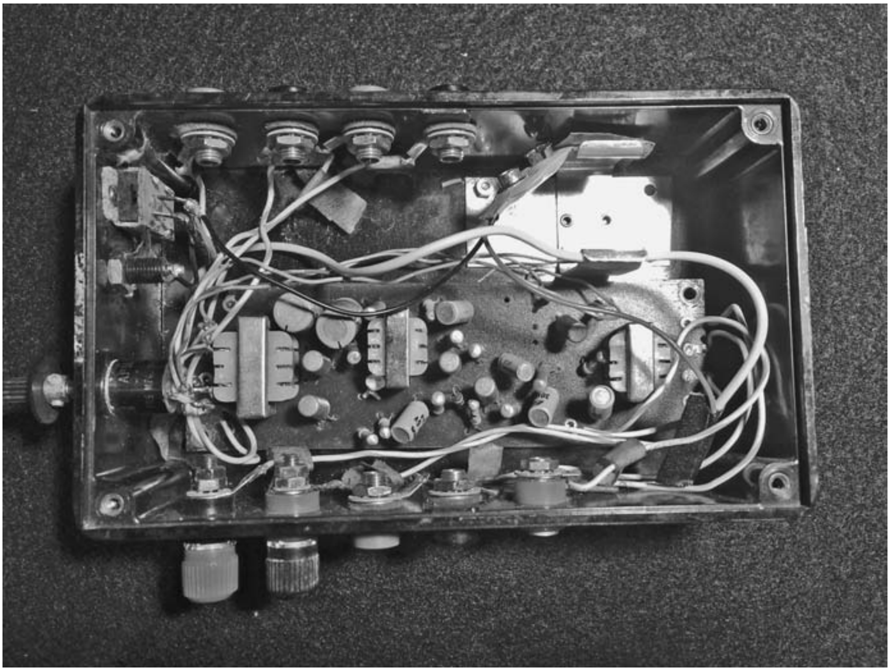


Figure B.6 Tudor | Unidentified amplifier (interior)
DTC, Instrument 0466 | World Instrument Collection, Wesleyan University

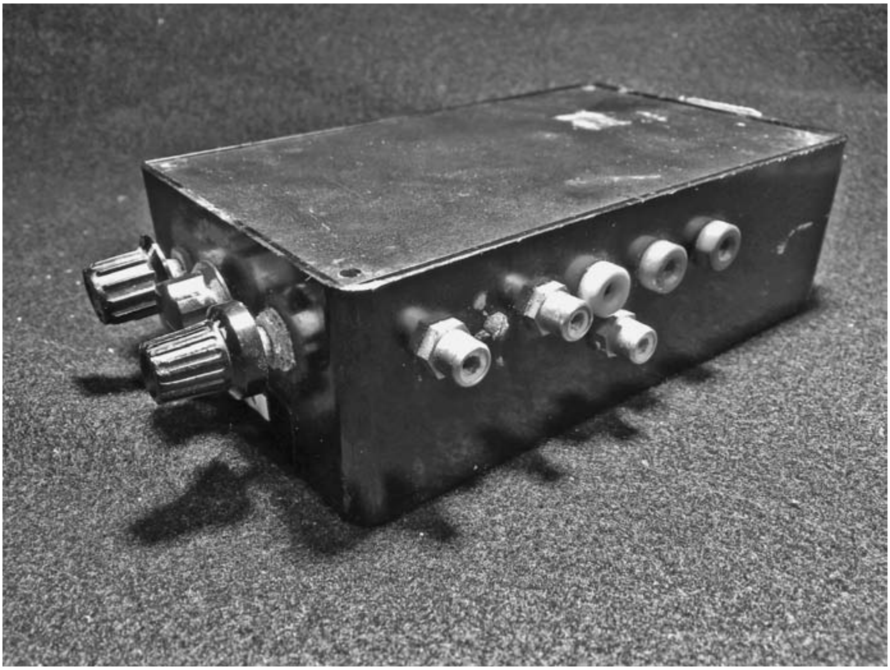


Figure B.7 Tudor | EG-2004 Audio Amplifier
DTC, Instrument 0464 | World Instrument Collection, Wesleyan University

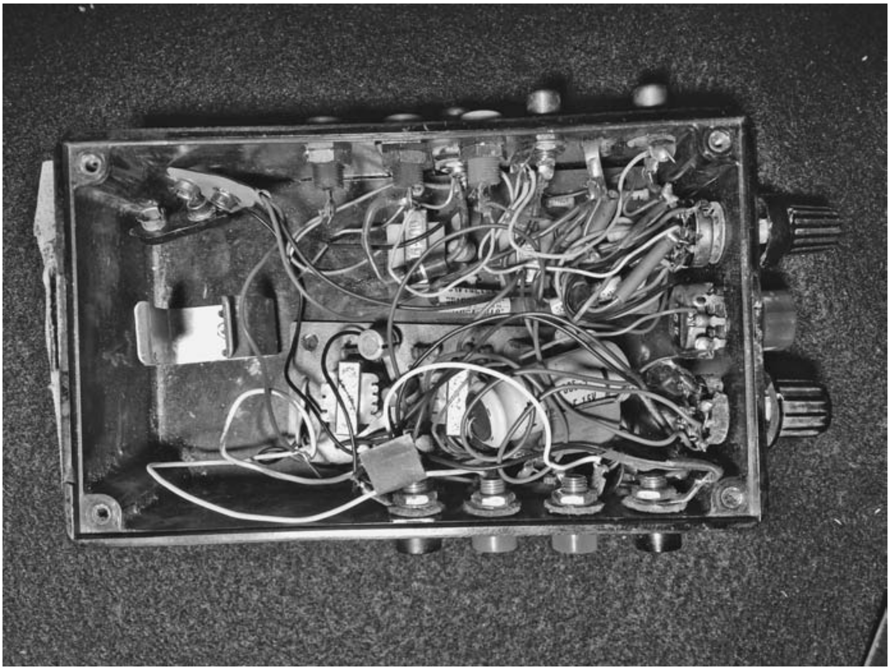


Figure B.8 Tudor | EG-2004 Audio Amplifier (interior)
DTC, Instrument 0464 | World Instrument Collection, Wesleyan University

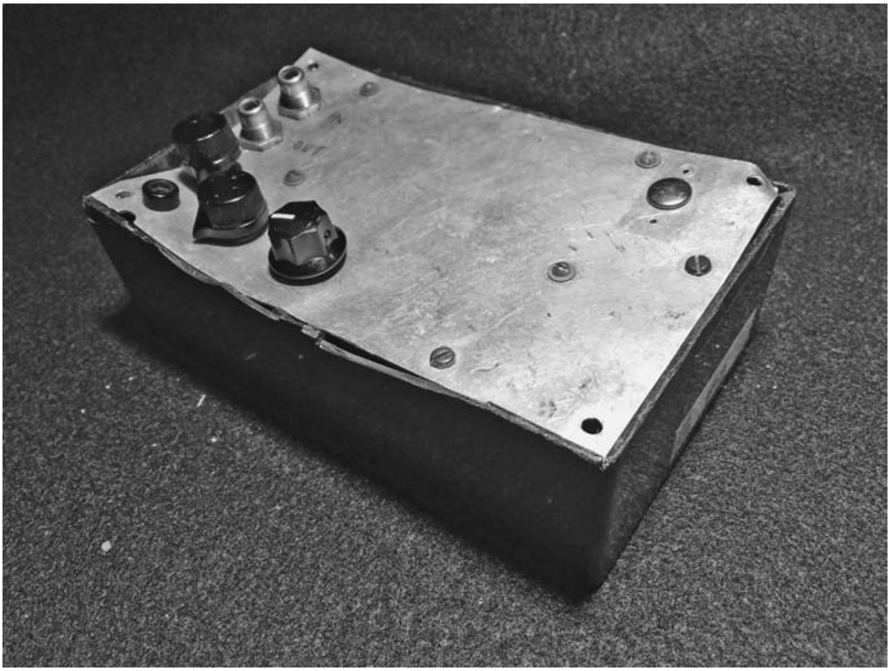


Figure B.9 Tudor | *Lafayette 99-9037 Push-pull Audio Amplifier*
DTC, Instrument 0230 | World Instrument Collection, Wesleyan University

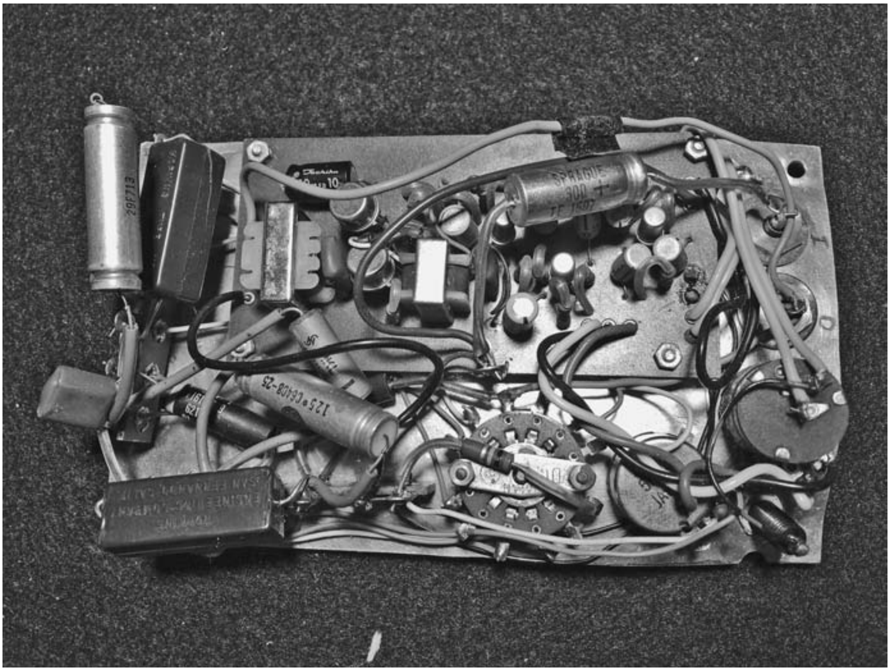


Figure B.10 Tudor | *Lafayette 99-9037 Push-pull Audio Amplifier* (interior)
DTC, Instrument 0230 | World Instrument Collection, Wesleyan University

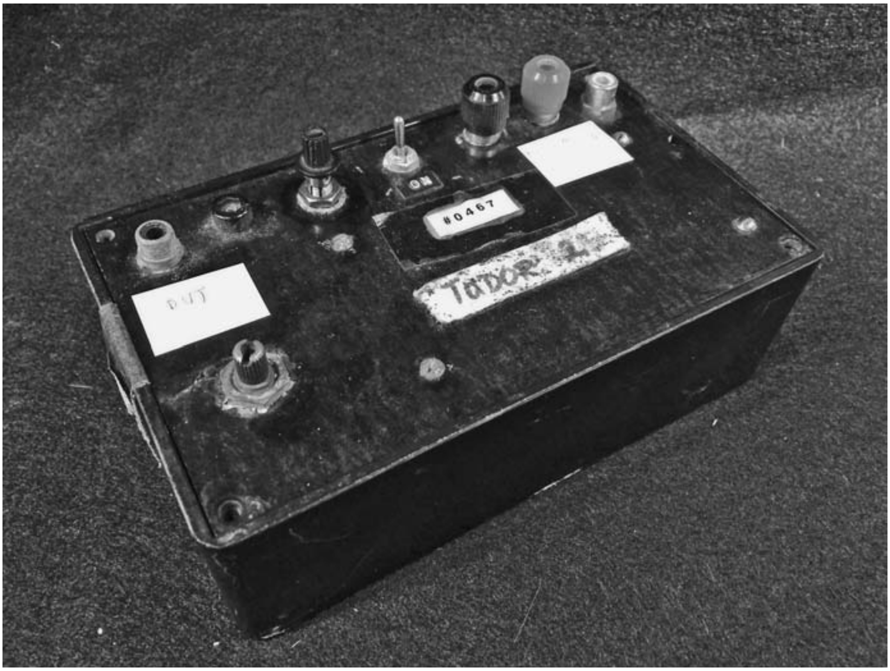


Figure B.11 Tudor | *Lafayette 99-9037 Push-pull Audio Amplifier*
DTC, Instrument 0467 | World Instrument Collection, Wesleyan University

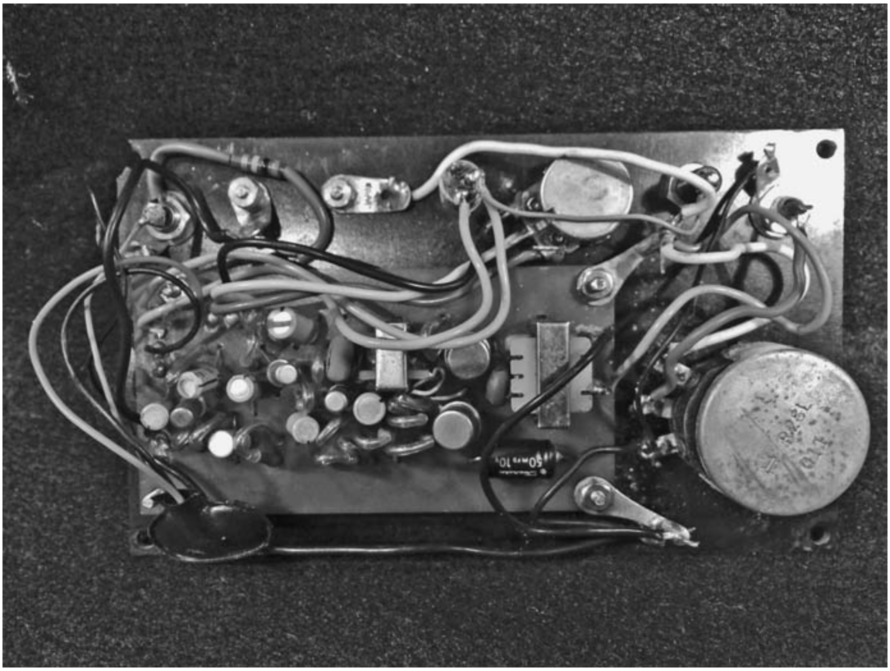


Figure B.12 Tudor | *Lafayette 99-9037 Push-pull Audio Amplifier* (interior)
DTC, Instrument 0467 | World Instrument Collection, Wesleyan University

Figure B.13 Tudor | *Dual "×1000" Amplifier*
DTC, Instrument 0189 | World Instrument Collection, Wesleyan University

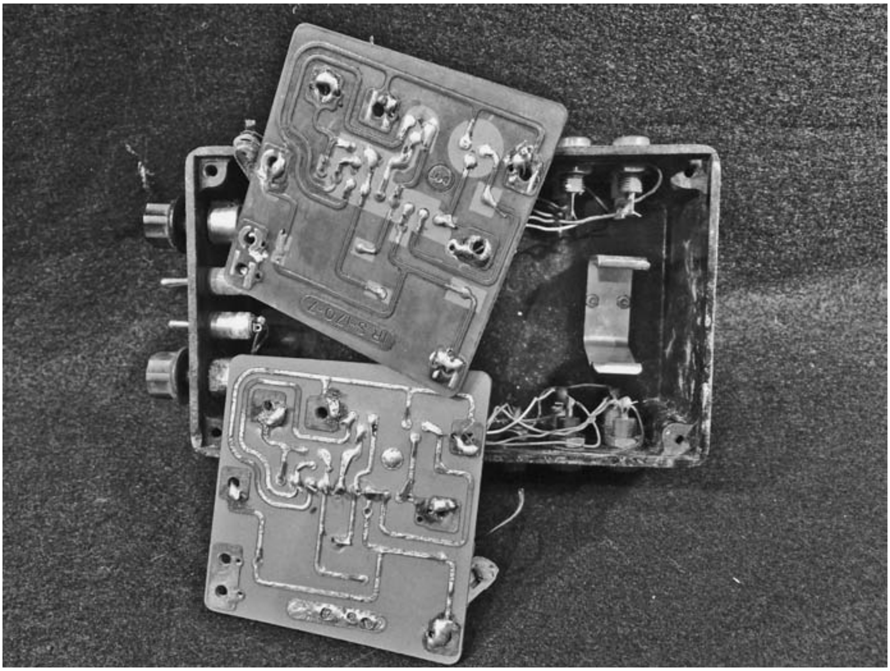


Figure B.14 *Dual "×1000" Amplifier* (interior)
DTC, Instrument 0189 | World Instrument Collection, Wesleyan University

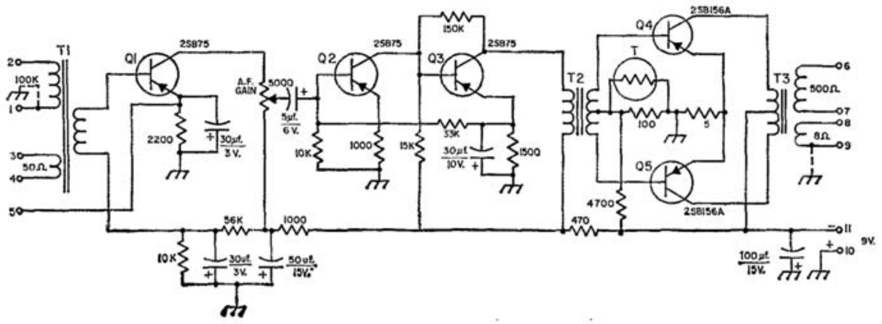


Figure B.15 Schematic of *Round Hill AA-100 Audio Amplifier*
Round Hill Associates, Technical Bulletin | All rights reserved

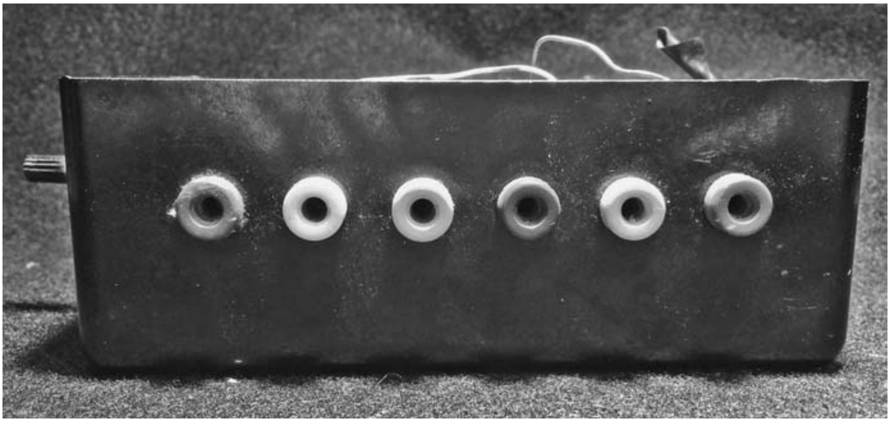


Figure B.16 External ports of Instrument 0463 (left side)
DTC, Instrument 0463 | World Instrument Collection, Wesleyan University

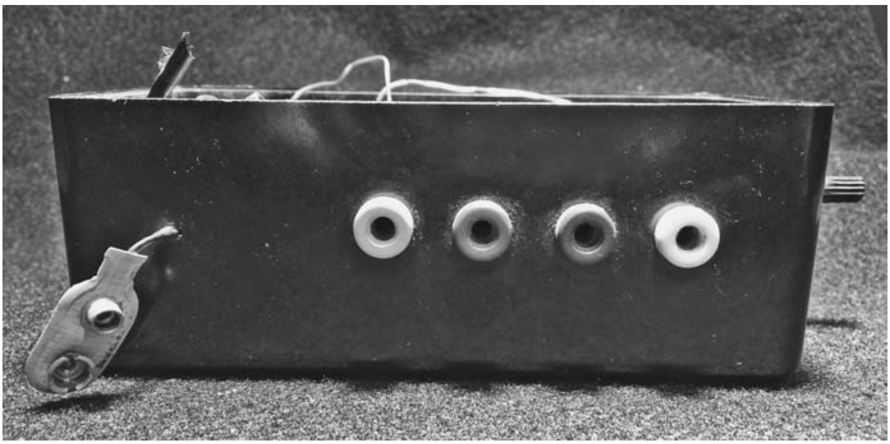


Figure B.17 External ports of Instrument 0463 (right side)
DTC, Instrument 0463 | World Instrument Collection, Wesleyan University

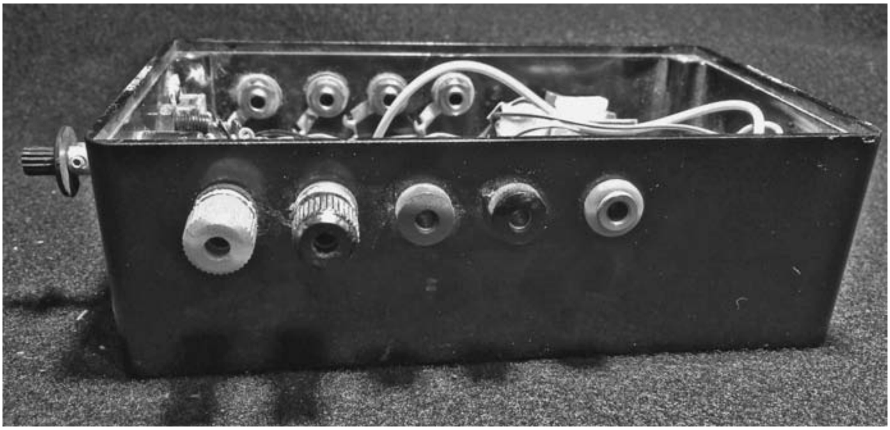


Figure B.18 External ports of Instrument 0465 (left side)
DTC, Instrument 0465 | World Instrument Collection, Wesleyan University

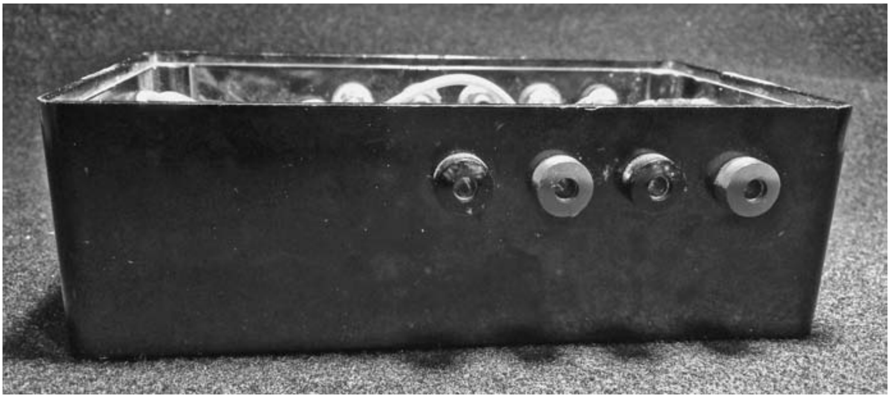


Figure B.19 External ports of Instrument 0465 (right side)
DTC, Instrument 0465 | World Instrument Collection, Wesleyan University

A number of sketches scattered across different boxes and folders of the David Tudor Papers at GRI share a certain likeness to one another: array of points or numbers with lines connecting them. In a note found in Folder 8 of Box 42, Tudor draws three instruments: one with five ports on the left and four on the right, and two others with six ports on the left and four on the right (Figure B.20). The drawings all appear to designate feedback paths that connect a port on one side to a port on the other side, either directly or through a capacitor or a diode inserted on the way. The output (right pointed arrow) and the ground (three horizontal lines attached to a vertical line extending from a black node) are drawn on the right side, so the left side must correspond to input. From the number of ports, the first drawing brings to mind Instrument 0466, whereas the second and third are reminiscent of Instruments 0463 and 0465.

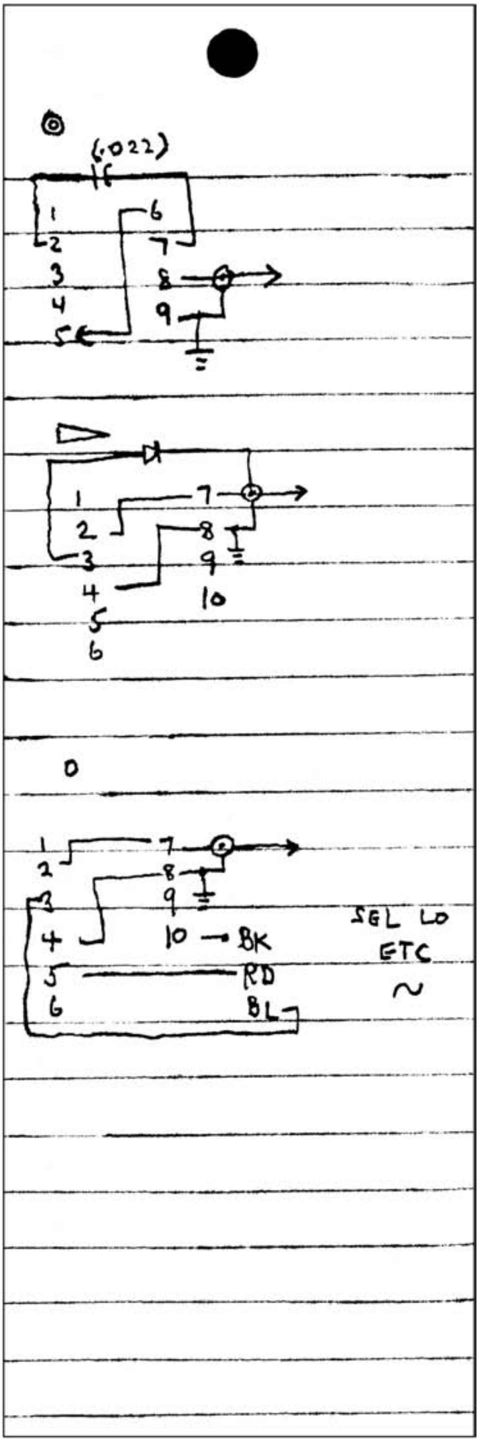


Figure B.20 Tudor | Notes showing exterior feedback paths around Instruments 0463, 0465, and 0466 | Undated

DTP, Box 42, Folder 8 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

Figure B.21 Control knobs of Instrument 0463
DTC, Instrument 0463 | World Instrument Collection, Wesleyan University

Figure B.22 Control knobs of Instrument 0465
DTC, Instrument 0465 | World Instrument Collection, Wesleyan University

Figure B.23 Control knobs of Instrument 0466
DTC, Instrument 0466 | World Instrument Collection, Wesleyan University

But it is difficult to tell them apart. The instruments are virtually identical, especially the two with the *AA-100 Amplifier* inside them. There is a symbol written above each drawing that shows Tudor's effort to distinguish them: a double circle, a right-sided narrow triangle, and a circle. Although they must represent some recognizable difference between the instruments, none of them appears to match any standard symbol used in electronics. But on the side of the instrument, there is indeed one difference besides the color of the banana jacks that can be used to tell one from the other: *the shape of their gain control knobs*. The symbols thus turn out to be icons: the circle is the round knob of Instrument 0463; the triangle is the pointer knob of Instrument 0465; and the double circle is the skirted knob of Instrument 0466 (Figures B.21–B.23).

2

In Folder 5 of Box 45, there is another related material: six pages of similar drawings of ports and their exterior feedback paths for ten different instruments. The instruments are numbered from one to ten. The same icons that were used for Instruments 0463, 0465, and 0466, are here assigned to *Instrument 1, 4*, and *5*, respectively (Figure B.24). Next to each drawing is a description of the type and number of output connectors ("B" stands for banana jack) and jumper cables to realize the designated connections. The acronym "PC," also written in the middle of the elongated square with plus and minus symbols on both sides, most likely stands for "Polarity Control." The *AA-100 Amplifier* had a floating ground, which made it possible for Tudor to flip the polarity of the circuit between positive and negative ground, and thereby switch between inverted and non-inverted feedback. As Michael Johnsen observed, the *Atlas Eclipticalis* amplifiers used in *Bandoneon!* were modified by cutting a trance on the output transformer which similarly allowed the ground of the output signal to float.

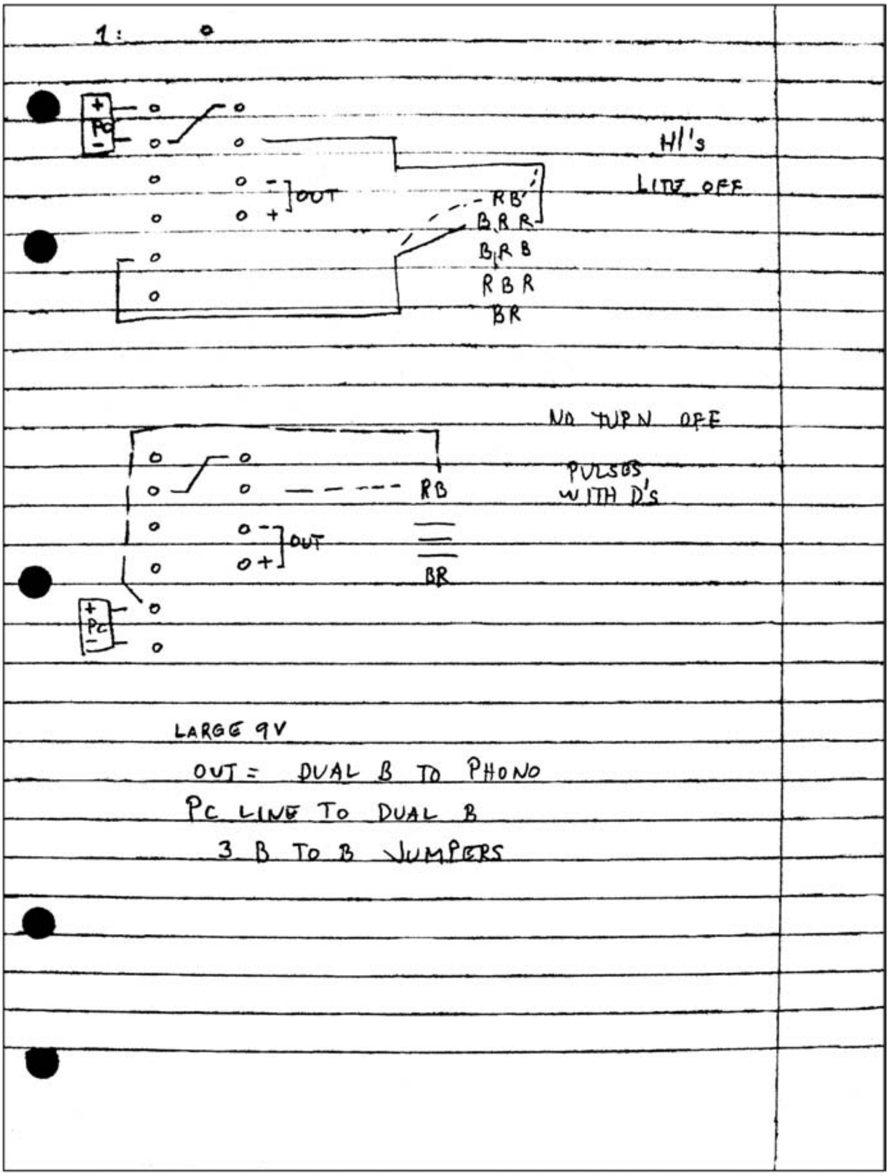


Figure B.24 Tudor | Ten instrument terminal configurations | Page 1, showing the external feedback paths for Instrument 0463 | Undated
DTP, Box 45, Folder 5 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

The two sketches for *Instrument 1* (Instrument 0463) specify "dual banana jack to phono plug adaptor," "power supply to dual banana adaptor," and "3 banana to banana jumpers." They also indicate one of the two feedback paths going through a device labeled enigmatically with a sequence of "R"s and "B"s: "RB/BRR/BRB/RBR/BR." As usual, this puzzle is solved through the coordination with an actual instrument: among the Wesleyan collection there is a small instrument labeled "Rectifier Box" (Instrument 0494) with thirteen red and black banana jacks on the panel in the exact same sequence as Tudor's note (Figures B.25 and B.26). The two letters turn out to be initials of colors.

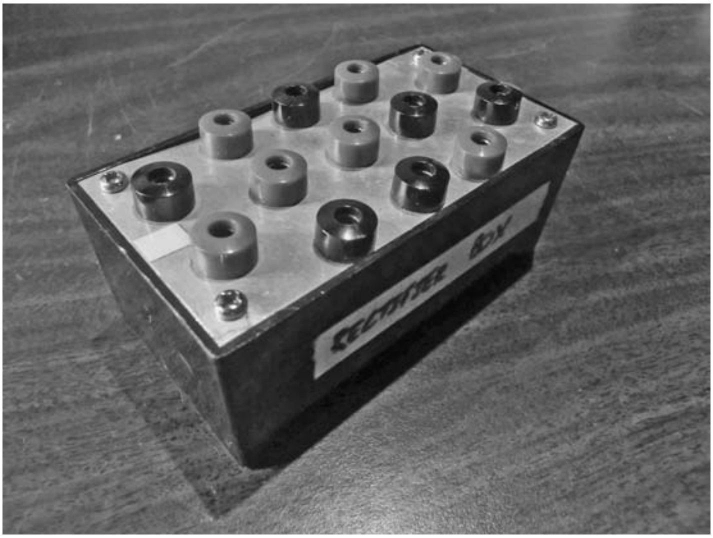


Figure B.25 Tudor | *Rectifier Box* with the terminal layout RB/BRR/BRB/RBR/BR
DTC, Instrument 0494 | World Instrument Collection, Wesleyan University

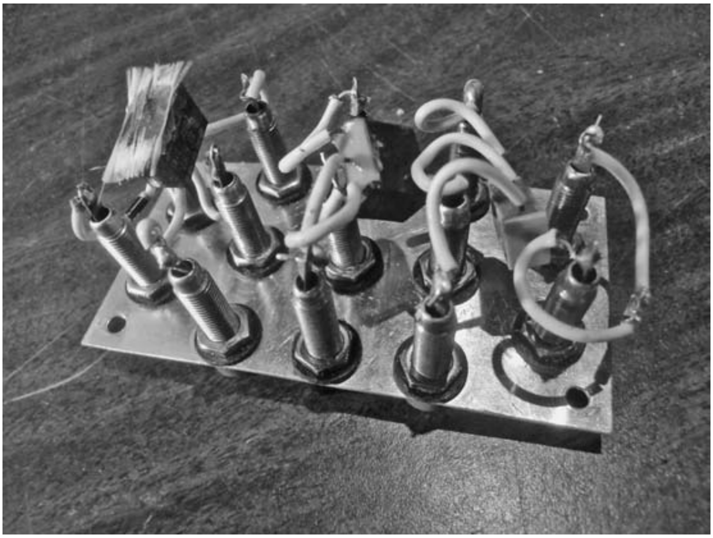


Figure B.26 Tudor | *Rectifier Box* (interior)
DTC, Instrument 0494 | World Instrument Collection, Wesleyan University

This is an extremely simple box. For the outer two pairs of ports, a diode connects each black banana jack input to a red banana jack output. For the inner three rows, dual diodes connect the three ports (black ports are always on the anode side of the diode). This instrument, then, is presumably what Tudor had in mind when he drew the diode symbol around Instrument 0465 in the other drawing from Box 42, Folder 8.

In the sketch for *Instrument 4* (Instrument 0466), one of the feedback paths goes through a capacitor whose value is notated as ".1–.22 etc." (Figure B.27). The description on the right side reads "C. SUBST." This stands *Capacitance Substitution Box*, a device that enables selection between various capacitors whose value range, in this case, extends from .0001 to .22 uF. Again, there is just such an instrument in the Wesleyan collection (Figure B.28).

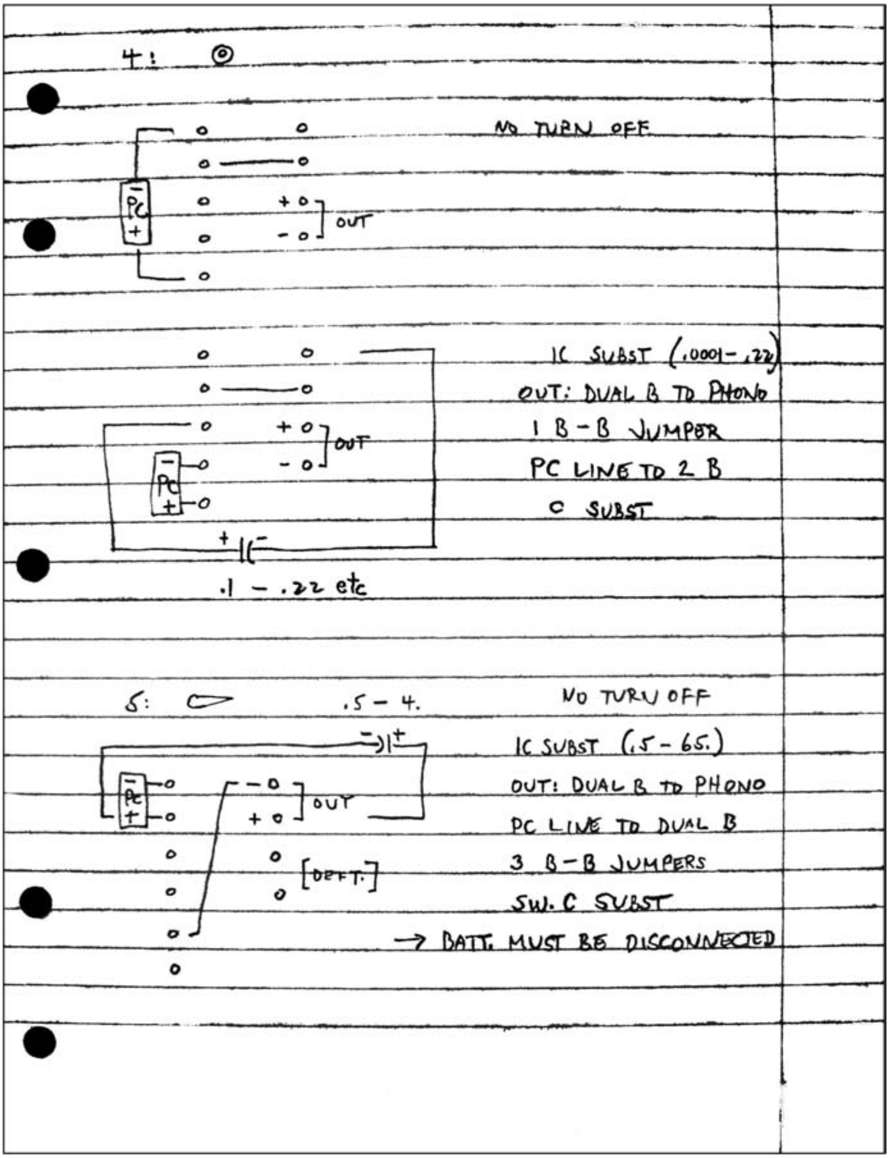


Figure B.27 Tudor | Ten instrument terminal configurations | Page 3 | Undated
DTP, Box 45, Folder 5 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

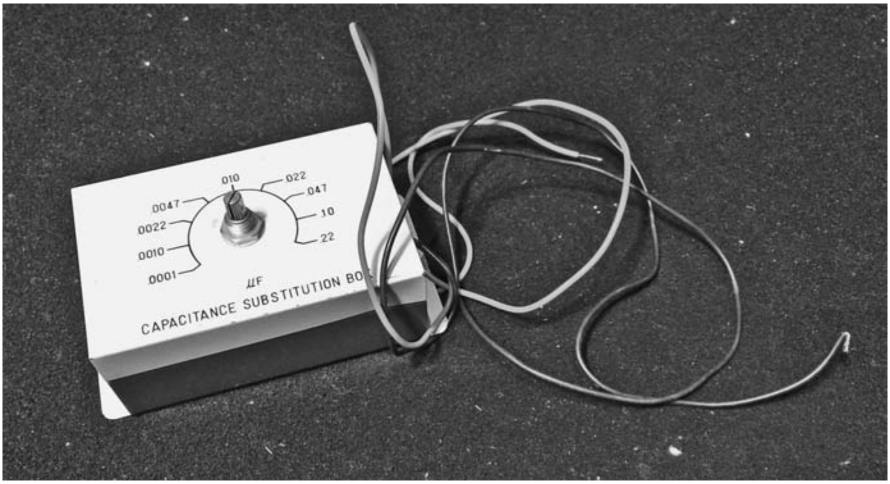


Figure B.28 *Capacitance Substitution Box*
DTC, Instrument 0180 | World Instrument Collection, Wesleyan University

The sketch for *Instrument 5* (Instrument 0465), on the same page, also shows a capacitor inserted into the feedback path. The accompanying notes list a "SW. C. SUBST."—a *Switch Capacitance Substitution Box*. But this time the value range is between .5 and 4 uF. Since no value above .22 uF is available on Instrument 0180, some other instrument is being called for. Indeed, a box that matches the description is found, this time it's something that Tudor made himself (Figures B.29 and B.30).

Figure B.29 Tudor | *Switch Capacitance Substitution Box*
DTC, Instrument 0452 | World Instrument Collection, Wesleyan University

Figure B.30 Tudor | *Switch Capacitance Substitution Box* (interior)
DTC, Instrument 0452 | World Instrument Collection, Wesleyan University

Instrument 0452 is composed of two independent parts, each having one input and one output. The main part consists of seven capacitors in parallel whose values increment by doubling: .5 uF, 1 uF, 2 uF, 4 uF, 8 uF, 16 uF, and 32 uF. Each can be switched independently using the seven switches on the panel, so it fits the name of *Switch Capacitance Box* perfectly. The range specification in the drawing matches the first four of these switches. If more than one switch is turned on, the capacitance will be the sum of all the switched capacitors in parallel. As usual, Tudor followed a magazine article when composing this instrument. A cut-out of instructions on how to build a "Capacitor Substitution Box" by John A. Dewar from the September 1957 issue of *Radio-Electronics* is found in Box 36, Folder 1 (Figure B.31).[2] Instrument 0452 follows this source exactly, even keeping all the capacitor values the same.

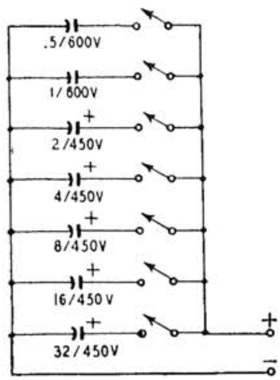
Two more correspondences with extant instruments have been discovered. The last page in the series of sketches shows *Instruments 9* and *10*, which are labeled "IR GREEN" and "IR RED" (Figure B.32). Instrument 0189 houses two amplifier boards of the same kind as the *"× 1000" Amplifier* (Instrument 0188) that had appeared in *Bandoneon!*. The description of the Instrument 0188 had informed its users that the three-transistor amplifier was originally made for a "PBS infrared detector." Because of this, there is an inscription on the board that reads "IR S-170-7." So "IR" turns out to be the acronym of "Infra-Red," and *Instrument 9* and *10* turn out to be diagrams of the two *"× 1000" Amplifier* boards housed inside Instrument 0189. The two kit amplifiers are identical except in one respect: the back-panel color. Tudor therefore used that nature to differentiate them: "IR Green" and "IR Red." The terminals of both kits are again

[2] John A. Dewar, "Capacitor Substitution Box," *Radio-Electronics*, September 1957: 48. Box 36, Folder 1, David Tudor Papers, GRI.

Capacitor Substitution Box

By JOHN A. DEWAR

Anyone who has used resistor and capacitor substitution boxes for service or development work knows how valuable they are. However, capacitor substitution boxes available in kit form



often go up to only 0.22 μf. This box has a range of 0.5–62.5 μf, supplying 126 capacitances in 0.5-μf steps. Only seven capacitors are used, singly or in parallel to supply the desired value.

The 0.5- and 1-μf capacitors are papers, the rest electrolytics. Polarity is indicated by color-coding the panel terminals.

A 4 x 8 x 2-inch chassis with a bottom plate is used for a cabinet. Numbers to show capacitor values were clipped from a small calender and glued to the panel. I used pushbutton switches but spst toggle switches are just as good.

Figure B.31 *John A. Dewar | Capacitor Substitution Box | Radio-Electronics* (September 1957)

DTP, Box 36, Folder 1 | Getty Research Institute, Los Angeles (980039)

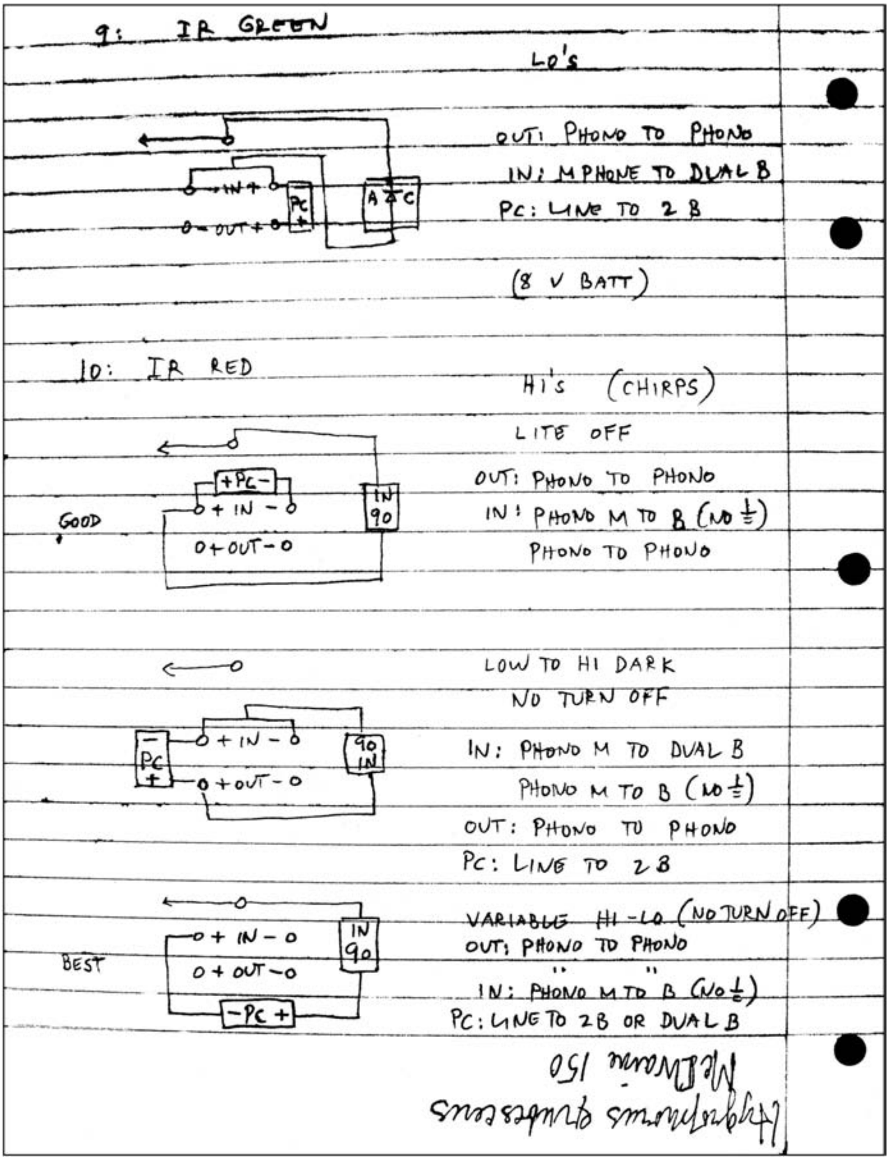


Figure B.32 Tudor | Ten instrument terminal configurations | Page 6 | Undated
DTP, Box 45, Folder 5 | Getty Research Institute, Los Angeles (980039) | Courtesy of David Tudor Trust

brought out to each side of the box. Which is to say that the ports on the right side and left side are completely independent. The configuration is identical on both sides, consisting of four banana jacks and one phono jack, which is reflected in the corresponding drawings (Figure B.33).

The remaining five instruments on the list are yet to be identified.[3]

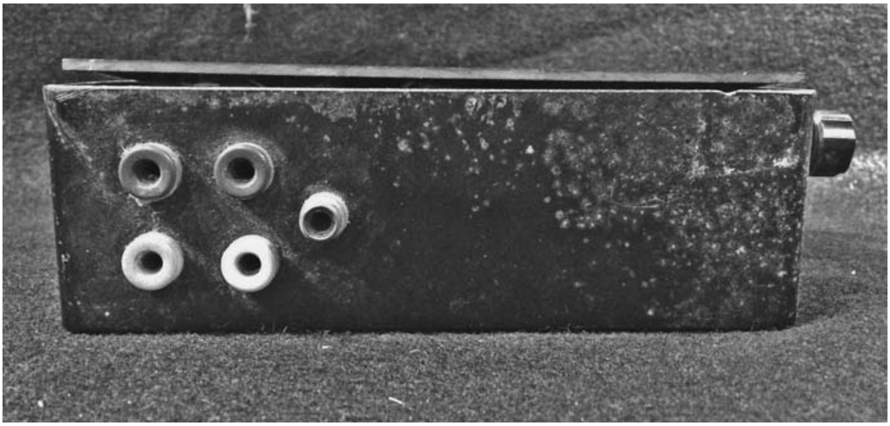


Figure B.33 Terminals of Instrument 0189
DTC, Instrument 0189 | World Instrument Collection, Wesleyan University

3

The primary use of these amplifiers was as inputs to the instrumental loudspeakers of *Rainforest*. The receipts Tudor kept reveal that he purchased one of the *AA-100 Amplifiers* on May 1, 1967.[4] Six months after *9 Evenings*, he was planning to develop the mobile speakers on remote-controlled carts that ran around the Armory into a separate piece, and extending the method of making amplifiers oscillate by wrapping feedback around them that he had explored in *Bandoneon!* seemed like a good idea for the generator of signals that went into those loudspeakers. *Rainforest* was premiered on March 9, 1968, at SUNY Buffalo, using inputs that Tudor would later characterize as "oscillators that made animal-*like* and bird-*like* sounds."[5]

The same amplifiers also appear in several photographs related to subsequent realizations of *Rainforest*. Matt Rogalsky spotted one in a 1971 photograph of Tudor's setup for a performance in Bloomington, Indiana, taken by Gordon Mumma.[6] Another material is a set of photographs taken at a much later date of October 14, 1988, and subsequently sent to Tudor from Rob Miller, who worked as the sound engineer of the MCDC.[7] *Rainforest* had been revived earlier that year in March, and there are indeed a series of sketches with similar drawings of amplifier ports and feedback paths dated October 11, 1989.[8]

3 *Instrument 3*, which has two terminals and three dials, could have been Instrument 0230.

4 He would subsequently purchase Lafayette 99-9037 Push-pull Audio Amplifier on June 19, 1968 (Lafayette Radio Electronics, "Receipt for 99-9037," Box 126, Folder 3, David Tudor Papers, GRI.

5 Tudor, "Interview by Fullemann," davidtudor.org.

6 Rogalsky, "Idea and Community," 137.

7 Rob Miller, "Letter to David Tudor (February 3, 1989)," Box 56, Folder 4, David Tudor Papers, GRI. Miller writes: "Here are two photos shot by Michael Mendelson at Stanford . . ." (ibid.).

8 Tudor, "drawings of *Rainforest* amplifiers and feedback paths," Box 39, Folder 3, David Tudor Papers, GRI.

In May 2015, during a joint research of Tudor's instruments at Wesleyan, Michael Johnsen and I connected the amplifiers and substitution boxes (which all happened to be extant in the collection) following Tudor's drawings. The electronic complex immediately came back to life, emitting recurring patterns of sound that could be switched abruptly by shifting the capacitor values or flipping the polarity. They reminded me of the chirpings and growlings processed by the mechanical filters of *Rainforest*, but also the electronic rhythm of *Pulsers*. When I checked the sketches and the generalized diagram of the 1975 piece, sure enough, the symbol of an oscillating amplifier was inserted in one of the feedback paths of the giant oscillator. Since the giant oscillator was itself composed by enlarging the principle of these oscillating amplifiers, it was yet another case of instrumental synecdoche.

APPENDIX C

Matrix Map Diagrams

(Note: Color version of these diagrams can be accessed at: remindedbytheinstruments.info)

	Tape
126	SONY TC-126 Cassette Recorder [0420]
150	SONY TC-150 Cassette Recorder [0416, 0417]
152	SONY TC-152 Cassette Recorder
D3	SONY TC-D3 Cassette Deck
D5	SONY TC-D5 Cassette Deck
D6	SONY TC-D6 Cassette Deck
I INF	INFINITY Intimate Walkman [0354] (3/24/82)
L LM	Unidentified
Mz MRZ	MARANTZ PMD-340 Cassette Recorder
P PAN	PANASONIC RQ P300 Stereo Cassette Player [0352]
PM PH. M	Unidentified
R	RADIO SHACK Walkman Cassette Recorder [0353]
T Tcs	TECHNICS RS646 DS Stereo Cassette Deck (8/1/78)
WM800 800	SHARP RT-W800 Dual Cassette Deck [0446] (10/15/88)
TBA	TOSHIBA KT-R2 Stereo Cassette Recorder
	Microphone
A. XDCR	AMPAK ASTRO-SOUND Transducer
F.L. XDCR	FRONTLINE Transducer
PIEZO	Piezo Microphone
C.M.	Contact Microphone
PROD	Unidentified
PROBE	Unidentified
BRANCH	Unidentified
flowers	Metal Flowers (Jackie Monnier)
SPDR	Metal Spider
SPGS	Metal Springs
FUNC GEN	LAWTRONICS Function Generator [0495]
76477	BULLET ELECTRONICS SE-01 Sound Effects Kit SN76477 Complex Sound Generator
R RTX3	MAPLIN RTX3 Radar Doppler Intruder Detector
US	MAPLIN Ultrasonic Intruder Detector

Legend, Input Source

AD, A/D, AT DCY	ELECTRO-HARMONIX Attack Decay Tape Reverse Simulator [No #]
AF, AFL	IBANEZ Auto Filter
AP, APN	ACCESSIT Auto Panner [0325-27]
APT	SUSTAINIAC C-Ducer Acoustic Percussion Trigger [0334]
ARION, ARION P.EQ	ARION SPE-1 Parametric EQ [No #]
AT EQ, ATT EQ	ELECTRO-HARMONIX Attack Equalizer
AUTO-WAA	MAPLIN Auto Waa Kit
BB	ELECTRO-HARMONIX Bass Balls Twin Dynamic Filter for Bass [No #]
BE&L, B E/L	GUYATONE PS-020 Bass Exciter/Limiter [No #]
BI FET	DOD FX-10 Bi-Fet Preamp [No #]
BI PHASE, BI-MODE PHASE, MT	MUTRON Bi-Phase [No #]
BMS	ELECTRO-HARMONIX Bass Micro Synthesizer [No #]
BS	ELECTRO-HARMONIX Bad Stone Phaser Shifter [0470]
B EQ, BS EQ	MAXON BE-01 Bass EQ [No #]
B&L, BUF/LOOP	VESTA FIRE Buff & Loop [No #]
C/E	PEARL CE-22 Chorus Ensemble [0304]
C/F, CH/FL, TC CH/FL	t.c. electronics Stereo Chorus+Flanger [No #]
CORON JET	CORON DC-841 Jet Flanger & Filter Matrix [No #]
CT	ELECTRO-HARMONIX Clone Theory
D, Dcv, Dso	PAiA 5700 The Drum [0117] (cv = control voltage, so = summing out)
DC2	Unidentified
DD, DDN	BOSS DC-3 Digital Dimension Chorus
DF, DYN. F	BOSS FT-2 Dynamic Filter
DG	DRAWMER DS-20 Dual Gate
D/H	Unidentified
DL PM, DUAL PAR.	Dual Parametric EQ
D.S., D.SYN	Drum Synthesizer
DT/DS	Unidentified
ECHO	PLAYBACK Microphone Echo Adaptor EA-100 [0453]
ELS, JMX	JMX ELS-408 Effect Loops Selector [No #]
EM	ELECTRO-HARMONIX Electric Mistress Flanger/Chorus
EMU, ENV MOD	BNB Kit Envelope Modifier Unit [0267]

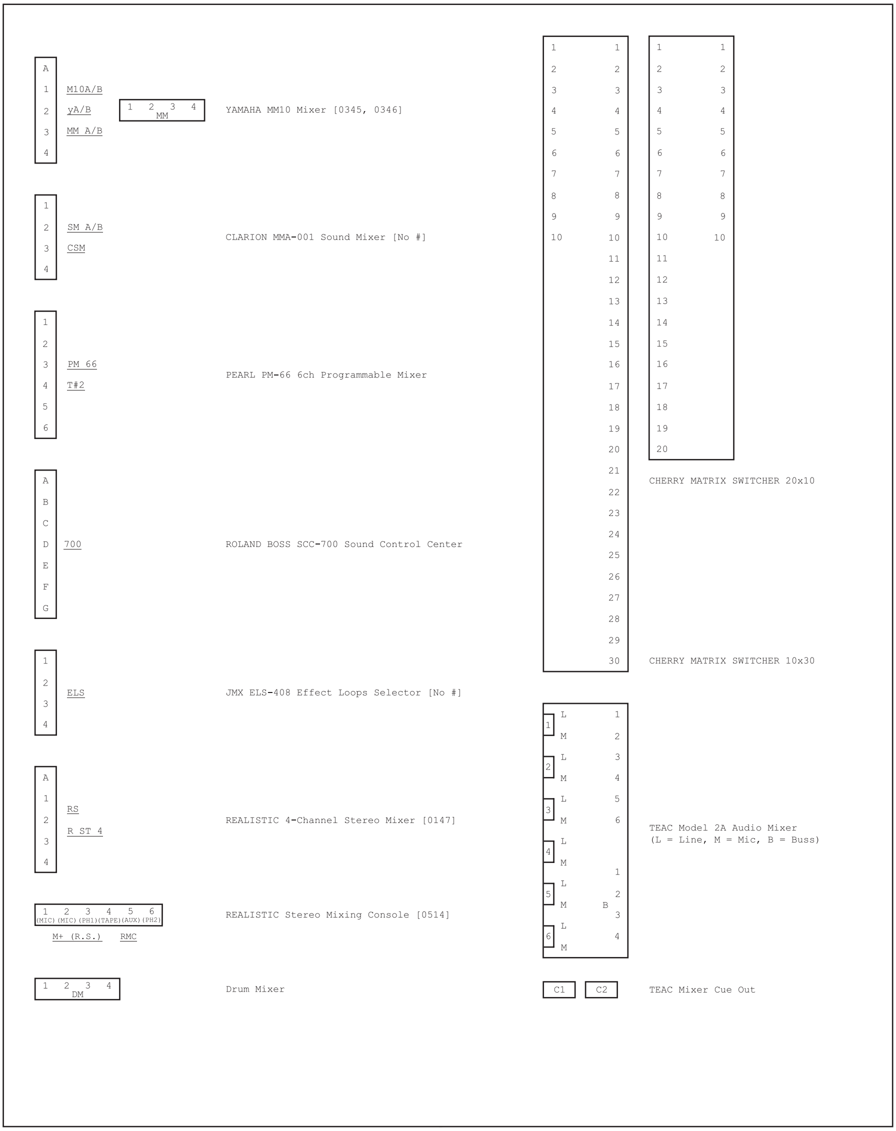
Legend, Effect Processors

EXCTR, EXCITER, EXC	TOKAI Exciter [No #] or CORON Deluxe Exciter Sound Creator DC-829
F, FL, FR	Filter (L = Left, R = Right)
FL M&A, FL MX/AMP, MIX AMP	FRONTLINE Mixer/Amplifier [No #]
F.L. PRE AMP	FRONTLINE Super Preamplifier [No #]
FP	IBANEZ FP-777 Flying Pan Phaser
G, GATE, NG	YAMAHA NG-01 Noise Gate [0287] or BOSS Noise Gate or DOD Noise Gate 230 [0290]
G/L	DOD FX30-B Gate/Loop
GTR	PAiA Gator Noise Gate/Envelope Follower
GUYA P. EQ, G P. EQ	GUYATONE PS-022 Parametric EQ [0312]
HF	ELECTRO-HARMONIX Hog's Foot Bass Booster [0297]
HG	HARRIS Professional P92 Noise Gate [0292]
HT	ELECTRO-HARMONIX Hot Tubes Tube Amp Overdrive Simulator
IBN, IBN P. EQ, PQL	IBANEZ PQ-9 Parametric EQ [No #] or IBANEZ PQL Parametric EQ [No #]
IBS	IN BETWEEN SOUNDS Mix/Line Amplifier
IP	t.c. electronics Integrated Preamplifier [0336]
J.amp	JULIETTE 4-Channel Amplifier [0406]
K	Photocell Key [0252] or Photocell Key Dual [0253] or Quad Key [0086]
KTB, KORG	KORG TNB-1 Tone Booster [No #]
LB EQ	LOCO BOX EQ-6 6-Band Graphic Equalizer [0303]
LS	YAMAHA LS-01 Line Selector [0291, No #] or IBANEZ Loop Selector [0317]
MB, MBX	SHIN-EI Mute Box [0472, No #]
MG	D&R Multi-Gate
M.SYN	DICK SMITH Mini Synthesizer [No #]
MT, M - T, MUTRON, MU PH II	MUTRON Phaser II
MXR	MXR Six-band Graphic EQ [0314, 0315]
MXR P.T.	MXR Pitch Transposer [No #]
NEXT, NXT, NEXT EXT, SG EXT	NEXT SE-100 Signal Gate [0275]
OM, OCT, OMX	ELECTRO-HARMONIX Octave Multiplexer [0300] or Pearl OC-07 Octaver
PAN	Panner
PB buss, PL. BUS	BOSS MA-5 Play Bus or HA-5 Play Bus Headphone Amp [0473]
PEARL EQ, P EQ	PEARL EQ
P/F	Phaser/Flanger [0039]

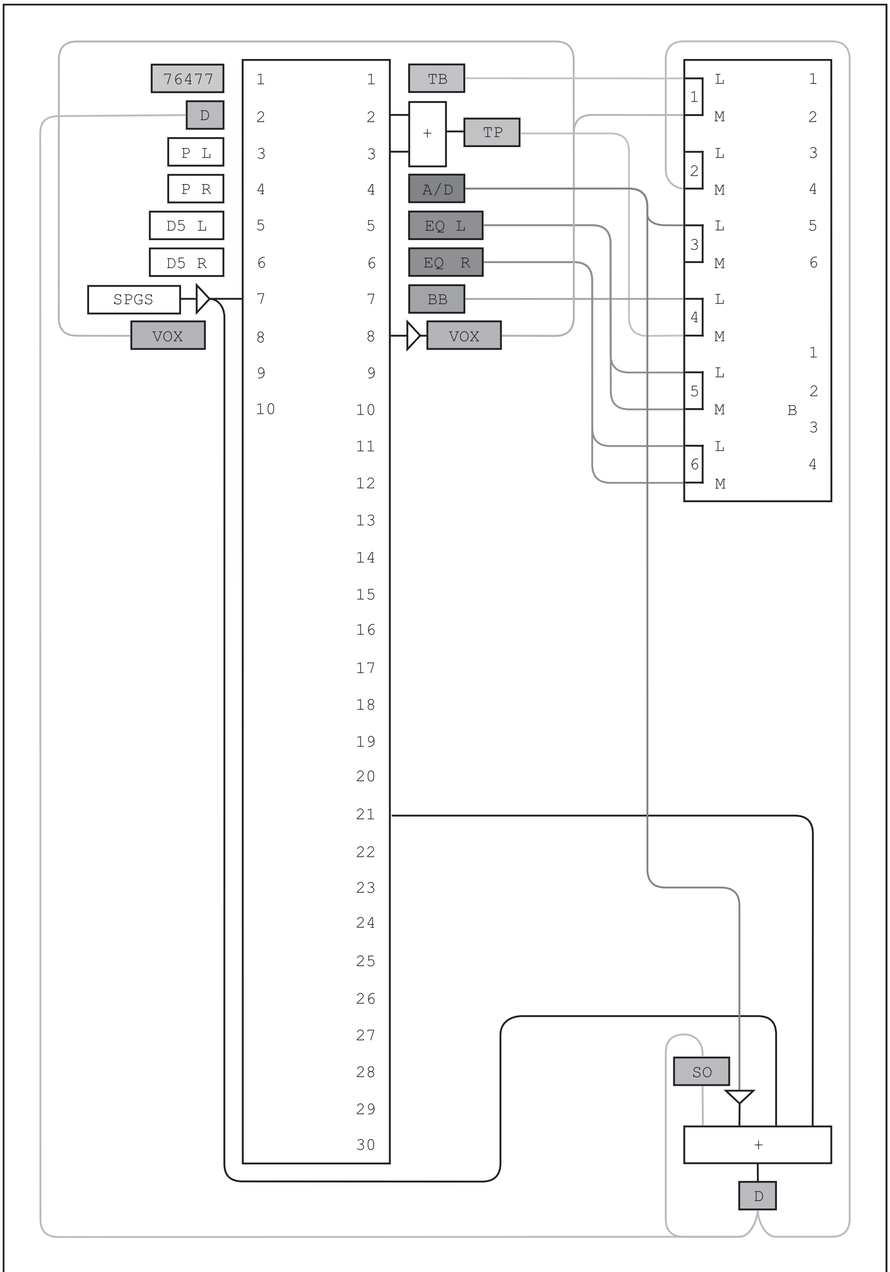
Legend, Effect Processors (continued)

PLL, PL/L	Phase-Locked Loop
PM EQ	PAiA Parametric EQ [0491] or AKAI EX 85P Parametric EQ
PM PH	Unidentified
PP, P/P	ELECTRO-HARMONIX Poly-Phase or ELECTRO-HARMONIX Ping Pong
PRB	ELECTRO-HARMONIX LPB-1 Power Booster [0149]
PS/D, PS, P. SHIFT	BOSS PS-2 Digital Pitch Shifter or BOSS PS-3 Pitch Shift/Delay
P.SYN, PC. SYN., PERC SYN, PERC/SYN	Forrest M. Mims Percussion Synthesizer [0025]
Q	Four Quadrant Multiplier [No #]
QP (SR), SR	POLYFUSION QP-1 Sound-A-Round [No #]
R EQ	REDSON Graphic Equalizer [0280]
RG	ROSS Direct Box Noise Gate [0289]
S, SYN	PAiA Synthespin [0265, 0511]
SAE	SAE Impulse Noise Reduction System [0333]
S.CH	VESTA FIRE Stereo Chorus [0284]
SD, STG. DP.	E&MM String Damper [0469]
SL	ELECTRO-HARMONIX The Silencer Line Noise Eliminator [0276]
SPEC	CORON DC-846 Spectrum [0277] or CYBERSONIC Spectrum Transfer [0450]
SPEC.ALZR., SP. AN, BIJO	BIJO QI-200 Spectrum Analyzer [0293]
ST. EM., ST. EMP.	Unidentified
SW	Unidentified
TB	Toneburst Generator [0118]
TC PH, TCP A	t.c. electronics XII B/K Programmable Phaser [No #]
TC P. EQ, TC SUST EQ, S/P EQ	t.c. electronics Sustain + Parametric EQ [No #]
TH	PEARL TH-20 Thriller
TP	ELECTRO-HARMONIX Talking Pedal Speech Synthesizer [No #]
VCDR, V IN, VCDR EXT, V	ETI Vocoder Powertran [0515]
VF, V.F. GATE, VF C/G	VESTA FIRE CG-1 Noise Gate/Compressor [0320]
VX, VOX	VOX Repeat Percussion [0257]
Z, ZOOM, 9002	ZOOM 9002 Multi Effector
2000	DOD Digitech PDS 2000 Digital Delay Sampler

Legend, Effect Processors (continued)

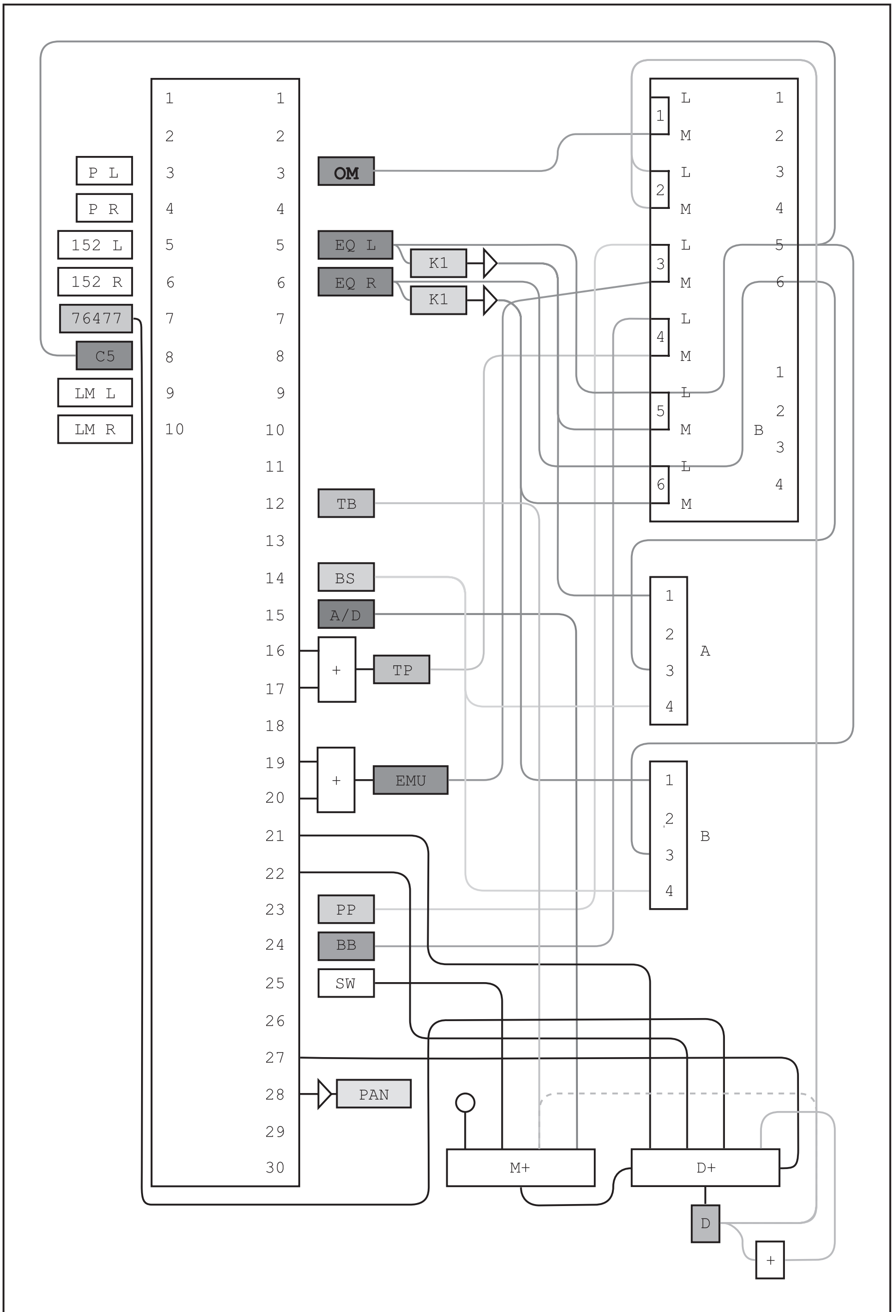


Legend, Mixers & Routers

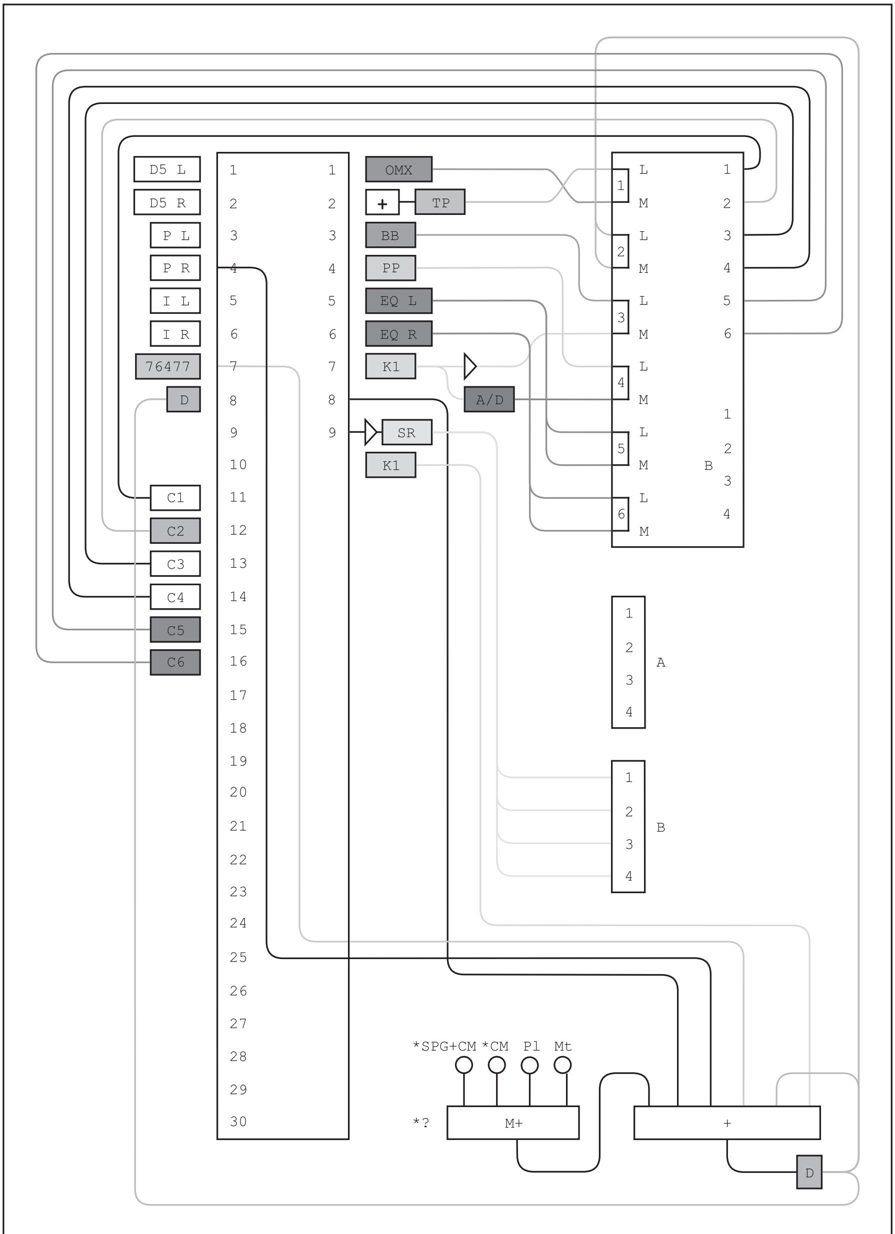


EVENT | 5/2/81 | WALKER ART CENTER, MINNEAPOLIS | B04-F12

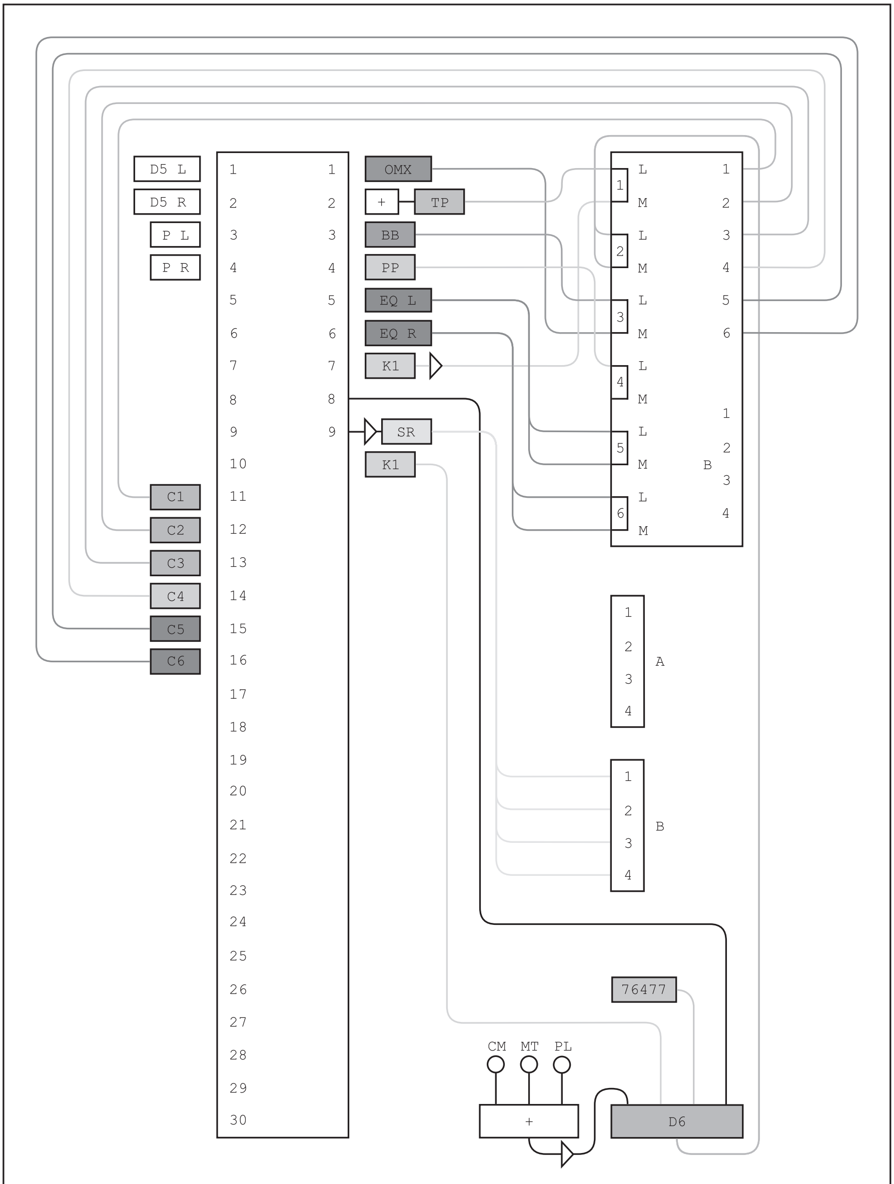
(Note: "B-F" = Box and Folder number of the original matrix map in the David Tudor Papers at GRI)



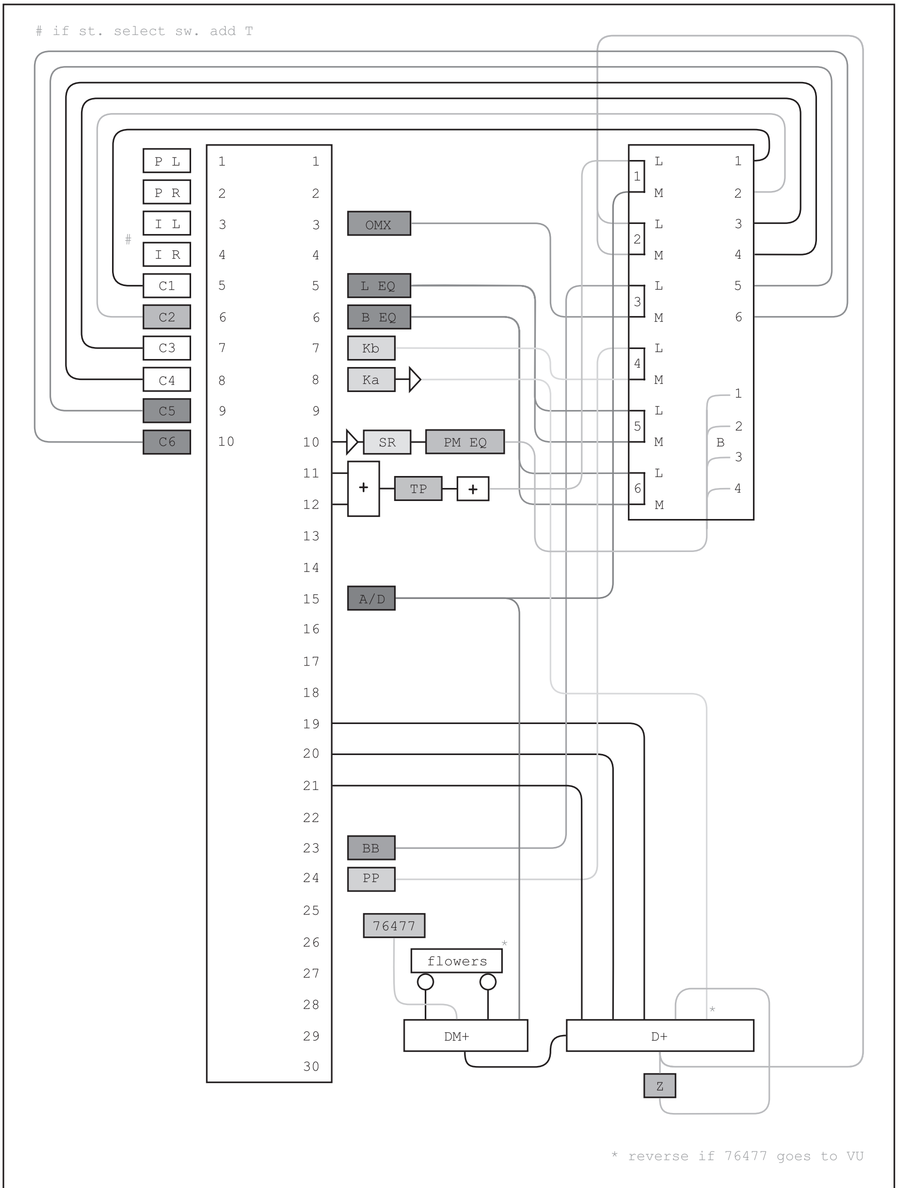
LIKENESS TO VOICES (SKETCH) | 2/6/82 | B04-F09



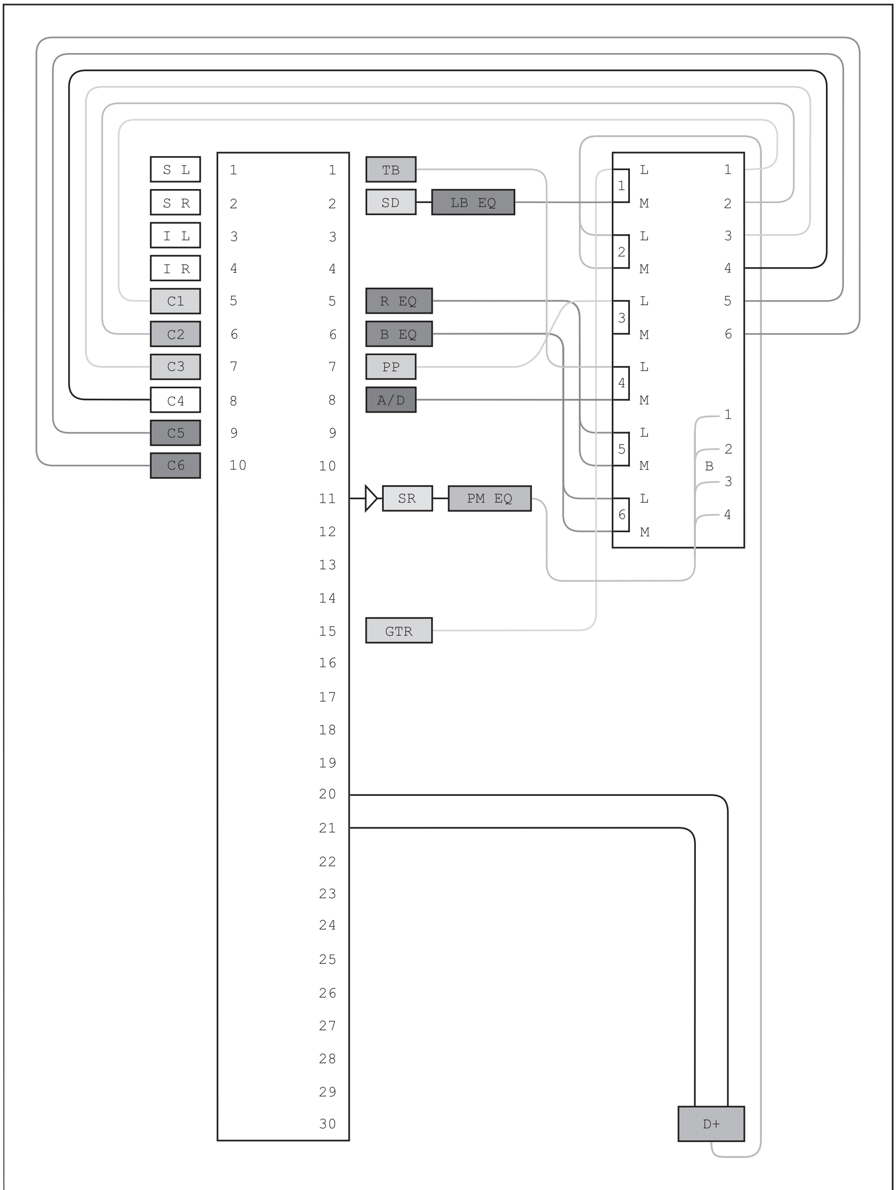
LIKENESS TO VOICES (SKETCH) | 2/6/82 | B03-F15



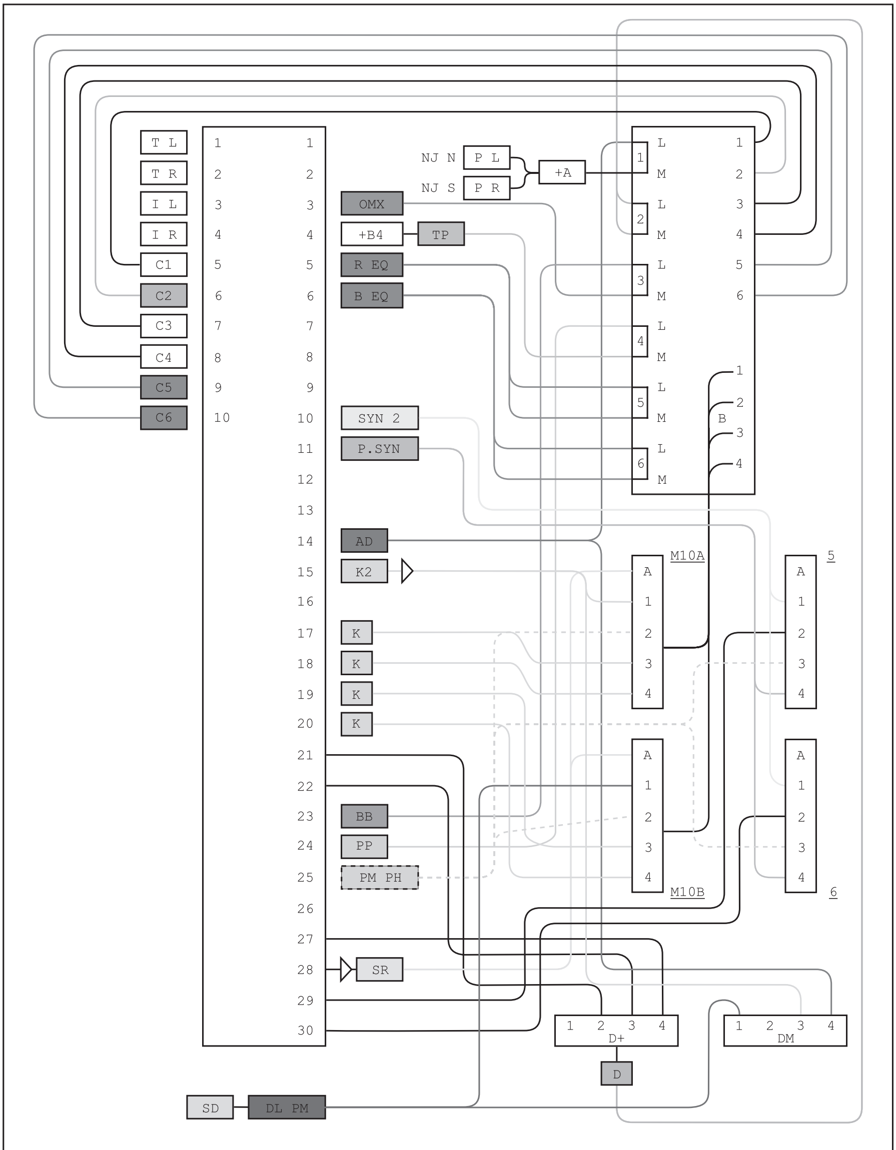
LIKENESS TO VOICES/DIALECTS | 3/19/82 | IRCAM, PARIS [PREMIERE] | B03-F15



DIALECTS | 1/26/83 | LOVELY MUSIC UPTOWN, MARYMOUNT MAHNATTAN COLLEGE | B04-F12



MCDC INFORMAL PERFORMANCE | 2/23/83 | VASSAR COLLEGE, NEW YORK | B04-F09



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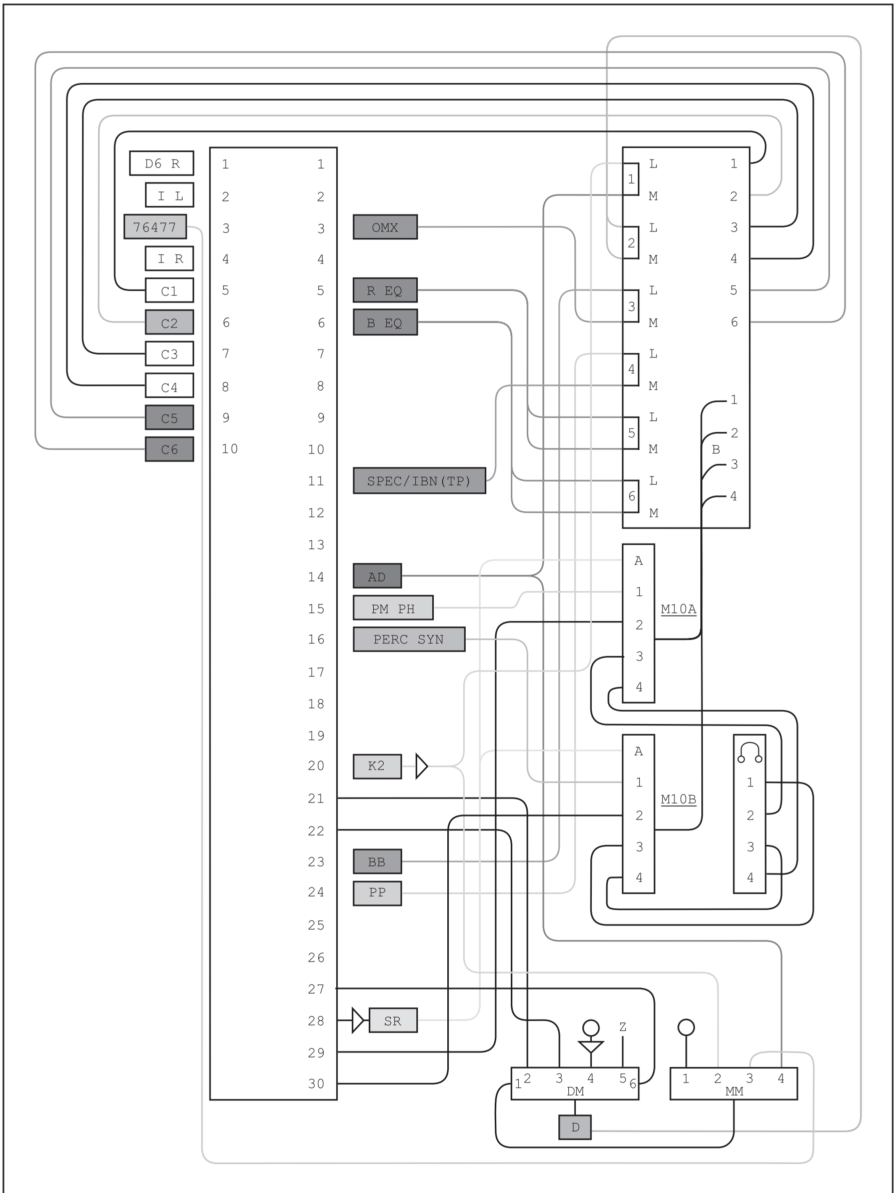
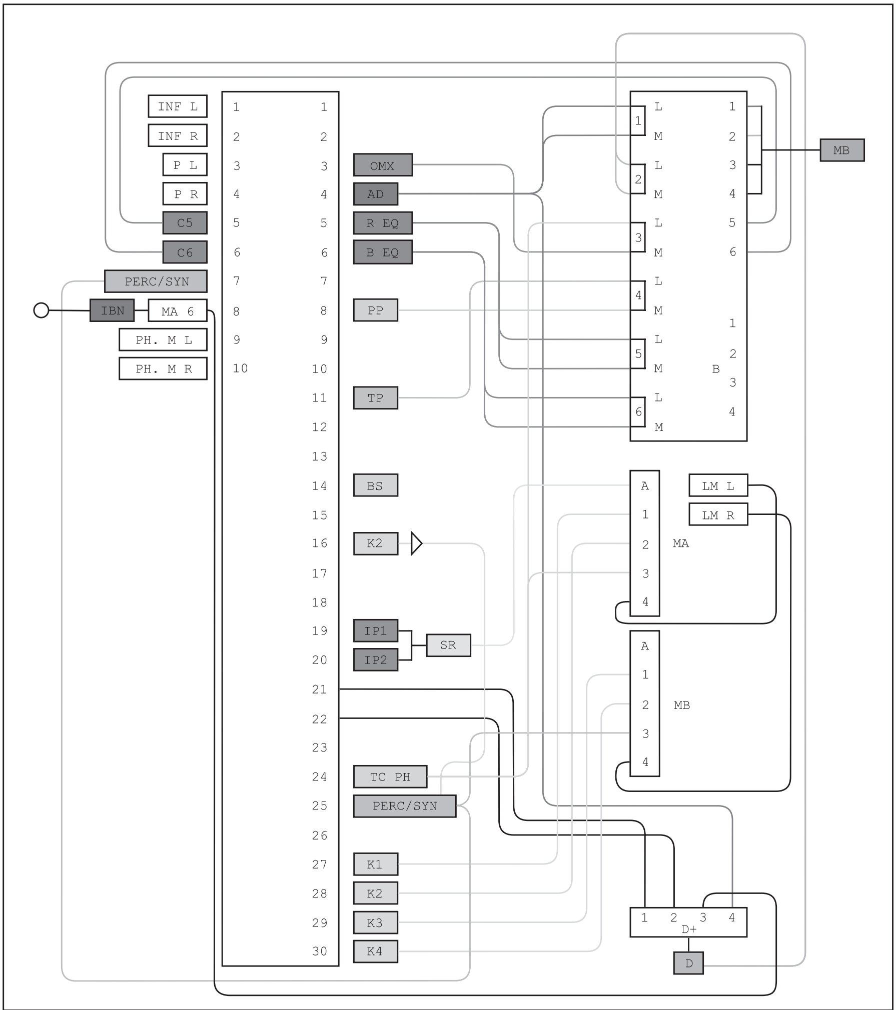


DIALECTS| 11/1/83 | HESSICHER RUNDFUNK, FRANKFURT (RECORDING) | B03-F06



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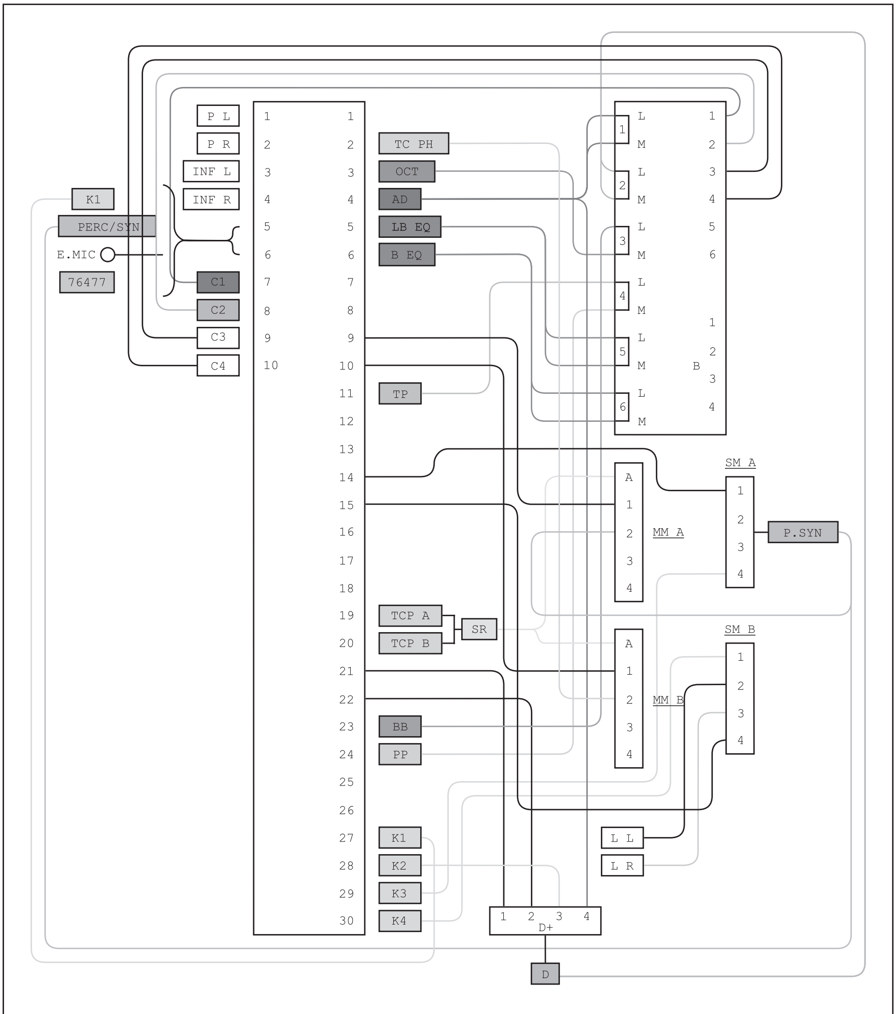

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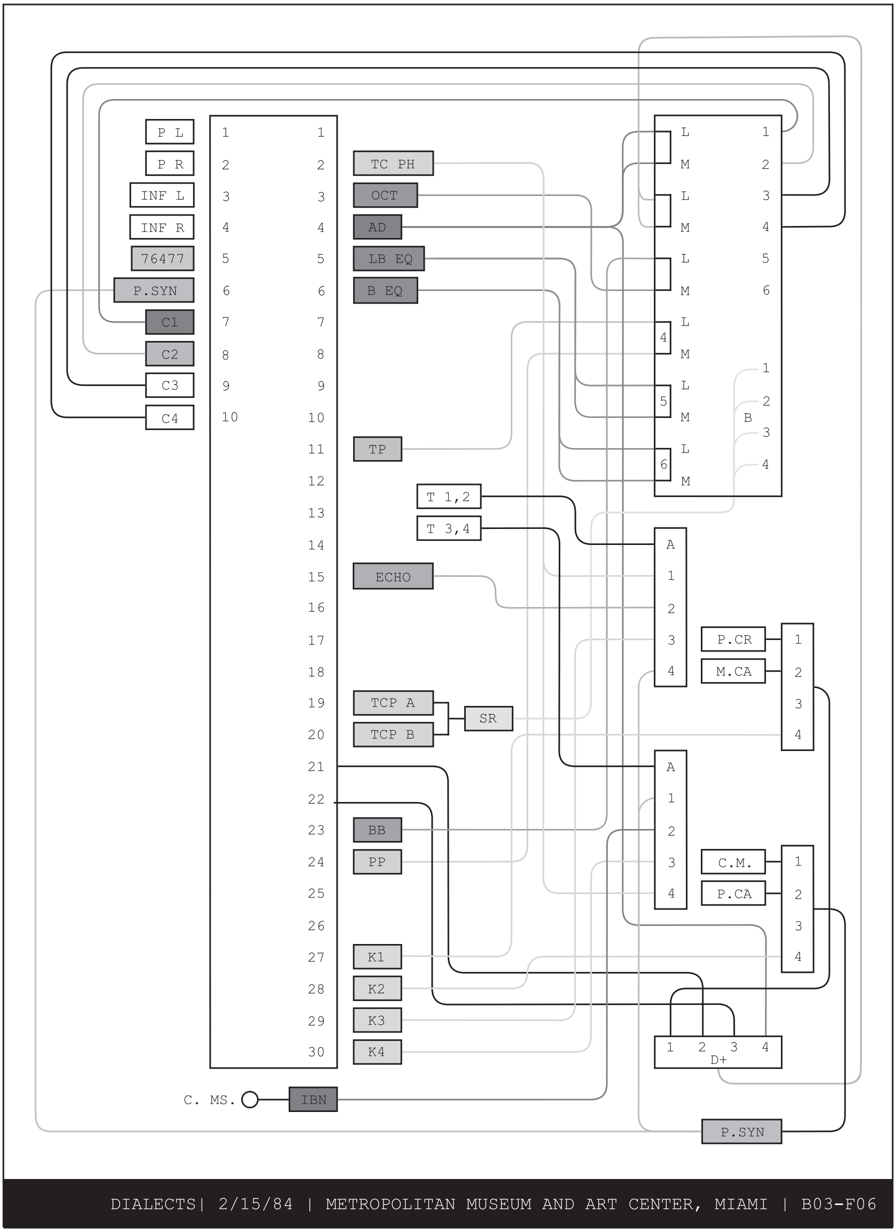
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P R
INF L
INF R
76477
P.SYN
C1
C2
C3
C4
TC PH
OCT
AD
LB EQ
B EQ
TP
T 1,2
T 3,4
ECHO
TCP A
TCP B
SR
BB
PP
K1
K2
K3
K4
C. MS.
IBN
P.CR
M.CA
C.M.
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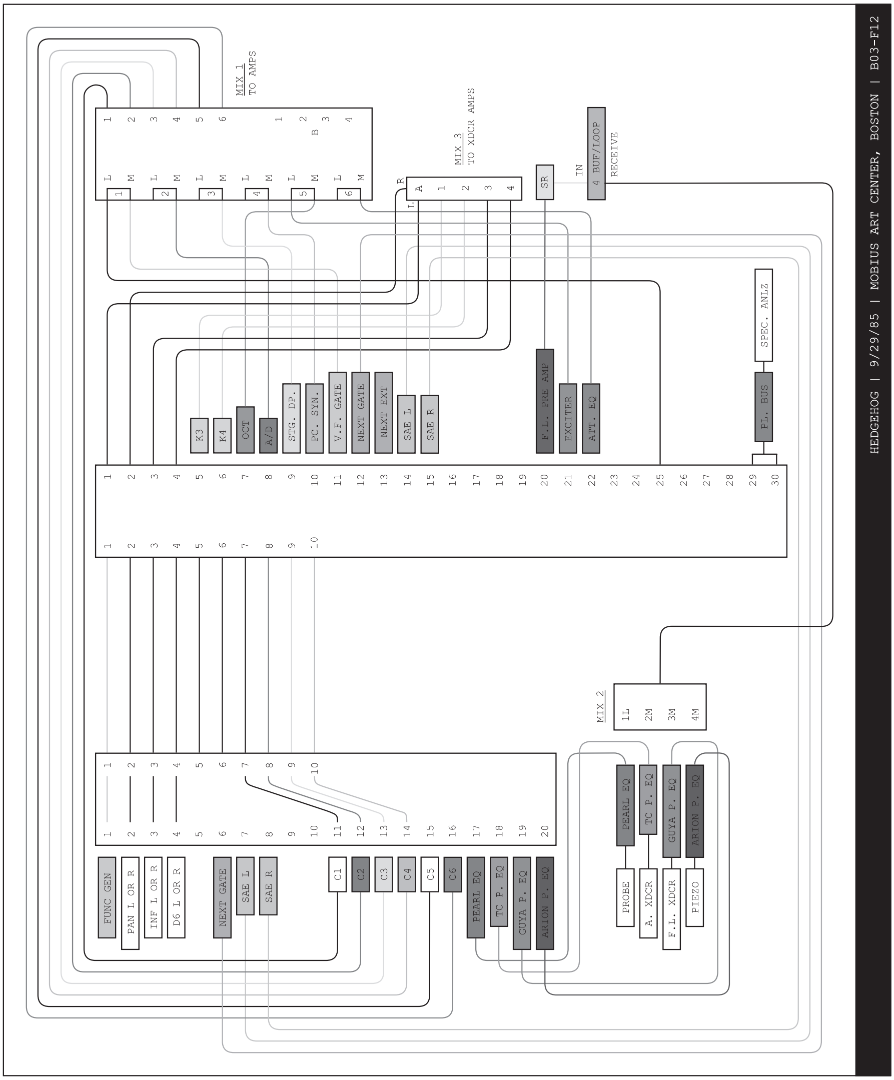
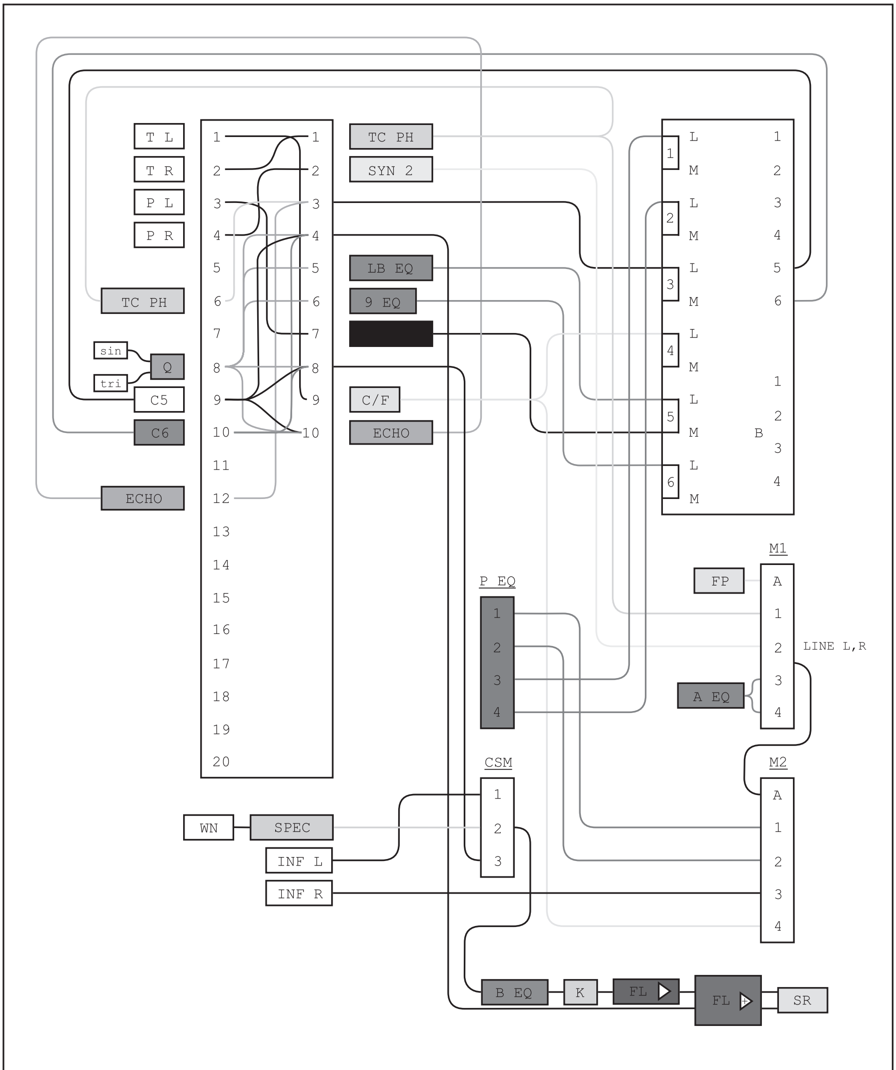
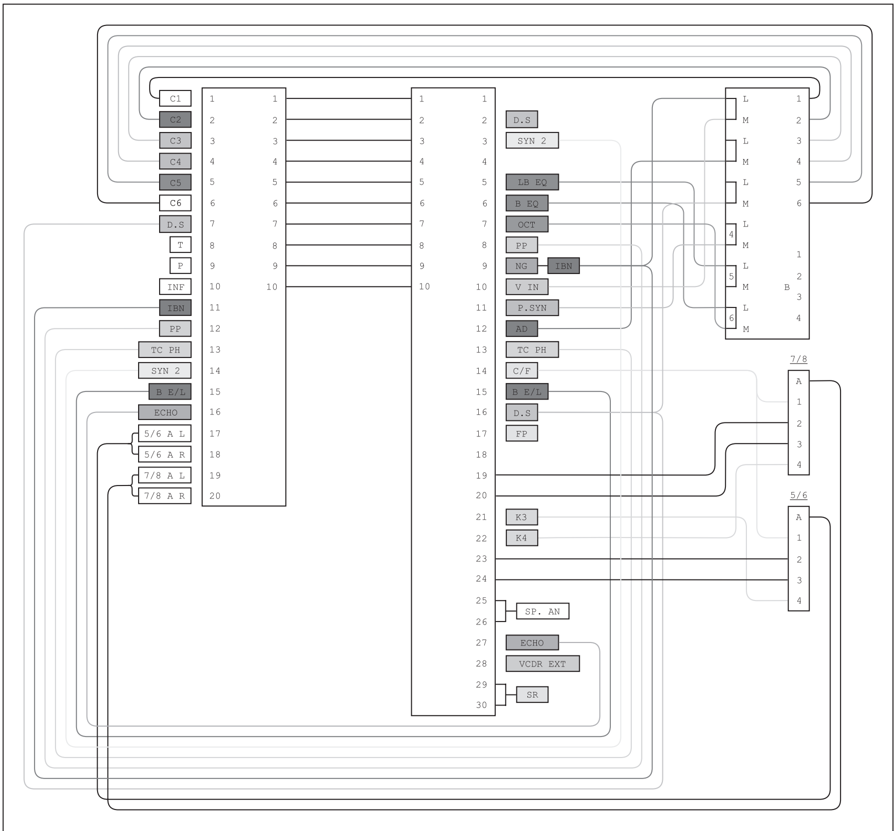
D+
P.SYN
B
DIALECTS| 2/15/84 | METROPOLITAN MUSEUM AND ART CENTER, MIAMI | B03-F06

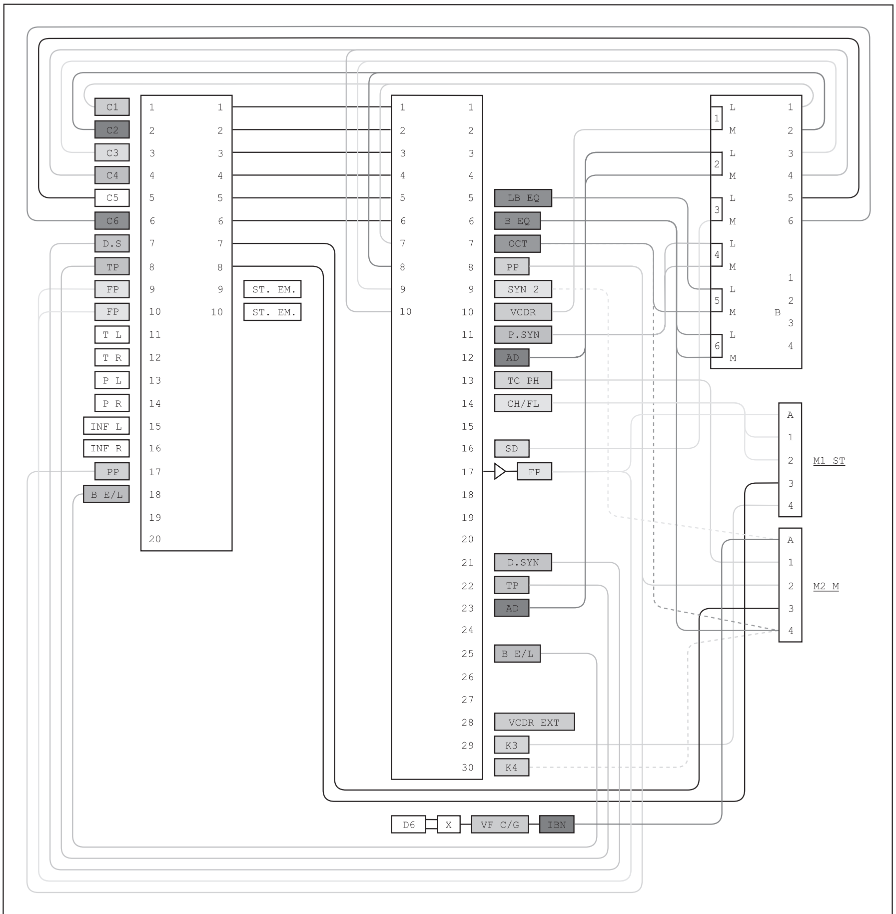

HEDGEHOG | 9/29/85 | MOBIUS ART CENTER, BOSTON | B03-F12
MIX 1
TO AMPS
MIX 3
TO XDCR AMPS
MIX 2
1L
2M
3M
4M
SR
IN
4 BUF/LOOP
RECEIVE
K3
K4
OCT
A/D
STG. DP.
PC. SYN.
V.F. GATE
NEXT GATE
NEXT EXT
SAE L
SAE R
F.L. PRE AMP
EXCITER
ATT. EQ
PL. BUS
SPEC. ANLZ
FUNC GEN
PAN L OR R
INF L OR R
D6 L OR R
NEXT GATE
SAE L
SAE R
C1
C2
C3
C4
C5
C6
PEARL EQ
TC P. EQ
GUYA P. EQ
ARION P. EQ
PROBE
A. XDCR
F.L. XDCR
PIEZO



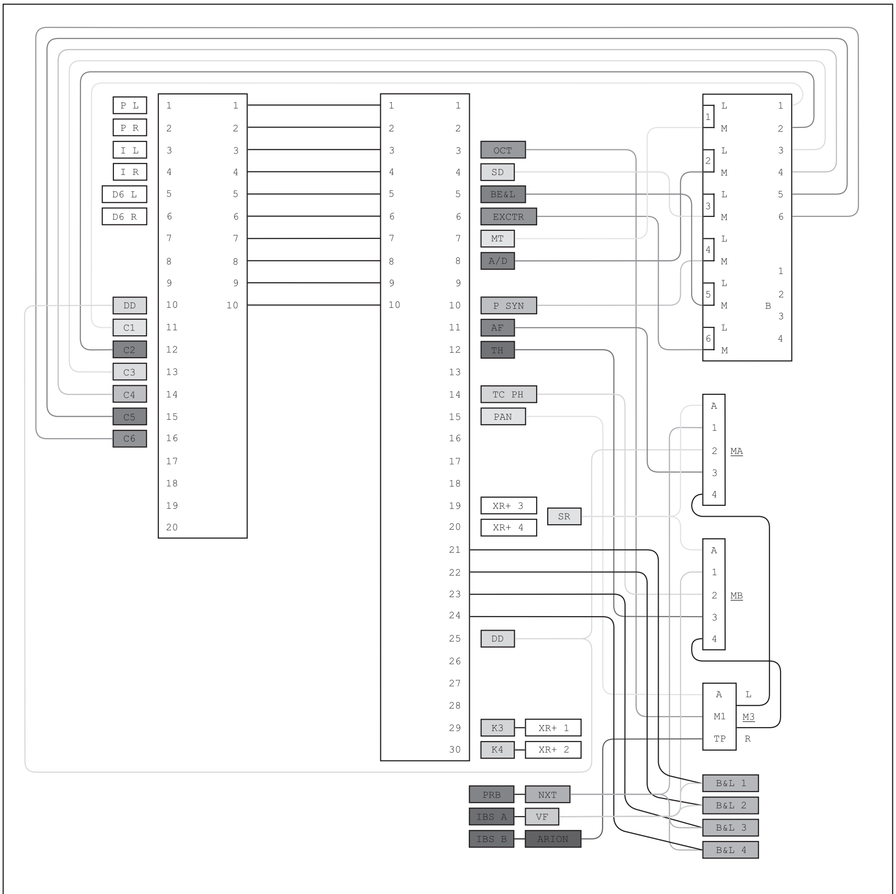
SEXTET FOR SEVEN | 10/9-13/85 | TEATRO ESPAÑOL, MADRID | B03-F32



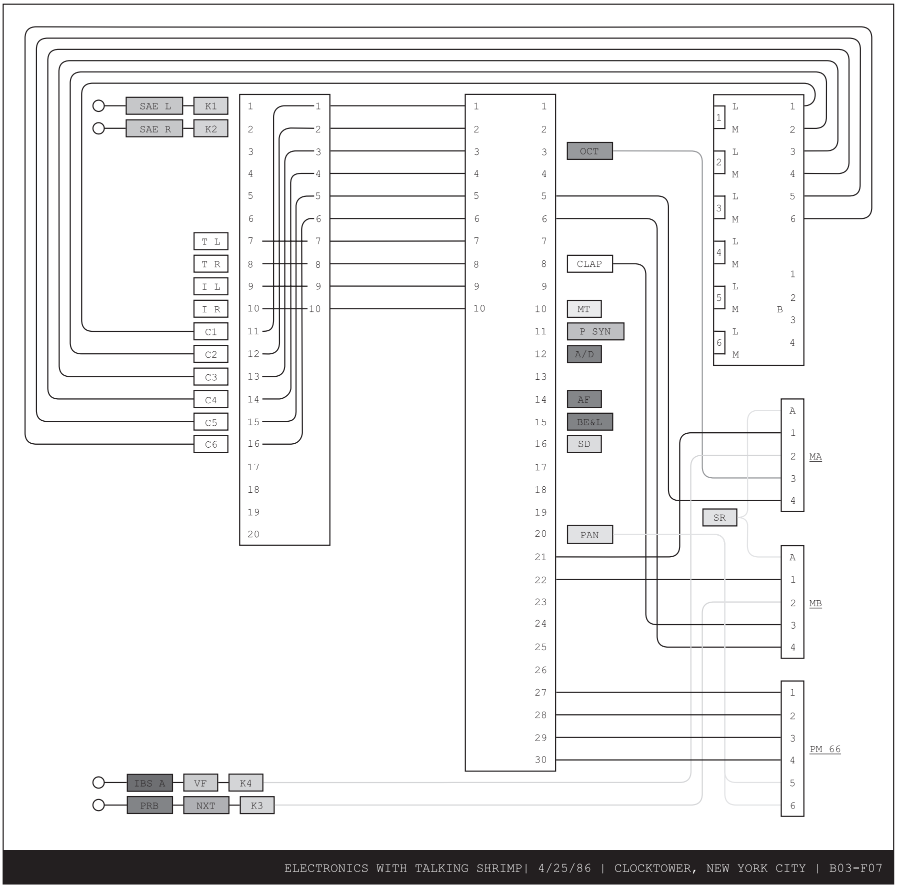
EVENT | 1985 | B04-F15



FRAGMENTS | 2/26/86 | UNIVERSITY OF TEXAS, AUSTIN | B03-F15



HEDGEHOG | 4/8/86 | THE ART INSTITUTE OF CHICAGO | B03-F02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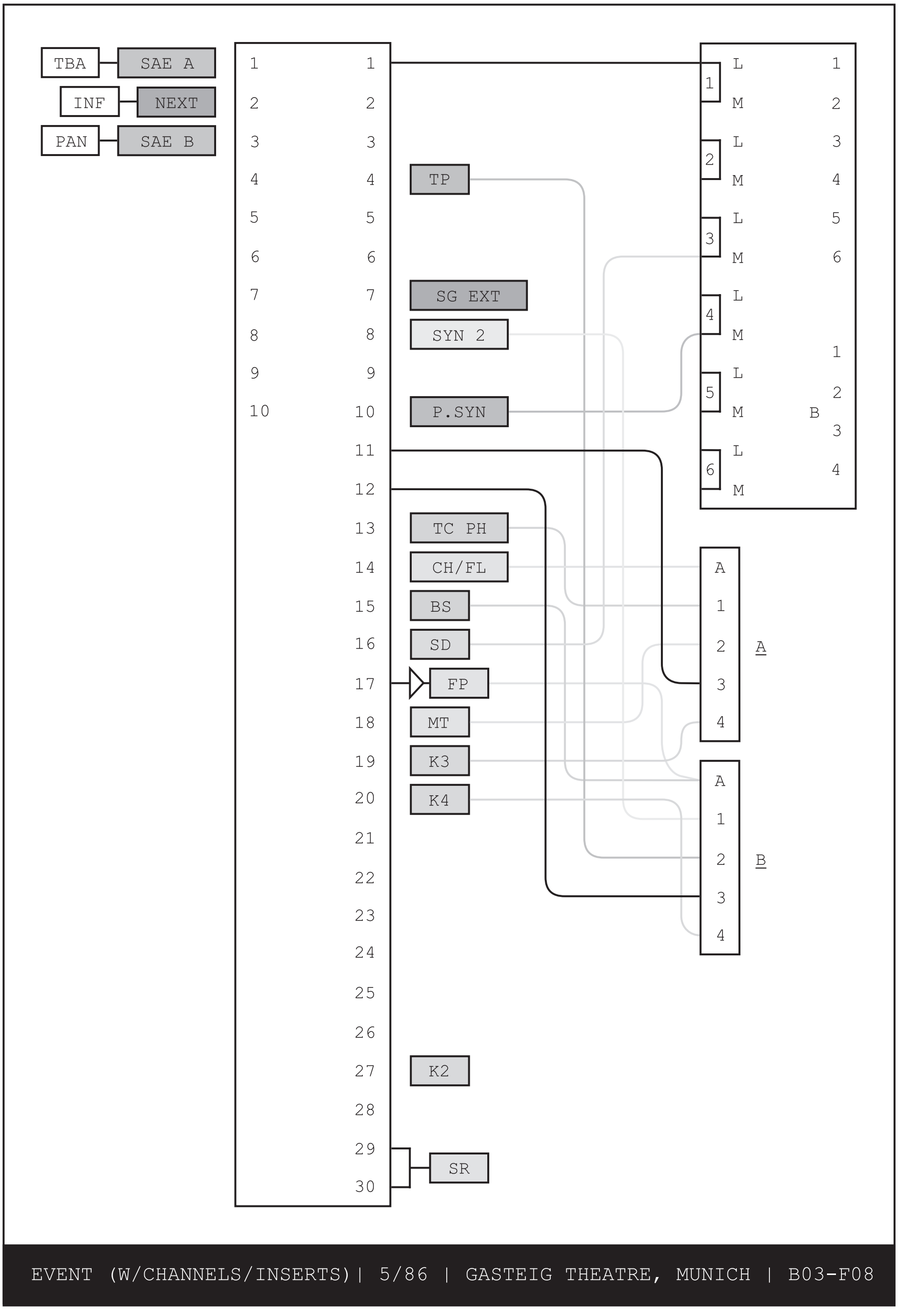
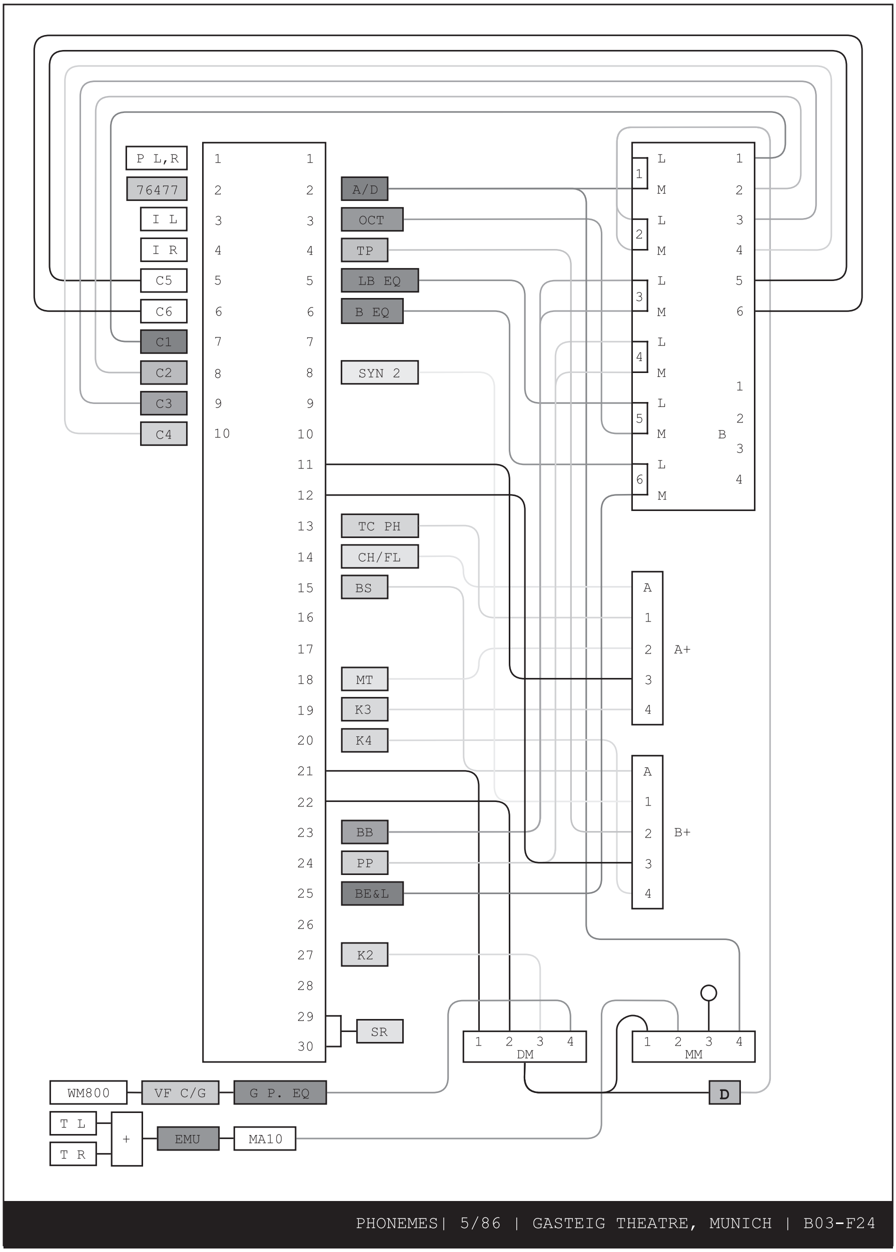
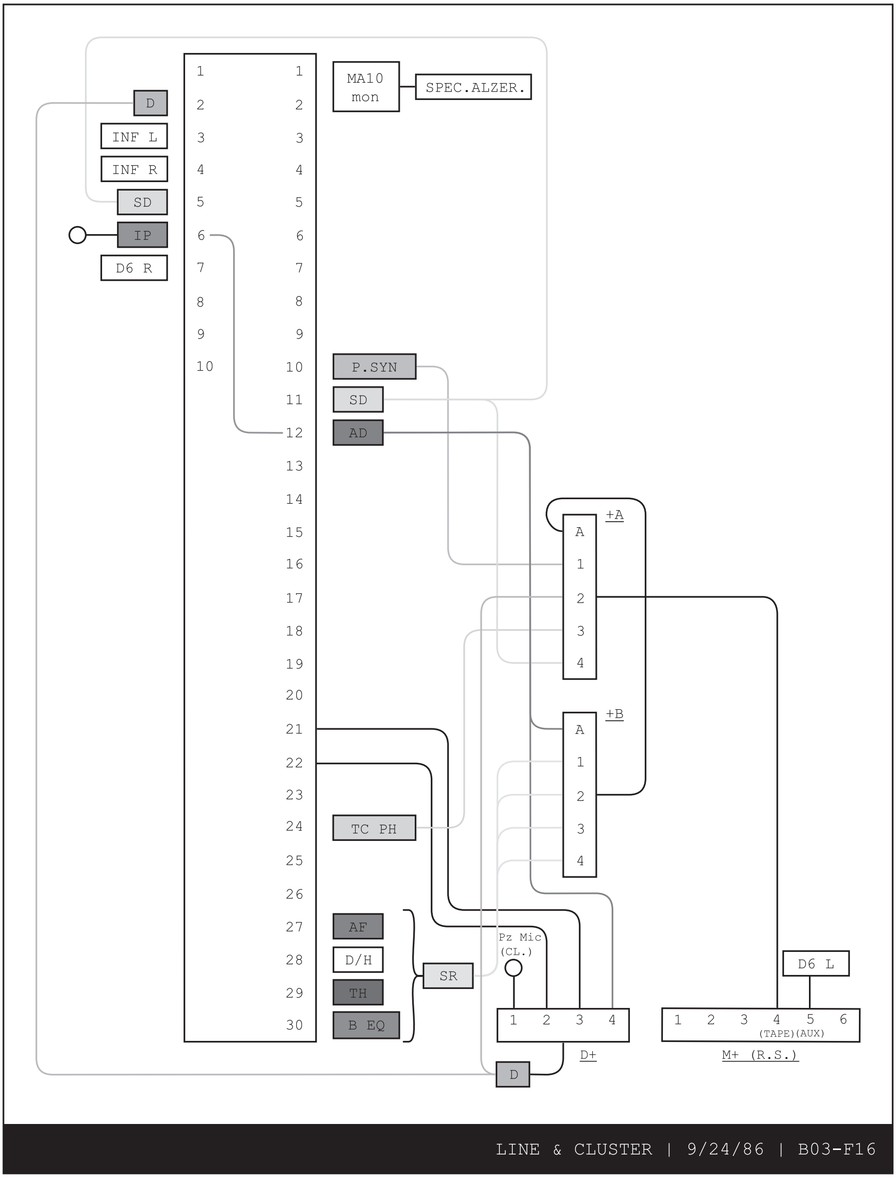
K1
SAE R
K2
T L
T R
I L
I R
C1
C2
C3
C4
C5
C6
OCT
CLAP
MT
P SYN
A/D
AF
BE&L
SD
PAN
SR
MA
MB
PM 66
B
IBS A
VF
K4
PRB
NXT
K3
ELECTRONICS WITH TALKING SHRIMP| 4/25/86 | CLOCKTOWER, NEW YORK CITY | B03-F07


TBA
SAE A
INF
NEXT
PAN
SAE B
TP
SG EXT
SYN 2
P.SYN
TC PH
CH/FL
BS
SD
FP
MT
K3
K4
K2
SR
A
B
EVENT (W/CHANNELS/INSERTS)| 5/86 | GASTEIG THEATRE, MUNICH | B03-F08


P L,R
76477
I L
I R
C5
C6
C1
C2
C3
C4
A/D
OCT
TP
LB EQ
B EQ
SYN 2
TC PH
CH/FL
BS
MT
K3
K4
BB
PP
BE&L
K2
SR
A+
B+
B
DM
MM
D
WM800
VF C/G
G P. EQ
T L
T R
+
EMU
MA10
PHONEMES| 5/86 | GASTEIG THEATRE, MUNICH | B03-F24


1
2
3
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5
6
7
8
9
10
1
2
3
4
5
6
7
8
9
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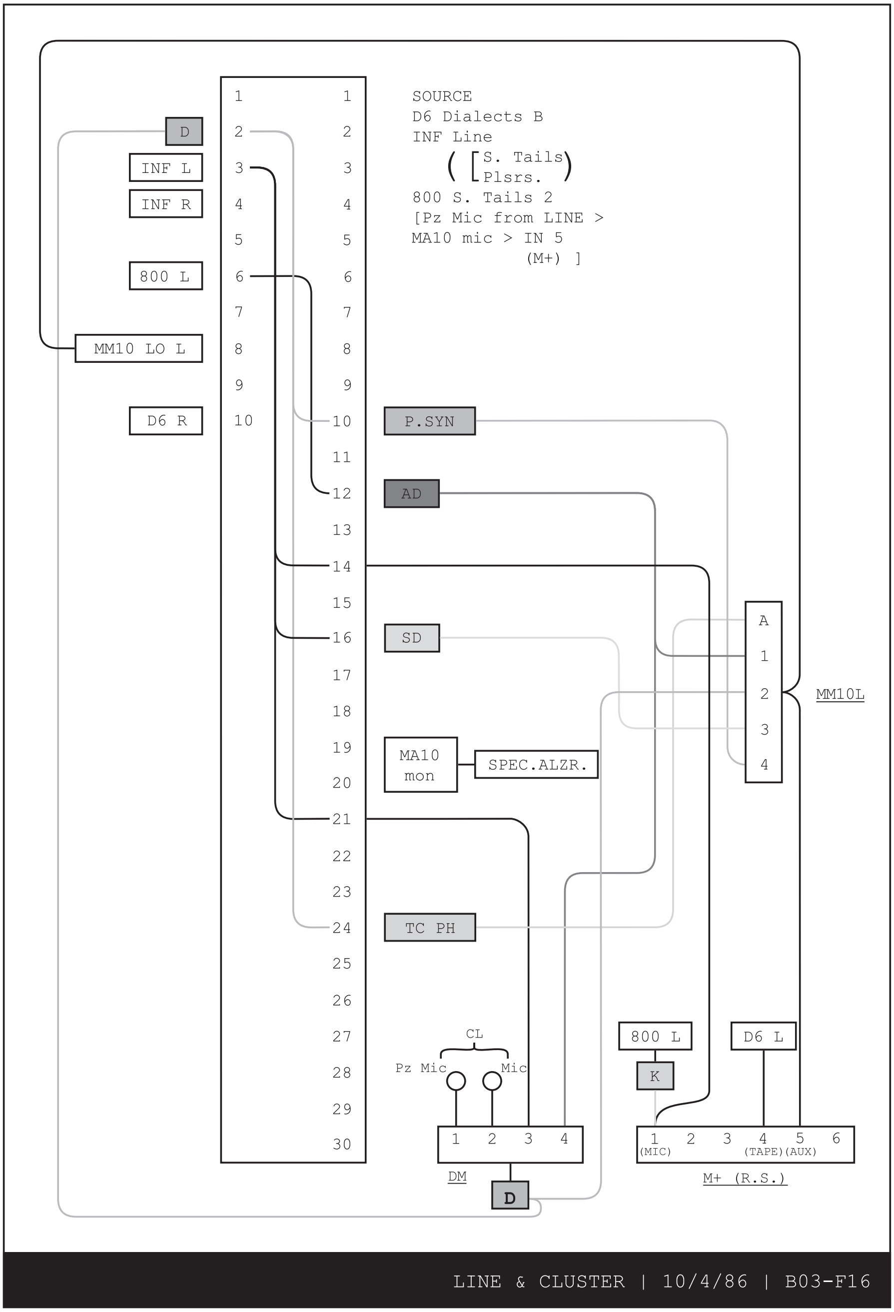
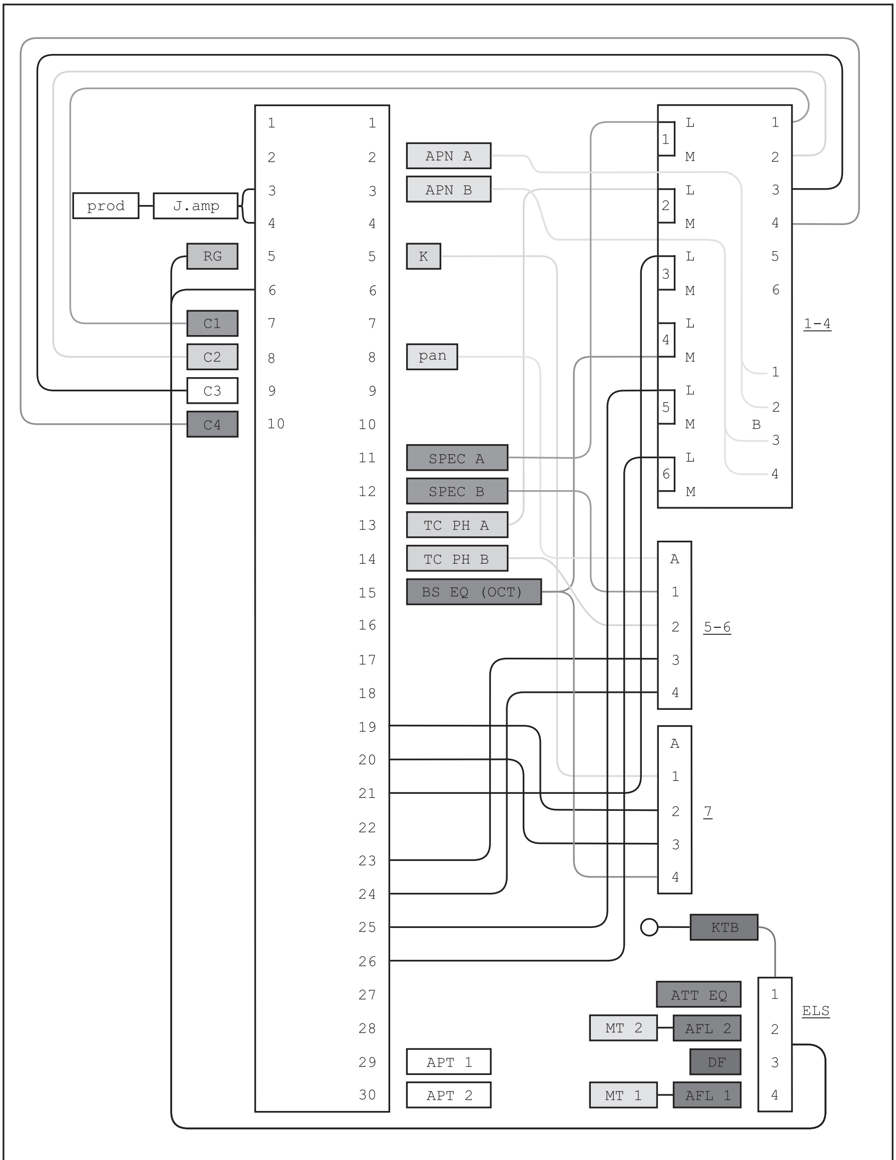
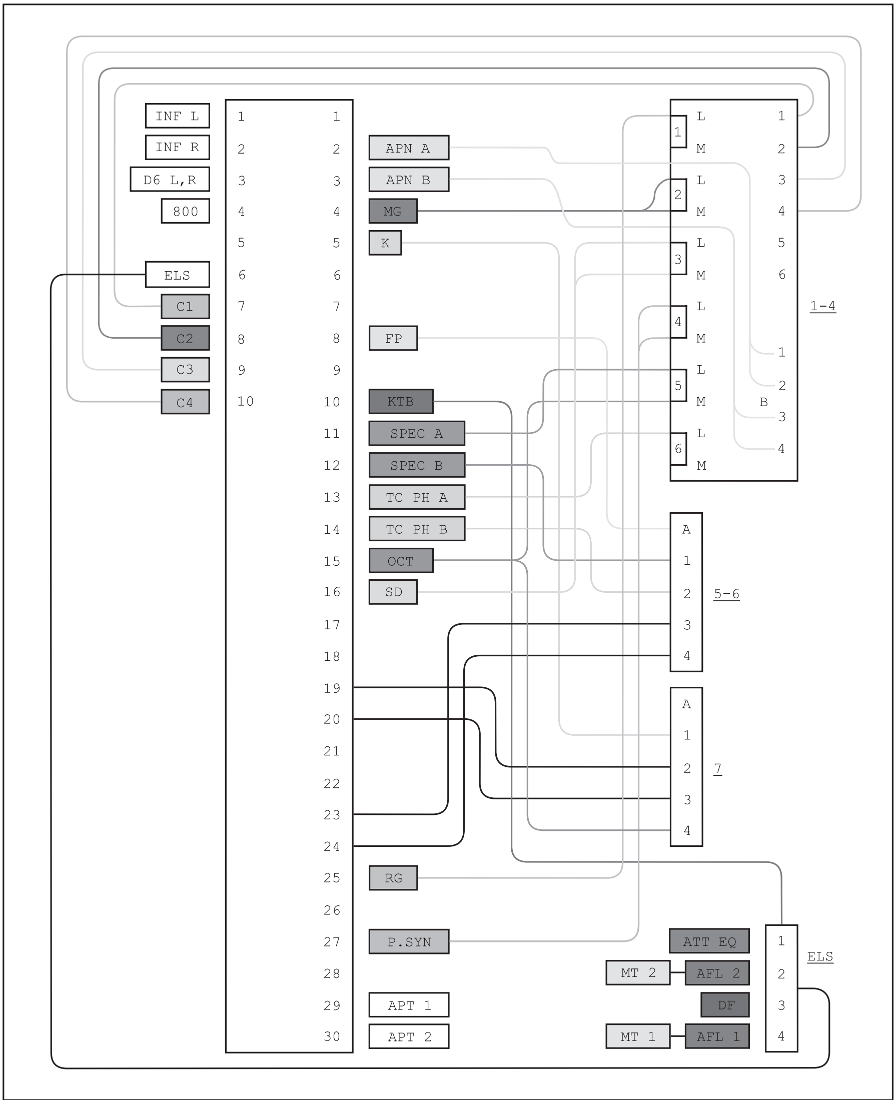
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
D
INF L
INF R
SD
IP
D6 R
MA10 mon
SPEC.ALZER.
P.SYN
SD
AD
TC PH
AF
D/H
TH
B EQ
SR
+A
A 1 2 3 4
+B
A 1 2 3 4
Pz Mic (CL.)
1 2 3 4
D+
D
D6 L
1 2 3 4 5 6
(TAPE)(AUX)
M+ (R.S.)
LINE & CLUSTER | 9/24/86 | B03-F16

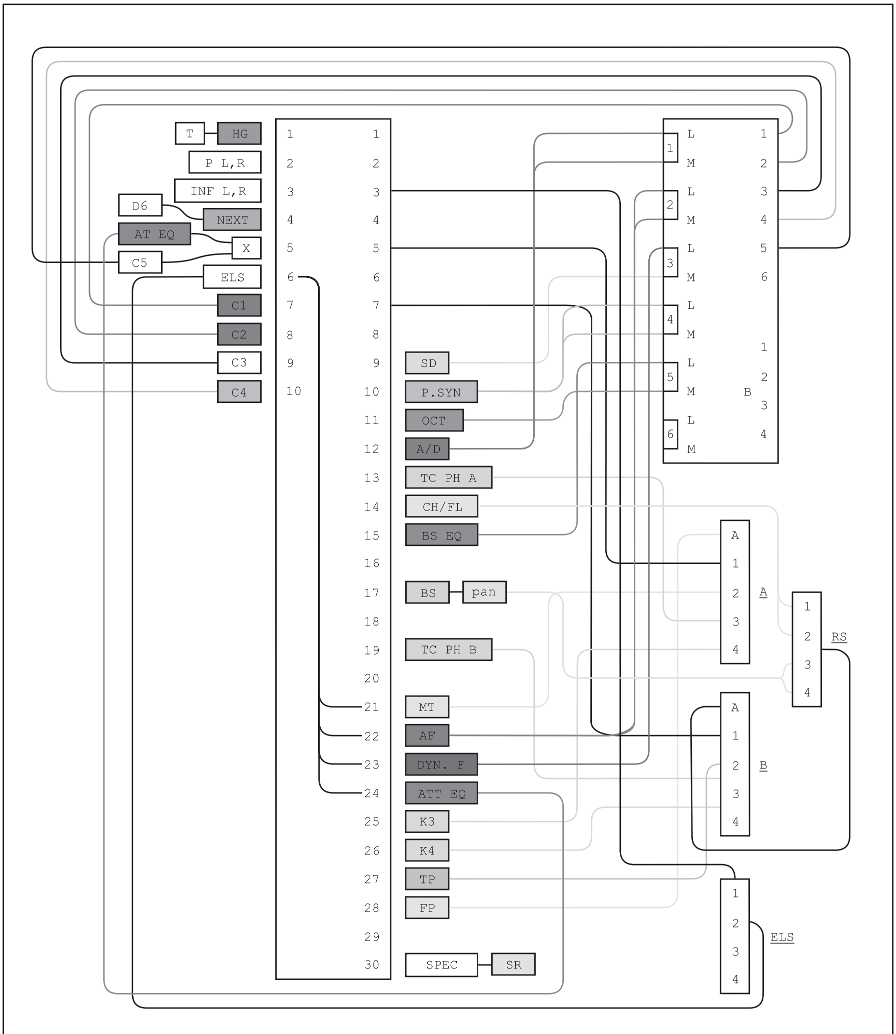

SOURCE
D6 Dialects B
INF Line
([S. Tails
Plsrs.)
800 S. Tails 2
[Pz Mic from LINE >
MA10 mic > IN 5
(M+)]
D
INF L
INF R
800 L
MM10 LO L
D6 R
P.SYN
AD
SD
MA10
mon
SPEC.ALZR.
TC PH
MM10L
CL
Pz Mic
Mic
DM
D
800 L
K
D6 L
(MIC)
(TAPE)(AUX)
M+ (R.S.)
LINE & CLUSTER | 10/4/86 | B03-F16



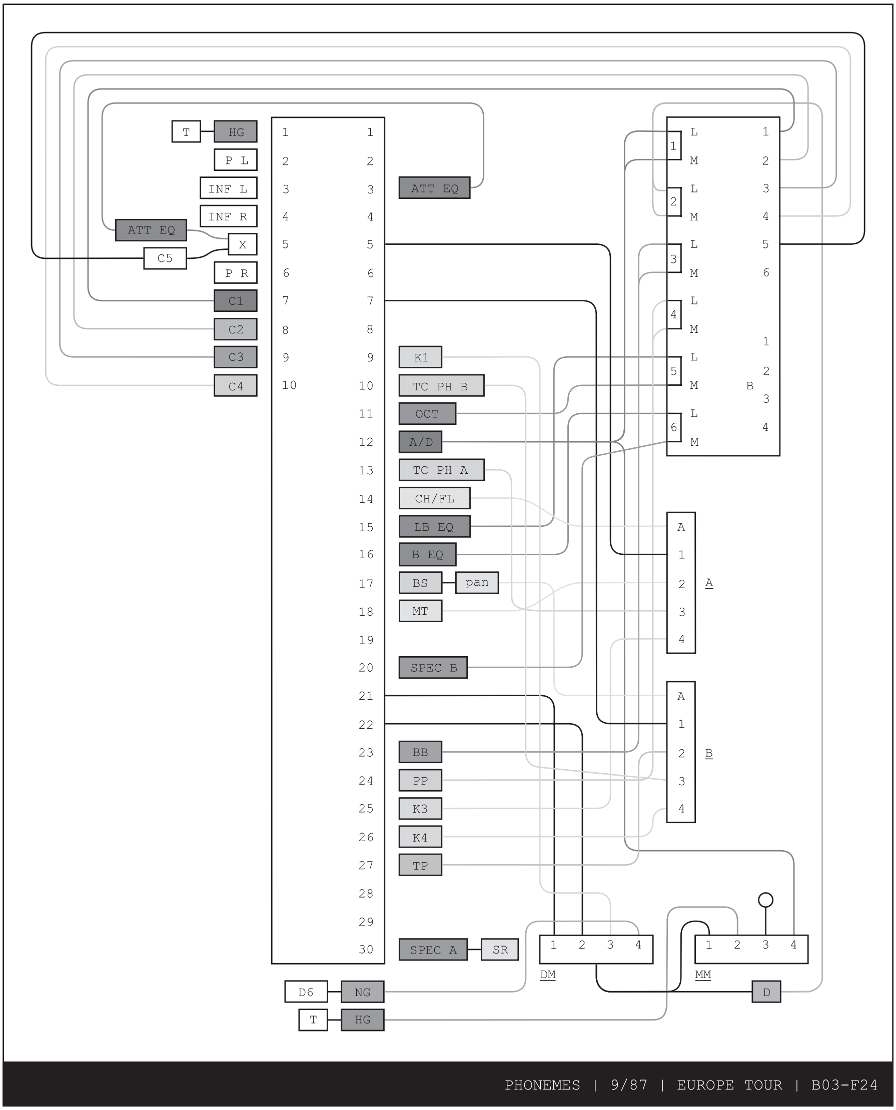
HAIKU (WITH ELECTRONIC WEB) | 9/6/87 | JAPAN AMERICA THEATRE, LA | B03E-F07

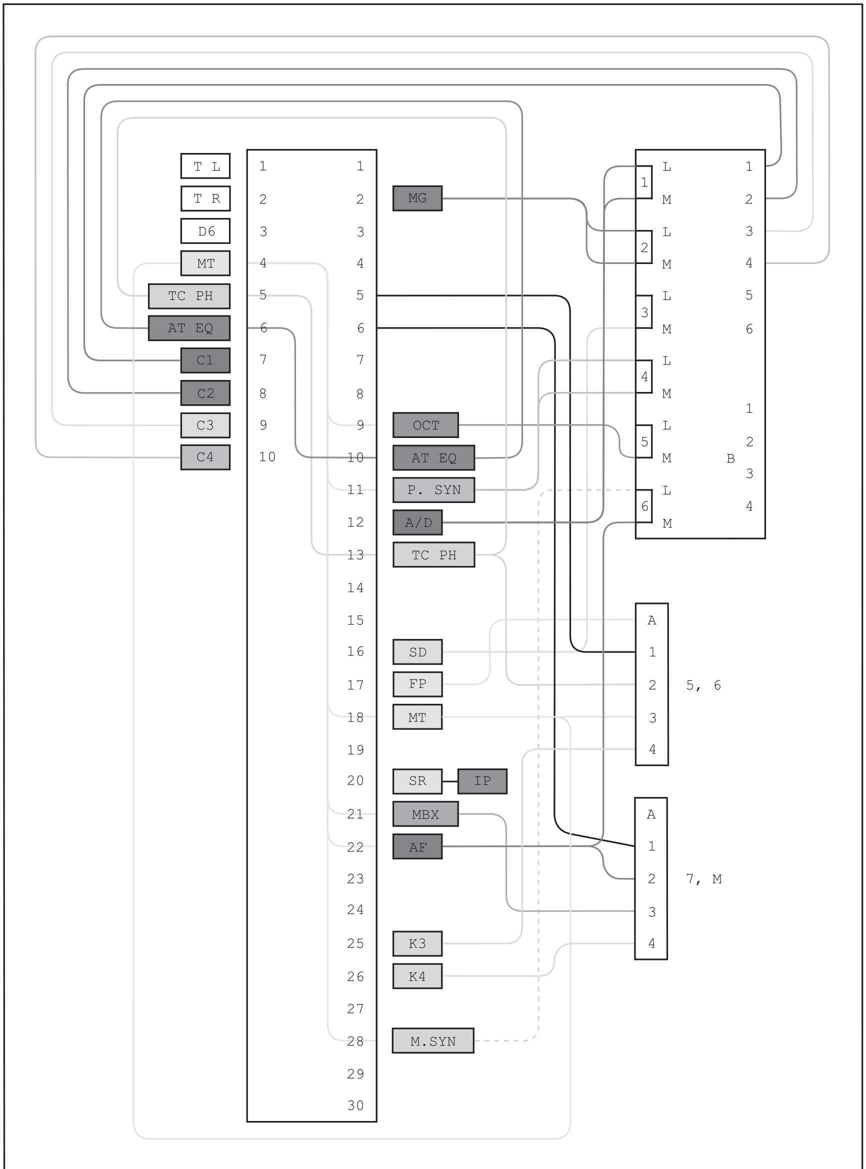


EVENT | 9/6/87 | CELEBRATION FOR JOHN CAGE, JAPAN AMERICA THEATRE, LA | B03-F08

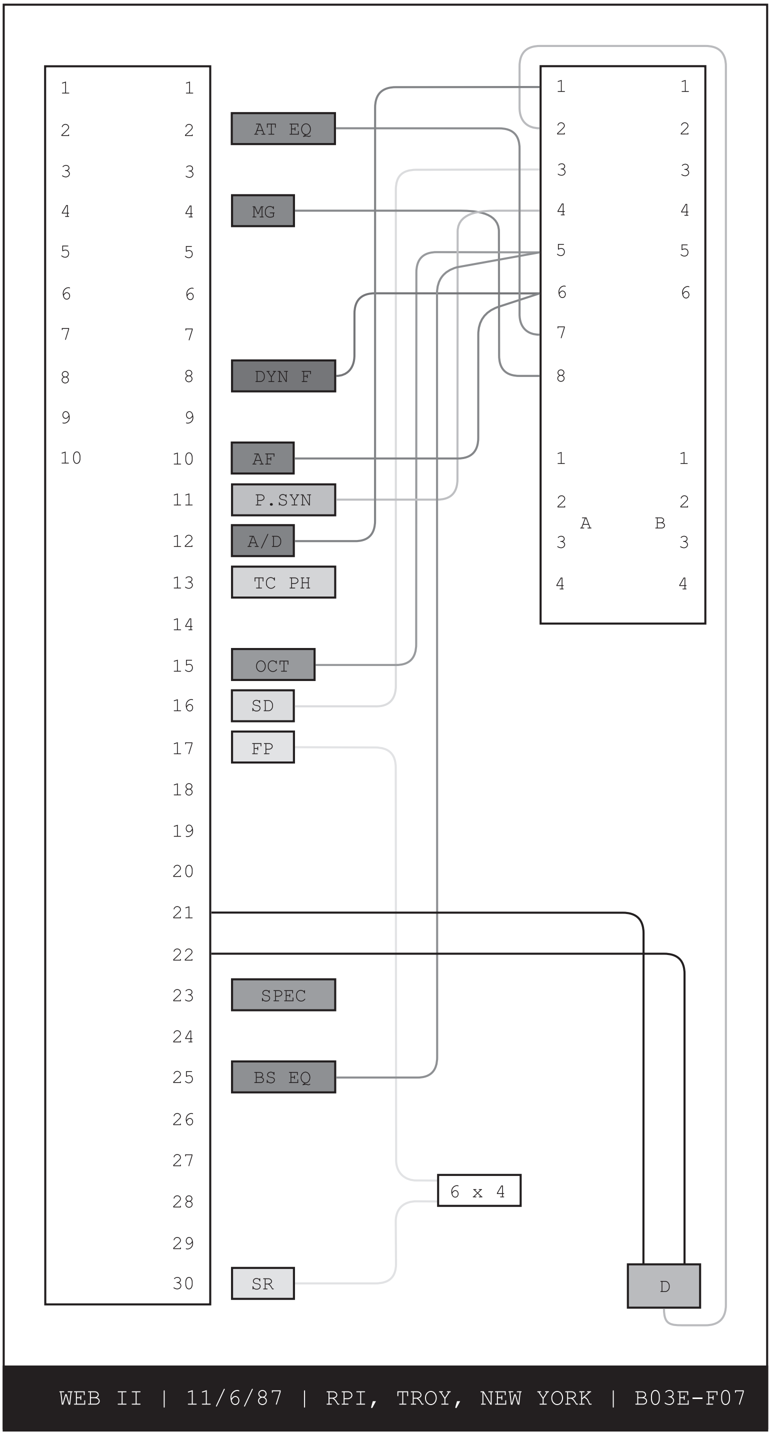


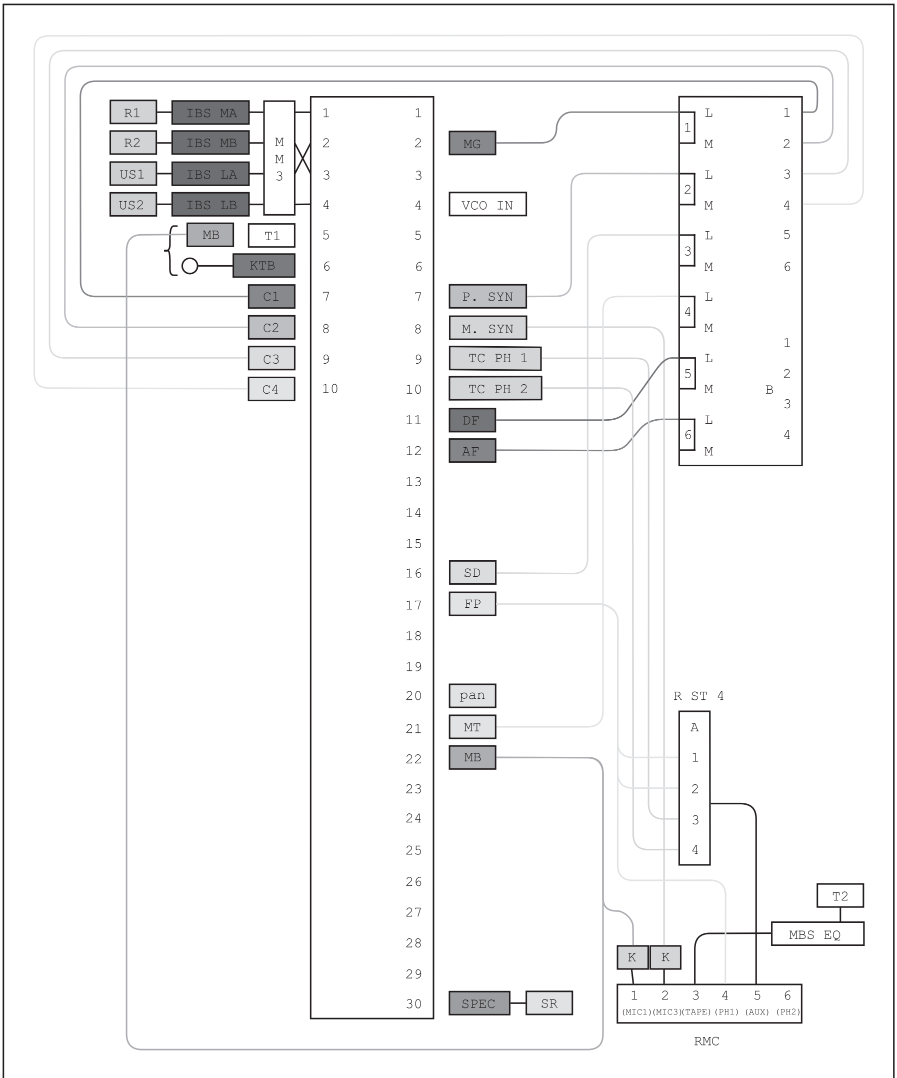
EVENT | 9/19/87 | DE SINGEL THEARE, ANTWERP | B03-F08


T
HG
P L
INF L
INF R
ATT EQ
X
C5
P R
C1
C2
C3
C4
1 2 3 4 5 6 7 8 9 10
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
ATT EQ
K1
TC PH B
OCT
A/D
TC PH A
CH/FL
LB EQ
B EQ
BS
pan
MT
SPEC B
BB
PP
K3
K4
TP
SPEC A
SR
D6
NG
T
HG
L M L M L M L M L M L M
1 2 3 4 5 6
1 2 3 4 5 6
1 2 3 4
B
A 1 2 3 4
A
A 1 2 3 4
B
1 2 3 4
DM
1 2 3 4
MM
D
PHONEMES | 9/87 | EUROPE TOUR | B03-F24

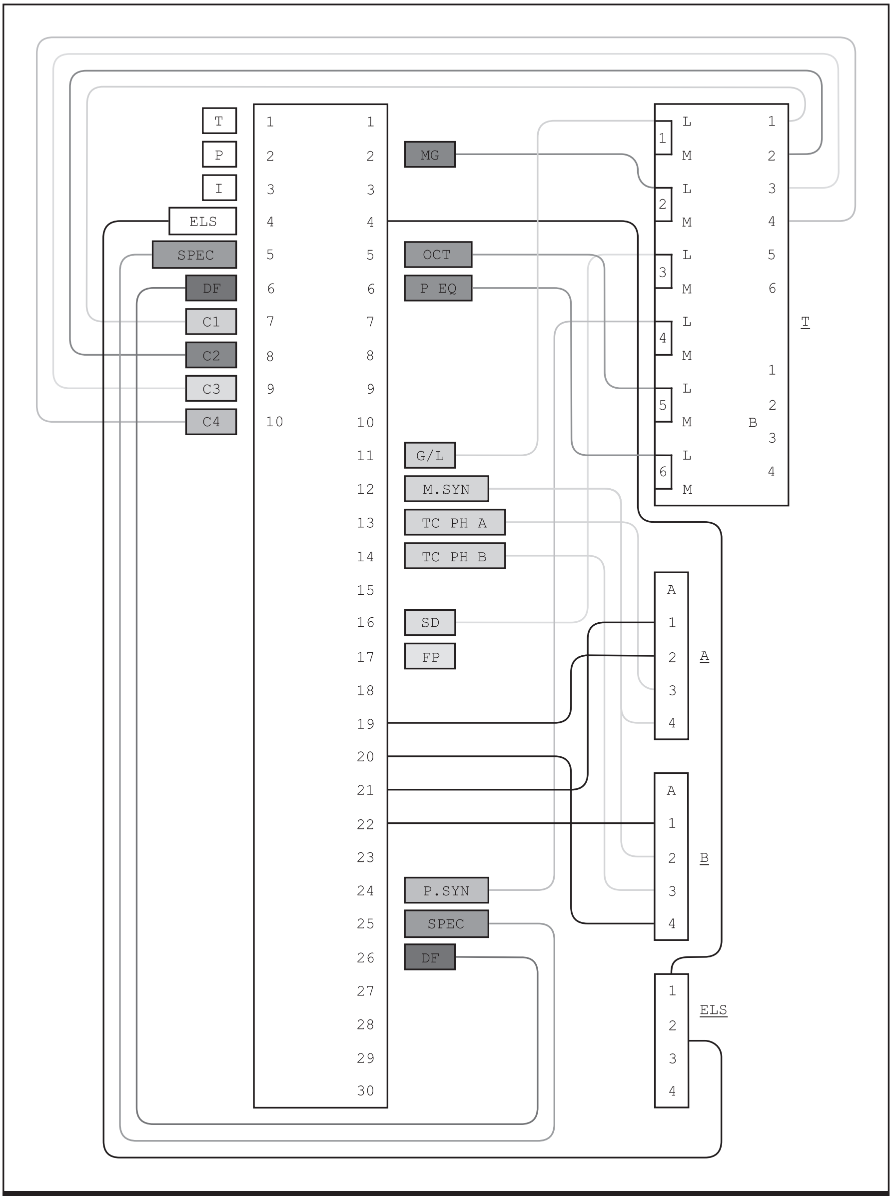


EVENT | 10/9-10/87 | GRAND CENTRAL STATION, NEW YORK | B03-F08

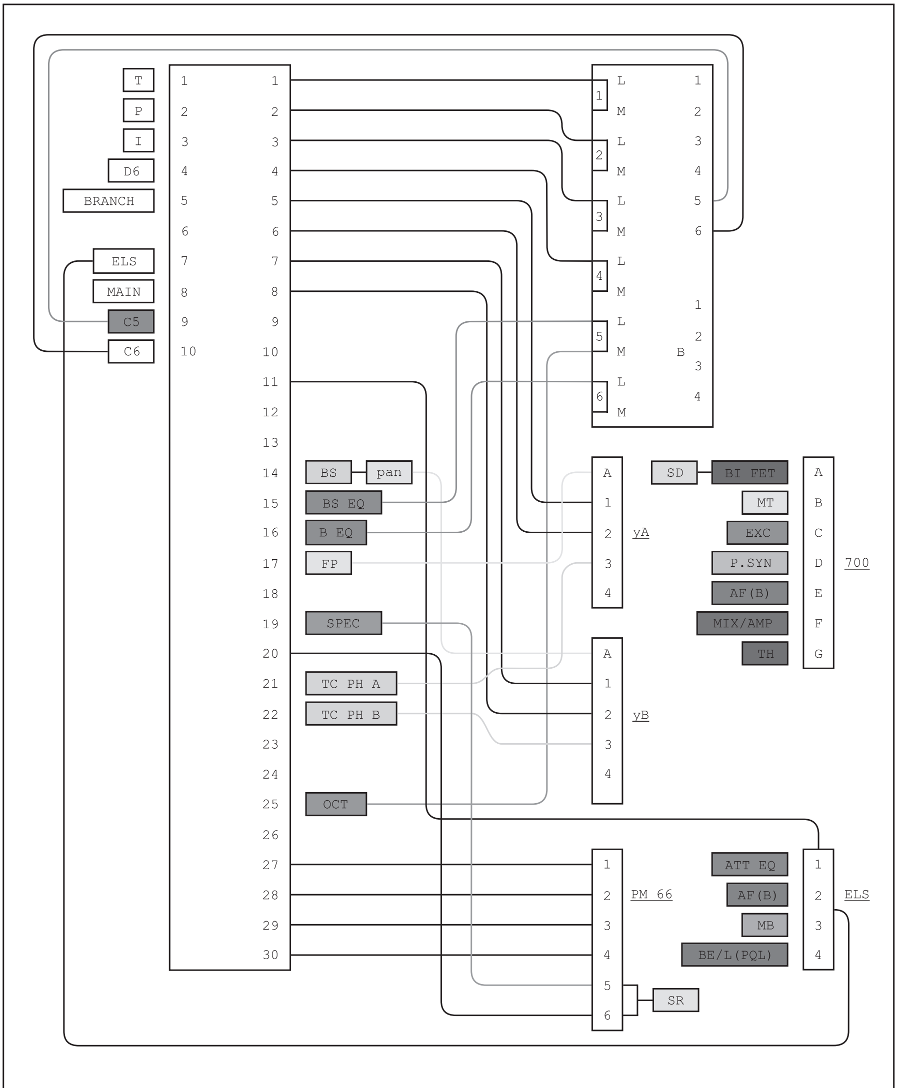

AT EQ
MG
DYN F
AF
P.SYN
A/D
TC PH
OCT
SD
FP
SPEC
BS EQ
6 x 4
SR
D
A
B
WEB II | 11/6/87 | RPI, TROY, NEW YORK | B03E-F07



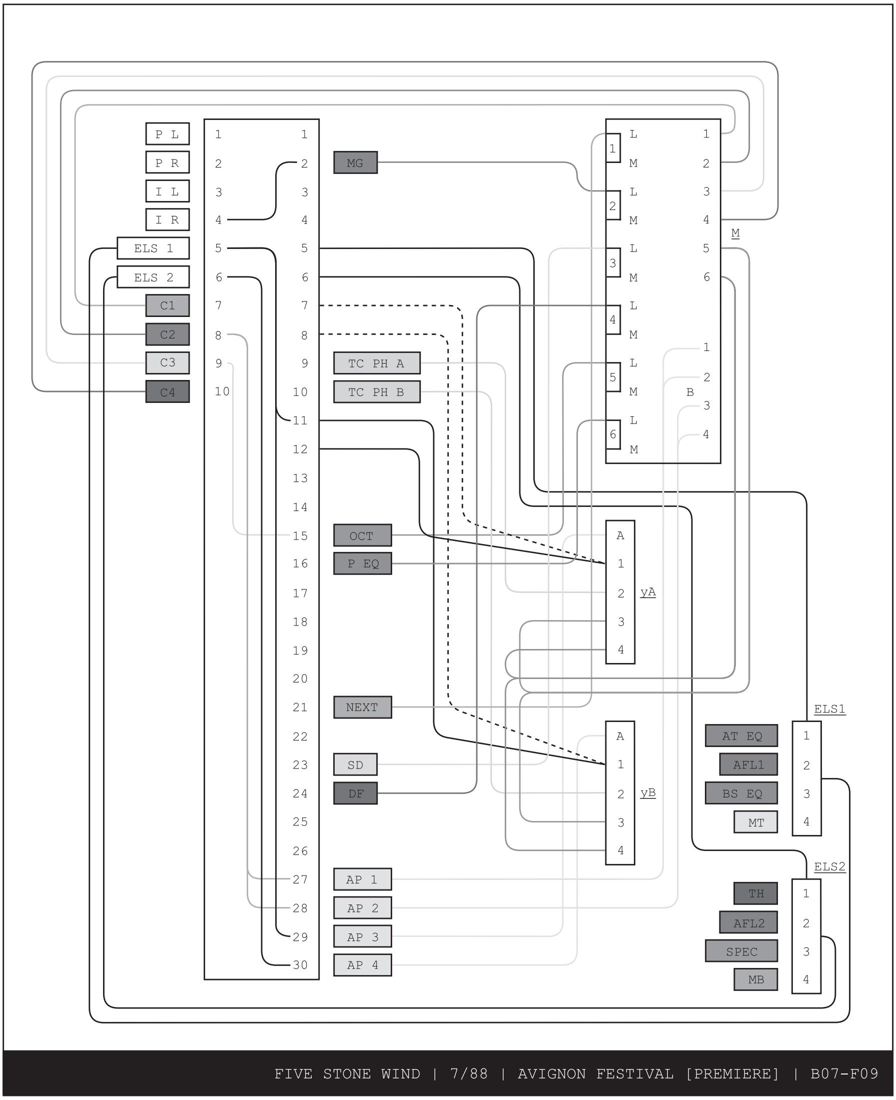
LINES & REFLECTIONS | 5/88 | RHEINISCHES MUSIKFEST, DÜSSELDORF | B03-F17

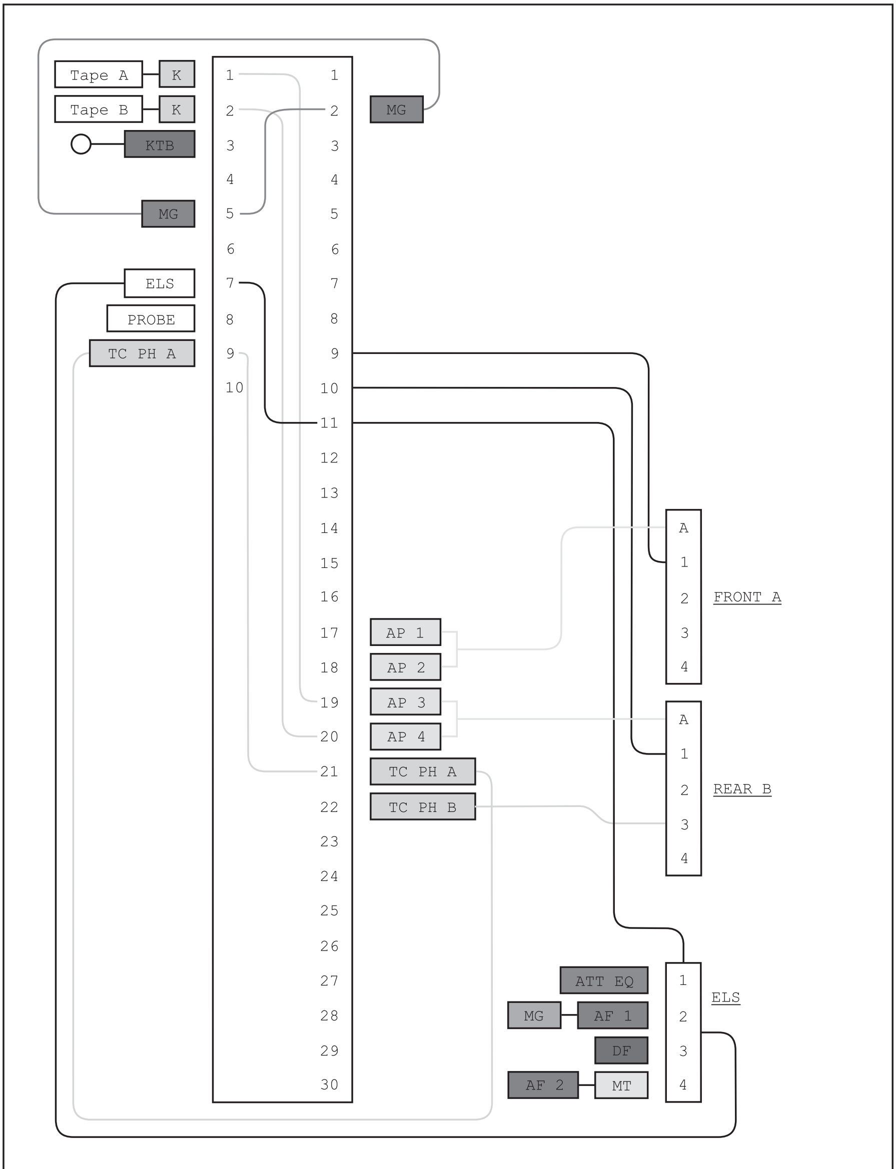


EVENT | 6/24/88 | LEVERKUSEN | B04-F05

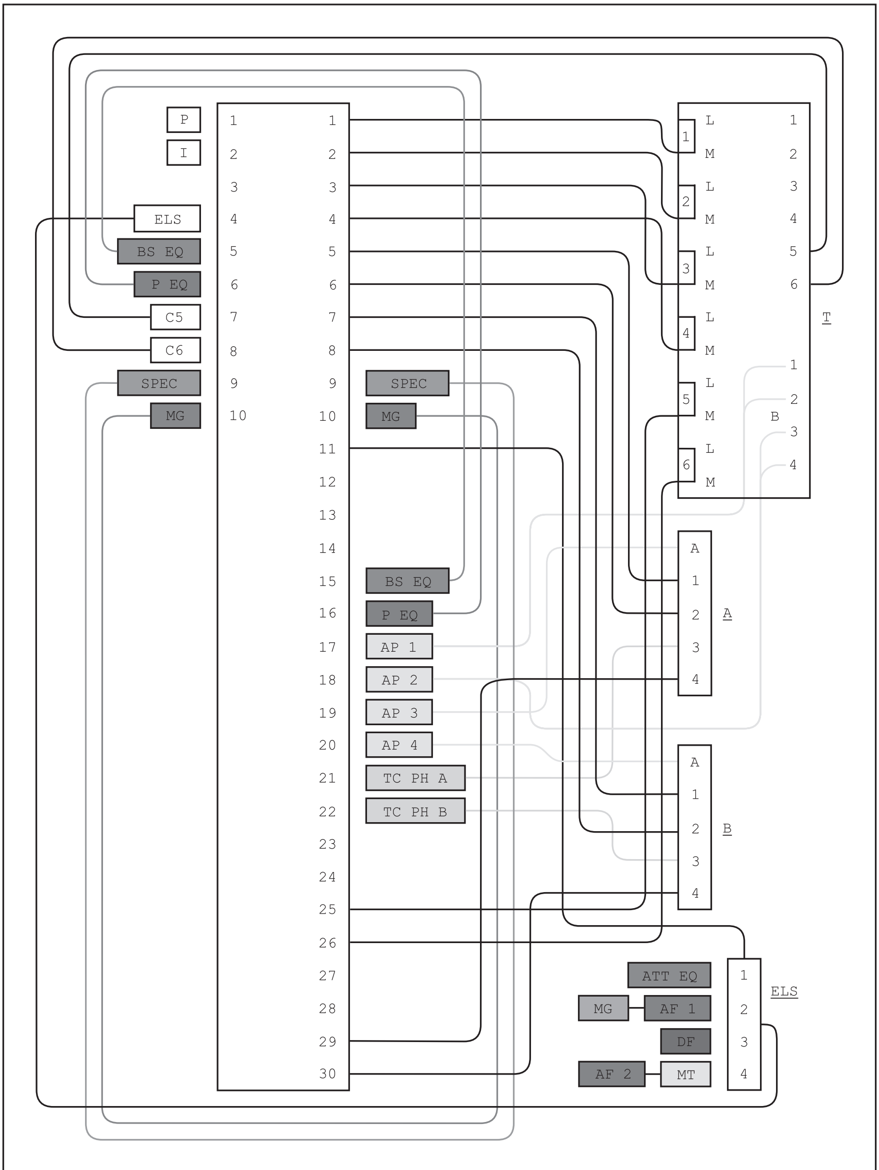


WEBWORK | 7/88 | AMERICAN DANCE FESTIVAL, DURHAM | B03E-F08

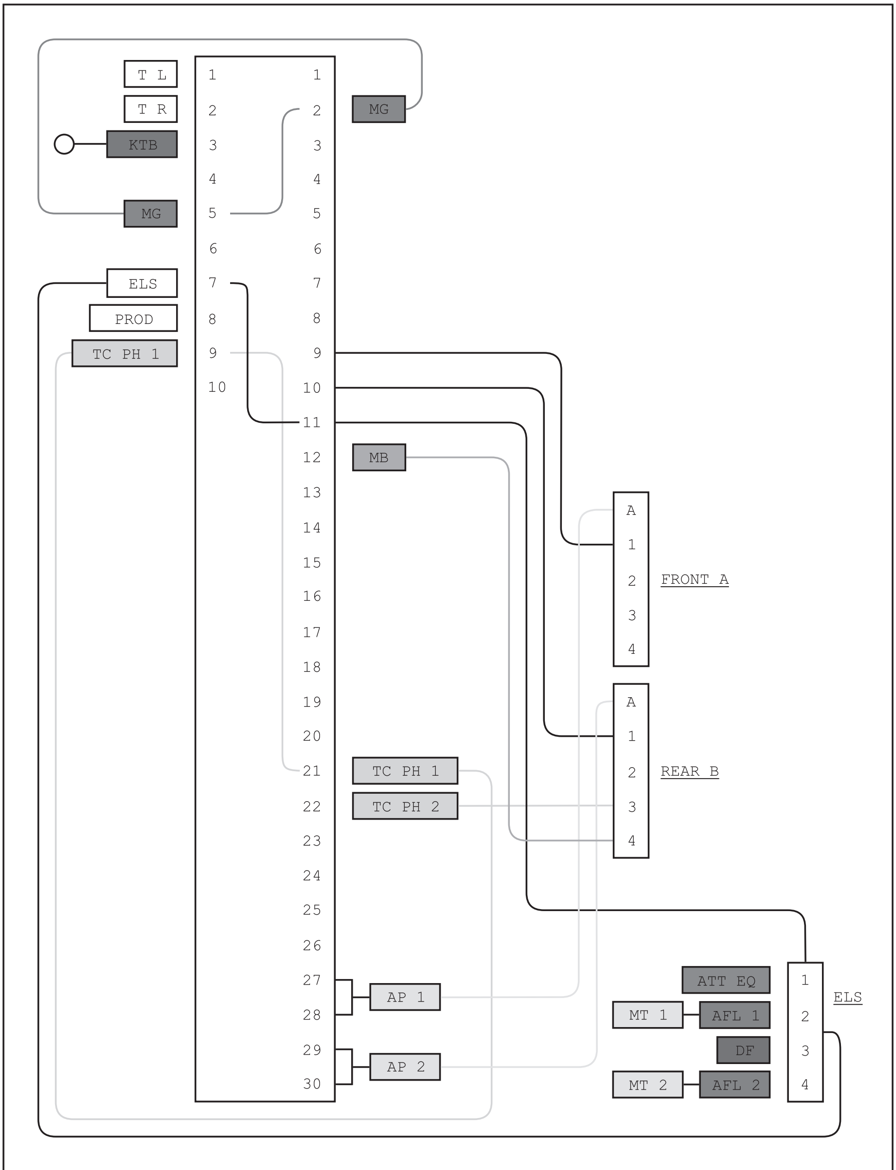

P L
P R
I L
I R
ELS 1
ELS 2
C1
C2
C3
C4
MG
TC PH A
TC PH B
OCT
P EQ
NEXT
SD
DF
AP 1
AP 2
AP 3
AP 4
M
B
yA
yB
ELS1
ELS2
AT EQ
AFL1
BS EQ
MT
TH
AFL2
SPEC
MB
FIVE STONE WIND | 7/88 | AVIGNON FESTIVAL [PREMIERE] | B07-F09



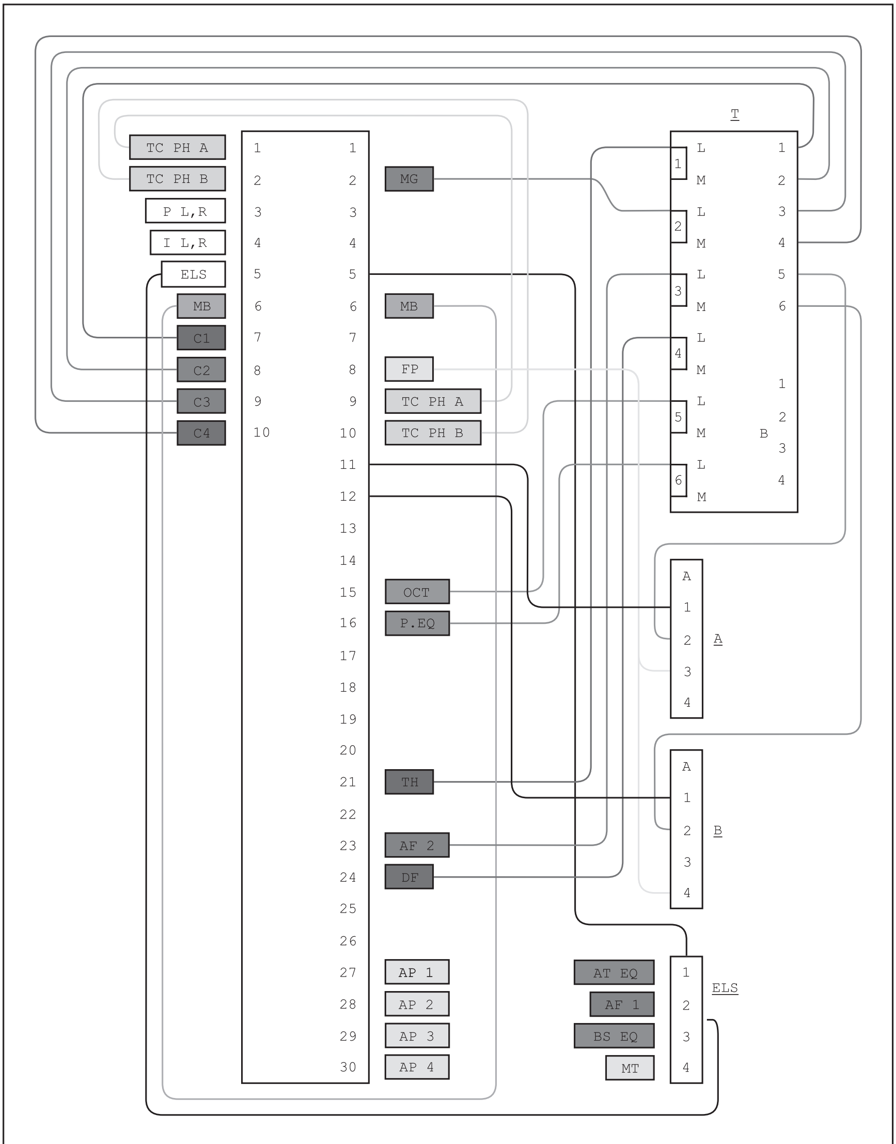
WEB II | 12/8/88 | HEIDELBERGER FESTIVAL, HEIDELBERG | B03E-F07



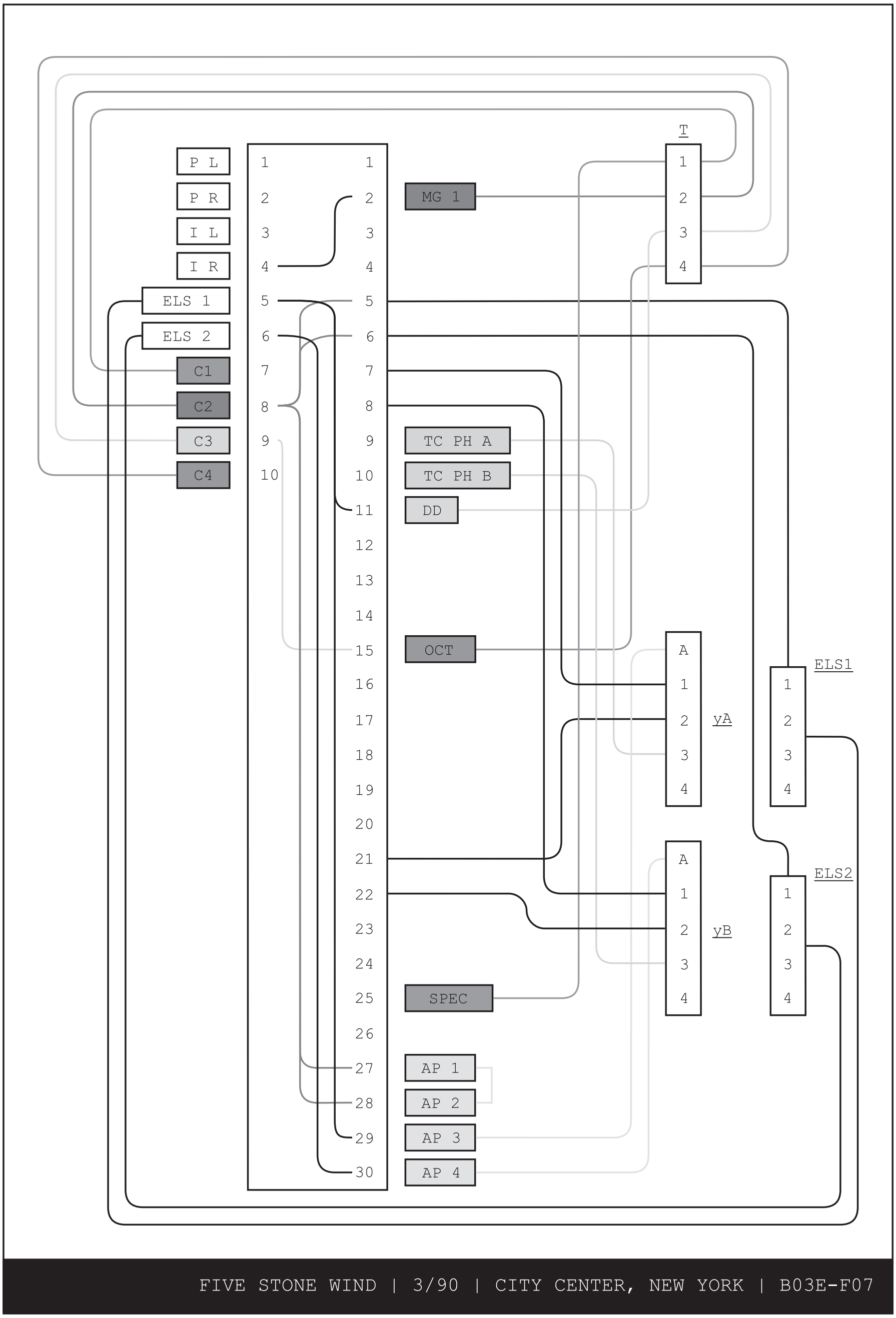
WEB II | 12/88 | HEIDELBERGER FESTIVAL, HEIDELBERG | B03E-F07



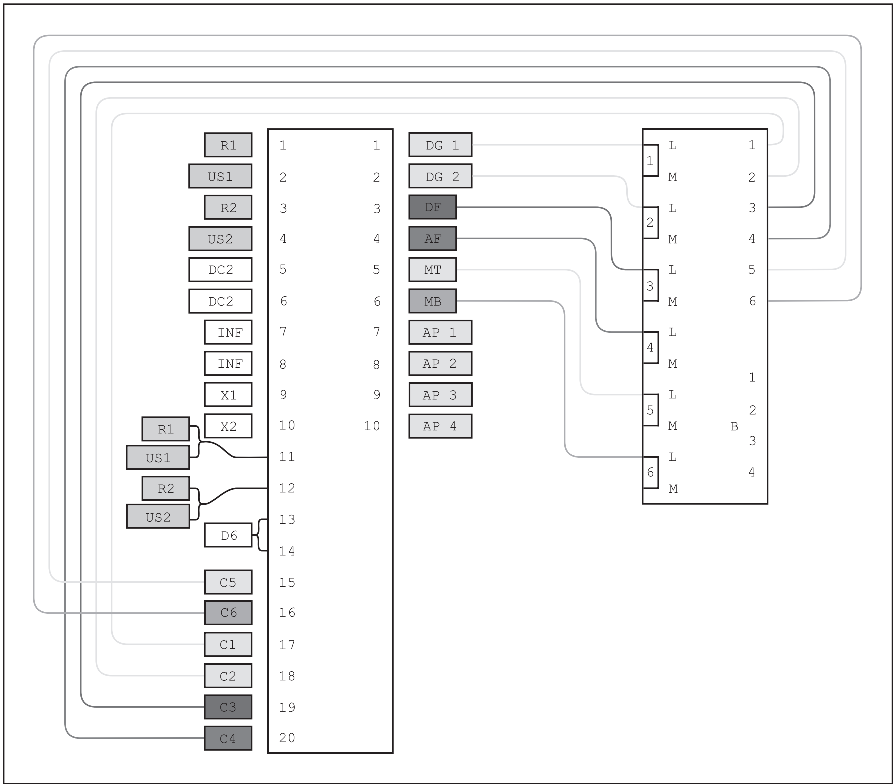
WEB II | 4/19/89 | ALTERNATIVE MUSEUM, NEW YORK | B03E-F07



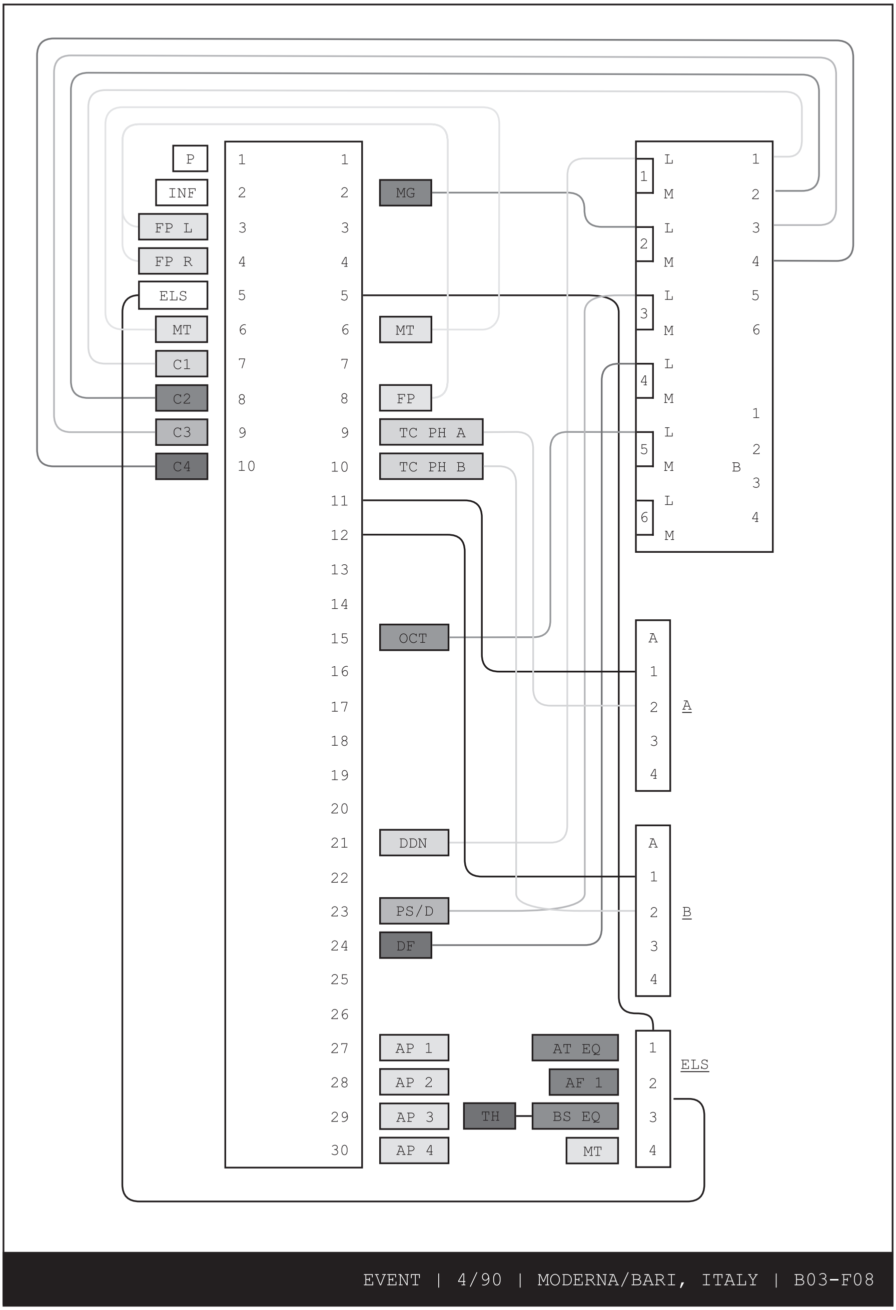
EVENT | 7/89 | EUROPE TOUR | B03-F08



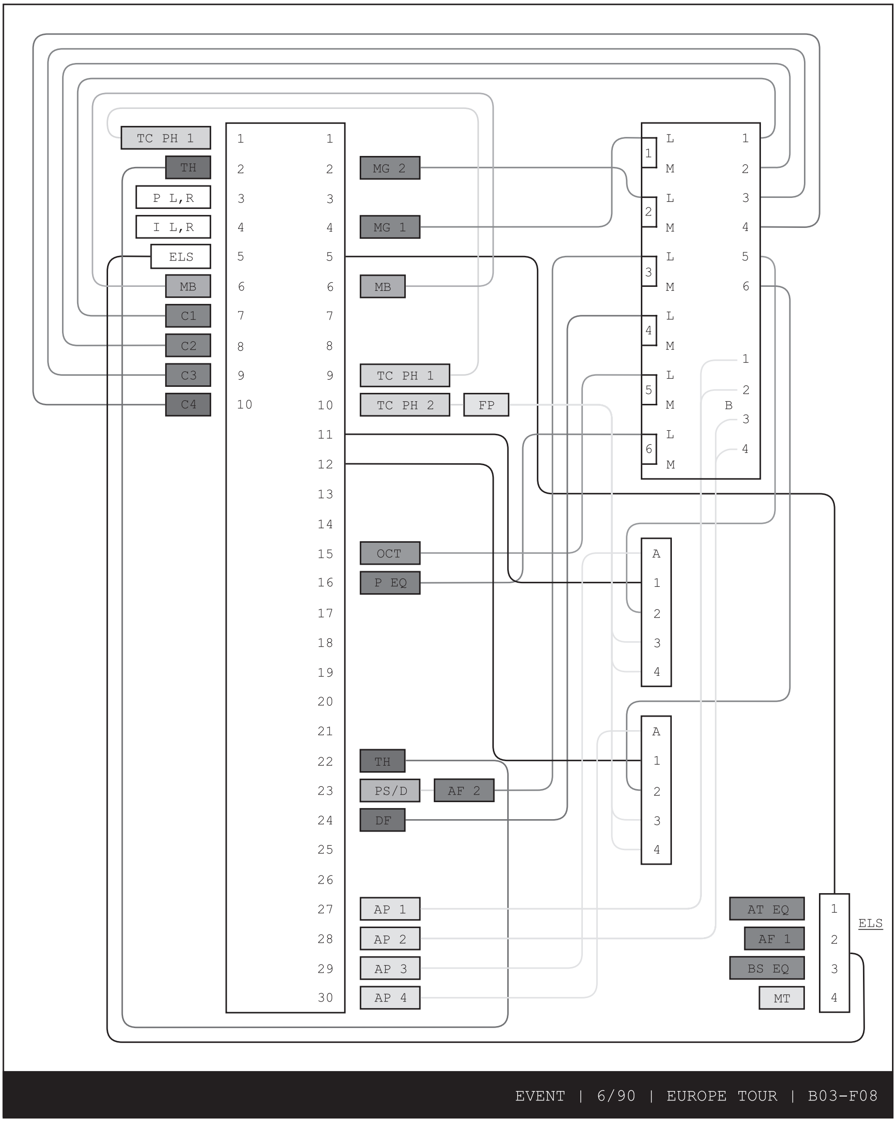
T
P L
P R
I L
I R
ELS 1
ELS 2
C1
C2
C3
C4
1 2 3 4 5 6 7 8 9 10
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
MG 1
TC PH A
TC PH B
DD
OCT
SPEC
AP 1
AP 2
AP 3
AP 4
yA
yB
ELS1
ELS2
A 1 2 3 4
FIVE STONE WIND | 3/90 | CITY CENTER, NEW YORK | B03E-F07

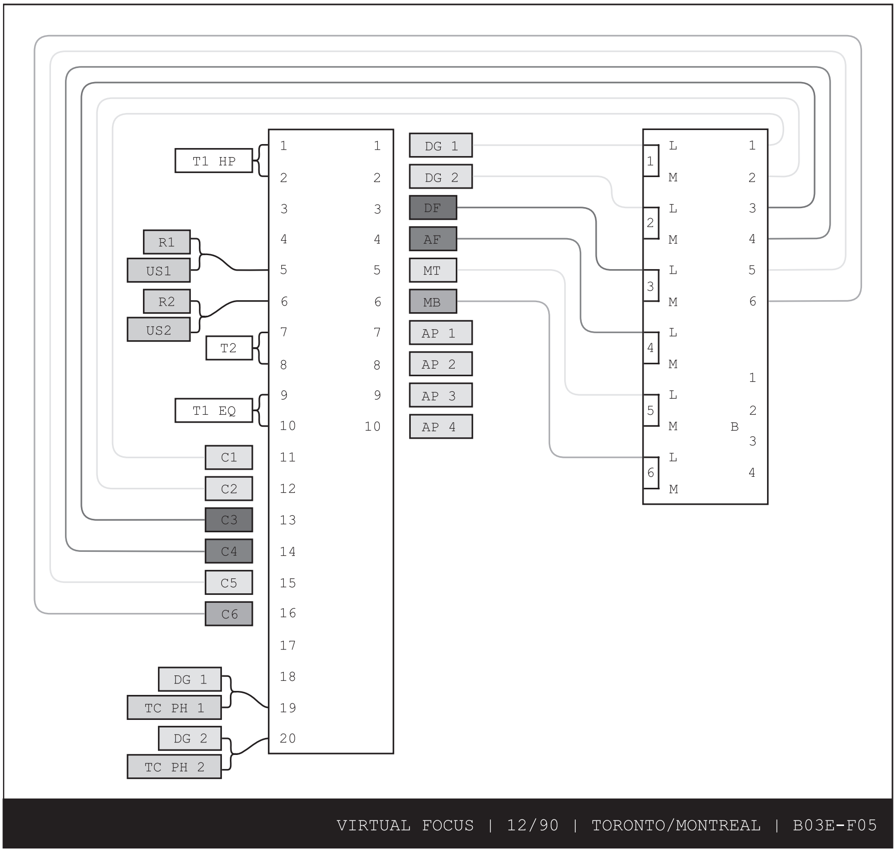


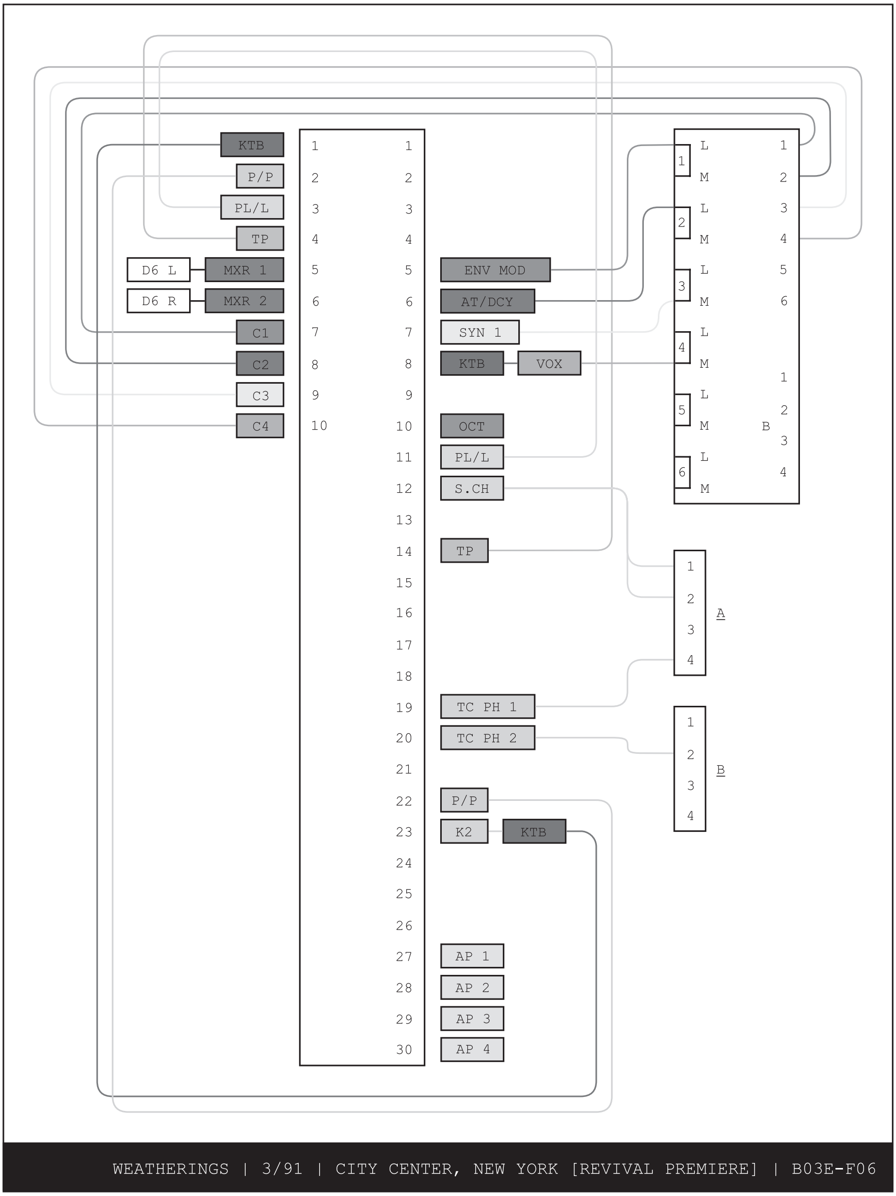
VIRTUAL FOCUS | 3/90 | CITY CENTER, NEW YORK [PREMIERE] | B03E-F05



P
INF
FP L
FP R
ELS
MT
C1
C2
C3
C4
1 2 3 4 5 6 7 8 9 10
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
MG
MT
FP
TC PH A
TC PH B
OCT
DDN
PS/D
DF
AP 1
AP 2
AP 3
AP 4
TH
AT EQ
AF 1
BS EQ
MT
1 2 3 4 5 6
L M L M L M L M L M L M
1 2 3 4 5 6
B
1 2 3 4
A 1 2 3 4
A
A 1 2 3 4
B
1 2 3 4
ELS
EVENT | 4/90 | MODERNA/BARI, ITALY | B03-F08


TC PH 1
TH
P L,R
I L,R
ELS
MB
C1
C2
C3
C4
MG 2
MG 1
MB
TC PH 1
TC PH 2
FP
OCT
P EQ
TH
PS/D
AF 2
DF
AP 1
AP 2
AP 3
AP 4
B
A
AT EQ
AF 1
BS EQ
MT
ELS
EVENT | 6/90 | EUROPE TOUR | B03-F08


T1 HP
R1
US1
R2
US2
T2
T1 EQ
C1
C2
C3
C4
C5
C6
DG 1
TC PH 1
DG 2
TC PH 2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
1 2 3 4 5 6 7 8 9 10
DG 1
DG 2
DF
AF
MT
MB
AP 1
AP 2
AP 3
AP 4
1 2 3 4 5 6
L M L M L M L M L M L M
1 2 3 4 5 6
B
1 2 3 4
VIRTUAL FOCUS | 12/90 | TORONTO/MONTREAL | B03E-F05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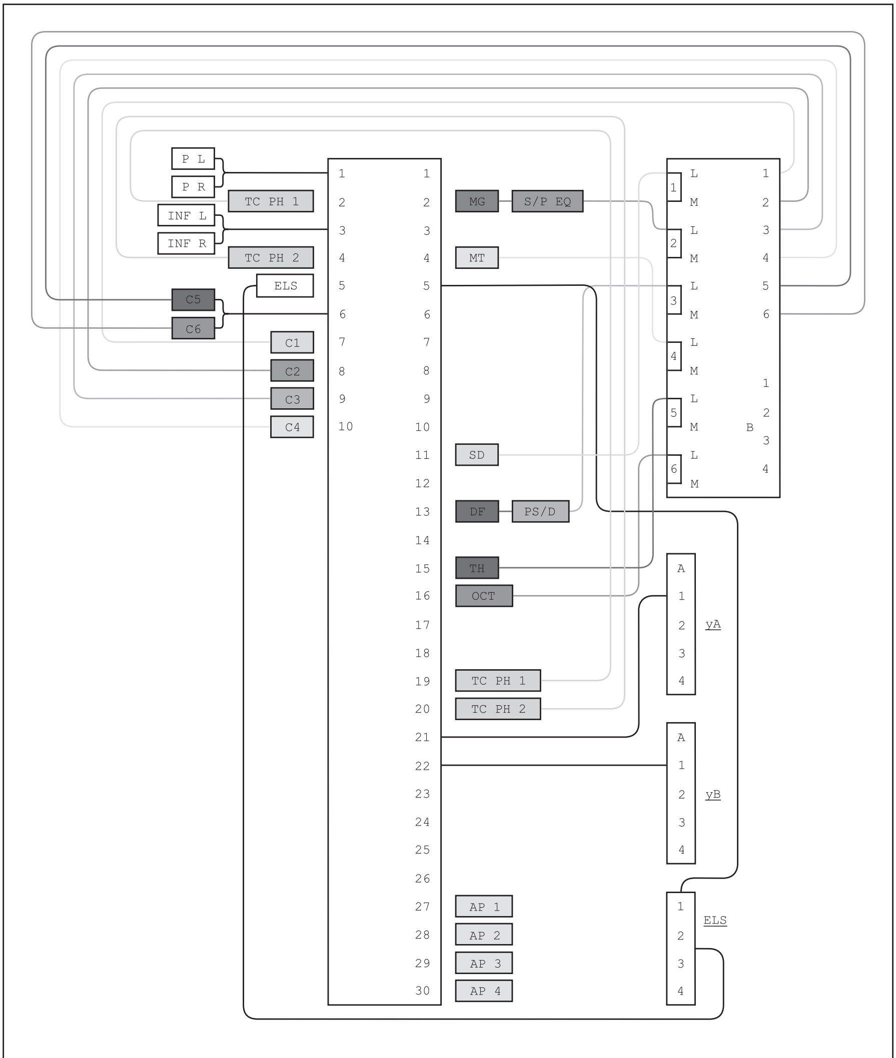
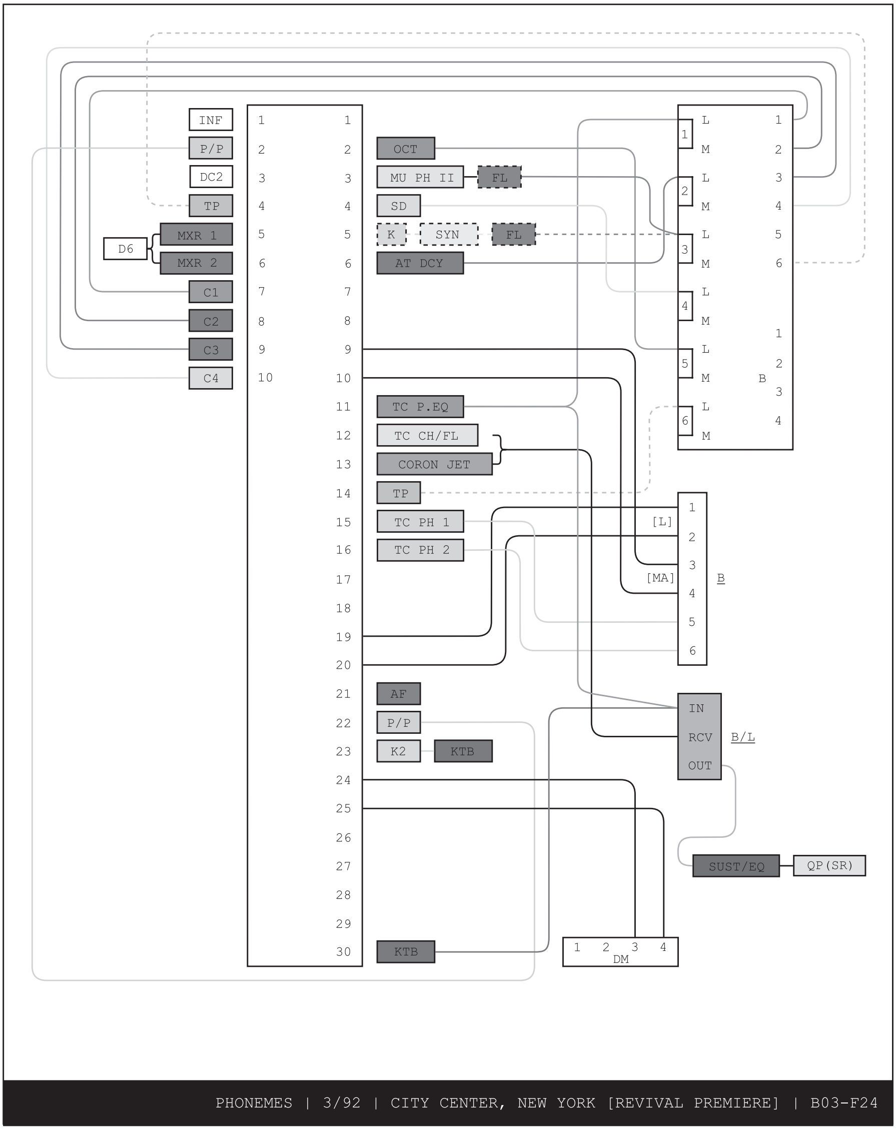
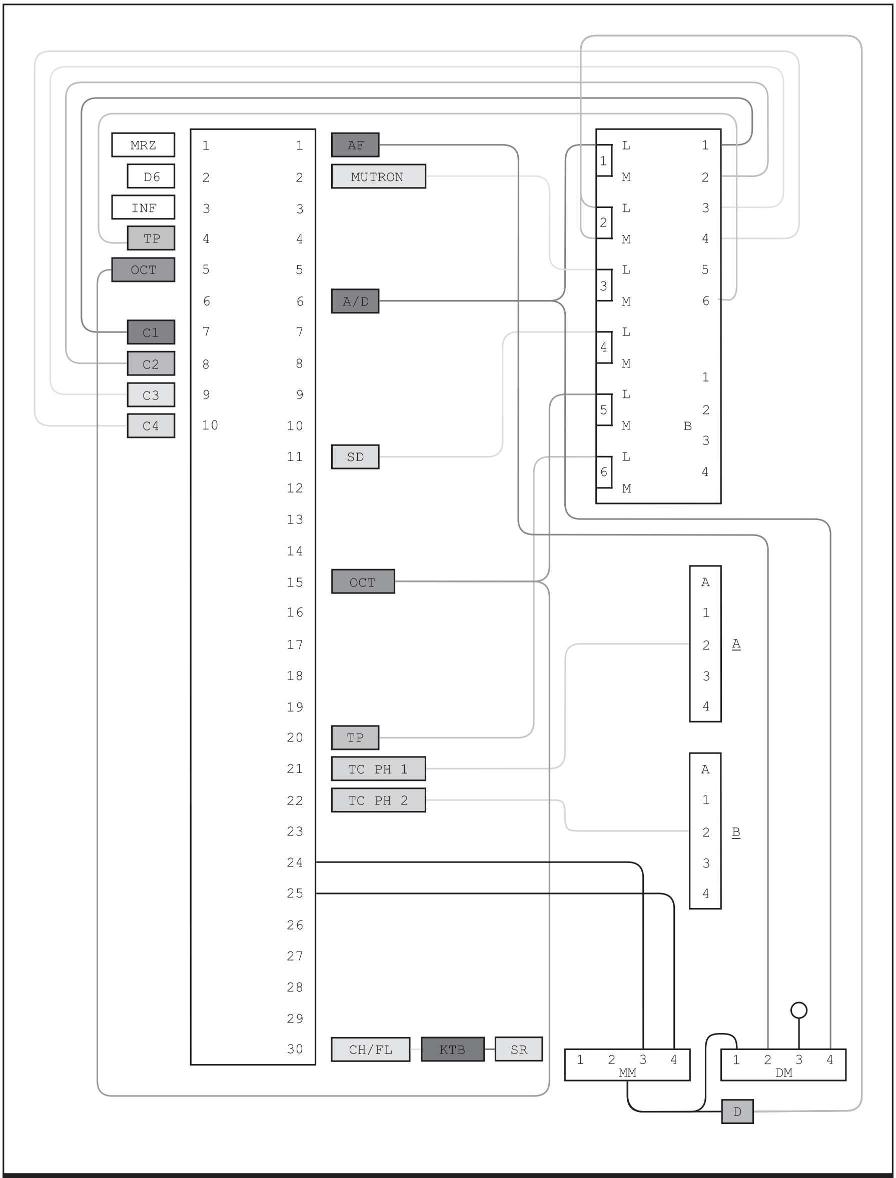
P/P
PL/L
TP
D6 L
MXR 1
D6 R
MXR 2
C1
C2
C3
C4
ENV MOD
AT/DCY
SYN 1
KTB
VOX
OCT
PL/L
S.CH
TP
TC PH 1
TC PH 2
P/P
K2
KTB
AP 1
AP 2
AP 3
AP 4
A
B
WEATHERINGS | 3/91 | CITY CENTER, NEW YORK [REVIVAL PREMIERE] | B03E-F06

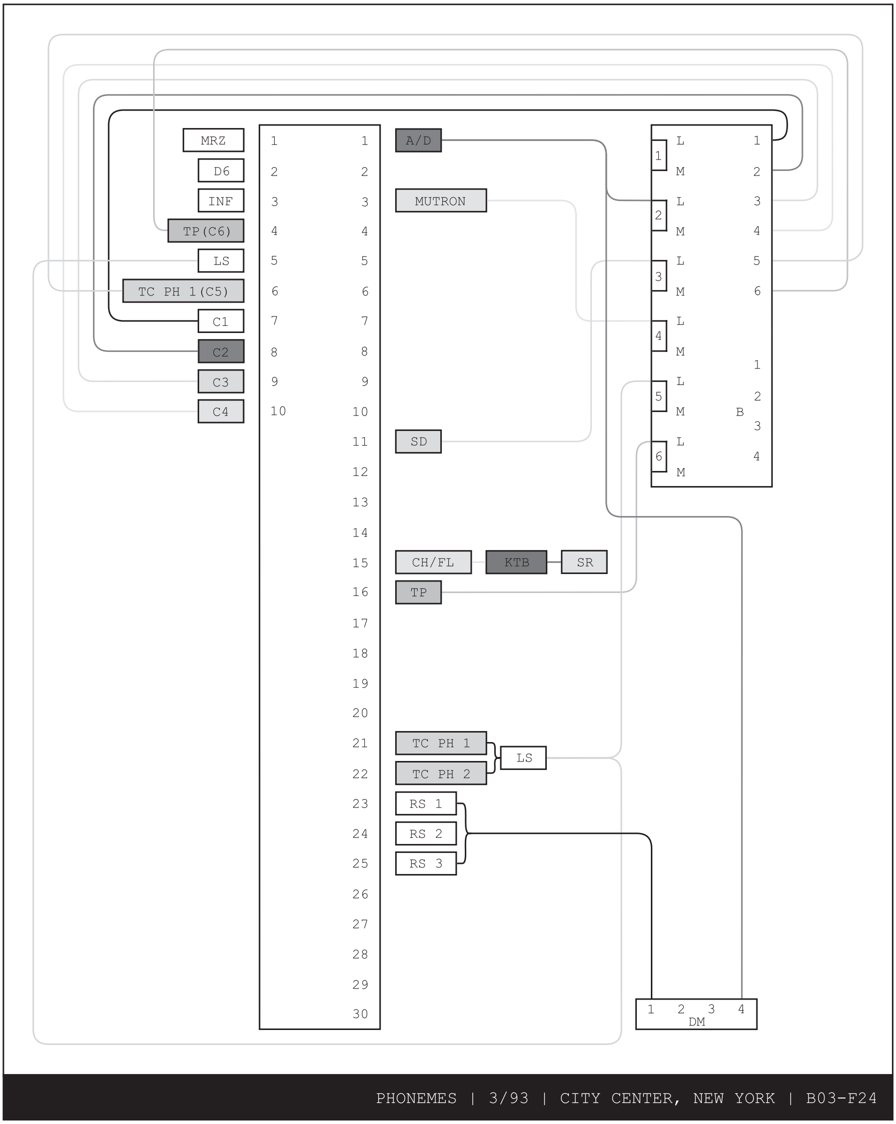


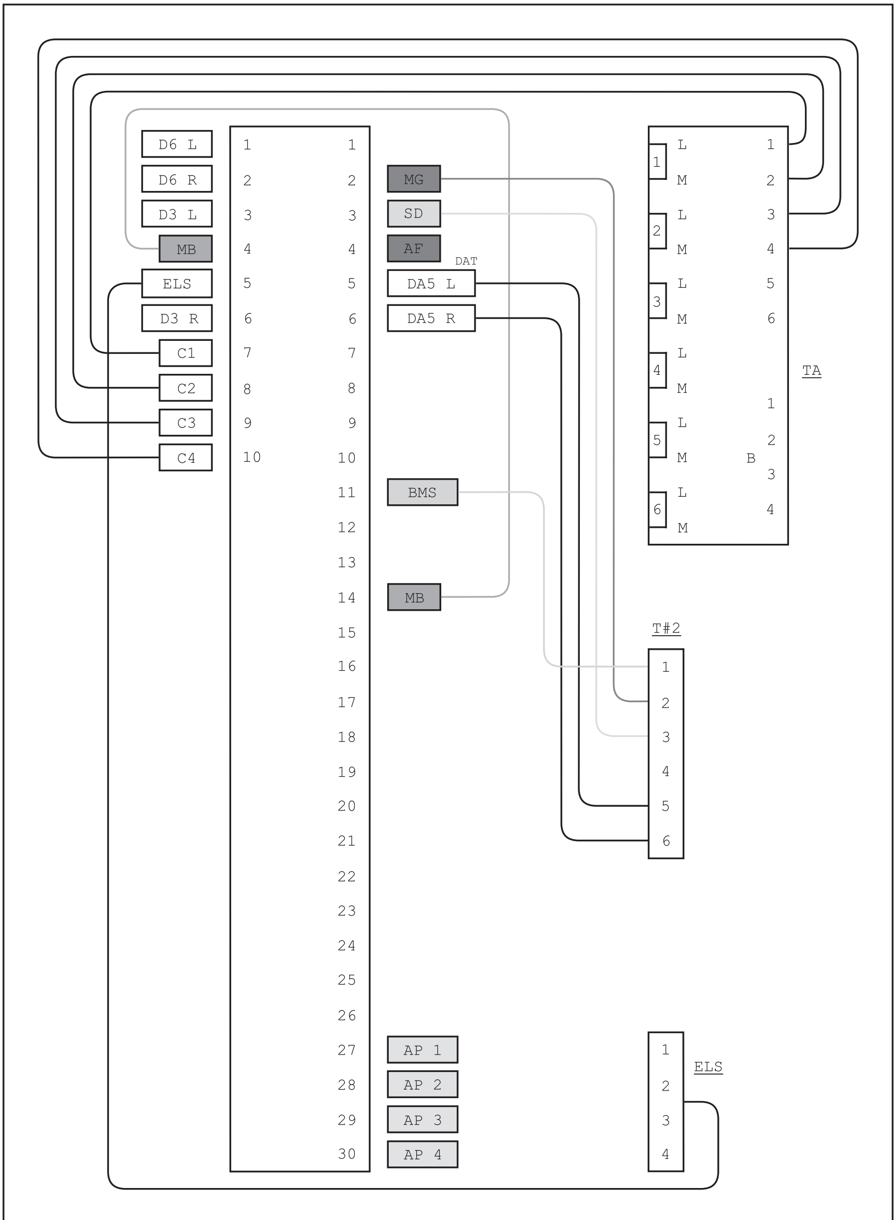
VIRTUAL FOCUS | 4/91 | STORA TEATERN, STOCKHOLM [LAST PERFORMANCE] | B03E-F05


INF
P/P
DC2
TP
D6
MXR 1
MXR 2
C1
C2
C3
C4
OCT
MU PH II
FL
SD
K
SYN
FL
AT DCY
TC P.EQ
TC CH/FL
CORON JET
TP
TC PH 1
TC PH 2
AF
P/P
K2
KTB
KTB
[L]
[MA]
B
IN
RCV
OUT
B/L
SUST/EQ
QP(SR)
DM
PHONEMES | 3/92 | CITY CENTER, NEW YORK [REVIVAL PREMIERE] | B03-F24

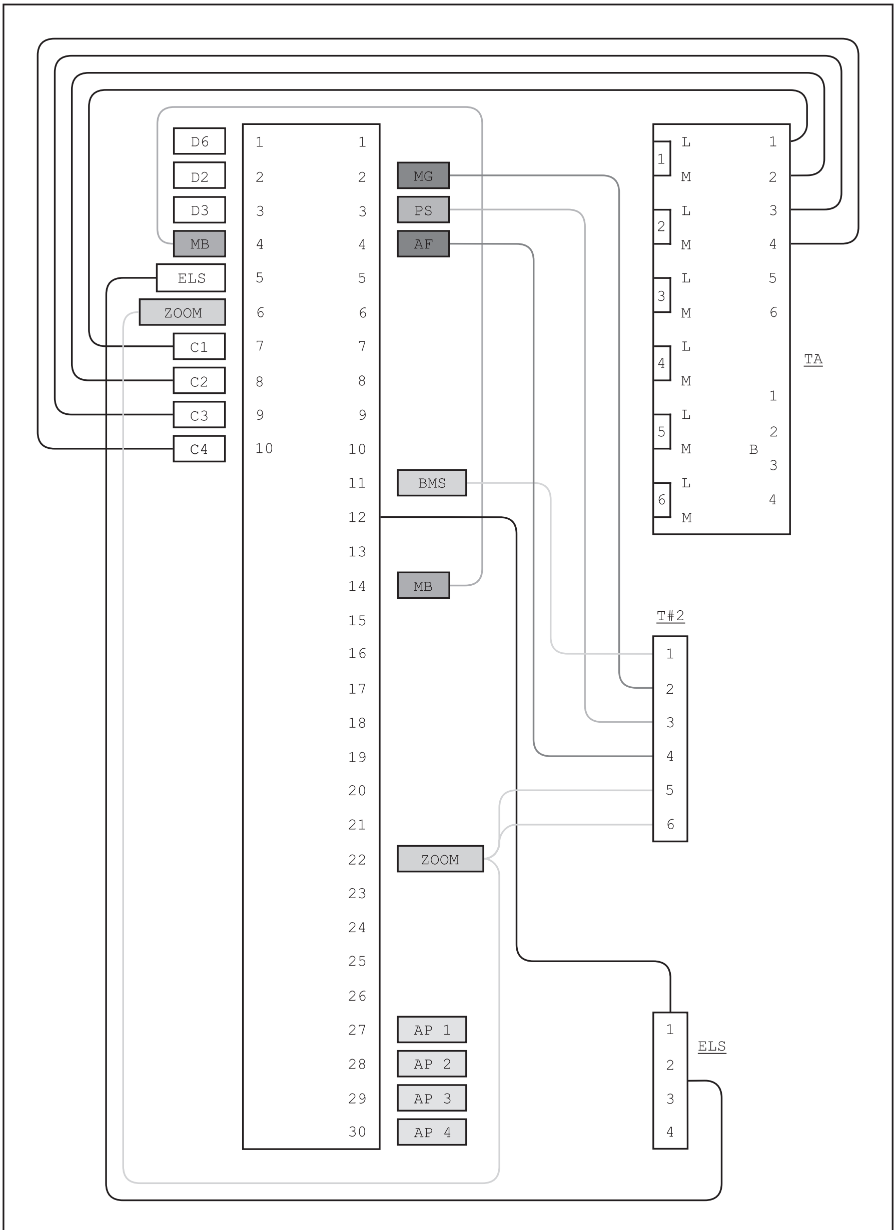


PHONEMES | 9/19/92 | FRANKFURT OPERA, FRANKFURT | B03-F24

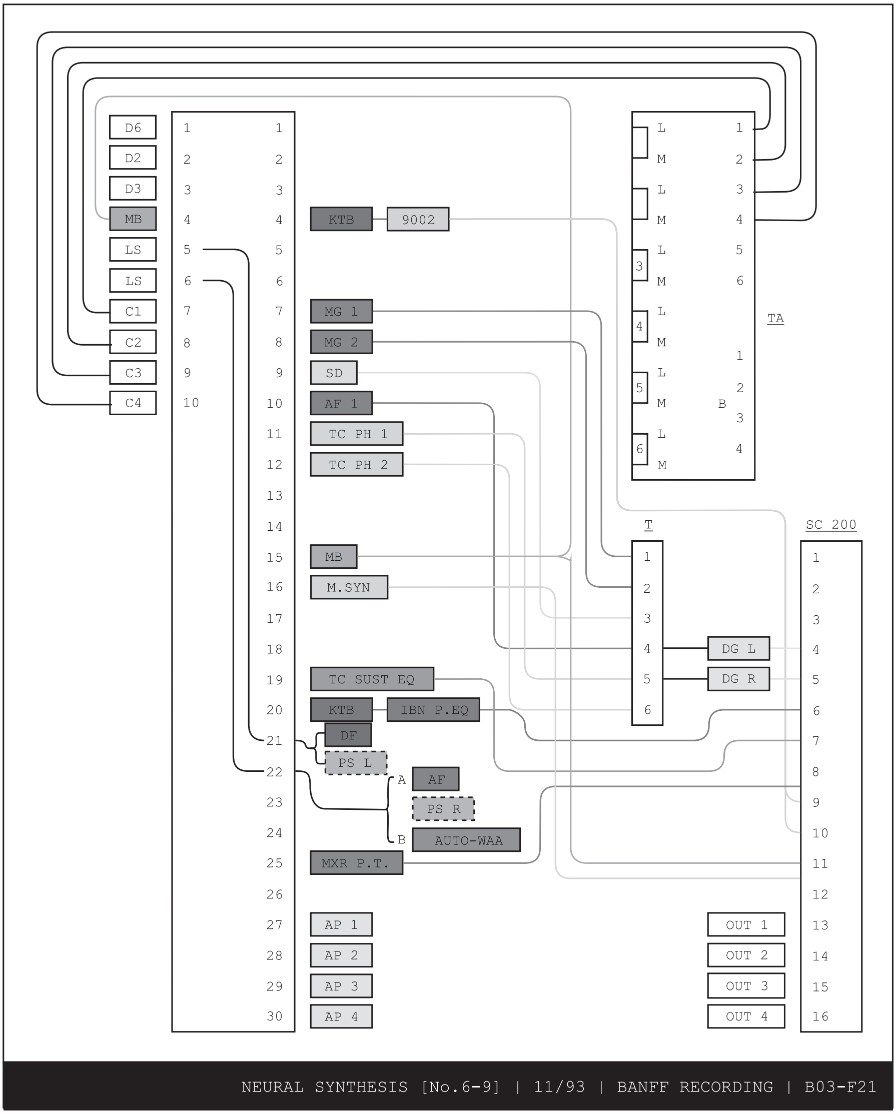

MRZ
D6
INF
TP(C6)
LS
TC PH 1(C5)
C1
C2
C3
C4
A/D
MUTRON
SD
CH/FL
KTB
SR
TP
TC PH 1
TC PH 2
LS
RS 1
RS 2
RS 3
B
DM
PHONEMES | 3/93 | CITY CENTER, NEW YORK | B03-F24



FIVE STONE WIND | 10/14/93 | FYLKINGEN, STOCKHOLM | B03-F21



NEURAL SYNTHESIS | 10/15/93 | FYLKINGEN, STOCKHOLM | B03-F21


D6
D2
D3
MB
LS
LS
C1
C2
C3
C4
KTB
9002
MG 1
MG 2
SD
AF 1
TC PH 1
TC PH 2
MB
M.SYN
TC SUST EQ
KTB
IBN P.EQ
DF
PS L
AF
PS R
AUTO-WAA
MXR P.T.
AP 1
AP 2
AP 3
AP 4
TA
T
SC 200
DG L
DG R
OUT 1
OUT 2
OUT 3
OUT 4
NEURAL SYNTHESIS [No.6-9] | 11/93 | BANFF RECORDING | B03-F21

Bibliography

A: Interviews/Conversations/Emails

A-1: With Tudor (in chronological order)

John Cage and David Tudor, "Interview by Gordon Mumma and Ed Burroughs [audio recording]," WUOM radio, Ann Arbor, May 16, 1960 (CD4 Interviews, CCM archive, Mills College).

KPFA Radio, "Interview with John Cage and David Tudor [audio recording]," May 29, 1972, Other Minds Audio Archive, accessed December 15, 2019: http://archive.org/details/am_1972_05_29. Partial transcript available at: http://remindedbytheinstruments.info

David Tudor and Victor Schonfield, "From Piano to Electronics," *Music and Musicians* 20 (August 1972), 24–26.

David Tudor, "Interview by Billy Klüver (November 24, 1978)," in E.A.T., "*Island Eye Island Ear*: A Sound and Cloud Environment on Boulder Island (January 11, 1979), Appendix I," Box 21, Folder 8, David Tudor Papers, GRI; draft transcription: Tudor, "Interview by Klüver (draft)," Box 111, Folder 25, Experiments in Art and Technology records, GRI.

WBFO, "Interview with David Tudor, John Driscoll, Ralph Jones, and Martin Kalve of Composers Inside Electronics, 'Plastic' [title of show] with host Mark Fruehauf [audio recording]," December 5, 1978, private collection of John Driscoll.

Massimo Villa and Stefano Bonagura, "Incontri: David Tudor: nei meandri del possibile," *Fare Musica*, Rome, Italy, December 1980, 27–29 (Box 65, Folder 7, David Tudor Papers, GRI).

David Tudor, "Tape-recorded interview with Austin Clarkson," Stony Point, NY, October 4, 1982 (Box 65, Folder 11, David Tudor Papers, GRI); abbreviated version published as: Austin Clarkson, "Composing the Performer: David Tudor Remembers Stefan Wolpe," *Musicworks* 73 (Spring 1999), 26–32; another version in: "Recollections of Stefan Wolpe," compiled by Clarkson, Wolpe.org, accessed December 15, 2019: http://www.wolpe.org/page10/page10.html#David%20Tudor

David Tudor, "'... performing is very much like cooking: putting it all together, raising the temperature,' Interview by John David Fullemann," Stockholm, Sweden, September 3, 1984, davidtudor.org, accessed December 15, 2019: http://davidtudor.org/Articles/fullemann.html; transcript in: Box 66, Folder 3, David Tudor Papers, GRI; German translation by Peter Behrendsen published as: "Composer Inside Electronics: David Tudor im Gespräch mit John David Fullemann," *MusikTexte: Zeitschrift für Neue Musik* 15 (July 1986), 11–19 (copy in Box 66, Folder 3, David Tudor Papers, GRI); also republished as: "Composer Inside Electronics: David Tudor im Gespräch mit John David Fullemann," *Schwarzer Faden* (January 2001), 52–58.

David Tudor, "Presenting David Tudor: A Conversation with Bruce Duffie," Chicago, IL, April 7, 1986, bruceduffie.com, accessed December 15, 2019: http://www.bruceduffie.com/tudor3.html

David Tudor, "Interview with Peter Dickinson," Ibis Hotel, London, July 26, 1987, *CageTalk: Dialogues with and about John Cage*, edited by Peter Dickinson (Rochester, NY: University of Rochester Press, 2006), 81–92.

David Tudor, "'I smile when the sound is singing through the space': An Interview with David Tudor by Teddy Hultberg," Düsseldorf, May 17–18, 1988, davidtudor.org, accessed December 15, 2019: http://davidtudor.org/Articles/hultberg.html; transcript in Box 66, Folder 7, David Tudor Papers, GRI.

David Tudor, “Workshop, Tudor, etc., June 14, 1988, Radio 100 (audio recording),” Box 3A, C157, David Tudor Papers, GRI. Partial transcript available at: http://remindedbytheinstruments.info

David Tudor, “Interview by Olivier Masson and Franck Roméro, Grenoble, November 24, 1988,” *Revue et Corrigée* 2 (Spring 1989), 8–10 (Box 65, Folder 7, David Tudor Papers, GRI); Italian translation published as: Tudor, “Intrevista,” *auditorium: trimestrale di musica, musicisti e strumenti*, anno II numero 4 (I trimestre 1990) (Box 66, Folder 10, David Tudor Papers, GRI).

David Tudor and Larry Austin, “A Conversation,” Denton, TX, April 3, 1989, davidtudor.org, accessed December 15, 2019: http://davidtudor.org/Articles/austin.html

David Tudor, “Interview by Julie Martin,” Stony Point, January 26, 1992, Billy Klüver/Julie Martin Archive. Partial transcript available at: http://remindedbytheinstruments.info

John Holzaepfel, “Reminiscences of a Twentieth-Century Pianist: Interview with David Tudor, Stony Point, New York, August 3, 1992,” Box 67, Folder 2, David Tudor Papers, GRI; published as: “Reminiscences of a Twentieth-Century Pianist: An Interview with David Tudor,” *Musical Quarterly* 78, no. 3 (1994), 626–636; also archived as: Tudor, “Interview by John Holzaepfel, Stony Point, NY, August 3, 1992 (241 m-q),” *Oral History of American Music*, Yale University Library.

David Tudor, “Interview by Joel Chadabe,” Tomkins Cove, NY, September 8, 1993, davidtudor.org, accessed December 15, 2019: http://davidtudor.org/Articles/chadabe.html

David Tudor, “Interview by Matt Rogalsky,” Tomkins Cove, NY, March 28, 1994, davidtudor.org, accessed December 15, 2019: http://davidtudor.org/Articles/rogalsky_inter2.html; also in: Rogalsky, “‘… in rehearsals, or preparation, or setup, or from one performance to another’: Live Electronic Music Practice and Musicians of the Merce Cunningham Dance Company,” MA thesis, Wesleyan University, 1995, 116–134.

David Tudor, “Interview by Jack Vees, Stony Point, NY, July 12, 1995 (241 r),” *Oral History of American Music*, Yale University Library.

David Tudor, “Interview by Jack Vees and John D. S. Adams, Stony Point, NY, July 19, 1995 (241 a–d),” *Oral History of American Music*, Yale University Library.

David Tudor, “Interview by Jack Vees, Stony Point, NY, August 6, 1995 (241 e–f),” *Oral History of American Music*, Yale University Library.

David Tudor, “Interview by Jack Vees, Stony Point, NY, September 18, 1995 (241 g–h),” *Oral History of American Music*, Yale University Library.

David Tudor, “Interview by Gustavo Matamoros and Russell Frehling,” Tomkins Cove, NY, October 1995, SFCA [isaw+subtropics] iSAW Media Archive.

David Tudor, “Interview by Jack Vees and Christian Wolff, Stony Point, NY, October 11, 1995 (241 i–j),” *Oral History of American Music*, Yale University Library.

David Tudor, “Interview by Jack Vees and Pauline Oliveros, Stony Point, NY, December 6, 1995 (241 k–l),” *Oral History of American Music*, Yale University Library.

David Tudor, “Interview by Billy Klüver, Barbro Schultz Lundestam (1996) [audio recording],” The Daniel Langlois Foundation for Art, Science, and Technology, 9 Evenings: Theatre and Engineering fonds. 9EVE 00034342.

David Tudor, “To accept what happens: Aufführungsgeschichte als Werkgeschichte , Interview by Christian Scheib,” *Positionen: Texte zur aktuellen Musik* 26 (1996), 36–38.

A-2: With Others (in chronological order)

Christian Wolff, “Interview with Ev Grimes (undated),” *Oral History of American Music*, Yale University.

Christian Wolff, “Interview with Victor Schonfield,” Music and Musicians (May 1969). Also in *Occasional Pieces: Writings and Interviews, 1952–2013*. New York, NY: Oxford University Press, 2017, 37–42.

Ellsworth Snyder, “Interview with Irma Wolpe Rademacher,” New York City, 1975; quoted in Holzaepfel, “David Tudor and the Performance of American Experimental Music,” 5.

Fujiko Nakaya, "Interview by Billy Klüver (November 24, 1978)," in E.A.T., "*Island Eye Island Ear*: A Sound and Cloud Environment on Boulder Island (January 11, 1979), Appendix I," Box 21, Folder 8, David Tudor Papers, GRI.

Bill Womack, "The Music of Contingency: An Interview," *Zero* 3 (1979). Also in *Conversing with Cage* (2nd edition), edited by Richard Kostelanetz. New York, NY: Routledge, 2003, 41–42.

Austin Clarkson, "Interview with Irma Wolpe Rademacher (November 22, 1979)," Recollections of Stefan Wolpe by former students and friends, accessed December 15, 2019: http://ada.evergreen.edu/~arunc/texts/music/wolpe/wolpe/Irma_Wolpe_Rademacher.html

Tom Darter, "John Cage," *Keyboard* 8, no. 9 (1982), 18–29. Also in *Conversing with Cage* (2nd edition), edited by Richard Kostelanetz. New York, NY: Routledge, 2003, 218–219.

Gordon Mumma, "Interview with Vincent Plush (May 17, 1982)," *Oral History of American Music*, Yale University Library.

David Vaughan, "Interview with Jean Erdman, 1983-06-08," Merce Cunningham Dance Foundation Collection, Jerome Robbins Dance Division, The New York Public Library.

Bill Shoemaker, "The Age of Cage," *Down Beat* 51, no. 12 (December 1984). Also in *Conversing with Cage* (2nd edition), edited by Richard Kostelanetz. New York, NY: Routledge, 2003, 225–226.

Peggyann Wachtel, "Meet the Composer: Pauline Oliveros Interview," *EAR (Magazine of New Music)* 12, no. 9 (December–January 1988), 26.

Merce Cunningham, "Interview with John Holzaepfel, 31 July 1989, New York City," quoted in: Holzaepfel, "The Roles of David Tudor in the Early Repertory of the Merce Cunningham Dance Company," in David Vaughan, ed., *Merce Cunningham: Creative Elements, Choreography and Dance.* New York, NY: Routledge, 2013, 48–49.

Christian Wolff, "In a Kind of No-Man's Land: Conversation with Cole Gagne (March 24, 1991)" in *Cues: Writings & Conversations* (Cologne, 1998), 244.

Kurt Schwertsik, "Gespräch III (19. Mai 1993)," in Markus Grassl and Reinhard Kapp, *Darmstadt-Gespräche: Die internationalen Ferienkurse für Neue Musik in Wien* (Wien, Austria: Böhlau, 1996), 39–62.

Gordon Mumma, "Telephone Interview by Matt Rogalsky (November 3, 1994)" in Rogalsky, "Live Electronic Music Practice and Musicians of the Merce Cunningham Dance Company," 136–151.

Anthony Gnazzo, "Interview by Julie Martin [video recording]," Oakland, CA, March 17, 1999, Martin/Klüver archive.

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.

Julie Martin, Vincent Bonin, and Éric Legendre, "Interview with Per Biorn [video recording]," August 25, 2004, Klüver/Martin Archive.

John Yaffe, "An Interview with Composer Earle Brown," *Contemporary Music Review* 26, no. 3–4 (June/August 2007), 289–310.

Christian Wolff and Richard Bernas, "Prof. Christian Wolff in conversation with Richard Bernas (March 24, 2015)," Podcast, New Music Insight Lectures, School of Advanced Study, University of London.

A-3: By You Nakai (in chronological order)

Gordon Mumma, "Conversation with You Nakai," Roulette, New York, NY, March 20, 2011.

Gordon Mumma, "Interview by You Nakai," San Francisco, CA, November 11, 2011.

John Driscoll and Phil Edelstein, "Interview by You Nakai," Long Island, NY, November 19, 2011.

John David Fullemann, "Interview by You Nakai," Skype, December 23, 2011.

Christian Wolff, "Email Interview with You Nakai," February 13, 2012.

Pauline Oliveros, "Interview by You Nakai," Skype, May 29, 2012.

Toshi Ichiyanagi, "Interview by You Nakai," Tokyo, Japan, September 13, 2012.
Forrest Warthman, "Interview by You Nakai," Skype, October 8, 2013.
Fujiko Nakaya, "Interview by You Nakai," Tokyo, Japan, January 7, 2014.
John D.S. Adams, "Interview by You Nakai," Skype, April 9, 2014.
Ritty Burchfield, "Interview by You Nakai and John Driscoll," New York, NY, September 8, 2014.
Lowell Cross, "E-mail Interview with You Nakai," March 5, 2015.
David Behrman, "Interview by You Nakai and John Driscoll," Hudson, NY, May 28, 2015.
Sören Brunes, "Interview by You Nakai and Mats Lindström," Stockholm, Sweden, July 1, 2015.
Gordon Mumma, "Email interview by You Nakai," March 5, 2016.
Gordon Mumma, "Interview by You Nakai," Vancouver, BC, November 4, 2016.
Ron Kuivila, "Private conversation with You Nakai," Middletown, CT, April 22, 2017.
Alvin Lucier, "Interview by You Nakai," Middletown, CT, April 22, 2017.
Joe Kubera, "Interview by Nakai," Staten Island, NY, April 28, 2017.
David Vaughan, "Interview by You Nakai," New York, NY, May 29, 2017.
Molly Davies, "Interview by You Nakai," Skype, August 9, 2017.
Rob Miller, "Interview by You Nakai," Skype, August 17, 2017.
David Meschter, "Interview by You Nakai," Astoria, NY, November 21, 2017.
Tony Martin, "Interview by You Nakai," Brooklyn, NY, January 23, 2018.
Carol Plantamura, "Email interview by You Nakai," February 3, 2018.
John Driscoll and Phil Edelstein, "Conversation with You Nakai," New York, NY, June 19, 2018.
Barbara Mayfield, "Interview by You Nakai," New York, NY, June 20, 2018.
Sophia Ogielska and Andy Ogielski, "Telephone Interview by You Nakai," September 24, 2018.

A-4: Emails (in chronological order)

Michael Johnsen, "Email to You Nakai, John Driscoll, Phil Edelstein, Ron Kuivila, Matt Rogalsky, Matt Wellins," February 11, 2014.
Phil Edelstein, "Email to Julie Martin," October 6, 2014.
John Holzaepfel, "Email to You Nakai," November 19, 2014.
Anthony Gnazzo, "Email to John Bischoff," March 3, 2015.
Nicolas Collins, "Email to Michael Johnsen," March 4, 2015.
Gnazzo, "Email to You Nakai," March 11, 2015.
Alden Jenks, "Email to You Nakai," March 13, 2015.
Ron Kuivila, "Email to Sam Hart, Charles Eppley, Michael Johnsen, and You Nakai," June 10, 2015.
Julie Martin, "Email to You Nakai, Jacob Kierkegaard, John Driscoll, and Phil Edelstein," September 9, 2015.
Michael Johnsen, "Email to You Nakai," December 4, 2015.
John Holzaepfel, "Email to You Nakai," January 3, 2016.
Johnsen, "Email to You Nakai and Ron Kuivila," April 21, 2016.
Holzaepfel, "Email to You Nakai," November 16, 2017.
Johnsen, "Email to You Nakai," July 30, 2018.
Julie Martin, "Comment on the Manuscript of *Reminded by the Instruments*," January 2, 2019.
Johnsen, "Comment on the Manuscript of *Reminded by the Instruments*," January 12, 2019.

B: Archival Material (Paper)

B-1: Correspondence (listed in alphabetical order by author)

Art Becofsky, "Letter to David Tudor (January 13, 1989)," Box 26, Folder 11, David Tudor Papers, GRI.

Michael von Biel, "Letter to David Tudor (July 2, 1962)," Box 51, Folder 7, David Tudor Papers, GRI.
Sylvano Bussotti, "Letter to David Tudor (May 22, 1959)," Box 51, Folder 8, David Tudor Papers, GRI.
John Cage, "Letter to Tudor (July 27, 1960)," Box 52, Folder 3, David Tudor Papers, GRI.
John Cage, "Letter to Lawrence Morton (January 4, 1961)," *Selected Letters*, 239.
John Cage, "Letter to Miss Epstein (April 23, 1961)," *Selected Letters*, 242.
John Cage, "Letter to Peter Yates (September 11, 1961)," *Selected Letters*, 248.
John Cage, "Letter to Hans Heinz Stuckenschmidt (January 2, 1963)," *Selected Letters*, 280.
John Cage, "Letter to Edward Downes (March 31, 1965)," *Selected Letters*, 315.
John Cage, "Letter to John L. Kennedy (April 24, 1966)," in *Selected Letters*, 342.
John Cage, "Letter to Billy Klüver (September 2, 1966)," Box 2, Folder 1, Experiments in Art and Technology records, GRI.
John Cage, "Letter to Walter Hinrichsen (March 3, 1968)," *Selected Letters*, 382.
John Cage, "Letter to Daniel Alpert (September 27, 1968)," *Selected Letters*, 388.
John Cage, "Letter to Hans Otte (February 11, 1971)," reprinted in: "Pro Musica Nova 1972 Program," Box 77, Folder 8, David Tudor Papers, GRI.
John Cage, "Letter to Hans Otte (April 29, 1971)," reprinted in: "Pro Musica Nova 1972 Program," Box 77, Folder 8, David Tudor Papers, GRI.
John Cage, "Letter to Hans Otte (July 27, 1971)," reprinted in: "Pro Musica Nova 1972 Program," Box 77, Folder 8, David Tudor Papers, GRI.
Lowell Cross, "Letter to Vernon J. Fowler (March 13, 1969)," Box 17, Folder 5, David Tudor Papers, GRI.
Lowell Cross, "Letter to David Tudor (October 30, 1969)," Box 52, Folder 7, David Tudor Papers, GRI.
John Driscoll, "Fax to Ron Kuivila (September 5, 1995)," Box 39, Folder 3, David Tudor Papers, GRI.
Marc Farre, "Memorandum (November 9, 1988)," Box 26, Folder 11, David Tudor Papers, GRI.
Getty Center for the History of Art and the Humanities, "Fax to Julie Martin (January 13, 1994)," Box 55, Folder 4, David Tudor Papers, GRI.
H. William Hawke, "Letter to David Tudor (June 12, 1940)," Box 54, Folder 3, David Tudor Papers, GRI.
John Holzaepfel, "Letter to David Tudor (December 18, 1988)," Box 26, Folder 11, David Tudor Papers, GRI.
Mimi Johnson, "Letter to Hans Otte (September 29, 1971)," Box 18, Folder 11, David Tudor Papers, GRI.
Hugh Le Caine, "Letter to John Cage (August 20, 1968)," Gayle Young Collection.
Lew Lloyd, "Letter to David Tudor (April 22, 1966)," Box 55, Folder 9, David Tudor Papers, GRI.
Alvin Lucier, "Letter to David Tudor (October 9, 1966)," Box 55, Folder 10, David Tudor Papers, GRI.
Alvin Lucier, "Letter to David Tudor (February 18, 1974), Box 19, Folder 6, David Tudor Papers, GRI.
Jackie Monnier, "Letter to David Tudor (June 28, 1974)," Box 56, Folder 5, David Tudor Papers, GRI.
Jackie Monnier, "Letter to David Tudor (January 17, 1976)," Box 21, Folder 4. David Tudor Papers, GRI.
Jackie Monnier, "Letter to David Tudor (November 28, 1983)," Box 56, Folder 6, David Tudor Papers, GRI.
Jackie Monnier, "Letter to David Tudor (June 23, 1984)," Box 56, Folder 6, David Tudor Papers, GRI.
Jackie Monnier, "Letter to David Tudor (July 15, 1984)," Box 56, Folder 6, David Tudor Papers, GRI.

Jackie Monnier, "Letter to David Tudor (February 1, 1985)," Box 56, Folder 6, David Tudor Papers, GRI.
Jackie Monnier, "Letter to David Tudor (March 14, 1985)," Box 56, Folder 6, David Tudor Papers, GRI.
Jackie Monnier, "Letter to David Tudor (April 30, 1985)," Box 56, Folder 6, David Tudor Papers, GRI.
Jackie Monnier, "Letter to Susan (April 15, 1986)," Box 26, Folder 2, David Tudor Papers, GRI.
Jackie Monnier, "Letter to David Tudor (April 16, 1986)," Box 26, Folder 2, David Tudor Papers, GRI.
Jackie Monnier, "Letter to Susan and Jeanette Vuocolo (June 6, 1986)," Box 56, Folder 6, David Tudor Papers, GRI.
Jackie Monnier, "Letter to David Tudor (October 16, 1986)," Box 56, Folder 6, David Tudor Papers, GRI.
Jackie Monnier, "Letter to David Tudor (January 27, 1989)," Box 56, Folder 8, David Tudor Papers, GRI.
Gordon Mumma, "Letter to Tudor (September 8, 1965)," Box 57, Folder 3, David Tudor Papers, GRI.
Gordon Mumma, "Letter to David Tudor (May 17, 1966)," Box 57, Folder 3, David Tudor Papers, GRI.
Gordon Mumma, "Letter to Tudor (August 27, 1966)," Box 57, Folder 3, David Tudor Papers, GRI.
Gordon Mumma, "Letter to Tudor (September 4, 1966)," Box 57, Folder 3, David Tudor Papers, GRI.
Gordon Mumma, "Letter to Tudor (September 9, 1966)," Box 57, Folder 3, David Tudor Papers, GRI.
Gordon Mumma, "Letter to Tudor (October 4, 1966)," Box 57, Folder 3, David Tudor Papers, GRI.
Gordon Mumma, "Letter to Larry Owens (October 29, 1969)," Box 46, Folder 12, Experiments in Art and Technology records, GRI.
Gordon Mumma, "E-mail to Matt Rogalsky (April 17, 2001)," quoted in: Rogalsky, "Idea and Community," 145.
Bo Nilsson, "Letter to Tudor (January 26, 1956)," Box 57, Folder 7, David Tudor Papers, GRI.
Bo Nilsson, "Letter to David Tudor (May 29, 1956)," Box 57, Folder 7, David Tudor Papers, GRI.
Bo Nilsson, "Letter to James Tudor (October 31, 1956)," Box 57, Folder 7, David Tudor Papers, GRI.
Bo Nilsson, "Postcard to David Tudor (March 20, 1958)," Box 57, Folder 7, David Tudor Papers, GRI.
Pauline Oliveros, "Letter to Edith Gutierrez (December 24, 1961)," Oliveros Archive, Houston Public Library.
Pauline Oliveros, "Letter to David Tudor (October 3, 1963)," Box 57, Folder 8, David Tudor Papers, GRI.
M. C. Richards, "Letter to David Tudor (undated, October 1960)," Box 58, Folder 7, David Tudor Papers, GRI.
M. C. Richards, "Letter to *MusikTexte* (April 1, 1997)," Box 67, Folder 7, David Tudor Papers, GRI.
Frederic Rzewski, "Fax to *MusikTexte* (April 8, 1997)," Box 67, Folder 6, David Tudor Papers, GRI.
David Tudor, "Letter to Mr. Rossin [draft] (April, 1947)," Box 61, Folder 4, David Tudor Papers, GRI.
David Tudor, "Letter to Shirley [draft] (undated)," Box 61, Folder 4, David Tudor Papers, GRI.
David Tudor, "Letter to M. C. Richards (March 26, 1952)," Box 26, Folder 2, Mary Caroline Richards Papers, GRI.

David Tudor, "Letter to M. C. Richards (October 27, 1954)," Box 26, Folder 1, Mary Caroline Richards Papers, GRI.
David Tudor, "Letter to Karlheinz Stockhausen (February 3, 1955)," Box 59, Folder 6, David Tudor Papers, GRI.
David Tudor, "Letter to Earle Brown (April 15, 1957)," Folder 5-39, Earle Brown Music Foundation.
David Tudor, "Letter to M. C. Richards (July 11, 1957)," Box 26, Folder 2, Mary Caroline Richards Papers, GRI.
David Tudor, "Draft of Letter to Hermann Scherchen (mid-1958)," Box 51, Folder 7, David Tudor Papers, GRI.
David Tudor, "Letter to M. C. Richards (September 10, 1958)," Box 26, Folder 2, Mary Caroline Richards Paper, GRI.
David Tudor, "Letter to M. C. Richards (October 2, 1958)," Box 26, Folder 2, Mary Caroline Richards Papers, GRI.
David Tudor, "Postcard to M. C. Richards (October 23, 1958)," Box 26, Folder 2, Mary Caroline Richards Papers, GRI.
David Tudor, "Letter to M. C. Richards (August 26–29, 1960)," Box 26, Folder 2, Mary Caroline Richards Papers, GRI.
David Tudor, "Letter to M. C. Richards (October 28, 1960)," Box 26, Folder 2, Mary Caroline Richards Papers, GRI.
David Tudor, "Letter to Wolfgang Steinecke (August 16, 1961)," Box 59, Folder 5, David Tudor Papers, GRI.
David Tudor, "Draft of a Letter to Michael Shamberg (June 27, 1975)," Box 55, Folder 1, David Tudor Papers, GRI.
David Tudor, "Letter to George Bolling (October 24, 1975)," Box 19, Folder 7, David Tudor Papers, GRI.
David Tudor, "Letter to National Endowment for the Arts (July 24, 1984)," Box 21, Folder 10, David Tudor Papers, GRI.
Forrest Warthman, "Letter to David Tudor (October 22, 1989)," Box 27, Folder 5, David Tudor Papers, GRI.
Ray Wilding-White, "Letter to David Tudor (December 11, 1970)," Box 60, Folder 5, David Tudor Papers, GRI.
Ray Wilding-White, "Letter to David Tudor (June 23, 1972)," Box 60, Folder 5, David Tudor Papers, GRI.
Ray Wilding-White, "Letter to David Tudor (July 7, 1974)," Box 19, Folder 2, David Tudor Papers, GRI.
Christian Wolff, "Letter to David Tudor (October 18, 1959)," Box 60, Folder 6, David Tudor Papers, GRI.
"E-mail from JM to MM (January 25, 1990)," Box 209, Folder 2, Merce Cunningham Dance Foundation archive, NYPL.

B-2: Diagrams, Sketches, Matrix Maps (in chronological order)

David Tudor, "Notes for the realization of *Music of Changes*," Box 7, Folder 18, David Tudor Papers, GRI.
David Tudor, "List of materials for *34'46.776" For a Pianist*," Box 180, Folder 2, David Tudor Papers, GRI.
David Tudor, "Realization Scores of *For a Pianist*," Box 13, Folder 4, David Tudor Papers, GRI.
David Tudor, "Realization score of *Piano Piece for David Tudor 3*," Box 174, Folder 2, David Tudor Papers, GRI.
David Tudor, "Calculations for *Night Wandering*," Box 193, Folder 4, David Tudor Papers, GRI.
David Tudor, "Notes for *Variations II*," Box 8, Folder 7, David Tudor Papers, GRI.

David Tudor, "Description of parameters for *Variations II*," Box 8, Folder 7, David Tudor Papers, GRI.
Anonymous, "Schematics for *Tube Box*," Box 40, Folder 7, David Tudor Papers, GRI.
David Tudor, "Notes on *Book for 3*," Box 5, Folder 14, David Tudor Papers, GRI.
David Tudor, "Note and Diagram for the Theater Version of *Book for 3* by Michael von Biel," Box 5, Folder 14, David Tudor Papers, GRI.
David Tudor, "Sketch (March 30, 1967)," Box 4, Folder 1, David Tudor Papers, GRI.
David Tudor, "Unidentified diagram (April 1, 1967)," "Unidentified diagram (April 15–16, 1967)," "Unidentified diagram (May 11, 1967)," Box 4, Folder 1, David Tudor Papers, GRI.
David Tudor, "*Rainforest* description with additional options (March 1968)," Box 3, Folder 27, David Tudor Papers, GRI.
David Tudor, "Sketch for *Activities for Orchestra*, Mexico City (June 1968)," Box 4, Folder 2, David Tudor Papers, GRI.
David Tudor, "Diagram for *Activities* for *Event #153* (Merce Cunningham), Amiens (1970)" Box 3, Folder 1, David Tudor Papers, GRI.
David Tudor, "Note on the *Pepsi Modifier*," Box 17, Folder 3, David Tudor Papers, GRI.
David Tudor, "Sketch of *Pepscillator*," Box 108, Folder 8, David Tudor Papers, GRI.
David Tudor, "Sketch for Rhythms," Box 18, Folder 2, David Tudor Papers, GRI.
David Tudor, "Blue Maruman Notebook," Box 4, Folder 21, David Tudor Papers, GRI.
David Tudor, "Notes for *QM*," Box 45, Folder 2, David Tudor Papers, GRI.
David Tudor, "*Untitled* Notebook," Box 4, Folder 21, David Tudor Papers, GRI.
David Tudor, "Sketch for *Untitled*," Box 4, Folder 17, David Tudor Papers, GRI.
David Tudor, "Notes and schematics for *Prototype Pepsi Modulator*," Box 41, Folder 1, David Tudor Papers, GRI.
David Tudor, "*Pulsers* diagram for V.F. at the Walker Art Center (October 1974)," Box 4, Folder 21, David Tudor Papers, GRI.
David Tudor, "Sketch for *Pulsers*, Palomar (April 7, 1975)," Box 4, Folder 21, David Tudor Papers, GRI.
David Tudor, "*Pulsers*, diagram sketch," Box 3, Folder 23, David Tudor Papers, GRI.
David Tudor, "Notes for Speech Synthesis kit," Box 46, Folder 3, David Tudor Papers, GRI.
David Tudor, "Sketch of *Toneburst* (March 6–10, 1977)," Box 4, Folder 12, David Tudor Papers, GRI.
David Tudor, "Diagram of *Forest Speech* (March 20, 1977)," Box 3, Folder 15, David Tudor Papers, GRI.
David Tudor, "Draft of *Forest Speech* diagram," Box 3, Folder 15, David Tudor Papers, GRI.
David Tudor, "*Weatherings*, Matrix Map (undated)," Box 4, Folder 7, David Tudor Papers, GRI.
David Tudor, "*Weatherings*, unfinished sketch (undated)," Box 4, Folder 16, David Tudor Papers, GRI.
David Tudor, "*Weatherings*, diagram (1979)," Box 3e, Folder 6, David Tudor Papers, GRI.
David Tudor, "Score for *Likeness to Voices*," Box 3, Folder 15, David Tudor Papers, GRI.
David Tudor, "Symbol/instrument chart for *Dialects*," Box 110, Folder 4, David Tudor Papers, GRI.
David Tudor, "Matrix Map (undated)," Box 3, Folder 8, David Tudor Papers, GRI.
David Tudor, "Matrix Map (undated)," Box 4, Folder 10, David Tudor Papers, GRI.
David Tudor, "Matrix Map, Seoul (January 31/February 1, 1984)," Box 3, Folder 8, David Tudor Papers, GRI.
David Tudor, "*Phrases*, Matrix Map (February 1986)," Box 3, Folder 25, David Tudor Papers, GRI.
David Tudor, "Note on *Rainforest* instrumental loudspeakers (1988)," Box 111, Folder 5, David Tudor Papers, GRI.

David Tudor, "Draft sketch for *9 Lines, Reflected* (undated)" Box 26, Folder 5, David Tudor Papers, GRI.

David Tudor, "Notes on *Virtual Focus*," Box 17, Folder 5, Merce Cunningham Dance Foundation Inc. Records, New York Public Library.

B-3: Descriptions, Proposals, Drafts (in chronological order)

John Cage, "Procedure (undated)," Box 179, Folder 2, David Tudor Papers, GRI.

David Tudor, "Note from Walt Whitman," Box 101, Folder 1, David Tudor Papers, GRI.

David Tudor, "Notes from *The Inner Nature of Music and the Experience of Tone* (undated)" Box 107, Folder 2, David Tudor Papers, GRI.

David Tudor, "Typed copy of *Theater and its Double* (Chapter XII)," Box 67, Folder 13, David Tudor Papers, GRI.

David Tudor, "Notes taken from Artaud," Box 111, Folder 23, David Tudor Papers, GRI.

David Tudor, "Notes for Darmstadt Seminar," Box 107, Folder 10, David Tudor Papers, GRI.

David Tudor, "Translation of instructions for *Quantitäten*," Box 194, Folder 1, David Tudor Papers, GRI.

David Tudor, "Translation of 'Spel med enkla Svangningar,'" Box 194, Folder 1, David Tudor Papers, GRI.

"David Tudor Proposal: Preliminary Technical Info," Box 19, Folder 1, David Tudor Papers, GRI.

David Tudor, "Handwritten Schedule for MCDC Tour (Fall 1963)," Box 15, Folder 23, David Tudor Papers, GRI.

Nam June Paik, "Announcement of Robot Opera (November 26, 1964)," Box 57, Folder 11, David Tudor Papers, GRI.

Mauricio Kagel, "Kagel on Music," *New Student Review* 12 (1965), 4–9. (Box 63, Folder 8, David Tudor Papers, GRI).

Bob Kieronski, "Wireless System (draft)," Klüver/Martin Archive.

"Projects for Stockholm Festival (February 13, 1966)," Box 16, Folder 2, David Tudor Papers, GRI.

"Projects for Stockholm Festival, 3rd List (May 1, 1966)," Box 16, Folder 2, David Tudor Papers, GRI).

"2nd Progress Report for Stockholm Festival (March 8, 1966)," Box 16, Folder 2, David Tudor Papers, GRI.

E.A.T., "Address List of artists for Nine Evenings: Theater and Engineering," Box 16, Folder 2, David Tudor Papers, GRI.

David Tudor, "*Bandoneon Factorial*, description," Box 3, Folder 2, David Tudor Papers, GRI.

E.A.T., "Technology for Art's Sake, Experiments in Art & Technology press release (September 14, 1966)," Box 16, Folder 2, David Tudor Papers, GRI.

Herbert A. Schneider, "A glimpse or more at some technical aspects not seen by the third partner of Nine Evenings—the public," Box 2, Folder 3, Experiments in Art and Technology, Records, 1966–1993, GRI.

Herbert A. Schneider, "A Systems Approach (February 1967)," Box 1, Folder 37, Experiments in Art and Technology, Records, 1966–1993, GRI.

L. J. Robinson, "At the Armory," Box 1, Folder 41, Experiments in Art and Technology, Records, 1966–1993, GRI.

Fondation Daniel Langlois, "Program Drum," 9 Evenings: Theatre and Engineering, accessed December 15, 2019: http://www.fondation-langlois.org/flash/e/index.php?NumPage=571

David Tudor, "Draft of description for *Rainforest*," Box 4, Folder 21, David Tudor Papers, GRI.

Gordon Mumma, "Notes on Cybersonics: Artificial Intelligence in Live Musical Performance (February 1970)," Box 57, Folder 3, David Tudor Papers, GRI.

Larry Owens, "Feasibility Study on the Incorporation of the E.A.T.—Designed Sound System with an Air Structure," Box 17, Folder 2, David Tudor Papers, GRI.
David Tudor, "Rock Environment (First Draft)," Box 17, Folder 3, David Tudor Papers, GRI.
David Tudor, "*Pepsibird*, Typed Description," Box 3, Folder 10, David Tudor Papers, GRI.
David Tudor, "*Anima Pepsi*, Typed Description," Box 3, Folder 10, David Tudor Papers, GRI.
David Tudor, Fred Waldhauer, Julie Martin, "Quick Review of Problems Encountered in Sound System (April 22, 1970)," Box 17, Folder 7, David Tudor Papers, GRI.
David Tudor, "Four Pepsi Pieces," Box 3, Folder 10, David Tudor Papers, GRI.
David Tudor, "*Bandoneon!*, Pre & Post-operative note," Box 16, Folder 6, David Tudor Papers, GRI.
Mimi Johnson, "Typed blurb of *Mureau* with a note to David Tudor (undated, early 1972)," Box 18, Folder 11, David Tudor Papers, GRI.
David Tudor, "*Untitled*, description," Box 3e, Folder 3, David Tudor Papers, GRI.
David Tudor, "*Untitled*, composer's note," Box 3e, Folder 3, David Tudor Papers, GRI.
Ray Wilding-White, "David Tudor: 10 selected realizations of graphic scores and related performances (1973)," Box 19, Folder 2, David Tudor Papers, GRI.
David Tudor, "The View from Inside," Box 19, Folder 12, David Tudor Papers, GRI.
David Tudor, "*Pulsers*, description," Box 3, Folder 26, David Tudor Papers, GRI.
E.A.T., "Report on Experiments for 'Knavelskär' Project (August 8, 1974)," Box 21, Folder 1, David Tudor Papers, GRI.
E.A.T., "Proposal for *Island Eye Island Ear* (September 3, 1974)," Box 21, Folder 1, David Tudor Papers, GRI.
E.A.T., "*Island Eye Island Ear*, Proposal (December 3, 1974)," Box 21, Folder 1, David Tudor Papers, GRI.
David Tudor, "Description of *Pulsers*," Box 3, Folder 26, David Tudor Papers, GRI.
David Tudor, "Description of *Forest Speech*," Box 3, Folder 9, David Tudor Papers, GRI.
E.A.T., "*Island Eye Island Ear*: Plan of Implementation for Seattle Concert (December 10, 1977)," Box 21, Folder 6, David Tudor Papers, GRI.
E.A.T., "*Island Eye Island Ear*: Description of a Concert for Bluff Island (October 4, 1978)," Box 21, Folder 7, David Tudor Papers, GRI.
Media Study/Buffalo, "Newsletter, January 1979," Woody and Steina Vasukla archive, accessed December 15, 2019: http://www.vasulka.org/archive/4-30d/MedBufJan79(6000).pdf; quoted in Rogalsky, "Idea and Community," 322; also available at davidtudor.org, accessed December 15, 2019: https://davidtudor.org/Articles/cie_buffalo.html
E.A.T., "*Island Eye Island Ear*: An Environmental Concert (September 18, 1979)," Box 21, Folder 6, David Tudor Papers, GRI.
Joseph Kubera, "Notes from Sessions with David Tudor," Personal archive of Joseph Kubera.
David Tudor, "Application for Rockefeller Fund For Music (January 12, 1981)," Box 25, Folder 11, David Tudor Papers, GRI.
David Tudor, "*Untitled*, description from 1982," Box 4, Folder 21, David Tudor Papers, GRI.
Molly Davies, "On Making *Seatails* (unpublished manuscript)," private collection of Molly Davies.
Jackie Monnier, "*Sea Tails*: Sound Totem version," Box 26, Folder 2, David Tudor Papers, GRI.
David Tudor, "Draft for *Likeness to Voices/Dialects*," Box 3, Folder 15, David Tudor Papers, GRI.
David Tudor, "Description for *Likeness to Voices*," Box 3, Folder 15, David Tudor Papers, GRI.
Jackie Monnier, "Hearing Space, Draft of Program Note for *Lines & Reflections*," Box 26, Folder 5, David Tudor Papers, GRI.
David Tudor, "*9 Lines,* draft description," Box 26, Folder 5, David Tudor Papers, GRI.
David Tudor, "*Lines & Reflections*, description," Box 26, Folder 5, David Tudor Papers, GRI.
Forrest Warthman, Ron Clapman, and David Tudor, "A Performance Computer: Design Definition (October 22, 1989), Box 27, Folder 5, David Tudor Papers, GRI.

David Tudor, "To: Critics, Re: Score for *Polarity* (March 20, 1990)," Box 3e, Folder 5, David Tudor Papers, GRI.

"ER/JA conversation #2 about *Soundance* (June 10, 1994)," Box 17, Folder 18, Merce Cunningham Dance Foundation Inc. Records, New York Public Library.

David Behrman, "Remarks Read at the David Tudor Celebration at Judson Church," Box 67, Folder 6, David Tudor Papers, GRI.

Merce Cunningham, "Statement delivered at David Tudor's Memorial Service (August 27, 1996)," Box 67, Folder 6, David Tudor Papers, GRI.

John Driscoll, "Electronics & Cooking (In Memoriam David Tudor) (1996)," Box 67, Folder 7, David Tudor Papers, GRI.

Alvin Lucier, "Remembering David Tudor (March 23, 1997)," Box 67, Folder 6, David Tudor Papers, GRI.

Billy Klüver, "Talk on David Tudor, Getty Center (May 17, 2001)," Klüver/Martin archive.

Julie Martin, "Jackie Matisse in America," Klüver/Martin archive.

B-4: Scores

Michael von Biel, "Book for 3 (Two Pianos and One Violin version), 11," Box 5, Folder 14, David Tudor Papers, GRI.

Michael von Biel, "Book for 3 (Three Piano version), 6," Box 5, Folder 14, David Tudor Papers, GRI).

Sylvano Bussotti, "Explanatory Notes for *Pieces de Chair II*, Page 8," Box 174 Folder 3, David Tudor Papers, GRI.

John Cage, "Instructions for *Variations II*," Box 8, Folder 7, David Tudor Papers, GRI.

Lowell Cross, "Performance Instructions," Box 36, Folder 2, David Tudor Papers, GRI.

Pauline Oliveros, "*Duo for Accordion and Bandoneon* (original score)," Box 11, Folder 9, David Tudor Papers, GRI.

David Tudor. *Solo for Piano by John Cage, Second Realization, Part 1: Essay and Critical Commentary*. Edited by John Holzaepfel. MUSA Volume 30A. Middleton, WI: A-R Editions, 2020.

B-5: Instrument Articles (in chronological order)

Albert Preisman, "The Piano," *Audio Engineering* (October/November 1953) (Box 36, Folder 2, David Tudor Papers, GRI).

Harry Kolbe, "Stereo Mike Mixer," *Electronics Illustrated* (September 1962), 67.

Don Lancaster, "Advanced Experimenter Project: Pulse Generator," *Popular Electronics* (April 1966), 60–62 (Box 39, Folder 4, David Tudor Papers, GRI).

G. B. Clayton, "Direct-Reading Phasemeter," *Wireless World* (August 1966), 391–394 (Box 44, Folder 1, David Tudor Papers, GRI).

Richard J. de Sa, "Build an Audio Tone-Burst Generator," *Radio-Electronics* (July 1967), 44–46 (Box 40, Folder 1, David Tudor Papers, GRI).

Frederic Rzewski, "A Photoresistor Mixer for Live Performance," *Electronic Music Review* 4 (October 1967), 33–34.

Donald W. Moffat, "RC Differentiator Design Nomograms," *Electronics World* (July 1968) (Box 37, Folder 9, David Tudor Papers, GRI).

Don M. Wherry, "Build an Audio Multicoupler," *Popular Electronics*, July 1970 (Box 41, Folder 1, David Tudor Papers, GRI).

John H. Roberts, "The 'Bucket Brigade' Audio Delay Line," *Popular Electronics* (June 1976), 33–38 (Box 43, Folder 6, David Tudor Papers, GRI).

Steve Wood, "Build This: The Drum … A Percussion Synthesizer (Part 1)," *Radio-Electronics* (May 1980), 49–52; Wood, "Build This: The Drum … A Percussion Synthesizer (Part 2)," *Radio-Electronics* (June 1980), 59–62 (Box 3, Folder 23, David Tudor Papers, GRI).

Forrest M. Mims, "Experimenting with a Joy Stick," *Popular Electronics*, December 1981 (Box 47, Folder 13, David Tudor Papers, GRI).
Paul Williams, "DO-IT-YOURSELF The String Damper," *Electronics & Music Maker* (May 1984), 92–94 (Box 48, Folder 4, David Tudor Papers, GRI).
Dick Smith, "Build This Mini Music Synthesizer," *Radio-Electronics* (February 1986), 75–78 (Box 48, Folder 7, David Tudor Papers, GRI).

B-6: Instrument Manuals

BNB Kits, "Catalog No. 791, 1979," Box 45, Folder 4, David Tudor Papers, GRI.
DAK Industries, Inc., "Click and Pop Assassin," *Stereo Review* (November 1983), 109.
D&R Electronics, "Multigate Manual," Box 49, Folder 4, David Tudor Papers, GRI.
Donald Buchla, "The System," Box 39, Folder 3, David Tudor Papers, GRI.
Donald Buchla, "Modular Electronic Music System, catalog (1966)," Box 39, Folder 3, David Tudor Papers, GRI.
Heathkit, "Electronic Crossover (Model XO-1) Manuals," Box 39, Folder 4, David Tudor Papers, GRI.
Lafayette Radio Electronics, "Diagram of PK-522," Box 40, Folder 1, David Tudor Papers, GRI.
Lafayette Radio Electronics, "Model PA-292 4 Channel Transistorized Microphone Mixer manual," Box 41, Folder 6, David Tudor Papers, GRI.
Ling Electronics, "Model EPN-10C Peak and Notch Filter Manual, 3-1," Box 37, Folder 1, David Tudor Papers, GRI.
Maplin, "The Maplin RTX3," Box 49, Folder 6, David Tudor Papers, GRI.
RCA, "Solid-State Hobby Circuits Manual," Technical Series HM-91, RCA, 1970.
Zoom, "Zoom 9002 manual," Box 50, Folder 3, David Tudor Papers, GRI.
"Spec Sheet of x1000 Amplifier," Box 47, Folder 6, David Tudor Papers, GRI.
"Electronotes (June 20, 1978)," Box 43, Folder 5, David Tudor Papers, GRI.
"4-Channel Preamp/Mixer," *Radio-Electronics* (January 1965), 86.

B-7: Receipts, Custom Declarations, Equipment Lists, Certifications (in chronological order)

The American Guild of Organists, "Certification of Associate Membership for David Tudor (June 26, 1942)," Box 97, Folder 3, David Tudor Papers, GRI.
Nathan Hoffspiegel, "Apartment Lease for 46 East 21st Street, New York, NY (August 16, 1948)," Box 116, Folder 3, David Tudor Papers, GRI.
Morroney Transportation Co., Inc., "Uniform Household Goods Bill of Lading for Motor Carriers (August 26, 1948)," Box 116, Folder 3, David Tudor Papers, GRI.
Anthroposophical Society in America, "Acknowledgement of Membership for David Tudor (July 1957)," Box 102, Folder 1, David Tudor Papers, GRI.
Lafayette Radio Electronics, "Receipt for PK-522 (April 24, 1962)," Box 120, Folder 1, David Tudor Papers, GRI.
Lafayette Radio Electronics, "Receipt for PA-292 (May 7, 1962)," Box 120, Folder 1, David Tudor Papers, GRI.
Lafayette Radio Electronics, "Receipt for PA-292 (June 19, 1962)," Box 120, Folder 4, David Tudor Papers, GRI.
Olson Electronics, "Receipt (March 9, 1966)," Box 124, Folder 6, David Tudor Papers, GRI.
Purchase Radio Supply, "Delivery Note, Ann Arbor, Michigan (April 8, 1966)," Box 121, Folder 1, David Tudor Papers, GRI.
Radio Equipment Corp., "Receipt (April 16, 1966)," Box 122, Folder 6, David Tudor Papers, GRI.
Olson Electronics, "Receipt (April 29, 1966)," Box 123, Folder 2, David Tudor Papers, GRI.

Musikhaus Detmering Hamburg, "Receipt for Hohner Microphone, (August 18, 1966)," Box 123, Folder 2, David Tudor Papers, GRI.
National Research Council of Canada, "Customs Declaration Form for Touch-Sensitive Key (September 18, 1968)," Box 40, Folder 2, David Tudor Papers, GRI.
MCDC, "Manifest for Customs Clearance and Air Freight for Rome, Italy (April 1969)," Box 29, Folder 10, David Tudor Papers, GRI.
Pan American World Airways, "Ticket, New York–Osaka (February 18, 1970)," Box 125, Folder 6, David Tudor Papers, GRI.
MCDC, "Manifest for Custom Clearance, USA-Canada (February 1972)," Box 30, Folder 3, David Tudor Papers, GRI.
American Airlines, "Ticket, Chicago-Buffalo (November 28, 1973)," Box 130, Folder 11, David Tudor Papers, GRI.
Phoenix Systems, "Shipping record of electronic parts (June 8, 1976)," Box 131, Folder 5, David Tudor Papers, GRI.
Jameco Electronics, "Receipt (July 2, 1976)," Box 131, Folder 5, David Tudor Papers, GRI.
Sam Ash Music Stores, "Receipt for E-H Talking Pedal (December 16, 1977)," Box 132, Folder 5, David Tudor Papers, GRI.
Tudor, "Order for *The Silencer* to Musician's Supply (June 21, 1979)," Box 134, Folder 5, David Tudor Papers, GRI.
Charles de Gaulle Airport, "Receipt for Sony ECM-150 (October 29, 1979)," Box 134, Folder 5, David Tudor Papers, GRI.
Tudor, "Expense Report: Gulbenkian Commission (July 9, 1982)," Box 137, Folder 3, David Tudor Papers, GRI.
DAK Industries Inc., "Receipt for Click and Pop Assassin (November 7, 1984)," Box 138, Folder 4, David Tudor Papers, GRI.
MCDC, "Equipment list (April 1986)," Box 32, Folder 4, David Tudor Papers, GRI.
Good Samaritan Hospital, "Receipt (March 10, 1988)," Box 142, Folder 6, David Tudor Papers, GRI.
Electronics Book Club, "Order Form (August 3, 1988)," Box 142, Folder 4, David Tudor Papers, GRI.
Rockland Neurological Associates, "Receipt (October 3, 1988)," Box 142, Folder 4, David Tudor Papers, GRI.
"Statement of Account, Montvale Diagnostic Imaging, (November 10, 1988)," Box 142, Folder 4, David Tudor Papers, GRI.
MCDC, "Active Repertory 1987, Basic Sound Manual," Box 28, Folder 8, David Tudor Papers, GRI.

B-8: Program Notes (in chronological order)

Trinity Church Swarthmore, "Program note, Christmas Music (December 30, 1945)," Box 61, Folder 4, David Tudor Papers, GRI.
Hochschule für Musik Köln, "Program, Studiokonzert (October 28, 1959)," Box 71, Folder 12, David Tudor Papers, GRI.
Living Theatre, "Program note, David Tudor concert (March 28, 1960)," Box 72, Folder 2, David Tudor Papers, GRI.
Konzertbüro der Wiener Konzerthausgesellschaft, "Program, Musik der Gegenwart: Mozart-Saal (May 2, 1963)," Box 74, Folder 1, David Tudor Papers, GRI.
John Cage, "Program Note for Sogetsu Art Center concert (November 27, 1964)," Box 75, Folder 1, David Tudor Papers, GRI.
David Tudor and John Cage, "Program, Sundance Festival (July 30, 1965)," Box 74, Folder 7, David Tudor Papers, GRI.
MCDC, "Program, A Modern Dance Concert, Long Island Festival (August 20, 1965)," Box 75, Folder 7, David Tudor Papers, GRI.

David Tudor and John Cage, "Program, Fine Arts Foundation concert (March 26, 1966)," Box 76, Folder 1, David Tudor Papers, GRI.

David Tudor and John Cage, "Program, Pan American Union Auditorium concert (April 27, 1966)," Box 76, Folder 1, David Tudor Papers, GRI.

David Tudor, "Program note, Troisiéme Concert de la Société de Musique Contemporaine du Québec (April 5, 1967)," Box 76, Folder 4, David Tudor Papers, GRI.

"Program, *Reunion* by John Cage, Gordon Mumma, David Tudor, at Westbrook Auditorium, Illinois Wesleyan University (April 29, 1968)," Box 76, Folder 5, David Tudor Papers, GRI.

MCDC, "Program, Illinois State University, Gym Event Number 2, at University High School (May 1, 1968)," Box 76, Folder 7, David Tudor Papers, GRI.

Pauline Oliveros, "Program note, *Video III* at the Electronic Sights and Sounds Concert in UC San Diego (May 10, 1968)," Box 76, Folder 5, David Tudor Papers, GRI.

David Tudor and John Cage, "Program, Pro Musica Nova (May 6, 1972)," Box 77, Folder 8, David Tudor Papers, GRI.

David Tudor and John Cage, "Program note, John Cage/David Tudor, Tage Neuer Musik, Konzerte der Stadt Bonn (May 18, 1972)," Box 77, Folder 8, David Tudor Papers, GRI.

David Tudor, "Draft of Program Note for *Variations II* (ca. 1980)," Box 8, Folder 7, David Tudor Papers, GRI.

David Tudor, "Program note, Experimental Music: New works by Ron Kuivila and guest composer David Tudor, Wesleyan University (September 9, 1983)," Box 80, Folder 2, David Tudor Papers, GRI.

David Tudor, "Program note, *Coefficient: Frictional Percussion and Electronics*, S.E.M. Ensemble at Paula Cooper Gallery (February 26, 1991)," Box 81, Folder 4, David Tudor Papers, GRI.

B-9: Newspaper and Magazine Articles/Reviews (in chronological order)

Eric Salzman, "Recital is Given by David Tudor," *New York Times*, March 29, 1960 (Box 63, Folder 1, David Tudor Papers, GRI).

Ed Wallace, "War on the Keys: Above Ground Test Deactivates Piano," *New York World-Telegram and Sun*, Tuesday, April 5, 1960 (Box 63, Folder 2, David Tudor Papers, GRI).

Avram Davidson, "Review of *A Likeness to Voices*," *The Magazine of Fantasy and Science Fiction* (November 1963), 71.

Gloria Steinem, "Review," *Show: The Magazine of the Arts* 4, no. 1. (January 1964), 59 (Box 63, Folder 7, David Tudor Papers, GRI).

J.D. "Rare Bandoneon Features in Kagel's 'Pandora's Box,'" *Buffalo Evening News*, April 5, 1965 (Box 63, Folder 8, David Tudor Papers, GRI).

William Littler, "It didn't add up to much," *Toronto Daily Star*, April 17, 1967 (Box 64, Folder 1, David Tudor Papers, GRI).

Steve Smoliar, "Music Communications," *The Colorado Daily*, June 28, 1968 (Box 64, Folder 4, David Tudor Papers, GRI).

Jonas Mekas, "Movie Journal," *The Village Voice* (March 18, 1971), 67.

Richard Bernas, "Mister Natural," *New Statesman*, May 26, 1972 (Box 67, Folder 13, David Tudor Papers, GRI).

Tom Johnson, "David Tudor's Homemade Pulsers," *The Village Voice*, January 24, 1977.

Jack Anderson, "Choreography Conceived as 'Reporting,'" *New York Times*, February 26, 1978.

T. O'Conell, "Unique concert offered to area for Bluff Island," *Press-Republican*, October 10, 1978.

"Bluff Island concert discussed at center," *Adirondack Daily Enterprise*, October 17, 1978.

"Island Project Opposed," *Adirondack Daily Enterprise*, October 18, 1978.

Editorial, "We like Bluff Island the way it is," *Adirondack Daily Enterprise*, October 18, 1978.

Editorial, "Something for those who would improve on nature," *Adirondack Daily Enterprise*, October 20, 1978.

"Sponsors of Bluff Island project grateful for publicity given show," *Adirondack Daily Enterprise*, October 20, 1978.
Anna Kisselgoff, "Dance: Cunningham's 'Coast Zone,'" *New York Times*, March 21, 1983.
David Miller, "David Tudor 'Hedgehog,'" *High Performance* 33 (1986), 88 (Box 66, Folder 4, David Tudor Papers, GRI).
Kyle Gann, "Music Notes: David Tudor, a legend in his own time," *Chicago Reader*, April 4, 1986 (Box 66, Folder 5, David Tudor Papers, GRI).
Jack Anderson, "The Dance: 'Channels/Inserts,'" *New York Times*, March 8, 1987.
Allan Kozinn, "Electronic Homage to John Cage," *New York Times*, April 23, 1989.

C: Archival Material (Other Media)

C-1: Audio

C-1-1: Performances

David Tudor, "Piano 1958 Ferienkurse II. Teil, 1958," Box 8A, CII, side B, David Tudor Papers, GRI.
David Tudor, "Piano 1959 Ferienkurse, 1959," Box 8A, CIII, side A, David Tudor Papers, GRI.
David Tudor, "*Five Piano Pieces for David Tudor* (undated)," Box 13A, R49, David Tudor Papers, GRI.
David Tudor, "*Pepsibird* (April 1970)," Box 2A, C88, side A, David Tudor Papers, GRI.
David Tudor, "*Pepsibird* (April 1970)," Box 23A, R19, David Tudor Papers, GRI.
David Tudor, "Homage to Toshi Ichiyanagi, Study 1 (1972)," Box 1A, C28, David Tudor Papers, GRI.
David Tudor, "Untitled (Homage to Toshi Ichiyanagi), Study 2 (undated)," Box 5A, C220 side B, David Tudor Papers, GRI.
David Tudor, "Homage to Toshi Ichiyanagi, Study 3 (1972)," Box 1A, C30, David Tudor Papers, GRI.
David Tudor, "*Forestspeech* Dub (undated)," Box 36A, RU5, David Tudor Papers, GRI.
Composers Inside Electronics, "*Forest Speech* (undated)," private collection of John Driscoll.
David Tudor, "*Weatherings*, Sadler Well's Theatre, London (June 18, 1981)," Box 1A, C11, David Tudor Papers, GRI.
David Tudor, "*Phonemes*, Sadler's Well Theatre, London (June 20, 1981)," Box 2A, C62, David Tudor Papers, GRI.
David Tudor, "*Untitled*, Theater Bellevue, Amsterdam (June 10, 1982)," Box 1A, C45B, David Tudor Papers, GRI.
David Tudor, "*Likeness to Voices* [4 channel] (undated)," Box 13A, R58, David Tudor Papers, GRI.
David Tudor, "*Hedgehog*, Mobius Art Center, Boston (September 28, 1985)," C74, David Tudor Papers, GRI.
David Tudor, "*Hedgehog*, Mobius Art Center, Boston (September 29, 1985)," C73, David Tudor Papers, GRI.
David Tudor, "*Fragments*, City Center of New York (March 12, 1986)," Box 2A, C57 Side B, David Tudor Papers, GRI.

C-1-2: Pepsi Tapes/Source Materials

"Alpha Waves," Box 20A, R158, David Tudor Papers, GRI.
"Bats," Box 19A, R137, David Tudor Papers, GRI.
"Brain Waves regular," Box 19A, R135, David Tudor Papers, GRI.
"Cat's Eye," Box 19A, R139, David Tudor Papers, GRI.

"Demodulated Alpha Waves," Box 18A, R127, David Tudor Papers, GRI.
"E.E.G." Box 19A, R134, David Tudor Papers, GRI.
"Longhorn Beetle Walking," Box 18A, R129, David Tudor Papers, GRI.
"Modified Nightjar Regular," Box 18A, R126, David Tudor Papers, GRI.
"Modified Nightjar Slow," Box 5A, C260, David Tudor Papers, GRI.
"Mosquitoes in a Water Jar," Box 18A, R123, David Tudor Papers, GRI.
"Nerves Firing," Box 19A, R138, David Tudor Papers, GRI.
"Sounds of Insects," Box 32A, R298, David Tudor Papers, GRI.
"Wasp Chewing," Box 18A, R130, David Tudor Papers, GRI.
"Wasp Chewing Slow, Mosquito in Test Tube Norm," Box 5A, C223, side B, David Tudor Papers, GRI.
David Tudor, "*Lines and Reflections* [source material—Line] (1987)," Box 2A, C81, side B, David Tudor Papers, GRI.
David Tudor, "*Lines and Reflections* [source material—Radarmania] (1987)," Box 2A, C81, side A, David Tudor Papers, GRI.
David Tudor, "*Lines and Reflections* [source material] (1987)," Box 2A, C78, David Tudor Papers, GRI.
David Tudor, "*Lines and Reflections* [source material—K?] (1987)," Box 2A, C79, David Tudor Papers, GRI.
David Tudor, "*Lines and Reflections* [source material—second recording] (1987)," Box 2A, C80, side A, David Tudor Papers, GRI.
David Tudor, "*Lines and Reflections* [source material—with Multgate] (1987)," Box 2A, C80, side B, David Tudor Papers, GRI.

C-1-3: Talks

David Vaughan, "Interview with John Cage, 1978-12-20/1979-01-18," Merce Cunningham Dance Foundation Collection, Jerome Robbins Dance Division, New York Public Library.
David Vaughan, "Interview with Jean Erdman, 1983-06-08," Merce Cunningham Dance Foundation Collection, Jerome Robbins Dance Division, New York Public Library.
David Tudor, "Workshop with students at Mobius, Boston (September 29, 1985)," Box 2A, C75, David Tudor Papers, GRI.
David Tudor, "Merce Cunningham Symposium at the Southern Methodist University (October 23–24, 1987)," Merce Cunningham Dance Foundation Collection, Rodgers and Hammerstein Archives of Recorded Sound, New York Public Library.

C-2: Video

Hans Heinz Stuckenschmidt, *Musik im technischen Zeitalter: John Cage mit David Tudor* (January 21, 1963), Sender Freies Berlin, ZKM, 1963.
E.A.T., "Commentary on the Fog Sculpture," Process Art, Fujiko Nakaya private collection, 1970.
"Barnard event with David Tudor, 1977-03? / choreography by Merce Cunningham," MGZIDF 1937, Merce Cunningham Dance Foundation Collection, New York Public Library.
George Bolling, "Rainforest, 1981," Box 37A, Item V10, David Tudor Papers, GRI.
Charles Amirkhanian, John Cage, Takehisa Kosugi, Gordon Mumma, Michael Pugliese, and David Tudor, "A Kind of Anarchy: Merce Cunningham and Music (September 19, 1989)," MGZIDVD 5-469, Merce Cunningham Dance Foundation Collection, New York Public Library. Partial transcript available at: http://remindedbytheinstruments.info
David Tudor, "Aftertalk of *Neural Synthesis* at STEIM (June 16, 1994)," Video, Private Collection of Molly Davies. Transcript available at: http://remindedbytheinstruments.info

D: Published Material

D-1: Papers/Articles/Essays

John D. S. Adams, "Equalization a la Tudor," davidtudor.org, accessed December 15, 2019. https://davidtudor.org/Electronics/eq.html

John D. S. Adams, "Giant Oscillations: The Birth of *Toneburst,*" *MusicWorks* 69 (Fall 1997), 14–17.

John D. S. Adams and Erin Donovan, "Still Listening: Pauline Oliveros Reflects on the Life and Music of David Tudor," *Musicworks* 70 (Spring 1998), 34–37.

Antonin Artaud, "Cinema and Reality," in *Antonin Artaud: Selected Writings*, edited by Susan Sontag. Berkeley: University of California Press, 1988, 150–152.

W. Ross Ashby, "Principles of the Self-Organizing System," in *Principles of Self-Organization: Transactions of the University of Illinois Symposium on Self-Organization*, edited by Heinz von Foerster. New York, NY: Pergamon Press, 1962, 255–278.

Larry Austin, "Is the Composer Anonymous?," *Source* 2 (1967); reprinted in: *Source: Music of the Avant-garde, 1966–1973*, edited by Larry Austin and Douglas Kahn. Berkeley: University of California Press, 2011, 52.

Clarisse Bardiot, "The Diagrams of 9 evening," in *9 Evenings Reconsidered: Art, Theatre, and Engineering.* Boston, MA: MIT List Visual Arts Center, 2006, 45–51.

Adam Barker-Mill, "David Tudor's Sound Table," *Musicworks* 73 (Spring 1999), 24–25.

Gregory Bateson, "Cybernetic Explanation (1967)," in *Steps to an Ecology of Mind.* Chicago, IL: University of Chicago Press, 2000, 405–416.

David Behrman, "Private Person, Public Figure: David Tudor in the '60s and '70s." *Musicworks* 71 (Summer 1998), 44–46.

Bell Telephone, "Art and Science: Two Worlds Merge," *Bell Telephone Magazine* 46, no. 6 (November–December, 1967), 15–16.

David W. Bernstein, "John Cage's *Music of Changes* and Its Genesis," in *Cage & Consequences*, edited by Julia H. Schröder and Volker Straebel. Hofheim, Germany: Wolke Verlag, 2012, 67–84.

David W. Bernstein, "John Cage's *Cartridge Music* (1960): 'A Galaxy Reconfigured,'" *Contemporary Music Review* 33, no. 5–6 (2014), 556–569.

Harald Bode, "Sound Synthesizer Creates New Musical Effects," *Electronics* (December 1, 1961), 33–37.

Harald Bode, "History of Electronic Sound Modification," *Journal of the Audio Engineering Society* 32, no. 10 (October 1984), 730–739.

Stanley Boorman, "The Musical Text," in *Rethinking Music*, edited by Nicholas Cook and Mark Everist. New York, NY: Oxford University Press, 1999, 403–423.

Pierre Boulez, "Propositions," *Polyphonie 2* (1948), 65–72.

John Cage, "Lecture on Something (1951)," in *Silence: Lectures & Writings.* Middletown, CT: Wesleyan University Press, 128–145.

John Cage, "45′ for a Speaker (1954)," in *Silence*, 146–193.

John Cage, "Experimental Music: A Doctrine (1955)," in *Silence*, 13–17.

John Cage, "Composition as Process: 1 Changes (1958)," *Silence*, 18–34.

John Cage, "Experimental Music (1957)," in *Silence*, 7–12.

John Cage, "Indeterminacy (1958)," in *Silence*, 260–273.

John Cage, "Remarks before a David Tudor Recital [La Maison Francaise NYU Concert on March 19, 1959]," in *John Cage: Writer*, edited by Richard Kostelanetz. New York, NY: Cooper Square Press, 2000, 72.

John Cage, "Rhythm Etc. (1962)," in *A Year from Monday.* Middletown, CT: Wesleyan University Press, 1967, 120–132.

John Cage, "Diary: Emma Lake Music Workshop 1965," in *A Year from Monday*, 21–25.

John Cage, "How to Pass, Kick, Fall and Run (1965)," in *A Year from Monday*, 133–140.
John Cage, "Talk 1 (1965)," in *A Year from Monday*, 141–144.
John Cage, "Seriously Comma (1966)," in *A Year From Monday*, 26–19.
John Cage, "Diary: How to Improve the World (You Will Only Make Matters Worse) Continued 1970–71," in *M: Writings '67–'72*. Middletown, CT: Wesleyan University, 1972, 96–116.
John Cage, "An Autobiographical Statement," johncage.org, accessed December 15, 2019: http://johncage.org/autobiographical_statement.html
John Cage, "How the Piano Came to be Prepared," johncage.org, accessed December 15, 2019: http://johncage.org/prepared_piano_essay.html
Allan Chen, "Neural Networks: Computing's Next Frontier," *Microcomputer Solutions* (March–April 1991), 3–6.
Austin Clarkson, "Composing the Performer: David Tudor Remembers Stefan Wolpe," *Musicworks* 73 (Spring 1999), 26–32.
Austin Clarkson, "A Creative Collaboration: Stefan Wolpe's and David Tudor's *Battle Piece*," *Musicworks* 73 (Spring 1999), 32–35.
Austin Clarkson, "David Tudor's Apprenticeship: The Years with Irma and Stefan Wolpe," *Leonardo Music Journal* 14 (2004), 5–10.
Perry R. Cook, "Singing Voice Synthesis: History, Current Work, and Future Directions," *Computer Music Journal* 20, no. 3 (Autumn 1996), 38–46.
Lowell Cross, "Remembering David Tudor: A 75th Anniversary Memoir," lowelcross.com, accessed December 15, 2018: http://www.lowellcross.com/articles/tudor/coda.html
Lowell Cross, "The Stirrer," *Source: Music of the Avant Garde* 4 (1968), 25–28.
Lowell Cross, "Audio/Video/Laser," *Source: Music of the Avant-Garde* 8 (1970), 26–36; reprinted in *Source: Music of the Avant-Garde 1966–1973*, edited by Larry Austin and Douglas Kahn. Berkeley: University of California Press, 2011.
Lowell Cross, "*Musica Instrumentalis*, *Video II (B)*, *Video II (C)*, *Video II (L)*," *Source: music of the avant garde* 9 (1971), 3–10.
Rebecca Cypess, "'Esprimere la voce humana': Connections between Vocal and Instrumental Music by Italian Composers of the Early 17th Century," *Journal of Musicology* 27 (2010), 181–223.
Stuart Dempster, "Working with David Tudor and the Merce Cunningham Dance Company," *Musicworks* 73 (Spring 1999), 14–19.
John Driscoll and Matt Rogalsky, "David Tudor's *Rainforest*: An Evolving Exploration of Resonance," *Leonardo Music Journal* 14 (2004), 25–30.
René Farley, "Touch-Sensitive Key," *electron* (October 1968), 38.
Simone Forti, "Theatre and Engineering: An Experiment: Notes by a Participant," *Artforum* (February 1967), 26–30.
Carlo Ginzburg, "Microhistory: Two or Three Things That I Know about It," translated by John and Anne C. Tedeschi, *Critical Inquiry* 20 (Autumn 1993), 10–35.
Jonathan Goldman, "The Buttons on Pandora's Box: David Tudor and the Bandoneon," *American Music* 30, no. 1 (Spring 2012), 30–60.
D'Arcy Philip Gray, "The Art of the Impossible," *Musicworks* 69 (Fall 1997), 18–21.
D'Arcy Philip Gray, "David Tudor in the Late 1980s: Understanding a Secret Voice," *Leonardo Music Journal* 14 (2004), 41–47.
David Gutkin, "Drastic or Plastic?: Threads from Karlheinz Stockhausen's 'Musik und Graphik,' 1959," *Perspectives of New Music* 50, no. 1–2, (Winter–Summer 2012), 255–305.
John Holzaepfel, "New Perspectives on the History of the 'New York School,' " paper delivered at the April 1990 meeting of The Sonneck Society, Hammond, Virginia.
John Holzaepfel, "David Tudor and the *Solo for Piano*," in *Writings through John Cage's Music, Poetry, and Art*, edited by David W. Bernstein and Christopher Hatch. Chicago, IL: University of Chicago Press, 2001, 137–156.

John Holzaepfel, "Cage and Tudor," in *The Cambridge Companion to John Cage*, edited by David Nicholls. Cambridge, UK: Cambridge University Press, 2002, 169–185.

John Holzaepfel, "Painting by Numbers: The Intersection of Morton Feldman and David Tudor," in *The New York Schools of Music and Visual Arts*, edited by Steven Johnson. London, UK: Routledge, 2002, 159–72.

John Holzaepfel, "Tudor Performs Cage," in *Cage & Consequences*, edited by Julia H. Schröder and Volker Straebel. Hofheim, Germany: Wolke Verlag, 2012, 111–124.

John Holzaepfel, "The Roles of David Tudor in the Early Repertory of the Merce Cunningham Dance Company," in *Merce Cunningham: Creative Elements*, edited by David Vaughan. New York, NY: Routledge, 2013, 45–50.

Stephen Husarik, "John Cage and Lejaren Hiller: HPSCHD, 1969," *American Music* 1, no. 2 (Summer 1983), 1–21.

Rebecca Y. Kim, "Four Musicians at Work and Earle Brown's Indices," in *Beyond Notation: The Music of Earle Brown*, edited by R. Y. Kim. Ann Arbor: University of Michigan Press, 2017, 113–141.

Gottfried Michael Koenig, "Bo Nilsson," *Die Reihe* 4 (1958), 85–88; English translation in *Die Reihe* 4 (1960), 85–88.

Ron Kuivila, "Open Sources: Words, Circuits and the Notation-Realization Relation in the Music of David Tudor," *Leonardo Music Journal* 14 (2004), 17–23.

Don Lancaster, "Imitating Musical Instruments with Synthesized Sound," *Popular Electronics* (August 1975), 37–44.

Tamara Levitz, "The Would-Be Master Student: Stefan Wolpe and Ferruccio Busoni, in *On the Music of Stefan Wolpe*, edited by Austin Clarkson. Hillsdale, NY: Pendragon Press, 2002, 31–40.

Nilo Lindgren, "Into the Collaboration," in *The Pavilion: Experiments in Art and Technology*, edited by Billy Klüver, Julie Martin, and Barbara Rose. New York, NY: E. P. Dutton, 1972, 3–59.

Norbert Linke and Elaine Barkin, "Darmstadt: The Younger German Composers," *Perspectives of New Music* 2, no. 2 (Spring–Summer, 1964), 163–165.

Julie Martin, "A Fifty-Year Friendship," Martin/Klüver Archive.

Julie Martin, "Kite Tails and Collaboration: Jackie Matisse in America," Klüver/Martin archive.

David P. Miller, "The Shapes of Indeterminacy: John Cage's *Variations I* and *Variations II,*" *Frankfurter Zeitschrift für Musikwissenschaft* 6. Jahrgang (2003), 18–45.

Leta E. Miller, "Cage, Cunningham, and Collaborators: The Odyssey of *Variations V*," *Music Quarterly* 85, no. 3 (2001), 545–567.

Robert Moog, "Voltage-Controlled Electronic Music Modules," *Journal of the Audio Engineering Society* 13, no. 3 (July 1965), 200–206 (Box 39, Folder 3, David Tudor Papers, GRI.)

Gordon Mumma, "Four Sound Environments for Modern Dance," *Impulse, Annual of Contemporary Dance* (1967), 12–15.

Gordon Mumma, "From Where the Circus Went," in *Merce Cunningham*, edited by James Krosty. New York, NY: E. P. Dutton, 1975, 64–73.

Gordon Mumma, "A Visit to Mount Olympus with David Tudor (1996)," in *Cybersonic Arts*, 245–246. Originally published as "David Tudor: A Historical Reminiscence," *20th-Century Music* 3 (1996), 6–7.

Gordon Mumma, "Creative Aspects of Live-Performance Electronic Music Technology (1967)," in Mumma, *Cybersonic Arts: Adventures in American New Music*. Chicago, IL: University of Illinois Press, 2015, 43–49.

Gordon Mumma, "Two Cybersonic Works: *Horn* and *Hornpipe* (1970–71/2012)," in *Cybersonic Arts*, 54–62.

Gordon Mumma, "With Tudor the Organist (2013)," in *Cybersonic Arts*, 144–150.

You Nakai, "Lost Information: Selected Perspectives on 'Experimental Actions' (1948–1972)," *Tacet: Experimental Music Review* 2 (2013), 19–51.

You Nakai, "How to Imitate Nature in Her Manner of Operation: Between What Cage Did and What He Said He Did," *Perspectives of New Music* 52, no. 3 (Autumn 2014), 141–160.
Bo Nilsson, "Spel med enkla Svangningar," *Musikrevy* IV (1957), 147–150.
No Collective and Shinichi Takashima, "Unconditional Restoration (Restored)," in *Matters of Act (A)*, edited by No Collective. New York, NY: Already Not Yet, 2017, 82–136.
Ekaterina Gur'evna Okuneva (Екатерина Гурьевна Окунева), "Композитор-авангардист Бу Нильсон: Забытый «гений из Мальмбергета» (The Avant-Garde Composer Bo Nilsson: A Forgotten 'Genius from Malmberget')," *Problemy muzykal'noj nauki: Rossijskij naučnyj specializirovannyj žurnal/Music Scholarship: Russian Journal of Academic Studies* 2, no. 9 (2011), 200–204.
Pauline Oliveros, "Tripping on Wires: The Wireless Body: Who Is Improvising?" in Oliveros, *Sounding the Margins: Collected Writings 1992–2009*, edited by Lawton Hall. Kingston, NY: Deep Listening Publications, 2010, 121–127; published first in: *Critical Studies in Improvisation / Études critiques en improvisation* 1, no. 1 (2004).
Pauline Oliveros, "Memoir of a Community Enterprise," in *The San Francisco Tape Music Center: 1960s Counterculture and the Avant-garde*, edited by David W. Bernstein. Berkeley: University of California Press, 2008, 80–94.
Pauline Oliveros, "From Outside the Window: Electronic Sound Performance," in *The Oxford Handbook of Computer Music*, edited by Roger T. Dean. New York, NY: Oxford University Press, 2009, 467–472.
Pauline Oliveros, "Still Listening: Reflections on the Life and Music of David Tudor," in *Sounding the Margins: Collected Writings 1992–2009*. New York, NY: Deep Listening Publications, 2010, 11–13.
Otto Ortmann, "Lights on Piano Touch and Tone," *The Etudes Magazine* 43, no. 9 (September 1925), 617–618.
Maggi Payne, "The System Is the Composition Itself," in *Music with Roots in the Aether*, edited by Robert Ashley. Cologne, Germany: Musiktexte, 2000, 118–119.
Rice Pekinpah, "The Rhetorics of Detective M.," in *Matters of Act (A)*, edited by No Collective. New York, NY: Already Not Yet, 2016.
Nancy Perloff, "Hearing Spaces: David Tudor's Collaboration on *Sea Tails*," *Leonardo Music Journal* 14 (2004), 31–39.
James Pritchett, "David Tudor as Composer/Performer in Cage's *Variations II*," *Leonardo Music Journal*, Vol. 14 (2004), 11–16.
James Pritchett, "David Tudor's Realization of John Cage's *Variations II*," rosewhitemusic.com, accessed December 15, 2019: http://www.rosewhitemusic.com/cage/texts/Var2.html
Matt Rogalsky, "David Tudor's *Virtual Focus*," *Musicworks* 73 (Spring 1999), 20–23.
Wolja Saraga, "Phase-Shift Single Side-Band Modulators," United States Patent 3225316, December 2, 1960.
Harold C. Schonberg, "The Far-Out Pianist," *Harper's Magazine* (June 1960), 49–54.
Rudolf Steiner, "The Ear," in *Anthroposophical Movement: Weekly News for English-speaking, Members of the Anthroposophical Society* IV, no. 15, April 10, 1927; no. 17, April 24, 1927; no. 18, May 1, 1927 (Box 102, Folder 1, David Tudor Papers, GRI).
Peter Stöckli, "David Tudor, John Cage in Basel, 1972," *du* (May 1991), 83.
Philip Thomas, "Understanding Indeterminate Music through Performance: Cage's *Solo for Piano*," *Twentieth Century Music* 10, no. 1 (2013), 91–113.
Mark Thorson, Forrest Warthman, and Mark Holler, "A Neural-Network Audio Synthesizer," *Dr. Dobb's Journal* (February 1993), 50–64.
Eric Ulman, "The Music of Sylvano Bussotti," *Perspectives of New Music* 34, no. 2 (Summer 1996), 186–201.
Various, "The Forming of an Esthetic: Merce Cunningham and John Cage (1985): Panel Discussion with Earle Brown, Remy Charlip, Marianne Preger Simon, and David Vaughan,"

in *Merce Cunningham: Dancing in Space and Time*, edited by Richard Kostelanetz. New York, NY: Da Capo Press, 1988, 48–65.

Bill Viola, "David Tudor: The Delicate Art of Falling," *Leonardo Music Journal* 14 (2004), 49–56.

Christian Wolff, "On Form (1960)," in *Occasional Pieces: Writings and Interviews, 1952–2013*. New York, NY: Oxford University Press, 2017, 19–26. Also published as: "Precise Actions under Variously INdeterminate Conditions. On Form," in *Cues: Writings and Conversations*. Cologne, Germany: Edition MusikText, 1998, 38–51.

Wolff, "'. . . how he made all the difference': Thinking of David Tudor," in *Cues*, 378–185.

Peter Zaparinuk, "David Tudor's Performance Composition," *Musicworks* 71 (Summer 1998), 47–51.

D-2: Dissertations

Gelsey Bell, "Voice-Acts: Relationality and Performance in the Vocal Activities of the American Experimental Tradition," PhD dissertation, New York University, 2014.

Larry M. Engstrom, "Contemporary Swedish Music for Solo Trumpet and Trumpet in Mixed Chamber Ensembles with a Performance Analysis of Selected Works of Bo Nilsson, Foke Rabe, and Tommy Zwedberg," PhD dissertation, University of North Texas, 1991.

Sara J. Heimbecker, "John Cage's *HPSCHD*," PhD dissertation, University of Illinois at Urbana-Champaign, 2011.

John Holzaepfel, "David Tudor and the Performance of American Experimental Music, 1950–1959," PhD thesis, City University of New York, 1994.

Rebecca Y. Kim, "In No Uncertain Musical Terms: The Cultural Politics of John Cage's Indeterminacy," PhD dissertation, Columbia University, 2008.

Norma Loewen, *Experiments in Art and Technology: A Descriptive History of the Organization*, PhD dissertation, New York University, 1975.

You Nakai, "The Manner of Operation of John Cage's Music," MA thesis, The University of Tokyo, 2006.

You Nakai, "On the Instrumental Natures of David Tudor's Music," PhD dissertation, New York University, 2016.

Eric Nedelman, "Performance Analysis of David Tudor's Interpretations of Karlheinz Stockhausen's *Klavierstücke*," PhD dissertation, University of California Santa Barbara, 2005.

Matt Rogalsky, "'. . . In Rehearsals, or Preparation, or Setup, or from One Performance to Another': Live Electronic Music Practice and Musicians of the Merce Cunningham Dance Company," MA thesis, Wesleyan University, 1995.

Matt Rogalsky, "Idea and Community: The Growth of David Tudor's Rainforest, 1965-2006," PhD dissertation, City University London, 2006.

Eric Smigel, "Alchemy of the Avant-garde: David Tudor and the New Music of the 1950s," PhD dissertation, University of Southern California, 2003.

D-3: Books

L. Emilie Adams. *Understanding Jamaican Patois: An Introduction to Afro-Jamaican Grammar*. Kingston, Jamaica: Kingston Publishers, 1991.

C. P. E. Bach. *Essay on the True Art of Playing Keyboard Instruments*. New York, NY: W. W. Norton, 1948.

Marie-Laure Bachmann. *Dalcroze Today: An Education through and into Music*. Translated by D. Parlett. New York, NY: Oxford University Press, 1991.

Amy C. Beal. *New Music, New Allies: American Experimental Music in West Germany from the Zero Hour to Reunification*. Berkeley: University of California Press, 2006.

David W. Bernstein, ed. *The San Francisco Tape Music Center: 1960s Counterculture and the Avant-garde*. Berkeley: University of California Press, 2008.

Barry Blesser and Linda-Ruth Salter. *Spaces Speak, Are You Listening?: Experiencing Aural Architecture*. Cambridge, MA: MIT Press, 2007.
Harold Bloom. *The Anxiety of Influence: A Theory of Poetry* (2nd edition). New York, NY: Oxford University Press, 1997.
Pierre Boulez. *Stocktakings from an Apprenticeship*. New York, NY: Oxford University Press, 1991.
Carolyn Brown. *Chance and Circumstance: Twenty Years with Cage and Cunningham*. New York, NY: Alfred A. Knopf, 2007.
Richard Bunger. *The Well-Prepared Piano*. Colorado Springs: Colorado College Music Press, 1973; reprint, Litoral Arts Press, 1981.
Ferruccio Busoni. *Sketches for a New Esthetic of Music*. Translated by Theodore Baker. New York, NY: G. Schirmer, 1911.
Shane Butler. *The Ancient Phonograph*. Cambridge, MA: MIT Press, 2015.
Pierre Cabanne. *Dialogues with Marcel Duchamp*. Translated by Ron Padgett. New York, NY: Da Capo Press, 1971.
John Cage. *Silence: Lectures and Writings*. Middletown, CT: Wesleyan University 1961.
John Cage. *A Year from Monday: New Lectures and Writings*. Middletown, CT: Wesleyan University, 1967.
John Cage. *M: Writings '67–'72*. Middletown, CT: Wesleyan University, 1972.
John Cage. *Empty Words: Writings '73–'78*. Middletown, CT: Wesleyan University Press, 1979.
John Cage. *For the Birds: John Cage in Conversation with Daniel Charles*. Boston, MA: Marion Boyars, 1981.
John Cage and Pierre Boulez. *The Boulez-Cage Correspondence*. Edited by Jean-Jacques Nattiez. Cambridge, UK: Cambridge University Press, 1993.
John Cage and Allison Knowles, eds. *Notations*. New York, NY: Something Else Press, 1969.
John Cage and Joan Retallack. *Musicage: Cage Muses on Words, Art, Music*. Middletown, CT: Wesleyan University Press, 1996.
Adrianna Cavarero. *For More than One Voice*. Translated by Paul A. Kottman. Stanford, CA: Stanford University Press, 2005.
Joel Chadabe. *Electric Sound: The Past and Promise of Electronic Music*. New York, NY: Prentice Hall, 1997.
Mark Changizi. *Harnessed: How Language and Music Mimicked Nature and Transformed Ape to Man*. Dallas, TX: Benbella Books, 2011.
Cecil Coker, Peter Devos, Elliot Pinsor. *Speech Synthesis, An Experiment in Electronic Speech Production, Bell Systems Science Experiment #3*. Murray Hill, NJ: Bell Systems, 1963.
Emile Jaques-Dalcroze. *Rhythm, Music, and Education*. New York, NY: G. P. Putnam's Sons, 1921.
Terrence Deacon. *The Symbolic Species: The Co-evolution of Language and the Brain*. New York, NY: W.W. Norton, 1997.
Thomas DeLio. *Circumscribing the Open Universe*. Lanham, MD: University Press of America, 1984.
Emily Dolan. *The Orchestral Revolution: Haydn and the Technologies of Timbre*. Cambridge, UK: Cambridge University Press, 2012.
Mladen Dolar. *Voice and Nothing More*. Cambridge, MA: MIT Press, 2006.
Nina Sun Eidsheim. *The Race of Sound: Listening, Timbre, and Vocality in African American Music*. Durham, NC: Duke University Press, 2019.
William Fetterman. *John Cage's Theatre Pieces*. New York, NY: New York University, 1992.
Charles Fernyhough. *The Voices Within: The History and Science of How We Talk to Ourselves*. London, UK: Wellcome Collection, 2016.
Michel Foucault. *The Order of Things: An Archaeology of the Human Sciences*. Translated by Alan Sheridan. New York, NY: Vintage, 1991.

Donald R. Griffin. *Echoes of Bats and Men*. Garden City, NY: Anchor Books, 1959.
Niall Griffith and Peter M. Todd, eds. *Musical Networks: Parallel Distributed Perception and Performance*. Cambridge, MA: MIT Press, 1999.
David Grubbs. *Records Ruin the Landscape: John Cage, the Sixties, and Sound Recording*. Durham, NC: Duke University Press, 2014.
Eric J. Heller. *Why You Hear What You Hear: An Experiential Approach to Sound, Music, and Psychoacoustics*. Princeton, NJ: Princeton University, 2013.
Daniel Heller-Roazen. *No One's Ways: An Essay on Infinite Naming*. Cambridge, MA: MIT Press, 2017.
Michael Hicks and Christian Asplund. *Christian Wolff*. Urbana: University of Illinois Press, 2012.
Frank Hilberg. *David Tudors Konzept des "Elektrifizierten Klaviers" und seine Interpretation von John Cages "Variations II"*. Saarbrücken, Germany: Pfau, 1996.
Jack Hirschman, ed. *Artaud Anthology*. San Francisco, CA: City Lights Books, 1963.
Thom Holmes. *Electronic and Experimental Music (Second Edition)*. New York, NY: Routledge, 2002.
Sungook Hong. *Wireless: From Marconi's Black-Box to the Audion*. Cambridge, MA: MIT Press, 2001.
Laurence R. Horn. *A Natural History of Negation*. Stanford, CA: CSLI Publications, 2001.
Pontus Hultén and Frank Königsberg, eds. *9 Evenings: Theatre and Engineering*. New York, NY: Experiments in Art and Technology, The Foundation for Contemporary Performance Arts, 1966.
The I Ching: or, Book of Changes. Translated by Richard Wilhelm and Cary Baynes. New York, NY: Pantheon Books, 1950.
Martin Iddon. *John Cage and David Tudor: Correspondence on Interpretation and Performance*. Cambridge, UK: Cambridge University Press, 2013.
Don Ihde. *Listening and Voice: Phenomenology of Sound*. Albany: State University of New York Press, 2007.
William James. *Pragmatism*. New York, NY: Dover Publications, 1995.
James Joyce. *Finnegan's Wake*. New York, NY: Viking Press, 1958.
Brian Kane. *Sound Unseen: Acousmatic Sound in Theory and Practice*. New York, NY: Oxford University Press, 2014.
Friedrich Kittler. *Musik und Mathematik I: Hellas 1: Aphrodite*. Munich, Germany: Wilhelm Fink, 2006.
Friedrich Kittler. *Musik und Mathematik I. Hellas 2: Eros*. Paderborn, Germany: Wilhelm Fink, 2009.
Billy Klüver, Julie Martin, and Barbara Rose, eds. *The Pavilion: Experiments in Art and Technology*. New York, NY: E. P. Dutton, 1972.
Eduardo Kohn. *How Forests Think: Toward an Anthropology beyond the Human*. Berkeley: University of California Press, 2013.
Liz Kotz. *Words to be Looked At: Language in 1960s*. Boston, MA: MIT Press, 2007.
Heinrich Kramer. *Malleus Maleficarum;* English translation available as: *The Hammer of Witches: A Complete Translation of the Malleus Maleficarum*. Translated by Christopher S. Mackay. Cambridge, UK: Cambridge University Press, 2009.
Laura Kuhn, ed. *The Selected Letters of John Cage*. Middletown, CT: Wesleyan University, 2016.
Ralph Kux. *Erinnerungen an Rudolf Steiner*. Stuttgart: Mellinger Verlag, 1976.
Leigh Landy. *Understanding the Art of Sound Organization*. Cambridge, MA: MIT Press, 2007.
John Markus, ed. *Electronic Circuits Manual*. New York, NY: McGraw-Hill, 1971.
Fionn Meade and Joan Rothfuss, eds. *Merce Cunningham: Common Time*. Minneapolis, MN: Walker Art Center, 2017.

Quentin Meillassoux. *The Number and the Siren: A Decipherment of Mallarme's Coup De Des*. Translated by Robin Mackay. New York, NY: Urbanomic/Sequence, 2012.
Tyrus Miller. *Singular Examples: Artistic Politics and the Neo-Avant-Garde*. Evanston, IL: Northwestern University Press, 2009.
David A. Mindell. *Between Human and Machine: Feedback, Control, and Computing before Cybernetics*. Baltimore, MD: Johns Hopkins University Press, 2002.
Martha Mockus. *Sounding Out: Pauline Oliveros and Lesbian Musicality*. New York, NY: Routledge, 2007.
Gordon Mumma. *Cybersonic Arts: Adventures in American New Music*. Chicago: University of Illinois Press, 2015.
No Collective, ed. *Matters of Act (A)*. New York, NY: Already Not Yet, 2017.
Otto Ortmann. *The Physical Basis of Piano Touch and Tone: An Experimental Investigation of the Effect of the Player's Touch upon the Tone of the Piano*. London, UK: K. Paul, Trench, Trubner, 1925.
Renee Levine Packer. *This Life of Sounds: Evenings for New Music in Buffalo*. New York, NY: Oxford University Press, 2010.
Judea Pearl and Dana Mackenzie. *The Book of Why: The New Science of Cause and Effect*. New York, NY: Basic Books, 2018.
Benjamin Piekut. *Experimentalism Otherwise: The New York Avant-Garde and Its Limits*. Berkeley: University of California Press, 2011.
Trevor Pinch and Frank Trocco. *Analog Days: The Invention and Impact of the Moog Synthesizer*. Cambridge, MA: Harvard University Press, 2002.
Stewart Pollens. *Bartolomeo Cristofori and the Invention of the Piano*. Cambridge, UK: Cambridge University Press, 2017.
Barry B. Powell. *Homer and the Origin of the Greek Alphabet*. Cambridge, UK: Cambridge University Press, 1991.
James Pritchett. *The Music of John Cage*. Cambridge, UK: Cambridge University Press, 1996.
Mary Quinlan-McGrath. *Influences: Art, Optics, and Astrology in the Italian Renaissance*. Chicago: The University of Chicago Press, 2013.
Yvonne Rainer. *A Woman Who: Essays, Interviews, Scripts*. Baltimore, MD, and London, UK: Johns Hopkins University Press, 1999.
Sven Sandstrom. *Levels of Unreality: Studies in Structure and Construction in Italian Mural Painting During Renaissance*. Uppsala, Sweden: Almqvist & Wiksell, 1963.
Mary Savage. *A Likeness to Voices*. New York, NY: Dell, 1965.
Mary Savage. *Savory Stews*. Garden City, NY: Doubleday, 1969.
Mary Savage. *Addicted to Suicide: A Woman Struggling to Live*. Santa Barbara, CA: Capra Press, 1979.
Michael Shamberg. *Guerilla Television*. New York, NY: Henry Holt, 1971.
Kenneth Silverman. *Begin Again: A Biography of John Cage*. Evanston, IL: Northwestern University Press, 2012.
Geoff Smith and Nicola Walker, eds. *New Voices: American Composers Talk about their Music*. Portland, OR: Amadeus Press, 1995.
Kerala J. Snyder. *The Organ as a Mirror of Its Time: North European Reflections, 1610–2000*. New York, NY: Oxford University Press, 2002.
Rudolf Steiner. *Eurythmy as Visible Speech*. Spring Valley, NY: Anthroposophic Press, 1931.
Rudolf Steiner. *Wonders of the World: Ordeals of the Soul, Revelations of the Spirit*. London, UK: Rudolf Steiner Press, 1963.
Rudolf Steiner. *Macrocosm and Microcosm*. London, UK: Rudolf Steiner Press, 1968.
Rudolf Steiner. *The Case for Anthroposophy: Selections from Von Seelenrätseln*. London, UK: Rudolf Steiner Press, 1970.
Rudolf Steiner. *Eurythmy as Visible Music*. London, UK: Rudolf Steiner Press, 1977.

Rudolf Steiner. *The Inner Nature of Music and the Experience of Tone: The Occult Basis of Music*. New York, NY: Anthroposophic Press, 1982; available online at Rudolf Steiner Archive & e.Lib, accessed December 15, 2019: https://wn.rsarchive.org/Lectures/19061203p01.html

Rudolf Steiner. *Planetary Spheres and Their Influence on Man's Life on Earth and in the Spiritual Worlds*. London, UK: Rudolf Steiner Press, 1982.

Rudolf Steiner. *Eurythmy as Visible Speech*. Leominster, Herefordshire: Anastasi, 2015.

Rudolf Steiner. *MUSIC: Mystery, Art and the Human Being*. Forest Row, UK: Rudolf Steiner Press, 2016.

Victor I. Stoichita. *A Short History of the Shadow*. London, UK: Reaktion Books, 1997.

Nicholas Thistlethwaite and Geoffrey Webber, eds. *The Cambridge Companion to Organ*. Cambridge, UK: Cambridge University Press, 1998.

Philip Thomas and Stephen Chase. *Changing the System: The Music of Christian Wolff*. Farnham, UK: Ashgate, 2013.

Peter M. Todd and D. Gareth Loy, eds. *Music and Connectionism*. Cambridge, MA: MIT Press, 1991.

Gary Tomlinson. *Music in Renaissance Magic: Toward a Historiography of Others*. Chicago, IL: University of Chicago Press, 1994.

Rufus P. Turner. *Diode Circuits Handbook*. New York, NY: Howard W. Sams, 1963.

John David White and Jean Christensen. *New Music of the Nordic Countries*. New York, NY: Pendragon Press, 2002.

Walt Whitman. *Leaves of Grass*. New York, NY: Simon & Brown, 2017.

Norbert Wiener. *Extrapolation, Interpolation, and Smoothing of Stationary Time Series: With Engineering Applications*. Boston, MA: MIT Press, 1964.

Norbert Wiener. *Cybernetics: or the Control and Communication in the Animal and the Machine*. Boston, MA: MIT Press, 1965.

Robin W. Winks. *Modus Operandi: An Excursion into Detective Fiction*. Boston, MA: David R. Godine, 1982.

Christian Wolff. *Cues: Writings and Conversations*. Cologne, Germany: Edition MusikText, 1998.

Christian Wolff. *Occasional Pieces: Writings and Interviews, 1952–2013*. New York, NY: Oxford University Press, 2017.

Gayle Young. *The Sackbut Blues: Hugh Le Caine, Pioneer in Electronic Music*. Ottawa, ON: National Museum of Science and Technology, 1989.

Rob Young and Irmin Schmidt. *All Gates Open: The Story of Can*. London, UK: Faber & Faber, 2018.

D-4: Liner Notes

Amy C. Beal, "A Short Stop Along the Way: Each-Thingness and Music for Merce," *Music for Merce 1952–2009*, New World Records (80712-2), 2010, CD.

John Cage, "Liner notes," *John Cage: Music for Merce Cunningham*, Mode Records (Mode 024), 1991, CD.

John Holzaepfel, "Liner Notes," *David Tudor and Gordon Mumma*, New World Records (80651), 2006, CD.

Art Lange, "Liner Notes," *David Tudor: Piano Avant-Garde 1956–1960*, Hat Hut Records (6181), 1996, CD.

Leta E. Miller, "ONCE and Again: The Evolution of a Legendary Festival," *Music from the ONCE Festival, 1961–1966*, New World Records (80567-2), 2003, 5 CDs.

Gordon Mumma, "Composer's Notes," *Electronic Music of Theatre and Public Activity*, New World Records (80632-2), 2005, CD.

Matt Rogalsky, "Liner Notes," *The Art of David Tudor 1963–1992*, New World Records (80737), 2013, 7 CDs.

David Tudor, "Liner notes," *Rainforest IV*, Gramavision (GR-EB 1), 1980, LP.
David Tudor, "Liner notes," *John Cage: Music for Merce Cunningham*, Mode Records (Mode 024), 1991, CD.
Forest Warthman, "Liner Notes," David Tudor, *Neural Synthesis Nos. 6-9*, Lovely Records (CD1602), 1995, 2CDs.
Christian Wolff, "Liner notes," *For Piano I / For Pianist / Burdocks*, WERGO (WER 60063), 1972, LP.

D-5: Online

Geeta Dayal, "Porträt / Max Matthews: An extensive interview with the late pioneer of computer music, covering Bell Labs, John Cage, Stockhausen and HAL's voice," May 9, 2011, *Frieze*, accessed December 15, 2019: https://frieze.com/article/max-mathews-1926%E2%80%932011?language=de. A PDF version can be obtained at: https://ccrma.stanford.edu/~aj/archives/docs/all/8
Electro-Harmonix, "Bass Balls," Electro-Harmonix.com, accessed December 15, 2019: https://www.ehx.com/products/bassballs
Chris Gill, "10 Strangest Vintage Effects of All Time," *Guitar World* (December 2006); online version available at guitarworld.com, accessed December 15, 2019: https://www.guitarworld.com/magazine/weird-science-10-strangest-vintage-effects-all-timeGuitar World
Hawkesbury Radio Astronomy Observatory, "Vela Pulsar Observations," Hawkesbury Radio Astronomy Observatory website, accessed December 15, 2019: http://hawkrao.joataman.net/pulsar/vela_pulsar/audio/vela.wav
Integrated Learning Strategies, "Vestibular System: Your Child's Internal GPS System for Motor Planning and Attention," April 13, 2016, *Integrated Learning Strategies*, accessed December 15, 2019: https://ilslearningcorner.com/2016-04-vestibular-system-your-childs-internal-gps-system-for-motor-planning-and-attention/
Alexander Keefe, "Subcontinental Synth: David Tudor and the First Moog in India," April 30, 2013, *east of borneo*, accessed December 15, 2019: https://eastofborneo.org/articles/subcontinental-synth-david-tudor-and-the-first-moog-in-india/
Alvin Lucier, "Thoughts on Installations," kunstradio.at, accessed December 15, 2019: http://kunstradio.at/ZEITGLEICH/CATALOG/ENGLISH/lucier-e.html
Merce Cunningham Trust, "Five Stone Wind (1988)," mercecunningham.org, accessed December 15, 2019: https://mercecunningham.org/index.cfm/choreography/dancedetail/params/work_ID/140/
Edward L. Stauff, *Encyclopedia of Organ Stops*, organstops.org, accessed December 15, 2019: http://www.organstops.org/index.html
Alan Stott, "Translator's Preface and Acknowledgments," *Eurythmy as Visible Singing*, Rudolf Steiner Archive online, accessed December 15, 2019: https://wn.rsarchive.org/Lectures/GA278/English/AMTRP1996/EuViSg_tpref.html.

D-6: Scores

John Cage, *34'46.776" For a Pianist* (New York, NY: Henmar Press, 1960.
John Cage, *Solo for Voice No. 2* (New York, NY: Peters Edition, 1960) EP 6751.
John Cage, *Variations V: Thirty-seven Remarks Re Audio-Visual Performance* (New York, NY: Peters Edition, 1965).
John Cage, *Variations VI* (New York, NY: Peters Edition, 1966).
John Cage, *Sixty-two Mesostics Re Merce Cunningham for Voice Unaccompanied using Microphone* (New York, NY: Peters Edition, 1971).
Toshi Ichiyanagi, *Activities for Brass* (New York, NY: Peters Edition, 1962).

D-7: Recordings

John Cage and David Tudor, *Communication (Darmstadt Aural Documents Box 2)*, NEOS (11213), 2012, CD.
David Tudor, *Variations II*, in *New Electronic Music From Leaders of the Avant-Garde*, Columbia Masterworks, Music of Our Time (MS 7051), 1967, LP.
David Tudor, *Pulsers/Untitled*, Lovely Music (VR 1601), 1984, LP.
David Tudor, *Piano Avant-Garde: Recordings 1956–60*, Hat Hut (6181), 1996, CD.
David Tudor, *The Art of David Tudor: 1963–1992*, New World Records (80737), 2013, 7 CDs.
Various, *Music for Merce: 1952–2009*, *Box 1*, New World Records (80712), 2010, 10 CDs.

D-8: Videos

Merce Cunningham and Charles Atlas, *Channels/Inserts*, Video, Cunningham Dance Foundation, 1982.
Kit Fitzgerald and John Sanborn, *re: Soundings*, Video, Electronic Arts Intermix, 1983.
Eliot Kaplan, *Cage/Cunningham*, Video, Cunningham Dance Foundation, 1991.
Julie Martin, Barbro Schultz Lundestam, *David Tudor: Bandoneon! (a combine)*, DVD, ArtPix, 2010.
John Cage, *Variations V: Cage, Tudor, Mumma, Merce Cunningham Dance Company* (NDR, 1966), DVD, Mode Records, 2013.

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(A) DAVID TUDOR

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