How the Performer Came to be Prepared: Three Moments in Music's Encounter with Everyday Technologies

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What kind of technology is the piano? It was once a distinctly everyday technology. In the bourgeois home of the nineteenth century it became an emblematic figure of gendered social life, its role shifting between visually pleasing piece of furniture, source of light entertainment, and expression of cultured upbringing.[1] It performed this role unobtrusively, acting as a transparent mediator of social relations. To the composer of concert music it was, and sometimes still is, says Samuel Wilson, like the philosopher's table: "an assumed background on which one writes."[2] Like other instruments standard to Western art music, the piano was designed to facilitate the production of a consistent and refined timbre.[3] More than most other such instruments, the piano also facilitated a kind of sonic neutrality. With its wide pitch range and smoothing of the percussive attack of its predecessor instruments, the piano presented composers with a technological means of approaching composition from a seemingly objective vantage point. It exemplified, in Heideggerian terms, the instrumentality of the instrument,[4] serving as a mediator between idea and expression that apparently adds no character of its own.

This notion of the invisibility, or transparency, of the mediations that musical technologies such as the piano enact is one of my areas of concern here.[5] So too is its inverse: when these mediations become visible or opaque. Transparency has been a topic of significant recent theoretical attention. Stefanos Geroulanos, for example, has detailed how the supposed transparency of intersubjective, epistemological, and social relations was a major point of critique in postwar French thought, where the supposition of transparency was taken to suppress how the world was "complex, layered, structured, filled with heterogeneity"[6] – and, as I will stress here, contingency. The thinkers Geroulanos considers, from Jean-Paul Sartre through to Jean-François Lyotard, can be said to be united in their refusal to invisibilise mediatedness.[7] From a starting point of conceiving of the piano as a technological artifact, and in particular from John Cage's 'prepared piano,' I will explore how a similar concern has appeared in musical contexts, albeit not without the risk of reversion back into a logic of transparency.

Treating the piano as a technological artifact also puts us into conversation with contemporary work on performance and musical technologies. A recent attempt by Tom Mudd to map the field of research concerning musical engagement with tools and technologies is useful here.[8] On one side there is, as Wilson highlighted regarding the piano, a position that treats technology as "an ideally transparent medium for communicating ideas."[9] Mudd follows the philosopher of technology Don Ihde in identifying within this a stance that accepts the transformative power of particular technological artifacts while diminishing awareness of their presence.[10] At the same time, the feeling of transparency and non-mediation can in fact be closer to its opposite: virtuosity can be understood as an immersion in the nature of a medium and its specific

characteristics, with the ideas of a performer being governed by the possibilities their instrument offers.[11]

On the opposite side of the spectrum, technology is seen as "a necessary and creative mediation that can be a source of ideas itself rather than simply a means for their expression." The former perspective treats technology as neutral, while the latter treats technologies as having "particular tendencies, biases, and values embedded within."[12] Expanding on Mudd's engagement, on Ihde's terms this would constitute a distinction between, or move from, embodiment relations to hermeneutic relations and alterity relations, and from transparency to opacity, with which the interpretive capacities technologies offer become tangible and ultimately the technology seems to take on a certain independence.[13] This can be pushed further still through Ihde's concept of "background relations." Ihde highlights cases of automatic and semiautomatic technologies that provide the basis for our activities without us entering into explicit relation with them or having any explicit experience of them. Thermostats and other such heating regulation devices are one such example, but the idea of a technology or set of technologies having a "background" or "field" relation to individuals in the constitution of an overall environment is increasingly pertinent. In what follows I will suggest, within and between examples, a movement between these different positions: movement between transparency and opaqueness, visibility and invisibility, audibility and inaudibility. How relations with musical technologies are conceived and enacted will be seen to raise a number of epistemic, aesthetic, social, and political questions.

Requiring a percussion ensemble but lacking the space, John Cage instead sought to turn the piano into one.[14] He inserted everyday objects – bolts, screws, coins – between the strings of the piano, turning it into a producer of unpredictable, diverse tones, redolent of the Gamelan orchestra. The transparent, highly stable emblem of Western art music is turned into an unpredictable mechanism for producing noises; the score is no longer a key to be accurately interpreted but a prompt to perform actions; the composer's control over their work, their capacity to directly communicate in the language of Western art music, is diminished. While Cage's composition work with his 'prepared piano,' the majority of which was in the 1940s, does not seem to share the explicit intent to deal with the piano as a historical and social object as the critical artistic inquiry of figures such as Nam June Paik, George Maciunas, Philip Corner, and Annea Lockwood did in the 1960s,[15] it nevertheless anticipates that later work in rendering the piano legible as a piece of technology, and as a piece of technology that operates as part of social and historical contexts.

I begin here with a study of the prepared piano and Cage's work for it. In particular, I highlight two tendencies in Cage's work and thought that the prepared piano is part of, and which, while overlapping, may be in some tension with each other. The first of these is the prepared piano as rendering visible of a piece of musical technology as a site of aesthetic, epistemic, and social contingency. The second is the prepared piano as part of a drive towards the goal of an "all-sound" music[16] – we might carry this forward to what Mudd, citing Peter Worth, describes as an "any sound you can imagine" approach[17] – and the accompanying desire to "liberate" the (sonic) "spirit […] inside each of the objects of this world."[18] The site of conflict here is between a fundamental openness to contingency and a desire to totalise.

Via the mediating point of Cage and the pianist David Tudor's work on *Variations II* (1961), and in particular Tudor's use of basic consumer electronics in the development of his 'amplified piano,' I turn to *Variations VII* (1966), performed as part of the *9 Evenings* series in collaboration with Bell Labs. This large-scale work, facilitated by Bell Labs's latest developments in communications technologies, can be seen as continuing to pursue the kinds of contingencies that the prepared piano prompted. It also, however, presents a more troubling tendency towards totalisation. Being facilitated in the capture of remote sounds by the then rapidly expanding communications network, *Variations VII* can be seen to enact, in Ihde's terms, a "background" mode of technological relation,[19] through which technology is once again rendered transparent and its social force rendered invisible.[20]

To close I will address some musical work that emerges as part of the shift from the industry-affiliated project that was *Variations VII* back to independent work with consumer electronics.[21] I will consider the characteristics of the improvising systems developed by the composer-performers David Behrman and George E. Lewis. Through a study of Behrman's work on human-machine interactions in pieces such as *Interspecies Smalltalk* (1984) and Lewis's constantly evolving *Voyager* software (1987-), I will suggest that this work signals a renewal of concern with the conditions of technology and of human-technological relations, equally facilitating an enriched understanding of musical technologies as sites of contingent encounter, with distinct social, aesthetic, and epistemic repercussions.

CAGE'S PREPARED PIANO AND AN "ALL-SOUND" MUSIC

In his 1940 essay "The Future of Music: Credo,"[22] John Cage discusses the capacity of technological advances to engender "new sound experiences."[23] Electric instruments, including "oscillators, turntables, generators, means for amplifying small sounds, film phonographs, etc.,"[24] are described in their potential to generate any sound or rhythmic characteristic whatsoever. The composer, no longer limited by traditional musical restraints, is free to work with "the entire field of sound."[25] This would be an "all-sound" music.[26]

In the years leading up to this essay, Cage's concerns increasingly moved towards percussion music. For Cage, percussion was a musical form where formerly excluded sounds – noise – could be reclaimed into the territory of music: insofar as percussion music is not concerned with the control of tones, any sound is permissible. This situates percussion music at a point between the keyboard-influenced music of the past and the all-sound music of the future, at the moment of a historical-aesthetic shift. Cage seems to have developed his prepared piano shortly after first delivering the lecture that became "Future of Music: Credo," and so in the terms of this period of Cage's thought we can discern that the prepared piano lies at a point between the piano-informed music of the past and the electrical instrument-informed music of the future, as a curious hybrid technology deforming the past to provide a provisional look towards the future.

Cage's perspective on an "all-sound" music also points in two directions. On the one hand there is the question of developing the technological means to explore the entire field of sound. But accompanying this is a seemingly more metaphysical question. Cage would speak of a "spirit […] inside each of the objects of this world," and of how "all we need to do to liberate that spirit is

to brush past the object, and to draw forth its sound,"[27] a notion he credits to the filmmaker Oskar Fischinger, with whom Cage briefly apprenticed in 1937. Percussion provides a very literal means towards the liberation of these 'spirits.' As the musicologist Richard H. Brown notes, "[a]s a mechanical act, the percussive strike of an object is the simplest application of a technology in the reproduction of sound."[28] Dealing with "the entire field of sound" is then not only a question of a quasi-scientific examination of this field, but of giving voice, through technological means, to a purported inner existence of objects.

A range of positions on Ihde's technological continuum are implied here. There is the suggestion of the kind of embodiment relation by which technological artifacts extend human abilities but awareness of their presence as technologies is diminished. The artifact is a neutral and ideally, if not yet actually, transparent point of access to an already intuited field. Yet to speak of a "spirit" inside of individual things suggests something not yet known by the human subject. Technology can be a means to enact an interpretive process with regards to the objects of the world, and can even make the objects of the world appear in their singular distinctness, in their alterity. At this end of the spectrum technology still seems to serve as a means – as tool, or 'instrument' in its musical and everyday senses – to access unknown, but conjectured, sounds.

However, a more radical kind of technological alterity also arises. As well as being a provisional point of access to the field of sound in its entirety, the prepared piano also pushes back. Much has been made of the seemingly incidental, yet significant, change that the preparation of the piano effects with regards to notation. There is, by tradition, a direct and determinate relation between scored note and sounded note. The passage from the mind of the composer, through score, performer, and instrument, has been conceived as transparently smooth. But, with the prepared piano, notation and sound event are decoupled. As Brown puts it, "[t]he notation […] was in essence a form of tablature, dissolving the relationship between notation and sound, and instead focusing on the relationship between mechanical action and sounds."[29] The decision to interfere with the mechanisms of the piano interrupts the appearance of a smooth passage from the mind of the composer to the sound event. The technological underpinning of the sounding process – where both instrument and notation can be understood as kinds of technologies mediating between composer and sound event – becomes tangible.[30]

The prepared piano, then, seems to have been intended as a means towards an all-sound music, a multiplication of the sounds with which the composer could work, potentially as transparent a means as the traditional piano was towards tonal music. But as a piece of technology it resisted this. It proved unstable and unpredictable, the sounds the piano and its performers produced, as Cage highlighted and came to embrace, slipping out of the composer's control.[31] It became no longer a transparent technology but an opaque one, disrupting the composer's attempts at expression. At a pivotal moment in Cage's development, then, there is another sense in which the prepared piano points both backwards and forwards: backwards towards a desire for an "all-sound" music and full command over the field of sound, and forwards towards the relinquishment of control and embrace of contingency Cage came to favour, evidenced in his erasure of questions of expression, deployment of chance procedures, and desire to "let sounds be themselves."[32]

The notion of a "spirit […] inside each of the objects of this world" can also be applied in both directions. Looking backwards, it deepens the concerns of an "all-sound" music, seeming to render it on a more ontological level, where every and any object has a sound that, through technological means, may be captured.[33] Looking forwards, it presents sounds and objects as having a life of their own, an alterity, that cannot be reduced to our attempts to know, capture, and control them, and that, Cage decided, we should let be. A question I wish to maintain, however, is the extent to which the past is really left behind. The question of whether these forwards and backwards perspectives can be neatly separated should be held in mind in the next section.

SECOND-ORDER PERFORMANCE: *VARIATIONS II*, *VARIATIONS VII* AND EXPERIMENTS IN ART AND TECHNOLOGY

Across the 1950s Cage would adopt various chance procedures into his compositional process, as well as experimenting with graphic notational practices that required interpretation on the part of the performer, among other attempts to relinquish his own control over the performance situation. 1961's *Variations II*, written with no specified instrumentation or number of players, presents a mature exemplification of these tendencies in Cage's work. Its mobile graphic score, making use of multiple transparencies for the performers to combine and then interpret, predetermines seemingly nothing of what kinds of sounding events a performance could involve, and intensifies the tangibility of notation as a constructed hermeneutic technology, short-circuiting any attempt at a transparent translation from the mind of the composer to the sound. On one hand the field of sound in its entirety then seems available to the performer, but at the same time the concern seems to be more with the production of singular, contingent sound events; Cage states that "the universe in which the action is to take place is not preconceived."[34]

Cage's long-time collaborator, the pianist David Tudor, took *Variations II* as an opportunity to perform his own inquiry into the piano as a technology, with what he termed his "amplified piano."[35] Working from the six basic parameters indicated in Cage's score, Tudor designed a complicated system of microphones and phonograph cartridges to be triggered in various ways, with the sound events deriving only from the resonances, feedback loops, and signal interferences of the piano, microphones, and cartridges in reciprocal interaction. The piano becomes, as You Nakai notes, a kind of resonance chamber.[36] This could be seen as a technological means to intensify the indeterminate qualities of Cage's prepared piano, going beyond what Cage expected of Tudor in his role as virtuoso pianist and making the piano the opposite of a transparent tool:[37] the control over sounding events is shifted away from the performer and distributed through a complex instrumental assemblage, with Tudor noting he could "only hope to influence" it.[38] More than even a relation of alterity, we move here into the explicit territory of distributed sounding agencies. The piano is perhaps no longer an instrument or a tool, if we are to understand those terms as means to a subject's ends, but fully a technological artifact, or part an assemblage of technological artifacts alongside performer, notation, and other factors, each in relations of alterity with the others.

With the amplified piano Tudor may, as John Driscoll and Matt Rogalsky suggest, have been following an impulse sparked by Cage, dating back to the attempts to reveal the sonic

characteristics of everyday objects, the "spirit […] inside each of the objects of this world," that his performances of Cage's *Cartridge Music* (1960) involved.[39] Yet in addition to the two directions in which I have already suggested this notion points, of the performer as transparently expressing the thought of an "all-sound" music and the performer as a producer of contingent events, Tudor's investigations into the amplified piano propose new ways of thinking of the performer within the performance situation. The integration of a position that might seem sovereign – observer, performer, experimenter – into a technological system, as just one part of that system, anticipates the more explicit concern with reflexivity that came to concern 'second-order' cybernetics.[40]

Such meetings of artistic, theoretical, and technological practices became more visible as the 1960s proceeded, and so too did the explicit and implicit refiguration of composer-performer-instrument/technology relations. The *9 Evenings: Theatre and Engineering* event series held in New York City in October 1966, organised with Bell Labs, and the subsequent Experiments in Art and Technology (E.A.T.) programme, marked a zenith of these meetings.[41] The cutting-edge audiovisual and communications technologies that Bell Labs could offer allowed artists including Tudor and Cage to drastically extend the scope of their working through of musical technology and its contingencies. Tudor, for his part, contributed to *9 Evenings* with *Bandoneon!* a performance for a bandoneon – a traditional Argentinian instrument similar to an accordion – through a setup of several microphones fed through electrical systems and transmitted via twelve conventional loudspeakers and further mobile speakers, and with accompanying visual effects. This setup flooded the cavernous 69th Regiment Armory in which *9 Evenings* was held with a fluctuating, self-sustaining tumult of sound. The sound of the audio system itself could be muted such that only the architectural resonance of the performance space itself would be audible. In the words of W. Patrick McCray, "Tudor was, in effect, playing not just the bandoneon but the Armory itself."[42] Here, another of Ihde's technological relations may become tangible in a musical context: in bringing into focus the sounding space as part of the technological apparatus, and suggesting not only a differentiated performance space but a single environment, background relations on which experience itself rests come into visibility.

If Tudor played the Armory, then Cage's *Variations VII*, performed by Cage, Tudor, and others, might be said to have played the entirety of New York City. *Variations VII* took advantage of the specialisation in telecommunications at Bell Labs to construct a system that included a number of radio and television receivers and ten telephone lines, linked to locations across New York. It stressed, as a retroactive draft score suggests, "[q]uantity instead of quality."[43] Alongside outside sounds transformed by electrical means, it included the inaccessible sounds of physiological processes (e.g. brainwaves) and other transformations of nonaural inputs into sound, and the recursive capture and redeployment of transmitted sound, "making inaudible what is otherwise silent." Everything became material to be captured, processed, and transmitted. Is this a "liberation" of the "spirit […] inside each of the objects of this world"? If it is, how should that notion be understood? *Variations VII* is, on the one hand, an extension of the radical contingencies that Cage introduced to his music with the prepared piano: the instruments, if the electrical devices involved can still be called that (archival footage shows Cage and the other performers working with a maze of wires and devices), become opaque to composer and performer, pushing back in their alterity, finding a kind of agency of their own and giving form

to a sound environment that the performer, in Tudor's earlier words, "could only hope to influence." It may seem to give individual objects and sounds an expressivity that is not determined by the ideals of composer or performer. Yet this is not the only way that *Variations VII* can be interpreted.

The subsequent history of Bell Labs's work with musicians and artists suggest an alternative perspective. Bell Labs engineer Billy Klüver and artist Robert Rauschenberg founded E.A.T. in late 1966 in order to capitalise on the momentum gathered by *9 Evenings*. Significantly, and as John Beck and Ryan Bishop have recently detailed, at this point the social basis for these art-technology explorations was made explicit. Klüver, making use of the kind of technological analogy that would become more pronounced in his stances over the next few years, saw the ultimate purpose of E.A.T. as being to "act as a transducer between the artist and industry, to protect the artist from industry and industry from the artist, to translate the artist's dreams into realistic technical projects."[44] Yet this vision of "adjustment" and "integration" did not prove easy. Ultimately, the organic meeting of art, technology, and commerce that E.A.T. sought to bring about proved unsustainable when artistic ideals could not be translated into commercial terms.[45] Furthermore, at a personal level, artists and engineers would come to clash over feasibility, undermining Klüver's desire to break down individual goals and achieve a fully accomplished kind of nonhierarchical collaboration.

More than this, Beck and Bishop highlight how the social forms Klüver sought to bring about were based on "the remarkably propulsive power of American modernity and its capacity to actualize new modes of experience on a grand scale,"[46] and Klüver was explicit on wanting to participate in a wave of American cultural ascendency.[47] By the late 1960s such attitudes were under increasing attack: in Beck and Bishop's words, "technology was no longer seen as an open invitation to the future but increasingly perceived simply as a weapon."[48] The imbrication of Bell Labs and other major technological organisations in Cold War military research (around 40 percent of Bell Labs's staff worked on military projects[49]) became unavoidable, and the project of dismantling boundaries in the name of radically nonhierarchical practices of problem-solving became rife with political tensions as well as corporate demands.

Despite Klüver's insistence on a practice approach – hence an emphasis on engineering rather than science – there is a significant theoretical parallel here. At this time the extension of ideas from cybernetics and information theory into other disciplines had become widespread, and such a perspective can be heard in Klüver's nonhierarchical, organic ideals concerning the social realm, where the ideal social setting seems to take on the form of a self-regulating system. Yet already in 1955 the philosopher of science Georges Canguilhem had expressed a worry that a cybernetics-informed analogy between organism and society could serve to falsely imply social and subjective harmony: the purportedly smooth transposition of one realm into another may well mask a violence being done in this process.[50] This is an example Stefanos Geroulanos highlights as part of his sustained account of the critique of transparency in postwar French thought. What is at risk in the analogy between realms is a seeming rendering transparent of every thing and every relation at the expense of that which does not fit or does not want to fit.[51] The ideals that Klüver seeks in proposing a nonhierarchical meeting between art, technology,

and commerce risk effacing the very real and often recalcitrant, even violent relations that already hold between these fields.

Yuk Hui's recent work has also brought attention to the troubling kinds of organic unity that cybernetic thought can imply, and the distinct theoretical difficulties involved in accounting for movement between domains.[52] Here, these unities present a complex dialectic between recursivity and contingency. The recursive system always faces and must incorporate contingencies if it wants to continue existing, but at an organicist limit point of a fully self-sustaining system it can do this comfortably: any contingency is accommodated, rendered into the terms of the system, and so loses any feature that made it meaningfully contingent. This presents cybernetics in a peculiar light. It is at once a theory of radical contingencies and of unprecedented control. This is manifest in how it has at once and the same time been characterised as a science of the counterculture, in Deleuze and Guattari's terms a "nomad" science,[53] working in the cracks of institutions, and as a totalising programme or metadisicplinary position;[54] even, on Hui's account, a kind of historical *a priori*. This peculiar feature of cybernetics gives cybernetics-informed art a peculiar status itself.

The musicologist Eric Drott has recently detailed a distinction between what he calls a "cybernetic sublime" and a "cybernetic mundane."[55] The cybernetic sublime can be found in artistic works that enact a spectacularisation of cybernetics – Drott names Tudor's *Rainforest IV* as an example, and we could add to that *Variations VII* – and involve for the spectator an oscillation between immersion and reflection. The cybernetic mundane, meanwhile involves situations in which ideas derived from cybernetics and information theory "operate in the background." (We may recall here Ihde's typology.) It concerns the obscured ways in which cybernetics has never left us. An instance of this is where the seemingly neutral cybernetic language of information is deployed not only to make comparisons but to assert equivalences.[56] Drott highlights the equivalence of music *is* information. When, in the early 1950s, the engineers who designed the RCA Synthesizer – originally intended to both analyse and synthesise music – equated music with information, this allowed them to cast this instrument as "a universal instrument capable of generating any sound imaginable."[57] Yet this requires the elimination, or standardisation, of the improbable: in musical terms, the unidiomatic, or, in terms equally cybernetic and musical, noise.[58] As Drott goes on to argue, the music *is* information equation is now taken as given, discussing the ways that Spotify binds user information and musical information together in a closed circuit that both incorporates and guides user receptivity. Where the cybernetic sublime involves making cybernetics visible, the cybernetic mundane renders it invisible, transparent.

Returning to *Variations VII* in this light presents a complicated picture. It is on one hand a thoroughgoing embrace of contingency, an act of radical openness to the alterities that the uncountable objects of the work present to us. Yet, at the same time, *Variations VII* participates in a much wider narrative that draws together information theory and cybernetics, the counterculture of the 1960s, the Cold War military-industrial complex, and a distinct brand of American exceptionalism. Moreover, through its use of the telecommunications network as a means to make, in principle, anything in New York function as its material to work with, it may even be seen as premonitory staging of what is now called, in Shoshana Zuboff's widely adopted

phrase, surveillance capitalism.[59] If what it means to liberate the "spirit […] inside each of the objects of this world" is to homogenise these 'spirits,' to use technological means to render them mutually legible, whether as sound or as information, then this is no kind of liberation. This is less the cybernetics of a utopian nonhierarchical sociality than the cybernetics of Amazon tracking and managing the movements of warehouse workers. Cage perhaps registers this himself with his departure, from the late 1960s, from work heavily invested in new technologies, and in the dedication to his 1969 essay collection, *A Year from Monday*: "To us and all those who hate us, that the U.S.A. may become just another part of the world, no more, no less."[60]

The issue, in short, is that with Cage's journey from the prepared piano into work with advanced telecommunications technologies, the tensions, opacity, and contingencies of the prepared piano risk becoming again something transparent, immediate, invisible, albeit not to the composer, but at an inhuman level of informational exchange. All 'noise,' whether defined sonically or informationally, can be readily absorbed into the system. Composers and performers, insofar as they remain significant, seem absorbed into the system too, one node among others. What strategies can there be for evading this risk?

CONCLUDING THOUGHTS: *INTERSPECIES SMALLTALK* AND *VOYAGER*

With the decline of large-scale art and technology collaborations, inquiry into this relation had to take on new forms. Two examples I will highlight to conclude here derive from the work of David Behrman and George E. Lewis.

Behrman was one of the performers on *Variations VII*, but his own compositional work has tended to smaller scales. In a conversation with Ron Kuivila, Behrman spoke of two moments when "that great, inviting door seemed to swing open": the introduction of inexpensive transistors in the early 1960s, and the advent of inexpensive microcomputers in the mid-late 1970s.[61] David Tudor and his "quirky, homemade circuitry" was a key figure in the first moment, with Behrman remarking on – and seeming compelled by – the instability and fleetingness that technological change imposed on this work. Much of Behrman's own work since the late 1970s has been marked by the second moment. In particular, Behrman has used consumer electronics – the KIM-1 microcomputer being a notable turning point[62] – in the development of interactive musical systems. Far from the inestimable complexity of *Variations VII*, Behrman's basic systems involved no more than pitch sensors and simple software to respond to sensed pitches with synthesizer sounds.

The vividly named *Interspecies Smalltalk*, commissioned by Cage and Merce Cunningham for the Cunningham Dance company, is exemplary of this approach. Performed by the violinist and Fluxus member Takehisa Kosugi alongside Behrman's interactive system, the elements are minimal: Kosugi's sinuous playing and simple synthesised tones. Yet the sense is of an exploration. The synthesizer responds to Kosugi in unexpected but seemingly sympathetic ways, and Kosugi does the same. Like work in the vein of a "cybernetic sublime," it dramatises a human-technology interaction, but one quite different from a shared entry into a totalising system. What is the distinction between *Interspecies Smalltalk* and *Variations VII*? It may be, in part, a recognition, and thematisation, of scale. These are small social interactions, and

coexistences, which yet may point elsewhere: for instance, to the seemingly radical alterity of the Cunningham dance piece they accompanied. Technological – and social – relations of alterity are sustained. They resist the total and remain with the contingent.

Lewis's *Voyager* work highlights and clarifies some of these themes further. The *Voyager* software, under constant development since 1987, is what Lewis calls an interactive "virtual improvising orchestra."[63] Like Behrman's systems it listens to and responds to human performers, and also produces its own independent behaviours. Where it significantly differs from *Interspecies Smalltalk* is at the level of complexity. Lewis highlights a specific concern with how attitudes about music become embedded in music software – as does Behrman when he suggests that music composed using established software could be treated as collaborations with the authors of that software.[64] *Voyager* is programmed in a way that does not adhere to many of the standards of Euro-American institutional computer music. It is designed with 64 asynchronous voices, permitting "simultaneous multiplicities of available timbres, microtonal pitchsets, rhythms, transposition levels and other elements."[65] By conventional compositional standards it is overcrowded. But these are not the standards to which Lewis appeals. He is instead favouring an Afrodiasporic notion of "multidominance,"[66] enacting a high degree of pluralism in contrast to the often unifying ideals of Western art music.

In Lewis's description, *Voyager* is dialogic: it involves "multiple parallel streams of music generation, emanating from both the computers and the humans – a nonhierarchical, improvisational, subject-subject model of discourse, rather than a stimulus/response setup."[67] The computer is treated not as an instrument as such, but as an independent improviser. Here we return to some of our initial considerations. Lewis treats the software as not a transparent tool for achieving musical ends, but a kind of subject in its own right. We find a technological relation of alterity. Yet it is not only this. On one hand, Lewis follows Behrman in directing his concern to specific performance spaces. Individual agents can be readily identified, even if this does not predetermine the multiagential sounding whole, and a system can be demarcated. But by highlighting the social perspective that underlies the software, Lewis brings into focus an inescapable outside that cannot be absorbed into the system. Not only alterity relations are thematised, but also background relations, both technologically and socially. Sound, in *Voyager*, is not only an objectively determinable and capturable object or quality. It sits within a social milieu, even if it does not only sit there.

Let us now circle back to the piano. A recent work by Lewis, *Timelike Weave* (2018), is scored for harpsichord – that Baroque predecessor of the concert piano – and inspired by Afrodiasporic quilting aesthetics. The piece highlights the distinctly percussive qualities of the harpsichord, but through its overlapping repetitions also suggests a peculiar digitality. This is suggestive of why Lewis also cites inspiration in the notion of the "closed timelike curve" from mathematical physics.[68] Where Cage's prepared piano was situated in a present pointing both forwards and backwards, Lewis locates the harpsichord within a set of paradoxical time loops. What permits mobility around these loops is the pluralisation of sound. Cage's "all-sound" approach to music presents a persisting concern of a tendency to totalisation. But Lewis highlights how sound is not only sound. It is something at once, and irreconcilably, sonic, social, and technological, and can be brought to run through these registers endlessly. It remains jarring that the piece of

technology that is the harpsichord is at once an emblem of early modern Europe, an image of Afrodiasporic quilting, and a digital system working through its inputs. In the encounters staged in these processes, there is a glimpse of a contingency without totalisation.

Notes

[1] See Richard Leppert, "Sexual Identity, Death, and the Family Piano," *19th-Century Music* 16, no. 2 (1992): 105-128; cited in Samuel Wilson, *New Music and the Crises of Materiality: Sounding Bodies and Objects in Late Modernity* (London: Routledge, 2021), 52.

[2] Wilson, *New Music*, 51. Alongside the table we could also consider the blank page – see Dominic Smith, *Exceptional Technologies: A Continental Philosophy of Technology* (London: Bloomsbury, 2018), chapter two.

[3] See Michael Chanan, *Musica Practica: The Social Practice of Western Music from Gregorian Chant to Postmodernism* (London: Verso, 1994), 242-43.

[4] See Martin Heidegger, "The Question Concerning Technology," in *Off the Beaten Track*, ed. and trans. Julian Young and Kenneth Haynes (Cambridge: Cambridge University Press, 2002).

[5] Musical mediation is a major topic in recent scholarship – see Georgina Born and Andrew Barry, "Music, mediation theories and actor-network theory: Introduction," *Contemporary Music Review* 5, no 6 (2018): 443-487.

[6] Stefanos Geroulanos, *Transparency in Postwar France: A Critical History of the Present* (Stanford, CA: Stanford University Press, 2017), 10.

[7] As Emmanuel Alloa puts it in his account of Maurice Merleau-Ponty, "[t]he fiction of transparency expresses […] the forgetting or oblivion of […] the constitutive corporeal mediatedness of any relationship to the world." Emmanuel Alloa, *Resistance of the Sensible World: An Introduction to Merleau-Ponty*, trans. Jane Marie Todd (New York: Fordham University Press, 2017), 13.

[8] Tom Mudd, "Material-Oriented Musical Interactions," in *New Directions in Music and Human-Computer Interaction*, ed. Simon Holland et al. (Cham: Springer, 2019), 123-134. Mudd's emphasis is on digital tools, but his demarcations can be understood within the more general field of instrument design.

[9] Ibid., 123.

[10] Ibid., 126.

[11] Ibid. See also the project "The Garden of Forking Paths" at the University of Leeds. "The Garden of Forking Paths: Overview," accessed 13 May 2022. https://forkingpaths.leeds.ac.uk/.

[12] Ibid., 125. Mudd here speaks of affordances, but I avoid that term so as to not suggest any particular link to the account of affordances developed by J.J. Gibson and, moreover, the many adoptions of it. See Patrick Valiquet, "Affordance Theory: a Rejoinder to 'Musical events and perceptual ecologies' by Eric Clarke et al.," *The Senses and Society* 14, no. 3 (2019): 346-350.

[13] Don Ihde, *Technology and the Lifeworld: From Garden to Earth* (Bloomington: Indiana University Press, 1990), chapter 5. Mudd himself cashes this out in terms of Karen Barad's account of intra-action, suggesting that we understand human-instrument relations as involving an entangled human and non-human "agencies" which only together constitute the specific performance situation. Mudd, "Material-Oriented," 131, Karen Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (Durham: Duke University Press, 2007).

[14] See John Cage, *Empty Words: Writings '73-'78* (Middletown, CT: Wesleyan University Press, 1981), 7-9.

[15] See the account in Wilson, *New Music*, chapter three.

[16] John Cage, *Silence: Lectures and Writings* (London: Marion Boyars, 2009), 5

[17] Mudd, "Material-Oriented," 124.

[18] John Cage, *For the Birds: In Conversation with Daniel Charles* (London: Marion Boyars, 1976), 73.

[19] Ihde, *Technology*, 108.

[20] Ihde highlights that background relations are not exactly either transparent or opaque at all, as they are not the kind of explicit relation that would permit such a description. What I wish to highlight here is that such background relations may permit other kinds of technological relation to take hold. As Dominic Smith has argued, in the philosophy of technology that Ihde develops and informs, the tendency may be towards a focus on individual technological artifacts rather than 'transcendental' questions of this kind. Dominic Smith, "Rewriting the Constitution: A Critique of 'Postphenomenology,'" *Philosophy of Technology* 28, no. 4 (2015): 533-551.

[21] On a comparable distinction between everyday technologies and a planetary-scale 'sensing layer,' see Smith, "Ugly David and the Magnetism of Everyday Technologies: On Hume, Habit, and Hindsight," in this volume.

[22] While in the first collection of Cage's texts, 1961's *Silence: Lectures and Writings*, this essay is said to have been delivered in 1937, Leta Miller's study has shown that it in fact appears to have been written no earlier than 1940. Leta Miller, "Cultural Intersections: John Cage in Seattle (1938-1940)," in *John Cage: Music, Philosophy, and Intention, 1933-1950*, ed. David W. Patterson (New York: Routledge, 2002), 15-46.

[23] Cage, *Silence*, 4.

[24] Ibid., 6.

[25] Ibid., 4.

[26] Ibid., 5.

[27] Cage, *For the Birds*, 73.

[28] Richard H. Brown, *Through the Looking Glass: John Cage and Avant-Garde Film* (Oxford: Oxford University Press, 2019), 22

[29] Brown, *Looking Glass*, 34.

[30] Notation may then be thought of as the kind of artistic technology analysed in Lushetich, "The Given and the Made: Thinking Transversal Plasticity with Duchamp, Brecht and Troika's Artistic Technologies" in this volume. See also Sha, "Adjacent Possibles: Indeterminacy and Ontogenesis" in this volume on mathematical notation as a kind of speculative abstraction.

[31] Cage, *Empty Words*, 8.

[32] Cage, *Silence*, 10.

[33] A major critical perspective on Cage concerns this question of whether he retains a goal of capturing every sound, such as from the purview of reclaiming everything that was once 'noise' into the far from neutral category of 'music.' His most famous piece, *4'33"* (1952), encompassing the 'silence' of any possible environmental sound, has presented a stage on which to consider this question. See, for example, Douglas Kahn, *Noise, Water, Meat: A History of Sound in the Arts* (Cambridge, MA: The MIT Press, 1999), chapter six.

[34] Cage, *Silence*, 28. See also Daniel Charles, "Figuration and Prefiguration: Notes on Some New Graphic Notions," in *Writings about John Cage*, ed. Richard Kostelanetz (Ann Arbor: The University of Michigan Press, 1993), 258; Joe Panzner, *The Process That Is the World: Cage/Deleuze/Events/Performances* (New York: Bloomsbury, 2015), 49-52.

[35] For a detailed study see You Nakai, *Reminded by the Instruments: David Tudor's Music* (Oxford: Oxford University Press, 2021), chapter two; James Pritchett, "David Tudor as Composer/Performer" in Cage's *Variations II*," *Leonardo Music Journal* 14 (2004): 11-16.

[36] Nakai, *Reminded*, 135.

[37] Ibid., 134.

[38] Pritchett, "David Tudor," 14.

[39] John Driscoll and Matt Rogalsky, "David Tudor's *Rainforest*: An Evolving Exploration of Resonance," *Leonardo Music Journal* 14 (2004): 25-30.

[40] See Bruce Clarke and Mark B.N. Hansen, eds. *Emergence and Embodiment: New Essays on Second-Order Systems Theory* (Durham, NC: Duke University Press, 2009).

[41] For an inside account see Billy Klüver, Julie Martin and Barbara Rose, *Pavilion: Experiments in Art and Technology* (New York: E.P. Dutton, 1972).
[42] W. Patrick McCray, *Making Art Work: How Cold War Engineers and Artists Forged a New Creative Culture* (Cambridge, MA: The MIT Press, 2020), 117.
[43] David P. Miller, "Indeterminacy and Performance Practice in Cage's 'Variations,'" *American Music* 27, no. 1 (2009), 74.
[44] John Beck and Ryan Bishop, *Technocrats of the Imagination: Art, Technology, and the Military-Industrial Avant-Garde* (Durham, NC: Duke University Press, 2020), 88.
[45] The most prominent example of this is in Pepsi's withdrawal of funds from the Pavilion E.A.T. had planned for Expo '70 in Osaka, Japan. See Fred Turner, "The Corporation and the Counterculture: Revisiting the Pepsi Pavilion and the Politics of Cold War Multimedia," *The Velvet Light Trap* 73 (Spring 2014): 66-78. On Tudor's place in this, see Driscoll and Rogalsky, "David Tudor's *Rainforest*."
[46] Beck and Bishop, *Technocrats*, 5
[47] Ibid., 86
[48] Ibid., 7
[49] McCray, *Making Art Work*, 110.
[50] Georges Canguilhem, "The Problem of Regulation in the Organism and in Society," in *Writings on Medicine*, trans. Stefanos Geroulanos and Todd Meyers (New York: Fordham University Press, 2012), 67-77.
[51] Geroulanos, *Transparency*, 209.
[52] Yuk Hui, *Recursivity and Contingency* (London: Rowman & Littlefield, 2019); Yuk Hui, *On the Existence of Digital Objects* (Minneapolis: University of Minnesota Press, 2016).
[53] Andrew Pickering, "Cybernetics as Nomad Science," in *Deleuzian Intersections: Science, Technology, Anthropology*, ed. Casper Bruun Jensen and Kjetil Rödje (New York: Berghahn Books, 2010), 155-162.
[54] See, for example, Ronald R. Kline, *The Cybernetics Moment: Or Why We Call Our Age the Information Age* (Baltimore: Johns Hopkins University Press, 2015), chapter two; Sebastian Franklin, *Control: Digitality as Cultural Logic* (Cambridge MA: The MIT Press, 2015), chapter two.
[55] Eric Drott, "Music and the Cybernetic Mundane," *Resonance: The Journal of Sound and Culture* 2, no. 4 (2021): 581.
[56] Ibid., 592.
[57] Ibid., 582.
[58] Ibid., 590.
[59] Shoshana Zuboff, *The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power* (London: Profile Books, 2019).
[60] John Cage, *A Year from Monday: New Lectures and Writings* (Middletown, CT: Wesleyan University Press, 1969), n.p.
[61] Ron Kuivila and David Behrman, "Composing with Shifting Sand: A Conversation between Ron Kuivila and David Behrman on Electronic Music and the Ephemerality of Technology," *Leonardo Music Journal* 8 (1998): 14, 15.
[62] "David Behrman: Interview by Jason Gross (August 1997)," *Perfect Sound Forever*, accessed 13 May 2022, http://www.furious.com/perfect/behrman.html.
[63] George E. Lewis, "Too Many Notes: Computers, Complexity and Culture in *Voyager*," *Leonardo Music Journal* 10 (2000): 33.
[64] Kuivilia and Behrman, "Composing," 15.
[65] Lewis, "Too Many Notes," 36.
[66] Ibid., 33-34.
[67] Ibid., 34.

[68] "Tectonics: Festival of New & Experimental Music, 4-5 May 2019," accessed 13 May 2022, http://2019.tectonicsfestival.com/assets/SSO_Tectonics19_Schedule_Single_(1).pdf.