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Music and Cybernetics in Historical Perspective

(Introduction to the special issue edited by Christopher Haworth and Eric Drott)

There is nothing especially surprising or controversial in observing the significant influence that cybernetics exerted on music, especially in its heyday during the 1940s, '50s, and '60s. Indeed, it is hard to see how things might have been otherwise. Cybernetics was distinct from traditional sciences in aspiring to create a universal interdiscipline that patched together the probabilistic worldview of information theory and the flattened abstractions of systems theory.[1] Its founding Macy conferences of 1946–53 assembled a cross-disciplinary network of intellectuals, the majority of whom worked in what would now be termed STEM disciplines, but some (and some of the most influential) were drawn from social science, linguistics, literary theory, and management theory.[2] Many of the scientists were returning to universities having undertaken war research, and the specter of totalitarianism shaped the overarching ethos of collaboration and cooperation that both the conferences and cybernetics itself would embody.[3] Some believed that the superdiscipline could contribute to a postwar "Unity of Science" movement based on the universal concepts of information, feedback, and homeostasis,[4] and in this way we can see cybernetics as aligned with supranational efforts to restore and protect liberalism following the war.[5] Yet scholarship of the past 30 years has suggested that it was via its extra-scientific mediation that cybernetics secured such a foothold in the 20th- and 21st-century imagination.[6] As Geoffrey Bowker put it: "Where traditional sciences operated behind the walls of the laboratory, cybernetics was everywhere you went. Where traditional sciences repudiated all possible mention of society, cybernetics proclaimed that it could produce the best possible description thereof, and that its universal truth was immediately tied to this historical conjuncture."[7] Bowker suggests that these factors worked together to position cybernetics as a "distributed obligatory passage point" capable of translating knowledge between incommensurate languages and facilitating exchanges of legitimacy in the process,[8] and from one perspective the cybernetic traces in music are simply an affirmation of this. They show how successfully cyberneticians managed to consolidate their universal discipline across intellectual spheres, describing and to an extent creating the conditions of a new technological age—famously dubbed the "age of communication and control" by Norbert Wiener.[9]

It is precisely the aspiration to universalism that makes musical cybernetics difficult to analyze. From experimental music to rave, musical social theory to psychology, jam bands to computer music, cybernetics can appear to be at once everywhere and

nowhere—a situation that contributes to both its paradoxical imperceptibility and its capacity for continual rediscovery. As a science, cybernetics is historical, left behind in the 20th century. Yet as a musical knowledge practice, it is positively contemporary, put to work either directly in the service of music theory,[10] history,[11] analysis,[12] and composition[13] or indirectly through the mediation of auditory psychology,[14] structuralist and poststructuralist theory,[15] or the methods associated with digital musicology.[16] These examples affirm the flexibility and hybridity of cybernetic language, yet music has also provided a keyhole into cybernetics' critique. For Alexander Weheliye, the cybernetics-derived figure of the posthuman represents the "white liberal subject in techno-informational disguise."[17] Addressing Katherine N. Hayles's "canon" of posthuman literature, he writes that "[c]ertainly, New World black subjects cannot inhabit this version of selfhood in quite the same manner as the 'white boys' of Hayles's canon due to slavery, colonialism, racism, and segregation, since these forces render the very idea that one could be 'free from the will of others' null and void.[18] In finding space for Black subjectivity within the body-agnosticism of cybernetics, Weheliye turned to sound and sound technologies, offering that such an orientation complicated the effacement of embodiment that theorizations of the posthuman enact, gesturing "toward a more complex interaction between embodiment and disembodiment, the human and posthuman."[19] Weheylie's attention to the racially marked absences and occlusions of cybernetics therefore gave the lie to its universalism, echoing Peter Galison's remark that cybernetics represented not the unity of science but the (white) Americanization of unity.[20]

Weheylie was not the first to draw Black sound and music into a critique of cybernetics. Writing a decade earlier, the information scientist and cultural theorist Ron Eglash drew attention to Blackness in the actual patterns of data that cyberneticians took as their object of analysis. Eglash's argument is too involved to do full justice to in this short essay, but at base he offers a critique of the organicism and romantic humanism of Varela and Maturana's cybernetics, which "made the erroneous claim that analog systems were more concrete, more 'real' or 'natural,' and therefore (according to this romantic cybernetics) ethically superior" to digital ones.[21] Eglash deemed this a "debilitating valorisation" for African Americans, for it meant that "African modes of *representation* in the use of sculpture, rhythm and movement were often abandoned to the claim that Africa was the culture of non-representation, the culture of the Real."[22] In seeking moments of resistance to this association Eglash looked to rap and rap-reggae fusion bands who display "an appreciation of cybernetics which is politically oppositional but no longer primitivist or naturalizing."[23] Eglash claimed not only that these hybrids celebrate the alienation of posthuman digitality (a view he partially credits to the Black political activist James Boggs's intervention at the first Cybercultural Research Conference in 1966),[24] but that this was *actually visible* in the statistical analyses of rap music's global waveform, which shows white noise rather than fractal noise.[25] Resistance was thus carried through both sound and information. The fusions of reggae (as analog, organic) and rap (as digital, alien), he argued, staged a clash of modernism and postmodernism, past and future. As he put it in "Africa in the Origins of Binary Code," the "beat" of African knowledge "is a heritage heard by those who listen to the future."[26]

Turning our attention to existing music-historical treatments of postwar encounters with cybernetics, we get little sense of the cultural dominance it came to assume, or the cultural power it would represent. As Eric Drott remarks in his essay for this issue, scholars who have considered how cybernetic concepts like feedback and autopoiesis found their way into musical practice have tended to train their attention on a fairly narrow slice of history (the decades after World War II), a fairly narrow selection of musicians, collaborators, and repertoires (mainly composer-engineer groupings working within the experimental tradition), and a fairly narrow set of pieces that wear the cybernetic influence on their sleeve (e.g., the biofeedback collaborations of Alvin Lucier and Edmond Dewan). When these examples are chronicled, cybernetics can appear less as a rigorous science and more a kind of practical poetry—an amateur, hobbyist craft concerned with experimentation and art–science cooperation, supported by an "upsurge of bricolage and homegrown elements that were seen as manifesting resistance to institutional hegemonies."[27] In trying to account for cybernetics' difference from traditional sciences, Andrew Pickering's adoption of Deleuze and Guattari's distinction between "royal" and "nomad" sciences has been influential. "The royal sciences," he writes, "are the modern sciences, which function as part of a stable social and political order—which prop up the state." Nomad sciences, on the other hand, "are a different kind of science, one which wanders in from the steppes to undermine stability."[28] But held against its totalizing aspirations we seem to have a cognitive dissonance: cybernetics as at once a metalanguage for articulating life in the information age and a maverick science steered by ontological experimentation.

The divergent lives of cybernetics are in part a product of its uneven reception across the many scientific and cultural fields it touched, but also of the impact its translation and "domesticization" outside of America had on its genealogy and lexical field.[29] In contrast to "sister" disciplines like informatics, cybernetics found only an occasional home in university research centers and curricula.[30] Instead, its influence spread via other channels, whether directly through quasi-popular science books like *Cybernetics: Control and Communication in the Human and Animal* and *The Living Brain*, indirectly through journals and magazines like the *Whole Earth Catalog* and *CoEvolution Quarterly,* or in experimental education contexts such as the British artist Roy Ascott's *Groundcourse*.[31] But even as these forums were often countercultural, they were also modeling the flexible, collaborative, postindustrial world of work that was just around the corner. Fred Turner has analyzed these dynamics in his history of the journalist Stewart Brand's movements from communes, to countercultural art worlds, to tech communities, to corporate culture and politics. As Turner shows, these alliances do not tell a story of the counterculture being recuperated by capital, technology, or the state, as accounts of neoliberalism often claim.[32] Rather, the counterculture (to be specific, the "new communalist" wing of the counterculture)[33] embraced those forces early on and subsequently, creating new "intellectual and practical contexts within which members of the two worlds could come together and legitimate one another's projects."[34] Cybernetics served to simultaneously enable the migrations and para-disciplinary collaborations that sustained this ambivalent two-step, and to rationalize and legitimize them.

The closer we look at musical cybernetics historically, the more this ambivalence rises to the surface. Take the San Francisco Bay Area–based League of Automatic Music Composers, for example. Like many of their contemporaries, the League's work was steeped in the language of cybernetics. In particular, it was the fragmentary "metalogues" of countercultural guru Gregory Bateson's *Steps to an Ecology of Mind* that inspired the group. Concert flyers featured aphorisms from the book that were dramatized in the music.[35] But other groups employed feedback systems without taking the detour through cybernetics, and one could be skeptical and ask whether the League's music would have developed similarly had its members never encountered cybernetic theory at all. What cybernetic theory surely *did* do was help naturalize the fluid exchanges between art and engineering contexts that members of the League would take advantage of. In 1991, the League's Rich Gold took a position at Xerox PARC, where he was encouraged to become "a corporate provocateur, cultural mediator, and institutional visionary, and to act as a catalyst for creative thinking and practice."[36] Gold helped the company innovate the area of "ubiquitous computing," a term that has since been eclipsed by the concept of "smart devices" but basically describes home and work environments where all electrical devices are connected and involved in data processing. In his 2017 essay on the group, George Lewis assesses this leap from interactive music to the corporate world of computing optimistically, as "linking the cybernetics orientation and social aesthetics of the early interactive computer musicians with a later vision of interactivity that may one day embrace an understanding of improvisation as a fundamental aspect of the human condition."[37] It could equally be seen the other way, however—as raising a question of whether the critical dimensions that are so often attributed to cybernetic arts were ever really there in the first place. The vision of a "physical world richly and invisibly interwoven with sensors, actuators, displays, and computational elements, embedded seamlessly in the everyday objects of our lives and connected through a continuous network"[38] is precisely the infrastructure of "instrumentarian power" undergirding what Shoshana Zuboff has termed "surveillance capitalism." Indeed, in defining it Zuboff quotes Gold's collaborator at Xerox PARC:

> Under the lash of the extraction imperative, digital instrumentation has been transformed into a global, sensate, computational, connected architecture of behavioral surplus capture and analysis, fulfilling computer scientist Mark Weiser's 1999 vision of "ubiquitous computing" memorialized in two legendary sentences: "The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it."[39]

From this perspective "everyday improvisation" starts to resemble the "full blown technology of the body moving" that feeds surveillance platforms in order to "optimize" user behavior, and that increasingly enroll sound and music to do so.[40] The music therapy app Humm.ly, for instance, draws on and adjusts to various physiological signals (including heart rate) in order to "bring [users] to their desired emotional state" by means of guided musical sequences. While ostensibly affording individuals a mediated form of control over their bodies and themselves—providing them with a servomechanism

of the self, as it were—the data thus collected on one's activities, physiological states, and imputed desires can and does feed other feedback loops—including, most notably, that which propels the circulation of digital capital. As Eric Drott writes, "[w]hat makes music so powerful a 'technology of the self,' as Tia DeNora and others have posited, is also what allows streaming platforms to repurpose it as an equally powerful technology of surveillance."[41]

Celebrating nomad science against a stable centralized state seems increasingly questionable when it is in the management-cybernetic terms of efficiency and decentralization that social institutions of government, work, education, and healthcare have been stripped away.[42] It is no coincidence, for example, that the theory of accelerationism, currently popular in the visual and sound arts,[43] has at its core a cybernetic understanding of technocultural change. The antihuman injunction that "the only radical political response to capitalism is not to protest, disrupt, or critique, nor to await its demise at the hands of its own contradictions, but to accelerate its uprooting, alienating, decoding, abstractive tendencies" derives from Sadie Plant and Nick Land's 1994 critique of Norbert Wiener's "propaganda against positive feedback."[44] Then termed "cyberpositivity" rather than "accelerationism,"[45] and animated by the "anonymous and inhuman sound" of techno, their advocacy for runaway processes and "inconceivable alienations" intensified the white supremacism of the posthuman, positing that we are "all foreigners now, no longer alienated but alien, merely duped into crumbling allegiance with entropic traditions."[46] Gone was the liberal mediation between inside and outside, above and below, that Wiener saw as a brake on fascism. Yet cyberpositivity also drew into relief, albeit exaggeratedly, the entanglement of cybernetics with capitalism. As it did so, it (ironically) echoed early Soviet resistance to cybernetics. In the words of a 1954 Soviet dictionary of philosophy, "[c]ybernetics makes clear one fundamental trait of the bourgeois outlook, namely its inhumanity, its effort to turn the worker into an accessory of the machine, into an instrument of production and into a weapon of war."[47]

Were there any signs of resistance to the cybernetic regime in the arts? Rainer Usselmann has speculated that complicity was built into cybernetic art from the start via the expense of computing devices and the need for lavish corporate sponsorship.[48] His view jibes with Fred Turner's analysis of the Bell Labs' supported interdisciplinary project *9 Evenings*, where he states that "Rauschenberg, Klüver, Cage and the other artists . . . committed an extraordinary act of cultural brokerage," allowing the "leaders of American industry and labor [to] imagine themselves not as the unthinking automatons that had populated the automation debates, but as creative, flexible individuals, whose agency and sense of self grew directly out of their understanding of the everyday world as a probabilistic place."[49] A closer look at the wave of international cybernetic exhibitions that served to popularize cybernetics in the late 1960s and early '70s gives a sense, perhaps, of paths drawn up but not followed.[50] In the catalog for the 1970 exhibition *Software*, the systems art curator Jack Burnham seemed to suggest that cybernetics in organizations would just add another layer of bureaucracy in place of the "technocratic" bureaucracy it was supposed to make obsolete.[51] Hans Haacke's developing position on cybernetics and systems theory was chronicled in these exhibitions, from early second-order cybernetics

works like *Condensation Cube* (1965) to manual data-processing works like *Poll* (1970). As Luke Skrebowski has shown, the beginning of the 1970s saw Haacke develop works that were explicitly critical of systems theory rhetoric. In the withdrawn *Norbert: All Systems Go,* visitors to the gallery would have encountered a caged mynah bird sitting silently until they passed it, at which point it would squawk "All Systems Go," "All Systems Go," to inanity. Skrebowski writes that, while Haacke's earlier works

> make direct use of the possibilities presented by cybernetic systems, Norbert: All Systems Go seems to negate them. In the later work the technology is stripped away and cybernetic theory . . . is mocked, its optimistic feedback-steered vision of human progress undermined. . . . The affirmative "All systems go!" of the Space Age translated, through the sardonic refrain of a caged bird, "All systems go . . . " (i.e. run down, no longer fit their intended purpose, fail).[52]

Seth Kim-Cohen's 2009 book *In the Blink of an Ear: Towards a Non-Cochlear Sound Art* asks the question of why, given the interdisciplinary moment in the 1960s around Fluxus and Happenings, sound art dropped the social and political commitments that seemed to be opened up and retreated into medium-specific tropes of sound-in-itself, sound as transcendence, sound as material and similar. For Kim-Cohen, the pivot point is the onset of conceptual art. "[I]ntentionally or not," he writes, "sound missed the conceptual turn. When the gallery arts branched off in the direction of Duchamp, so the story goes, the sonic arts stayed the course."[53] His provocation has been taken up in several contexts, whether directly in the form of music fora[54] and critical responses seeking to develop a musical conceptual art or critical music,[55] or indirectly in the way it channeled and fed into adjacent concerns in the context of German new music.[56] It has, furthermore, developed alongside scholarly revisions of the history of conceptual art in light of the postconceptual and relational turns—notably those that have sought to give the cybernetics-informed art genre of systems art a fuller role in the development of conceptualism.[57] Untangling the lines into and out of conceptualism is an open problem, and one that is too often mired by a tendency to overestimate the radicality of strands like institutional critique, only to hold this up as a standard that music or sound art should meet in a reheated modernist teleology.[58] Nevertheless, attending to the differing reception of cybernetics will be crucial in this, both in understanding the bifurcation and how the arts were able to come together in the first place. Following the historian Ronald Kline we might insist, not on the unity of cybernetics, but on its disunity as manifest in changing epistemologies and interpretations.[59] While promising a universal interdiscipline that could unify disparate fields, cybernetics was equally enrolled to suit intents and purposes that were often in contradiction.

This special issue seeks to provide a more nuanced account of the moments of reception, translation, recovery, and loss that constitute the encounter between a disunited cybernetics and music. Through historical criticism we seek to throw music's cybernetic episteme into sharper focus than previously and thereby better understand the conjuncture of music, technology, knowledge, and politics as it took shape in the middle of the 20th century and has radiated forward into the present moment. In short, we endeavour

to think music's relation to cybernetics otherwise: not as a linear transmission from a select group of key thinkers to an equally select group of musicians, but as a complex, nonlinear, and reticulated feedback process, one that is as recursive and autopoietic as the looping systems modeled by successive generations of cyberneticians.

The articles consider the recursive and nonlinear impacts of cybernetics and information theory as they infiltrate musical composition (Loughridge), music theory (Miller and Bell), instrument design (Latham and Drott), and music consumption (Drott). Brian Miller's article offers a detailed examination of the place occupied by information theory and cybernetics in the thought of Leonard Meyer, one of the most influential music thinkers to have engaged with this intellectual current during its heyday. Far from limiting his focus to the handful of 1950s-era texts where Meyer explicitly sought to integrate information-theoretical models into his evolving theories of musical emotion and meaning, Miller situates Meyer's "cybernetics moment" within the broader arc of his intellectual career. On the one hand, by situating Meyer's encounter with information theory and cybernetics against the backdrop of his earlier (and somewhat idiosyncratic) application of pragmatist understandings of meaning to music, Miller convincingly underscores how these earlier intellectual commitments both prepared the way for and shaped his subsequent adoption of Shannonian concepts of entropy, redundancy, and noise. At the same time, however, these same concepts rewired (as it were) a number of core premises of Meyer's latent pragmatism: Entropy, as a proxy for surprise, appeared to offer a "quantitative measure" for what was previously conceived as a purely "qualitative experience," while the dynamic figure of the interpretant Meyer had previously borrowed from Peircean semiotics (via Morris Cohen) became "reified" in the form of the "receiver programmed to decode," one of the poles of Shannon's famous model of transmission over a noisy channel. On the other hand, Miller tracks the lingering effects of information theory's influence on Meyer's later work on musical perception and musical style, despite the near-total disappearance of direct references to this literature. As Miller makes clear, Meyer's preoccupation with information theory and cybernetics may have been short-lived, but its impact was anything but. Indeed, long after his intellectual allegiances had shifted yet again, this time to cognitive psychology (a discipline itself indebted to cybernetics and systems thinking), key concepts like redundancy and "cultural noise" still occupied a key place in Meyer's thought. But as Miller also makes clear, the cognitive turn of Meyer's later work has meant that information theory occupies a somewhat ambiguous position in music studies at present, its close identification with music cognition having discouraged theorists and musicologists from exploring its potential implications for their own work (a tendency manifest in the relative neglect of the sort of computational methods that other disciplines affiliated with the digital humanities have embraced in recent years).

Deirdre Loughridge's essay examines British electronic musician Daphne Oram's career from 1968 to 1972, leading up to the publication of her book, *An Individual Note*. During this period Oram discovered cybernetic theory, and Loughridge assesses the impact it has on her work and thinking. Early reactions against both German and Italian serialism ("the land of the slide rule") and the computer music on display at *Cybernetic*

Serendipity ("music by the yard") show that Oram's views on computers in art were in line with longstanding popular fears about automation and the physical replacement of humans with machines. Oram, by contrast, sought to "humanize" machines, with the Oramics machine being the embodiment of this. However, Loughridge also teases out a compelling line of cybernetic influence in Oram's encounter with the clairvoyant Shafica Karagulla, whose Beverly Hills, California, based Higher Sense Perception Research Foundation Oram sought to pair her Oramics studio with. As she shows, the "scientific-spiritual space" that Oram occupied has no easy categorization, and it is perhaps for this reason that earlier studies of Oram have dismissed or ignored it. By taking this line seriously, and by finding a definition in Oram's own theory rather than imposing it from outside, Loughridge's careful reading offers a new perspective both on Oram and on the cybernetic mysticism her work animated.

Eamon Bell's article centers on the French cybernetician and music theorist Abraham Moles. The coauthor of Pierre Schaeffer's "*Esquisse d'un solfège concret*," and an important interlocutor for both Lejaren Hiller and Iannis Xenakis, Moles remains little known to Anglophone readers. Like Schaeffer, Moles's experiments were rooted both in "direct" perception of sound and in experiments with sonic media—although, as Bell shows, this influence came primarily from the influence of his PhD adviser, Gaston Bachelard. Bell examines the audio techniques Moles developed in order to distort audio, not to determine the limits of intelligibility (as in psychoacoustics studies), but to attempt to quantify the aesthetic value of particular types of music and thereby to distinguish between aesthetic and semantic information. Bell's reading opens out a crucial attempt to develop a postliterate musical cybernetics, one that not only has impacts on our understanding of postwar composition but that also has implications for historical epistemology.

Clara Latham's essay considers the cybernetics of the theremin. Although the invention of the theremin predates the field of cybernetics, in Latham's telling it was retrospectively domesticated (or made alien) as a "cyber instrument" through its contact with popular culture, and particularly science fiction films, during the Cold War. Because the theremin challenged established understandings about the relationship between sound and source, it paradoxically became a "perfect candidate to embody cybernetic anxiety about the fusion of information and materiality that emerged in the post–World War II era." Latham's piece weaves perceptual analysis of the ambiguous source of the theremin with textual, reception, and sonic analyses of the wave of post-1950s sci-fi films that fell for the instrument, including *Rocketship X-M, The Day the Earth Stood Still, Spellbound,* and *It Came from Outer Space*. As cybernetic history, her article shows how tentative, provisional, perspectival, and dynamic cybernetics was, in the way its boundaries could extend back in time as well as forward.[60] Yet ultimately Latham assesses the cybernetic episteme positively, as capable of imagining better and more just futures. Drawing on Donna Haraway's call to fictionalize when imagining couplings between machines and bodies, and threading back to cybernetics' universalism, she argues that the alien Other is no more imaginary than the disembodied and abstract universal human that the theremin's mechanical mystery is presumed to have disrupted.

Finally, Eric Drott's essay returns to a dilemma flagged at the outset of this introduction, having to do with the difficulties faced in trying to think about music's relation to cybernetics. This is a dilemma that follows from cybernetics' very success in universalizing its project—which, paradoxically, has facilitated its disappearance into the intellectual and material infrastructures of the post-cybernetic world. Drott pursues these questions via a consideration of what he dubs the "cybernetic mundane"; that is, the various ordinary practices and projects that cybernetics and information theory have deeply informed, without necessarily calling attention to themselves. Standing at the center of his essay is the RCA Synthesizer, a landmark instrument in the history of electronic music, which, curiously enough, wasn't originally conceived as such. Rather, as Drott shows, the Synthesizer was initially intended to form part of a larger, proto-digital recording apparatus, which sought to put Shannon's work on bandwidth compression to work on behalf of record manufacture. Yet even after efforts to construct this recording system were abandoned, and the Synthesizer was reframed as a standalone instrument, the conceptual underpinning of the project remained intact. Nowhere was this more apparent than with the metaphoric identification of music with information. This, in turn, was key to the elision of cybernetics and information theory from the history of the Synthesizer, as recourse to metaphoric equivalences masked the role cybernetic and information-theoretical models played in mediating such equivalences. And the same dynamic persists to this day, as cybernetic feedback loops and the tacit equation of music with information underpins the architecture of most digital music providers—Spotify being a case in point. Thoroughly fused with the circuits of digital capitalism, cybernetics' influence on music has never been so pervasive. Nor has it ever been so hard to discern.

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NOTES
1. For an introduction to cybernetic theory from the horse's mouth, see Norbert Wiener, *Cybernetics or Control and Communication in the Animal and the Machine* (Cambridge, MA: MIT Press); and Norbert Wiener, *The Human Use of Human Beings: Cybernetics and Society* (New York: Avon Books, 1950, 1967). Recent secondary studies of cybernetics include: Ronald R. Kline, *The Cybernetics Moment: Or Why We Call Our Age the Information Age* (Baltimore: JHU Press, 2015); and Thomas Rid, *Rise of the Machines: The Lost History of Cybernetics* (London: Scribe Publications, 2016).
2. Claus Pias (ed), *Cybernetics—The Macy Conferences 1946–1953: The Complete Transactions*. (Chicago: Chicago University Press, 2016).

3. As Norbert Wiener stated, "Our view of society differs from the ideal of society which is held by many Fascists, Strong Men in Business, and Government. . . . Such people prefer an organization in which all orders come from above, and none return." Norbert Wiener, *The Human Use of Human Beings: Cybernetics and Society* (Boston: Houghton Mifflin, 1950), 15–16.

4. Ronald Kline, "How Disunity Matters to the History of Cybernetics in the Human Sciences in the United States, 1940–80," *History of the Human Sciences* 33, no. 1 (2020): 13.

5. See Fred Turner, *The Democratic Surround: Multimedia and American Liberalism from World War II to the Psychedelic Sixties* (Chicago: University of Chicago Press, 2013) and Michael A. Wilkinson, "The Reconstitution of Postwar Europe: Lineages of Authoritarian Liberalism," LSE Law, Society and Economy working paper, London School of Economics and Political Science Law Department, 2016.

6. See for example Katherine Hayles, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature and Informatics* (Chicago: University of Chicago Press, 1999).

7. Geof Bowker, "How to Be Universal: Some Cybernetic Strategies, 1943–70," *Social Studies of Science* 23, no. 1 (1993): 123.

8. Bowker's concept of distributed obligatory passage point expands Michel Callon's classic ANT-adjacent concept of the "obligatory passage point." The "obligatory passage point" operates "in terms of a translation strategy posited on an incommensurability between the two languages concerned." The distributed passage point, on the other hand, "is inescapable because wherever we do go (the farthest reaches of the human mind, the depths of the jungle) we will find the new universal science. Cyberneticians in the period 1943–70 created just such a science."

9. Indeed, so successful was the cybernetic project that it could even appear to assimilate cultural techniques of the past, such as the clockwork machines of the 18th century that behave as humans or animals, or dances in which humans would behave as machines. Simon Schaffer, "Enlightened Automata," in *The Sciences in Enlightened Europe*, eds. William Clark, Jan Golinski, and Simon Schaffer (Chicago: University of Chicago Press, 1999).

10. To give just two recent and prominent examples, the "loops of biocultural evolution" that are theorized in Gary Tomlinson's *A Million Years of Music* (2015) rely on cybernetic framings of the co-evolution of organism and environment that are convention in the brain sciences; while Holly Watkins's *Musical Vitalities* (2018) likewise draws from the concepts of the Chilean cyberneticians Humberto Maturana and Francisco Varela, particularly autopoeisis, in order to revitalize musical organicism. See Gary Tomlinson, *A Million Years of Music: The Emergence of Human Modernity* (Cambridge, MA: MIT Press, 2015); Gary Tomlinson, *Culture and the Course of Human Evolution* (Chicago: University of Chicago Press, 2018); Holly Watkins, *Musical Vitalities: Ventures in a Biotic Aesthetics of Music* (Chicago: University of Chicago Press, 2018).

11. David Novak's *Japanoise* (2013) reflexively understands feedback as both an audio technique and a metaphor for transcultural circulation and exchange. David Novak, *Japanoise: Music at the Edge of Circulation* (Durham, NC: Duke University Press, 2013).

12. For example, David Borgo's *Sync Or Swarm* (2005) channels the "third wave" cybernetics of chaos, complexity, and emergence to analyze the complex musical and collaborative dynamics of improvised music. David Borgo, *Sync or Swarm: Improvising Music in a Complex Age* (London: A&C Black, 2005).

13. Leaving aside the innumerable popular musics that use "cyber"-derived terminology, cybernetic theory has been most resilient in the genres that stem from the fields of electronic and computer music. A contemporary example is network music, or telematic music, which involves musicians playing together in real time over computer networks. For a perspective on cybernetics' role in the distinctions between network and telematic music, see Eric C. Lemmon, "Telematic Music vs. Networked Music: Distinguishing Between Cybernetic Aspirations and Technological Music-Making," *Journal of Network Music and Arts* 1, no. 1 (2019): 2. For

an example of network music in the context of studio-based pop music, see Christopher Haworth, "Network Music and Digital Utopianism: The Rise and Fall of the Res Rocket Surfer Project, 1994–2003," in *Finding Democracy in Music* (London: Routledge, 2020), 144–63.

14. Jonathan Sterne has analyzed the place of cybernetics and information theory in the auditory models and experimental procedures underlying the development of the MP3. Jonathan Sterne, *MP3: The Meaning of a Format* (Durham, NC: Duke University Press, 2012).

15. The role cybernetic theory played in the development of structuralism has been examined in a number of recent pieces, notably Celine Lafontaine, "The Cybernetic Matrix of 'French Theory,'" *Theory Culture Society* 24 (2007): 27–46, and Bernard Dionysius Geoghegan, "From Information Theory to French Theory: Jakobson, Levi-Strauss, and the Cybernetic Apparatus," *Critical Inquiry* 38, no. 1 (2011): 96–126.

16. For a discussion of cybernetics' legacy in the digital humanities, see Stefanos Geroulanos and Leif Weatherby, "Cybernetics and the Human Sciences," *History of the Human Sciences* 33, no. 1 (2020): 3–11.

17. Alexander G. Weheliye, "Feenin': Posthuman Voices in Contemporary Black Popular Music," *Social Text* 20, no. 2 (2002): 24.

18. Weheliye, "Feenin'," 24.

19. Weheliye, "Feenin'," 25.

20. Peter Galison, "The Americanization of Unity," *Daedalus* 127, no. 1, Science in Culture (Winter 1998): 45–71.

21. Ron Eglash, "African Influences in Cybernetics," in *The Cyborg Handbook* (New York: Routledge, 1995), 19.

22. Eglash, "African Influences in Cybernetics," 19.

23. Eglash, "African Influences in Cybernetics," 23.

24. In this, Eglash drew on the Black activist James Boggs's comments to the first Cybercultural Research Conference in 1966, in which he suggested that the "new cybercultural society" would not be alienating to Blacks because (unlike whites) they could draw on a labor history in which their dual identity as both biological automatic machines and the makers/users of machines were deeply imbricated with their cultural identity.

25. As Eglash put it: "Voss (1988) later showed that this relationship held for all types of music, both instrumental and vocal, with samples ranging from Indian ragas to Russian folksongs. My own studies (Eglash 1993) show that while reggae music also has this fractal structure, rap is the only music (aside from avant-garde experiments such as those of John Cage) which violates this rule. The reason for this is the intentional violation of analog representation by digital coding, a violation that invokes rap artists' oppositional stance, but also offers a positive outlook in the possibilities for their cybernetic innovation. Moreover, the rap-reggae fusions that are now becoming increasingly popular (e.g. ragamuffin) have characteristics which indicate that their signals are likely to avenge a fractal dimension value half-way between the two. This precision of control over an abstract cybernetic principle indicates that it is not simply a matter of the adaption of terminology; African diasporic identity is expressed in these examples through a conscious manipulation of complex signal characteristics." Eglash, "African Influences in Cybernetics," 24–25.

26. Ron Eglash, "Africa in the Origins of Binary Code," *Digital Hyperstition, Abstract Culture* (Self-published 'zine, 1999), 37.

27. George E. Lewis, "From Network Bands to Ubiquitous Computing: Rich Gold and the Social Aesthetics of Interactivity," in *Improvisation and Social Aesthetics* (Durham, NC: Duke University Press, 2017), 91.

28. Andrew Pickering, *The Cybernetic Brain* (Chicago: University of Chicago Press, 2010), 11.

29. Christopher Johnson, "'French' Cybernetics," *French Studies* 69, no. 1 (2015): 60–78.

30. Pickering, *The Cybernetic Brain*, 400.

31. Kate Sloan, *Art, Cybernetics and Pedagogy in Post-War Britain: Roy Ascott's Groundcourse* (London: Routledge, 2019).

32. As Régis Debray put it in 1979—on the one-year anniversary of the general strike in France—May '68 represented not the turning over of bourgeois society but "the cradle of a new bourgeois society. It may not yet realise it, but it is time someone told it so." Régis Debray, "A Modest Contribution to the Rites and Ceremonies of the Tenth Anniversary," *New Left Review* 1, no. 115 (1979): 45.

33. Turner defines the new communalists as hippies of San Francisco and the East Coast who saw "the mind-expanding turn toward sexuality and toward the small-scale technologies of psyche- delia and music" not only as "a turn away from the constrained cultural style of middle-class cold war America" but also as "a turn toward what they imagined could become a new nation, a land of small, egalitarian communities linked to one another by a network of shared beliefs." Although they rejected the military industrial complex of their parents' generation, defined in Theodor Rozsack's terms as "technocracy," they embraced technology as "tools" for the real- ization of personal and communal "wholeness," which was defined in information-theoretical and cybernetic terms. Fred Turner, *From Counterculture to Cyberculture* (Chicago: University of Chicago Press, 2010), 33.

34. Turner, *From Counterculture to Cyberculture*, 8.

35. A concert in 1980 featured the following quote attributed to Bateson: "All that is not information, not redundancy, not form and not restraint—is noise, the only possible source of new patterns." Quoted in the catalog for League of Automatic Music Composers, Music Concert, 80 Langton Street, San Francisco, November 15, 1980.

36. Lewis, "From Network Bands to Ubiquitous Computing," 108.

37. Lewis, "From Network Bands to Ubiquitous Computing," 108.

38. Quoted in Mark Weiser, Rich Gold, and John Seely Brown, "The Origins of Ubiquitous Computing Research at PARC in the Late 1980s," *IBM Systems Journal* 38, no. 4 (1999): 694.

39. Shoshana Zuboff, "Surveillance Capitalism and the Challenge of Collective Action," *New Labor Forum* 28, no. 1 (2019): 16.

40. Nigel Thrift, *Knowing Capitalism* (Los Angeles: Sage Publications, 2004), 13.

41. Eric A. Drott, "Music as a Technology of Surveillance," *Journal of the Society for American Music* 12, no. 3 (2018): 262.

42. It is of course also true that management cybernetics influenced attempts to build cybernetic governance systems for the socialist government of Salvador Allende. More common was the implementation of management cybernetics in capitalist institutions. See Eden Medina, *Cyber- netic Revolutionaries: Technology and Politics in Allende's Chile* (Cambridge, MA: MIT Press, 2011); Thrift, *Knowing Capitalism*, 13.

43. Gean Moreno, Editorial, "Accelerationist Aesthetics," *E-flux Journal* 46, no. 6 (2013).

44. Armen Avanessian and Robin Mackay, eds. *# Accelerate#: The Accelerationist Reader* (Fal- mouth, UK: Urbanomic, 2012), 5.

45. Accelerationism was a retrospectively applied "etic" term introduced, but possibly not coined, by the philosopher Benjamin Noys in 2014. It was subsequently and defiantly embraced by the key proponents. See Benjamin Noys, *Malign Velocities* (Alresford, UK: Zero Books, 2014).

46. Nick Land and Sadie Plant, "Cyberpositive," in *Unnatural: Techno-Theory for a Contaminated Culture* (London: Underground,1994). For a rich critique of Land and Plant's legacies in Xenofeminism and Accelerationism, particularly the Eurocentric universalism that brackets out histories of coloniality and whiteness while also appropriating the figure of the alien from marginalized peoples, see Annie Goh, "Appropriating the Alien: A Critique of Xenofeminism," https://www.metamute.org/editorial/articles/appropriating-alien-critique-xenofeminism.

47. Quoted in Michael Csizmas and Patrick McNally, "Cybernetics, Marxism, Jurisprudence," *Studies in Soviet Thought* 11, no. 2 (1971): 91.

48. Rainer Usselmann, "The Dilemma of Media Art: Cybernetic Serendipity at the ICA London," *Leonardo* 36, no. 5 (2003): 390.

49. Fred Turner, "Romantic Automatism: Art, Technology, and Collaborative Labor in Cold War America," *Journal of Visual Culture* 7, no. 1 (2008): 22–23.

50. The cybernetic wave in the arts was captured in a series of high-profile international exhibitions that took place between 1968 and 1972. They included *Cybernetic Serendipity: The Computer and the Arts* at the Institute of Contemporary Arts in London, 1968; *The Machine as Seen at the End of the Mechanical Age* at the Museum of Modern Art in New York, 1968; *When Attitudes Become Form, Concepts, Processes, Situations, Information* at the Kunsthalle in Bern, 1969; *Information* at the Museum of Modern Art in New York, 1970; *Software* at the Jewish Museum in New York, 1970; and *Systems* at the Whitechapel Art Gallery in London, 1972.

51. "In a sense, the original purpose of Cybernetics was to produce a unified theory of the control levels and types of messages used by men and machines and processes in normal operation. Thus the history of computer technology may be interpreted as progress in making communication between men and machines more natural and complete. This remains an ideal definition however, because quite often in industry human beings have been adapted to inhuman machine schedules, rather than the other way around. What is less realized is that most businesses of any size have had to adapt themselves, more or less traumatically, to radically different patterns of administration and organization as the result of information structures made possible by computer systems." Jack Burnham, *SOFTWARE: Information Technology, Its New Meaning in Art* (New York: Jewish Museum,1970), 11.

52. Luke Skrebowski, "All Systems Go: Recovering Hans Haacke's Systems Art," *Grey Room* (2008), 57.

53. Seth Kim-Cohen, *In the Blink of an Ear: Toward a Non-cochlear Sonic Art* (London: A&C Black, 2009), xx.

54. For example, INSTAL 10 held November 12–14, 2010, at Tramway, Glasgow, was themed "music is more than music." Its brochure stated: "We think that the most exciting music, music that is genuinely radical, makes a basic appeal to ideas. It reaches out, tries to be bigger than itself, engages with things other than the just musical; and occasionally, admirably so." https://arika.org.uk/archive/items/instal-10

55. See, for example, G. Douglas Barrett, *After Sound: Toward a Critical Music* (New York: Bloomsbury Publishing USA, 2016); Iain Campbell, "Sonic Obstacles and Conceptual Nostalgia: Preliminary Considerations on Musical Conceptualism and Contemporary Art," *Philosophical Inquiries* 9, no. 2 (2021).

56. See Max Erwin, "Here Comes Newer Despair: An Aesthetic Primer for the New Conceptualism of Johannes Kreidler," *Tempo* 70, no. 278 (2016): 5–15.

57. See Luke Skrebowski, "Systems, Contexts, Relations: An Alternative Genealogy of Conceptual Art" (PhD diss., Middlesex University, 2009). See also Georgina Born, "After Relational Aesthetics: Improvised Music, the Social, and (Re) Theorizing the Aesthetic," in *Improvisation and Social Aesthetics* (Durham, NC: Duke University Press, 2017).

58. Several authors have discussed the failure inherent in institutional critique as a result of its institutionalization. Peter Osborne has taken a meta-view, arguing that while the recuperation of critique "strengthens and develops the art institution," and so fails (as political practice), it simultaneously acts as a "constructed mimesis of the ability of cultural institutions within developed capitalist societies to sustain and recuperate their own critique," and so succeeds (as critical art). Boris Groys meanwhile has observed the folding of institutional critique into a legitimacy-accruing game of positioning, where the artist can pit herself against curator in

order to "w[i]n the general public over to their side, because the general public didn't know all the art history." On the first point see, for example Andrea Fraser, "From the Critique of Institutions to an Institution of Critique," *Artforum* 44, no. 1 (2005): 278. On the second see Peter Osborne, *Anywhere or Not at All: Philosophy of Contemporary Art* (London: Verso, 2013), 159. On the third, see Boris Groys, *Art Power* (Bielefeld, Germany: Transcript-Verlag, 2019), 45.

59. Ronald Kline, "How Disunity Matters to the History of Cybernetics in the Human Sciences in the United States, 1940–80," *History of the Human Sciences* 33, no. 1 (2020): 12–35. This argument chimes with Christina Dunbar-Hester's view that "Bowker's emphasis on cybernetics as a universal language also causes him to elide what Hayles has described, the changes in the meanings of cybernetics over time, and what I have argued for above, the (sometimes subtle) variations in cybernetic themes [. . .] Yet even seen as being unified by autopoeisis and self-making of systems, cybernetic theories were robust for these people, allowing the four different themes discussed above to flourish." Christina Dunbar-Hester, "Listening to Cybernetics: Music, Machines, and Nervous Systems, 1950–1980," *Science, Technology, & Human Values* 35, no. 1 (2010): 133.

60. As Ronald Kline reports, the scientific identity of cybernetics was often unclear, to the extent that some of its central figures didn't know what it was, or where it started. President of the International Association of Cybernetics Georges Boulanger asked in 1969: "But after all what is cybernetics? Or rather what is it not, for paradoxically the more people talk about cybernetics the less they seem to agree on a definition." Kline, Ronald, "How Disunity Matters," 13.