

HUMANS IN THE LOOP

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“Devices already have been perfected to record the impulses of the brain. In the music of the future, the composer will sit alone on the concert stage and merely THINK his idealized conception of his music. His brain waves will be picked up by mechanical equipment and channeled directly into the minds of his hearers, thus allowing no room for distortion of the original idea. Instead of recordings of actual music sound, recordings will carry the brain waves of the composer directly to the mind of the listener.”—Raymond Scott¹

1 Raymond Scott, liner notes for *Manhattan Research, Inc.*, Basta 90782, 2000: 49.

2 Anais Nin, *The Diary of Anais Nin*, Vol. 5: 1947-1955, (Boston: Mariner Books, 1975), 99.

“This music is electronic music based on Cybernetics, the science which sets forth principles of behavior which apply both to machines and people... instead of writing musical notes to express our feelings, we design special electronic circuits. We feed instructions to these circuits. The instructions inform them how they should react and interact to the sensations they receive from other circuits, and how they should react to their own behavior, which they sample through feedback loops. This means that these circuits have an awareness of what other circuits are doing, what they themselves are doing, and what is expected of them by the designer—in this case, the composer.”—Louis and Bebe Barron (as quoted by Anais Nin)²

- 3 John Cage, "The Future Of Music: Credo," in *Audio Culture: Readings in Modern Music*, Christoph Cox and Daniel Warner, eds., (New York: Continuum, 2006), 25-28.
- 4 Edgard Varèse and Chou Wen-chung, "The Liberation of Sound," *Perspectives of New Music*, Vol. 5, No. 1 (Autumn-Winter, 1966): 11-19.

Looking beyond the seemingly exhausted technology of written notation, some composers foresaw the imminent arrival of the medium of electronic music and described everything they expected these new tools to fulfill for them — namely, an even greater and unadulterated control over the materials of sound itself. In 1936, Edgard Varèse described what he expected from the future: score-reading machines, designed to "faithfully transmit the musical content to the listener."³ And the following year, John Cage looked forward to music which could "reach the listener unadulterated by 'interpretation'... without the assistance of intermediary performers."⁴ If sound recordings were a promising form of automation (albeit one which still required at least an original, capturable performance), perhaps they were only the first step towards an even more desirable form of music — an absolute work, that once conceived, would be obediently rendered in final form by the new tools, entirely uncompromised by any further human involvement.

By the 1940s, the engineering tools built to record and to measure sound had reached a sufficient level of sophistication to allow for the 'discovery' of their creative uses. The dueling manifestos of France's GRM and Germany's WDR studios struggled to define the intrinsic nature of the new medium and the expanded worlds of control they offered to the composer. Pierre Schaeffer defined the new medium through its ability to capture and manipulate recorded sounds in ways which could liberate them for aesthetic use. For Herbert Eimert, the potential lay in the systematic measurement of all existing sonic phenomena, allowing the composer to synthesize any known or imaginable waveform, including sounds yet unheard. Yet, any apparent aesthetic divide between *musique concrète* and *elektronische Musik* quickly evaporated in the flood of compositions simply helping themselves to any and all technical approaches, as those studios were joined by an increasing number of other studios, each with their own distinctive approach to instrument design. Indeed, while the manifestos declare the will of the composer as paramount, the real key to understanding the music made during these early stages of development is to list the works not by the composer that cre-

ated them, but by the studio in which they were made.

In hindsight, it is the less-circulated, early '50s writings of Louis and Bebe Barron that grasp the real creative advantages and that touch on so many of the concepts we take for granted: generative music; self-playing instruments; ceaseless musical forms which one guides and interacts with rather than author or fully control. Their visits to the early Macy Conferences exposed them to the emerging field of *cybernetics*, suggesting an entirely different paradigm for musical control from the outset. Norbert Wiener's insight that self-regulating feedback systems, capable of adjusting their behavior through the self-observation of their outputs, were already exhibiting characteristics easily definable as forms of intelligence. Louis Barron, experimenting with electronics and audio, went home from Wiener's lectures and routed the output of electrical circuits back into their inputs, driving them into audible self-oscillation. Adding variable capacitors and resistors to the circuits in ways that allowed them to interact with the sounds without controlling them outright, the Barrons discovered sounds that unmistakably resembled insect voices and birdsong — an immediate musical proof of concept for Wiener's theories. And whereas negative feedback was key to the design of simple self-regulating servo-mechanisms (such as thermostats and fuel gauges), perhaps there were creative uses to be found in positive feedback, where energy reamplifies itself as it loops, over and over, until it reaches, and thusly illustrates, the physical limits of a system (such as a vacuum tube or amplifier). The Barrons' experiments with feedback made a habit of pushing their equipment to the point of collapse to produce fascinating and evolving sounds with a greater expressive complexity than any of the laboriously edited, yet still largely rudimentary music of their contemporaries, leading to their earliest compositions, *Heavenly Menagerie* and *For An Electronic Nervous System* (1950-1953).

In the early 1950s, John Cage realized his early electronic works for tape at the Barrons's studio in Greenwich Village, regularly accompanied by his colleagues who assisted with the long hours of tape editing. One can only imagine the conversations that occurred in a studio dedicated to

the design of autonomous musical instruments during the years Cage closed in on his formal practice of indeterminacy. It is likely they were played the Barrons's early compositions. And proof of a particularly critical collaboration from this time is found in the credits for Ian Hugo's 1954 film *Jazz of Lights*, where David Tudor's name is given as an assistant to the Barrons. Unlike their better known, highly composed cues for the 1956 Hollywood film *Forbidden Planet*, their score for Hugo deploys raucous outbursts of raw circuit feedback in a shockingly modern manner, anticipating Tudor's early '70s work with circuit feedback, as well as drawing a straight line to the piezo-and-microphone feedback systems that Cage and Tudor would soon make central in their works of "live electronic music" for the concert hall: *Cartridge Music* and *Variations II*.

Robert Ashley has called feedback "the only sound that is intrinsic to electronic music"⁵ The supposedly transparent medium of reproduction is flooded, overdriven, until a native voice is revealed, those artifacts which could not have existed before circuits, amplifiers, microphones, and recordings. In the wake of Tudor's realization of Cage's *Variations II*, we see a quick succession of creative works in which elemental principles of gain staging are taken to extremes that nearly have to be experienced as metaphors if they were not also on the edge of being physically dangerous, such as Ashley's *The Wolfman*, David Behrman's *Wave Train*, and Max Neuhaus's *Fontana Mix-Feed*. Extended tape delays become another form of feedback by incorporating recorded media into real-time improvisations, as in the works of Pauline Oliveros and Terry Riley (who reapplied his work with feedback delay into notation that helped give rise to the development of Minimalism), and the hybrid of tape delay and acoustic feedback demonstrated within Alvin Lucier's *I Am Sitting In A Room*.

Wiener's influence reappears in Gordon Mumma's name for his cybersonic circuits, capable of determining, and then storing, the most resonant frequencies of a room, then sending that room into overdrive by tuning electronic processing precisely to those frequencies. And in France, Éliane Radigue's interest in the endlessly sustained pitches intrinsic to sound generation with microphone feedback

seemed to naturally lead her to extended, ceaseless meditative forms in her works for tape. One critical aspect shared by all of these ‘compositions’ is that there is no predictable sonic outcome. Rather than a fixed sequence of sonic events, the performer’s actions serve to influence and illustrate larger complex systems, rather than claim to control them outright.

The introduction of commercial modular synthesizers in the mid 1960s brought a new level of public visibility to the practice of electronic music. Robert Moog’s commercial success and decades-long influence over subsequent commercial synthesizer design is easily explained: He built ever-simpler, ever-more-limited interfaces that allowed a user to quickly ‘dial in’ a sound with certainty. Don Buchla, on the other hand, intentionally cultivated coincidences, offering designs such as the Source of Uncertainty and the Multiple Arbitrary Function Generator, recognizing automated random-number generation as a powerful electronic tool, and allowing for a certain amount of user control over the desired amount of chaos.

These design goals were hardly limited to the United States. Gottfried Michael Koenig and Jaap Vink configured unpredictable modular systems capable of producing effectively endless performances in real time; many of their hyper-detailed works for tape are live captures. And in the Brussels basement of composer Leo Kupper lies his GAME synthesizer, designed in the 1960s; one particularly powerful module can be set to fire off a trigger at random intervals, with a maximum threshold of up to one week. As Kupper puts it: “This means that when performing on this machine, you would require as much as one week before you could perceive the structure of the music.”⁶ This synthesizer, almost undetectable beneath a forest of patch cables, appears in the packaging for German composer Roland Kayn’s *Simultan*, along with this definition: “Cybernetic music, whether vocal, instrumental, or electronic, is above all that which is no longer ‘composed’ and rehearsed... the composer... completely loses his original function. He now merely decides whether to intervene, guide, and regulate, or whether he is prepared to accept that which emerges as an auto-generative process.”⁷

- 6 Leo Kupper, personal interview with author, Brussels, February 11, 2020.
- 7 Roland Kayn, liner notes for *Simultan*, Colosseum Colos SM 1473, 1977.

From the 1950s to the 1970s, the process of working with digital computers seemed bound to the compositional model by simple virtue of requiring extended amounts of rendering time to produce a score, let alone an audible waveform. Infinite variety was conceptually possible, though not in real time. Statistical and stochastic generation opened possibilities for new forms in the work of Lejaren Hiller, Iannis Xenakis, Max Mathews and John Pierce, James Tenney, Pierre Barbaud, and Sister Harriet Padberg. When personal computers and simple digital-audio processors started becoming available in the mid-1970s, the principles of feedback made way for real-time data streams.

Consider the algorithms capable of simple pitch tracking, which analyze an audio waveform and extract a monophonic melody from it to create a control signal capable of driving a distinct, synthesized voice singing along with it. Up until that point in history, hearing a tune sung by more than one voice at once implied preparation, rehearsal, tradition. Technology that is now capable of reflexively singing in unison, in under 30 milliseconds, liquidates our ability to distinguish composition apart from improvisation. And that is just the very surface of the kind of complexity these tools are capable of extracting and responding to in real-time performance.

That kind of complexity is certainly less meaningful when left to its own devices; an audience can only truly perceive the nature of the machine's listening if they can also see and hear a human performing, in real time, with a role to play as an intrinsic part of the larger network. Music that leaves room for a human in the loop becomes a way for us to understand and to model the evolving nature of the relationship between ourselves and our technologies. As Joseph Weizenbaum was trying to tell us with his computer program ELIZA, the question at hand is not what work machines are capable of automating: They're already capable of too much. The real question is: What is the work that should not be ceded to machines without doing damage to ourselves?

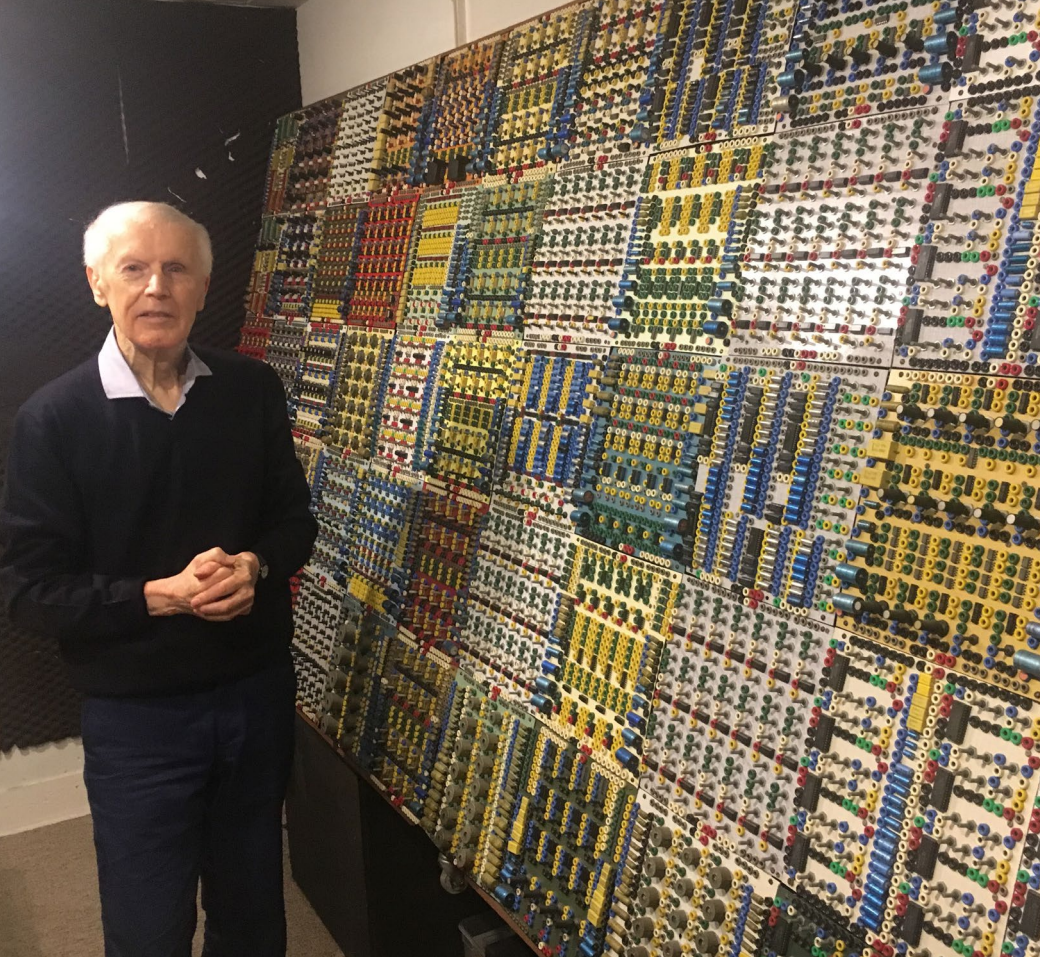
Over the last five years, advances in deep learning have led to networks capable of rendering 'original' works of music in the styles of known artists. Unlike the work of Le-

jaren Hiller or David Cope, who manually translated baseline aspects of musical theory and compositional styles into code, a deep-learning project such as OpenAI Jukebox starts from scratch, reverse engineering its own understanding of the underlying rules of music strictly by training itself upon musical recordings. There are clear financial incentives guiding this kind of corporate work; an endless pipeline of new content in the style of musicians that audiences are already known to enjoy, regardless of whether those musicians happen to be alive. And there is certainly much to be learned by listening to these recombinant experiments hearing the kinds of patterns only computers can detect. Once trained on a data set, and given enough processing power, newly rendered waveforms can be produced faster than the time it takes to listen to them, creating recordings that seem to challenge our definitions of live music. One project by the Boston-based programming team Dadabots, entitled ‘Relentless Doppelgänger’, has been continuously live-streaming algorithmic death metal since September 3rd, 2019. One of their slogans is ‘eliminating humans from music.’⁸

One could easily make the point that humans are still in the loop, even if only as listeners, when regarding such works of generative music. A lot can be revealed about the world we live in by regarding the bizarre productions of neural networks that have ravenously ingested the history of our recorded music and found certain baseline structures within it that slide between the recognizable and the utterly alien. Such renders contain those kinds of fascinating mistakes that it would never even occur to humans to make, once again beautifully revealing our various assumptions about what music is.

Experiments in music are less dangerous than the experiments being made with autonomous weapons, which (for now) still legally require humans in the loop to make the final kill decision, but of course could be far more effectively fatal without them.⁹ Later in his life, after several decades of creating unstable feedback circuits designed to fail in spectacularly interesting ways, Louis Barron’s feelings of ethical responsibility to his instruments intensified: What precisely is being modeled by a music which uses the ex-

- 8 Singing and AI channel, “Dadabots: Neural Synthesis - Eliminating Humans from Music,” YouTube, June 1, 2021, <http://youtube.com/watch?v=Y2VWYk2suWw>.
- 9 Will Knight, “The Pentagon Inches Toward Letting AI Control Weapons,” *Wired*, May 10, 2021, <https://www.wired.com/story/pentagon-inches-toward-letting-ai-control-weapons>.



Leo Kupper standing next to his GAME (Générateur Automatique de Musique Électronique) modular system in Brussels, Belgium, February 11, 2020. (Photo: Jon Leidecker)

10 Phone conversation with David Barron, May 31, 2018.

11 This quote by Tudor is taken from personal transcriptions of interviews since lost and quite possibly apocryphal.

pressive ‘death screams’ produced by his equipment as it self-destructed, occasionally bursting into flames while doing so?¹⁰

Rolling back to the beginning of the medium, there is a line leading through the work which recognized that the new tools were already more than neutral servo-mechanisms, and that the music made with them always expressed more than the personal will of the individual composer working with them: the resulting sounds are a model of the complex systems that created them. Or, as David Tudor put it when asked what he hoped an audience would take away from one of his concerts, “I would hope that it would be obvious to the listener that this was music made by humans.”¹¹