The History of Electronic Music as a Reflection of Structural Paradigms

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THEORETICAL PERSPECTIVE

The History of Electronic Music as a Reflection of Structural Paradigms

Joel Chadabe

ABSTRACT

The author proposes that new and similar paradigms appear in all fields simultaneously. He posits that the two most important developments in the history of electronic music were (1) the opening up of music to all sounds and (2) the development of interactive instruments. He discusses the first development at length, suggesting ways in which it reflected general paradigm shifts in other fields. He then points to ways in which the second development may also reflect broad paradigm shifts, and concludes by speculating about the direction that such paradigmatic changes may be taking in our time.

At the time of writing this article, I am completing a book on the history of electronic music. The book narrates stories of early instruments, tape music studios, early electronic music performance groups, computer music, synthesizers and MIDI, and it speculates on the concepts involved in the development of electronic musical instruments. Except in certain fleeting moments, the book is not interdisciplinary. This article is an expansion of some of those fleeting moments.

I have been noticing for quite a while that similar major innovations in thinking seem to occur in different fields more or less simultaneously. This observation has led me to conclude that major innovations in any particular field are related to generally new perceptions of how things happen in the world and how things should happen. New structural paradigms, in other words—at least within the scope of what we know as Western cultural history—seem to develop ubiquitously. At any moment they seem to be in the air, to be whiffed by different members of the scientific and cultural vanguard. Scientists formulate new paradigms in new theories, painters show them in new imagery and composers play them in new music. In short, new structural paradigms do not flow from one field to another: it is not true, as the old adage suggests, that the sciences discover and the arts express. Ives did not read Einstein before he composed *The Unanswered Question*. New structural paradigms happen in every field at the same time.

In my view, the two most important developments in the history of electronic music were (1) the opening up of music to all sounds and (2) the development of interactive instruments, and both developments have reflected general shifts from old to new paradigms. The opening up of music to all sound reflected the shift from Newton's concept of Absolute Time to Einstein's concept of relativity as described in the Special Theory in 1905. The development of musical automata as the basis for algorithmic composition and interactive instruments reflected a paradigm shift from determinism to indeterminacy.

THE OPENING UP OF MUSIC TO ALL SOUND

An orrery is a tabletop model of the Newtonian solar system. Miniature planets and moons are connected to a crank via gears and mechanical arms, and as the crank is turned, the planets and moons revolve at their different speeds and in their different cycles around a stationary sun in the middle. Turning the crank is a metaphor for the passage of Newtonian time. All of the motions of the planets and moons are synchronized to it, and the speed with which time passes is defined by the speed at which the crank is turned. In his *Principia* (1687), Newton called that singular line of time Absolute Time: "Absolute, True, and Mathematical Time, of itself, and from its own nature flows. . . . All motions may be accelerated and retarded, but the True, or equable progress, of Absolute Time is liable to no change" [1].

The music composed during the Newtonian period, between 1600 and 1900, reflected the idea of a universe in which all motions were synchronized to a single line of time. In all tonal compositions, there was one line of chord progressions to which all notes, of whatever rhythmic values, were synchronized. The painting of the period also reflected Newton's concept of one line of time. Our eyes traveled along one line of perspective to the horizon, and all objects were synchronized to it.

The most important implication of Newton's universe, however, was that it was a universe scaled to human capability and common sense. It was a direct extension of what humans could perceive, understand and do with the simplest technology. It was common sense, understandable in simple human terms, that there was one line of time. How could we make appointments, for example, if our watches were not set to the same time line? It was an extension of everyday life that the painting of the era represented the world as it was seen, with objects getting smaller as they receded into the distance. It was a normal human activity to dance, march and clap to music with a discernible beat. The flow of tonal music, with its rises and falls in pitch and loudness supported by the tension and release of harmonic progressions, was understood as running parallel to the flow of human emotion: human voices also rise or fall in pitch and become louder or softer with emotional change. The music of the period from 1600 to 1900, especially as compared to the ornate music of the Renaissance, involved and affected people. It connected. And Striggio's words at the opening to Monteverdi's *Orfeo* (1607) signified the passage from the complex counterpoint of the Renaissance to the emotionally involving romanticism of the early Baroque. Striggio wrote:

> *Io la musica son, ch'ai dolci accenti*
> *so far tranquillo ogni turbato core,*
> *ed or di nobil ira ed or d'amore*
> *posso infiammar le piùgelate menti.*

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I am music, that with sweet accents
I know how to make tranquil each turbulent heart,
and now with noble anger and now with love
I can inflame the most frigid minds [2].

At the beginning of the twentieth century, the paradigm changed. It became clear that nature extended beyond the human scale to include items—atoms, light quanta, stars, galaxies—that were smaller or larger than those that could be seen or verified by the naked eye or common sense. In the Special Theory, Einstein went beyond all notions of human-scale perception and common sense with his descriptions of a universe in which time passed differently for every object according to the speed, relative to the speeds of other objects, with which it moved through space. The point of the Special Theory was that the faster something moved, the more slowly its time passed. Einstein's theory, in short, described a universe that was a multiplicity of parallel and unsynchronized time lines.

The idea of a universe based on a multiplicity of parallel time lines was, not surprisingly, reflected at about the same time in the arts. Analytic cubism, for example, saw the world through a prism of multiple perspectives. Any of Picasso's cubist paintings of the period would serve as an example. To choose one, consider *The Reservoir, Horta,* which was painted during a visit to Spain in the summer of 1909. This painting shows the natural angles of the rooftops and walls as distorted, so that they flow from one to the other and to the background in an overlapping, interlaced texture of planes, giving the impression that the scene is seen simultaneously from every direction. This concept was also reflected in the literary vanguard. In "Lundi Rue Christine" (1913), Guillaume Apollinaire plucked phrases from a multiplicity of parallel stories:

Trois becs de gaz allumés
La Patronne est poitrinaire
Quand tu auras fini nous jouerons une partie de jacquet
Un chef d'orchestre qui a mal à la gorge
Quand tu viendras à Tunis je te ferai fumer du kief
Ça a l'air de rimer

Three lit gas jets
The proprietress has bad lungs
When you've finished we'll play a hand of backgammon
An orchestra conductor who has a sore throat
When you come to Tunis I'll give you some kef to smoke
This seems to rhyme [3]

The idea of parallel realities was also reflected in music. Debussy, Stravinsky and Ives combined bits and fragments of chords and rhythms as if they were "sampling" multiple streams of simultaneously occurring tonal activities. Upon hearing *La Soirée dans Grenade* (1903), for example, one might imagine Debussy standing in the center square of Grenada, turning his "microphone" to the left to catch a group of musicians playing a *habanera* as they walk down a hill, then turning to the right to hear a guitarist in a cafe, then turning again to catch another group approaching from another direction. One can point to the quick cuts and superimpositions in the first tableau in Stravinsky's *Petrushka* (1911), to the Petrushka chord itself—a combination of F# and C major—and to the discrete layers of music that move in dissimilar cycles in the "Wet Nurse's Dance." One could mention the superimposed processes in Ives's *The Unanswered Question* (1908), where a dialogue between an inquiring trumpet and answering woodwinds is juxtaposed with a sober, hymn-like background.

Further, the artists who perceived the world as a multiplicity of parallel processes also perceived that those processes were resident in a multiplicity of materials. Not only did they pluck moments of imagery from normal storylines, they plucked materials from their normal habitats. Indeed, from Pablo Picasso's *papiers collés* in the early 1900s to Robert Rauschenberg's combines in the mid-1900s, no matter what the specific artistic style or intent, the use of found objects in the arts became normal. This liberation of materials, wherein materials could be disassociated from their normal habitats and recombined in new settings, led to a different kind of artistic expression. No longer were artists poetic souls expressing themselves. Science, art and music became disconnected from human capability, physiology and common sense. They now conveyed a picture of the world as a collage of unrelated and juxtaposed objects.

Sounds were no longer connected to instruments, human expression or physical activity. As Gertrude Stein might have put it, a sound was a sound was a sound was a sound. Sounds became objects—*objets sonores,* as Pierre Schaeffer was to call them—for further investigation and manipulation. As synthesis and processing tools were developed, the ability to create sounds became, for many composers, the fundamental reason to engage in electronic music. Referring to the use of computers, Jonathan Harvey said, "Before the microscope, we never knew what the microworld looked like—and now, because of the tremendous precision in being able to look into sounds and work with them, the whole world of microsound has opened up and we can compose with it" [4]. Denis Smalley stated, "My musical ideas come out of the sounds themselves" [5]. Trevor Wishart observed, "You can now treat sound in the same logical way that we treated pitch before" [6]. Innumerable other composers have expressed related thoughts.

INDETERMINACY

The orrery also demonstrates Newtonian determinism in action. As we turn the crank, A, the present state of things, flows seamlessly to B, another state of things. A also flows to B in painting based on perspective, where the eye follows from one object to the next along structural lines. And A flows to B in tonal music, as one chord flows into the next. Determinism makes sense. It allows us to see our lives flowing smoothly from present to future, with the future positions of our lives following clearly from our present efforts. It allows us to believe that good is rewarded and evil punished. Determinism is comforting and satisfying, as it reinforces concepts of order, control and justice.

It also provides structure. We can turn the orrery's crank backward as easily as forward. From the vantage point of the present, we can look toward past and future with equal certainty. Time, in the context of Newtonian determinism, is symmetrical. As Norbert Wiener put it, "The music of the spheres is a palindrome" [7]. Indeed, at the level of harmonic structure, every tonal composition is a palindrome, a two-part form that leads away from a tonic chord at the beginning and back to it at the end. Those chords define the boundaries of the composition, the closure of the form at both ends, the whole. When the whole is known as the parts are being made, the parts can be made to fit. And structure, which is the division of a whole into parts, becomes possible. When structure becomes possible, the classical values of proportion and balance become possible. With an adequate sense of structure, we can see the whole of our lives—the big picture—and understand how we fit and where we belong. We can balance our activities and put our actions in proportion.

When one seeks to establish order, control and justice, words such as "chance," "randomness" and "indeterminacy" can be disturbing. When there is no continuity between past and future and no just desserts, basic values may come into doubt. When time and musical form move toward an unpredictable future, a musical composition as a whole can be known only retrospectively, after the parts have been made. Structure, proportion and balance cannot exist. It is true that indeterministic music lacks these qualities. Someone once asked John Cage, "Why doesn't your music have any structure?" and Cage replied: "My music is a process. Like the weather" [8].

In their formulation during the 1920s of what came to be known as the Copenhagen Interpretation of Quantum Theory, Niels Bohr and Werner Heisenberg presented a picture of an essential randomness in the behavior of subatomic particles. Following Heisenberg's 1926 statement of his Uncertainty Principle, which showed that there is no law that connects values for the position and momentum of a subatomic particle at one point in time with values for those properties at another point in time, Einstein objected. Underlying Einstein's often-quoted statement that God does not play dice with the world was his belief that the laws of chance represent an irrationality that is impossible in nature. In 1948, Max Born, Einstein's friend and colleague, expressed what many scientists felt at the time when he wrote: ". . . when out of his own work a synthesis of statistical and quantum principles emerged which seemed acceptable to almost all physicists he kept himself aloof and skeptical. Many of us regard this as a tragedy" [9].

However, no matter how offensive to classical values and how disturbing it may seem, indeterminacy does exist in the world; and it is interesting to note that in nature, as in music, chance often serves to produce interesting results. As molecular biologist and Nobel laureate Jacques Monod pointed out:

> Life appeared on earth: what, *before the event*, were the chances that this would occur? The present structure of the biosphere far from excludes the possibility that the decisive event occurred *only once*.. . . Our number came up in the Monte Carlo game [10].

Responding to what he observed as a human tendency to see purpose in all things, Monod continued: "Destiny is written concurrently with the event, not prior to it. Our own was not written before the emergence of the human species" [11]. He went further to point out that evolution was affected by chance: reproductive invariance is determined by information coded in DNA, yet generational change is determined by random perturbations in the DNA sequence that become, however, part of its invariant message in the succeeding generation. In other words, random change in the DNA sequence is captured in offspring and passed on to succeeding generations. In Monod's words:

> And so one may say that the same source of fortuitous perturbations, of "noise" . . . is the progenitor of evolution in the biosphere and accounts for its unrestricted liberty of creation, thanks to the replicative structure of DNA: that registry of chance, that tone-deaf conservatory where the noise is preserved along with the music [12].

The basic question, then, for a composer of electronic music is: Does a composer view a composition as an object, with its sound and structure carefully determined? If so, that composer will need to control the process of composition at every level. On the other hand, if a composer views a composition as an interactive process that can take many forms in performance depending upon who is performing it, that composer will need to accept some level of indeterminacy in leaving certain aspects of the composition open for the performer to compose. The surprises of indeterminacy are often rewarding. Of a performance of his *Untitled*, David Tudor once recalled: "It was so unpredictable, it was just wonderful" [13].

Indeterminacy is the heartbeat of the interactive system. The surprises produced by the system put its human performer in the position of a conversationalist interacting with a clever friend, giving the performer cues for further action. As Bruno Spoerri put it, referring to his interactive performance systems, "The important thing for me was to have a partner in the computer who threw balls at me, who gave me a reason to react in a certain way" [14]. George Lewis said, "I try to get the computer to do its own thing as well as follow a performer. As soon as the computer generates something independent, a performer can react to that and go with it" [15].

CONCLUSION

It is, of course, simplistic to reduce our world views to a single question of whether we prefer to plan or improvise, and it is equally simplistic to reduce our musical preferences to the question of whether we like electronic sounds. We all prefer specific types of sounds, regardless of how they are made, and we all prefer to plan and improvise in different balances at different times. New and old paradigms coexist in our minds. It is not just paradigms, but also our educational and cultural histories that determine our actions and reactions.

But it is also true that, as technology expands our powers to perceive and act, we develop new paradigms to understand what it is that we see and how we should react to it. This involves something of a chicken-and-egg process in which new paradigms lead us to new tools and new tools lead us to new paradigms. Many people, at least to some extent, abandon old paradigms when they are no longer useful. For many people, it is neither realistic nor useful to limit music to tonality and to the range of sounds that can be played by acoustic instruments.

In my view, determinism is no longer a useful paradigm. The assertion that A leads to B requires a simplification that eliminates all contributory causalities. Simply reading the daily newspapers is enough to lead one to conclude that no one cause leads to any one effect, but that everything results from an underlying complexity of causes. Even the seemingly simple cause-and-effect sequence of throwing a switch and thus turning on a light is, in fact, dependent upon an underlying support and delivery system that sometimes fails and produces blackouts. The expected, after all, is often boring.

Does indeterminacy remain a useful paradigm? Perhaps not. It was certainly useful to explain the surprises that resulted from underlying complexity. But once understood, it became an old paradigm. Newer paradigms of the 1960s dealt with issues of information processing and control, as in the cybernetic model, and controllable complexities, as in the general systems model. And even those paradigms have evolved. Given, then, an awareness of the underlying complexities in the universe and their potential for producing surprises (indeterminacy), the issues involved in processing information and controlling events (cybernetics) and the web-like multidirectional causalities within a system (general system theory), I would propose that today's prevailing paradigm is interaction. In fact, the ubiquity of the word "interactive" already indicates that interaction is fast becoming a widely accepted and, consequently, old paradigm.

Interaction means mutual influence. In environmental terms, it means that we influence changes in the environment and react to environmental events. In musical terms, it means that we influence the instrument that we play and that we are influenced by the sounds that it produces. It means that an instrument has a mind of its own, so to speak, such that it produces musical information that contains surprises. The first interactive instruments were developed around 1970, concurrently but independently by Salvatore Martirano and me. Since then, the paradigm has matured. In an article written in 1984, I referred to the interaction paradigm as "interactive composing" and concluded:

> The ultimate significance of interactive composing is that it represents a new way for composers and performers to participate in a musical activity. I offer my nontechnical perception that good things often happen—in work, in romance, and in other aspects of life—as the result of a successful interaction during opportunities presented as if by chance; to that I would add only that it seems to me reasonable that such a perception should also find expression in music [16].

The interaction paradigm is probably due for replacement. One paradigm builds on another. My guess is that, as musical control systems become increasingly complex, a strategies paradigm will be developed to deal not only with our immediate interactions with a system, but also with the implications of those interactions in terms of the achievement of a particular long-term goal. Whatever the next paradigm will be, however, it is now gradually emerging in all fields, and I, for one, am looking forward to hearing its manifestations in new music.

References and Notes

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2. Alessandro Striggio, Prologue, libretto to Claudio Monteverdi, *L'Orfeo* (1607) (translation mine).

3. "Lundi Rue Christine" was first published in *Soirées de Paris* **2**, No. 19 (1913) p. 27. Quoted in William C. Seitz, *The Art of Assemblage* (New York: Museum of Modern Art, 1961) p. 15 (translation mine).

4. Jonathan Harvey, personal communication, 12 May 1994.

5. Denis Smalley, personal communication, 18 May 1994.

6. Trevor Wishart, personal communication, 17 September 1994.

7. Norbert Wiener, *Cybernetics* (Cambridge, MA: MIT Press, 1961) p. 31.

8. Cage made this remark at a public forum conducted by Lukas Foss following a production of John Cage and Lejaren Hiller's *HPSCHD* at the Brooklyn Academy of Music in 1974. The question was asked by someone in the audience. I had been artistic director of the production and was onstage as part of the forum.

9. Max Born, "Einstein's Statistical Theories," in Paul Arthur Schilpp, ed., *Albert Einstein: Philosopher-Scientist* (New York: Harper & Row, 1959) pp. 163–164.

10. Jacques Monod, *Chance and Necessity* (New York: Vintage, 1972) p. 144.

11. Monod [10] p. 145.

12. Monod [10] pp. 116–117.

13. David Tudor, personal communication, 8 September 1993.

14. Bruno Spoerri, personal communication, 21 February 1994.

15. George Lewis, personal communication, 11 December 1993.

16. Joel Chadabe, "Interactive Composing: An Overview," *Computer Music Journal* **8**, No. 1, 22–27 (1984); reprinted in Curtis Roads, ed., *The Music Machine* (Cambridge, MA: MIT Press, 1989) pp. 143–148.

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