Complexity and Emergence in the American Experimental Music Tradition

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I'm going to talk today a little bit about my own work, but primarily about a particular tradition, the American experimental music tradition which my generation of composers has inherited. This tradition has a strange and unique character, I think, which gives it a special relevance for our topic here: in short, the music coming out of this tradition is explicitly concerned with the perception and appreciation of complex dynamical systems. I do electronic music. In my case, this generally means that I set up a system of interacting components of some kind. Sometimes the piece consists of a computer program, sometimes it's a set of analog electronic equipment, sometimes it consists of systems that involve people, and instructions to people. It could be all three, or it could be a network of computers. Generally I design some process of interaction, and allow it to behave. This behavior is what makes the music—in fact this behavior *is* the music.

Of course I didn't invent the whole idea of working this way—there's a clear chain of development throughout this century that led to this practice. When I started doing this kind of work in the late 1970s, there was a very active scene of people working this way in the San Francisco Bay Area, many around Mills College in Oakland, which has long been a major center for new music in the United States. There was the very exciting feeling in the air that this was the way music was going to be made now, that we were on the threshold of a new way of thinking about things that was going to change culture in a major way. Unfortunately, I've found that while we were right about this to some degree—certainly using computers to make music, for example, has become something that nearly everyone accepts—this particular way of working has other aspects that are often misunderstood. And so now I feel that when I talk about my music I need to also talk about the historical context in which this way of working arose. It's actually an interesting story. I believe the American experimental music tradition

is unique, arising from a strange confluence of things that has led to a way of thinking about music, and working in music that is unlike what goes on in other traditions. It has elements of the influence of science and of technology, of the visual arts, of Asian philosophy, of European music—especially French music, I think—and it also has a distinctive American kind of rebelliousness about it.

The salient feature of this tradition is its unique and characteristic way of thinking about the activity of making music. The music is seen not primarily as implementing a vision of the composer, or the will of the composer—something the composer hears in his head. Rather it's about setting up situations that allow the appearance of sonic entities that are more like natural phenomena than traditional music. The practitioners of this type of music build machines, or things akin to machines or simulations, things that have a behavior of some kind that is unanticipated by the composer.

The modernist American composer Morton Feldman once, when asked whether he hears the music in his head before he writes it, said, more or less "people who hear music in their head are nuts—they should be locked up. That's not what a composer does." In his view, what the composer does is set up a situation, set it in motion, and observe, listen. In essence, once that happens, the composer's position is not that different from the audience. He or she is capable of being as surprised as anyone by what actually happens in the music.

This is an unusual way to think about music, and there is a still very healthy, living alternate way to think about music, the more traditional view of what the composer does, of somehow pulling the music out of his head. Of course Beethoven provides the preeminent archetype of this conception: the lone genius (deaf, yet!) whose mind is full of completely realized symphonies, and who struggles to write fast enough to capture them. I suppose there are people like that—I don't know anyone like that—and in fact, that's not a way of thinking about music that particularly interests me, and has not been what this American tradition I'm discussing is about.

This heroic, romantic view of the composer, and of music as some sort of ectoplasmic excretion of a mind or soul, is actually not all that old, really arising in the 18th century and gaining pre-eminence in the 19th. There are pre-romantic antecedents of the American experimental perspective, in which music is seen as somehow more external: whether in the medieval conception of music as a divine visitation, or the late renaissance aesthetic of music as providing an image or representation of real physical phenomena. The role of the composer in the experimental view is in a sense more passive than that of a romantic composer: once set in motion, the music has its own life and the composer is a listener like any other. Calling this music experimental is quite precisely correct: like a scientist setting up an experiment, the experimental composer sets up the conditions that define the piece, and is interested in hearing what actually happens with it.

I'm now going to discuss some examples of different music I think belongs in this tradition. The first example is from someone who is the grandfather of the American experimental tradition, one who has had a great influence on many American composers: Charles Ives. There are a rich variety of innovations in Ives'

music, but the selection I draw your attention to, from his *Symphony No. 4* (1916), conveys something of his experimental attitude. He described how as a child he went to a Fourth of July parade—a parade with more than one band in it—and as the bands went by, there would be moments when two bands could be heard at once. They were playing completely separate pieces, completely uncoordinated rhythmically, harmonically, in any way. In one movement of the *Symphony No. 4* he recreates that phenomenon with an orchestra.

This music is an attempt to represent something he heard, a depiction of an acoustic effect. The simultaneous sound of two bands is of course a man-made phenomenon, but Ives' interest in it is in its aspect as an uncontrolled, naturally occuring event. Representing this event in his symphony is not primarily an act of self-expression: it's really about listening, and exploring the world on its own terms.

Once one has decided that musical work in some sense involves studying the behavior of entities beyond oneself, than a next logical step is to actually construct situations that exhibit musical behavior. Rather than composing music, the composer designs an algorithm, a virtual machine, which he uses to generate a score for players. More recently, composers working this way will build literal machines, electronic circuits, or software machines that generate music. These machines are not really machines for a specific, well understood purpose like a car, or a watch: they really have more in common with a mathematical simulation. As with a simulation, what the composer is really interested in is eliciting some unknown behavior. One designs a machine, an algorithm, which is perhaps predictable, but the new relationships that arise in the musical product of this mechanism are unknown, in fact unknowable in advance. A pioneer in this approach to music in the early twentieeth century is Henry Cowell, a Californian. In 1930 he built a rhythm machine, with a big mechanically driven wheel, which held pegs set to play different rhythms, and one could study different rhythmic patterns this way.

John Cage, who is central to this entire tradition, was another musical bricoleur. Cage used to quote Arnold Schonberg's comment about him, that he was "not a composer, but an inventor—of genius." And this is quite accurate—he was an inventor of musical machinery of different types, machinery that has musical behavior, providing us with new and undreamed of musical sensations. Cage's 1947 work *Sonatas and Interludes* illustrates the machine-like aspect of his work well. This work is a series of short movements for prepared piano, a piano with various items stuck in the strings to make it a miniature percussion orchestra. Simple and strict geometric and arithmetic procedures are followed in the composition of the piece. While the conceptual framework is meticulously planned, the actual musical affect is not pre-conceived. Cage makes it quite explicit that the underlying intent of his work is a spiritual one, the idea of opening our ears to hear things we haven't heard before. He talks about escaping our own tastes, and escaping our cultural prejudices. Central to the American take on modernism in music is the notion that, like science, it's about the discovery and perception of alien, unknown phenomena.

I keep calling this an American tradition, and it is important to look at what was happening in Europe in the same period. Many of the same technical innovations the Americans were exploring were also being used by European composers,

but in Europe they took on a different spiritual meaning. We have an interesting exchange of letters between Cage and Pierre Boulez in the 1940s. In this correspondance they're both very excited, there's clearly a shared sensation that they were on the same track. Many of the letters are very technical, describing in detail complicated arithmetic schemes, ideas we would recognize now as algorithmic music, schemes just crying out for a computer to implement them. There was eventually a drifting apart of the two composers, however, because there was a radical disjunction in purpose. The Europeans—Boulez, Stockhausen, Varese, Xenakis—took the new compositional innovations available, using randomness, arithmetic and geometric techniques, and other gleanings from science, as a way to continue—to look at it from the American point of view—the romantic project of self-expression through music. These new ways of working were mere techniques, to be added to the toolkit of a skillful composer who was still in the business of creating masterpieces. But for Cage these techniques had a radically different meaning: they were tools for building complex systems that were as free as possible from human influence, a way of opening our ears to hearing things that have absolutely not been made, or pre-chosen, by human beings.

Cage and other composers working at mid-century gave great import to randomness, and spoke often of the meaning and use of randomness in composition. But I would contend that we almost need to mistrust their own statements about what they were doing. What was really happening was an interest in exploring the nature of complex systems, but the terminology of chaos and complexity theory was not available to these artists at this time. Cage pieces that involved random decision making always used randomness as a way to feed systems akin to Monte Carlo simulations. The most important feature of these systems is not their incorporation of randomness: randomness is merely the food that the pattern-making machinery of the algorithmic composition uses to create the authentically new pattern it creates.

A good example of a system of this sort is the Cage composition which is usually talked of as being the *ne plus ultra* of randomness, *Variations IV*. In this piece the score consists of eight sheets of clear acetate, four of which have one line on them, and four of which have one dot. The performer is asked to prepare a performance score for himself, before the performance, by using these materials. First one chooses the set of performance parameters one wants to subject to the process: they may be pitch, loudness, density, some kind of harmonic measures, anything the performer chooses. These become associated with the lines. Then one throws this stack on a table, and takes measurements of the distance between the dots and the lines, each dot representing a particular musical event. The process continues until enough material is generated to specify the performance. Every performance of *Variations IV*, as you might imagine, is radically different, depending on the instruments used—clarinets, sinewave oscillators, automobile horns, shortwave radios—and the parameters chosen.

Now this piece is random, in some sense, but what's interesting about it, upon reflection, is that it's actually a quite constrained system, determined by the geometry, the possible relations of the points and lines. There ends up being correlations between the presumably random parameters that are based on the constraints of this geometry. The constraints are not analytically understood, cer-

tainly not by Cage, perhaps by no-one—I don't know if anyone has ever analyzed this—but what results is a complex system of relationships, which is essentially removed from human taste. And the underlying aim, again, is to open the ears to hearing a new experience.

There are many descendents of Cage in this experimental tradition; one important movement following Cage was minimalism. The idea of American minimalist composition is to pare down the systems involved to the point that all the complexity very clearly arises out of the simple physics of the situation. One example would be the piece *Pedulum Music* (1969) by Steve Reich, in which he hung microphones on long cords from a high ceiling, forming pendula of different lengths. The microphones were set swinging and under each microphone was a loudspeaker which output that microphone's signal, forming a squealing feedback loop whenever the mic passed near the speaker. The piece was over when they all stopped, forming a godawful static howl.

Perhaps the most purely minimalist piece of music in this vein is *Music on a Long Thin Wire* (1979) by Alvin Lucier. I quote from the composer's notes accompanying the double LP recording of this music:

> An 80 foot long wire is driven to oscillation by passing a pure sine wave signal through it while a large fixed horeshoe magnet is mounted nearby. That is an electrical sine wave, not a sound; an electrical circuit is formed through the 80 foot long wire. The electrical oscillation in the fixed magnetic field of the horseshoe magnet induces motion of the wire, which creates the sound.
> A single oscillator tuning was chosen. No alteration of the tuning, or manipulation of the wire or fixed magnet was made in any way. The wire played itself: all changes in volume, timbre, harmonic structure, rhythmic and cyclic patterning, and other sonic phenomena were brought about solely by the modes of vibration of the system.

It's difficult to imagine a more passive notion of composition. Lucier doesn't control anything about the process after it is set in motion. The consequences, and the musical interest, are purely the result of physical law and the contingencies of the moment: the wind, the temperature, the imperfections of the string.

Its interesting to look back now at the progression of this tradition, and what's happened as we've gone along through the century. We start, in Ives, with a musical reinterpretation of a musical/acoustic phenomenon. The representation of the phenomenon is still largely filtered through the composer's musical sensibility. In as much as it partakes of what we're calling our experimental music intent, of hearing something that's beyond human composition, it's done through the medium of the composer's artistic recreation.

In Cage we have a further distancing of the artist from the work, where the composer comes up with an algorithm, building a virtual machine that generates music. The framework of the piece is foreordained, but the relationships that arise between the different parts of the music generated may not be forseen when the scheme was developed. The music is more raw and direct in a way, there's more of

a "hands-off" attitude: the shaping work of the composer is more restrained, the raw phenomenon of the piece shines through more directly.

And with Lucier, we have an even more hands-off and physically direct situation, where the body of the music is **only** the physics of an actual performance situation. There is no representation going on at all, there is no reinterpretation. We've really reached the point where the whole interest is in listening to the natural phenomena, and Lucier has reduced the machine or mechanism to put us in that situation to the absolute minimum point. The minimalism of the means forms a nice bit of theatre here, as well: the simplicity of the system involved is transparent, and it becomes absolutely clear that we're letting the physical phenomena speak for themselves.

Looking further back to the influences that led up to the American experimental tradition, one can see the sources for our interest in musically embodying the natural. French music has been a key influence, not only *musique concrete*, early experiments in composition with the tape recorder, but the French impressionism of Satie, Ravel, and Debussy. This French music is concerned with painting sonic pictures, with representing sonic environments as living interacting entities. These composers in turn have their origin in what I would call pre-impressionism, the eighteenth century music of Lully and Rameau. According to James H. Johnson's fascinating history of French musical culture *Listening In Paris*, the critical criterion of success for a musical composition in this period was whether the composition successfully portrayed a particular sonic environment. The eighteenth century conventional mappings of natural sounds into musical expression are obscure by our standards—we, having been trained by recording technologies, have grown quite literal minded about sonic imagery—but the intent has similarities to that of our modern experimental work.

We can perhaps see here a thread that provides some continuity through the stormy nineteenth century period of self-obsession. There is a long tradition of thinking of music as providing an image of real world dynamics, but over time the language and means of representation have changed, and become ever more direct and unmediated. Lucier, is, in a sense, the culmination of this process: in his work the notion of music as a way for us to re-experience natural phenomena is taken completely literally.

The next composer I want to discuss is David Tudor. He was a collaborator with Cage, and a virtuoso pianist and performer of contemporary music, who also developed a performance/composition career of his own doing electronic music. His practice was to string together cheap electronic components into complex and ill-understood circuits which exhibited complex and ill-understood behavior. These networks can be thought of as simulations of some kind: simulations perhaps of things that never existed, if that makes any sense. The dynamic behavior of these complex systems is very explicitly what this music is about.

Tudor has this to say about how his piece *Untitled* (1972) was created:

> The generation of Untitled begins with two chains of components, each chain linked together with multiple feedback loops having variable gain and variable phase-shift characteristics. The configurations of devices and their inter-connections, was conceived of as a "giant oscillator," with ran-

> dom characteristics variable by the performers response and consequent actions.
> The components used, mostly home-brew, were: amplifiers (fixed or variable gain, fixed or variable phase-shift, tuned, saturating types), attenuators, filters (several types), switches, and modulators with variable sideband capability.

Tudor's music is difficult to listen to, consisting usually of extremely distorted, noisy, abrasively electronic sounds. This music is often hated, and I can certainly understand how one could legitimately hate it; it makes few, if any concessions to musical taste, and doesn't attempt to satisfy any conventional musical expectations. This inhuman "otherness" is in some sense the point of the music—it's specifically **not** crafted for your delectation. Tis music has not been shaped to be an ideal object of contemplation. Traditionally music is a kind of sound tailored to our ears; but this music requests that the audience make the effort to attend to the behavior of a system which is indifferent to its effect on human beings.

Tudor's work represents an attempt to map a dynamical phenomenon—the gyrations of electronic circuits—into a sonic form. As such, it's not necessarily a good fit to our perceptual apparatus. It's the composer's job to make as good a fit as he can, but the misfit, the rawness of the music, the stretching that we have to do as listeners is the spiritual task that this music is about. We are asked to find a way to somehow immerse ourselves in the world created by an alien phenomenon.

To me, this is the core of what is so extraordinary about this tradition: it is calling on us to use our inherent ability to analyze an acoustic scene as a way of getting a view into the workings of a complex system of some kind. It's asking for a new kind of listening, some hybrid of aesthetic attention and natural perception, a way of listening adequate for parsing the sonic traces that make up this music. Musical pieces in this world are not communications from one person (the artist) to another (the listener). They are some strange new kind of object, that is not quite natural and not quite a typical artifact either. In other words, rather than receiving a musical form that was created by another person, we're listening to the hidden structure that arises out of a situation that was certainly initiated by a human composer, but which actually has something of a life of its own.

I think we can see that there is a correspondence between what is going on in the Lucier and Tudor pieces, and some of the practices of contemporary physics. Scientists involved in experimental mathematics, or in doing dynamical systems simulation, are performing a very similar work: they create artificial objects/systems, designed to be contemplated and studied as if they were natural objects.

So our little history has now reached the 1970s, and at this time it was pretty well established, in experimental music circles, that the dynamics of a complex system are interesting in themselves as musical phenomena. The "guerilla electronics" approach of Tudor and his followers, of which I count myself, is one approach, but this is also the time when the analog synthesizer is being developed. Or another way to look at this, which perhaps makes the point clearer, is that at this time

analog computers, designed as simulation machines, were being re-purposed for use as musical instruments.

This is the context in which I started making music, and I accepted most of the points I've been trying to make above as givens. In the context of the late 1970s and early 1980s, as I said at the beginning, there was a very exciting musical scene happening, of people playing in different collaborational contexts, often hooking different analog synthesizers together to make one big analog synthesizer which would have unpredictable and interesting behavior.

So it was natural when microcomputers became available for us to extend our practice to include little microcomputers in our big synthesizer patches. The League of Automatic Music Composers, a group I played with that began in the late 70s, was dedicated to just that: we would interconnect little single board microcomputers with music synthesis equipment. It opened up a whole new area for us, introducing us to the possibilities inherent in including these very non-linear devices called microprocessors into our networks.

Hooking up a tangle of ad-hoc connections every time we wanted to rehearse or play a concert started to be a nuisance, especially as more and more people were around who wanted to play music in this way. We really needed a way to connect computers for the purpose of making music. (The commercial standard for this purpose now available, called MIDI, didn't exist at this time.) This is where the Hub came in. The Hub was a name we used for a box built by a small group of us to interconnect separate computer/synthesizer systems; eventually it also became the name of a regular computer network band that made use of it.

The band was a group of six composer/performers who each had our own synthesizers, controlled by our own computers, which were all interconnected through our central "mailbox" computer, the Hub itself. The whole point of this exercise was to build music that arose out of the unpredictable behavior of the interconnected systems. Usually a piece was designed by one person, who came up with a specification for what kind of data could be interchanged between players in a particular piece. The players would then program their own computers to have some behavior that follows that spec—as long as their system followed the spec, which was usually pretty simple, they were free to do whatever they wanted. Often the algorithms in each machine were quite simple, and didn't seem to account for the larger structure that would emerge from the asynchronous communication between the machines.

For example, the piece *Is it Borrowing or Stealing?* (1987) by Hub member Phil Stone, has a very simple design. The Hub was used as a repository for melodic figures and the only requirement was that whenever a player played a melodic figure, he reported to the central Hub what he had played, by putting a copy of the information specifying the figure there. Anyone else could take it, use it, modify it, and play what they want. It's a completely open specification for what each player does: it's just that each player has information about what the other players are doing.

Perhaps I should make clear what I mean by a "player"—I mean a person, and his computer and the program he has written. Usually the process would be almost completely automatic, and the action of each player directed by an algorithm running on a computer. No-one is playing anything on a musical keyboard, but

the players—the people—generally have some knobs and switches they use to fine tune the operation of the algorithm running on their system. In a sense we acted more like composers or conductors than performers while in performance, just listening and making fine adjustments from time to time. So the system really includes the people, and the musical reactions of the players would be one element of an overall social/electronic musical network.

The communal aspect was really important to me, and I think it was probably the most interesting aspect of the work with the Hub. It was a social experiment, as much as a technical and aesthetic one, and many of the pieces we did were really about exploring the new social permutations suggested by this new way of music making. I did a piece in the late 80's for the Hub called *The Minister of Pitch* where I looked into apportioning musical responsibility in an unusual way. Players were assigned areas of global responsibility based on different musical parameters: one player was in charge of the pitch relations of all the players, another in charge of everyone's timbral decisions, another in charge of rhythm. Other pieces had game structures, in others players would vote or bid on the musical direction. In this sense the Hub was something of a laboratory for new kinds of collaborative work. It was as if the Hub was one collective instrument, which radically changed its character from piece to piece and demanded different modes of cooperation—sometimes including competition!—between players.

One of the more complex of these "social experiment" pieces was *Hub Renga* (1987). It was based on the Japanese poetry form called renga, in which different people each write one line, each responding to the previous line written by someone else. *Hub Renga* was a live radio performance, in collaboration with the Well, a computer bulletin board and messaging system. The Hub was connected to the Well through a dialup line in the studios of KPFA radio in Berkeley. The public could dial up the Well from their home and type in lines of poetry which would be read aloud on the air; this stream of text also was fed directly into the Hub computers, which were programmed to respond to certain "power words" in the text with musical actions of each Hub composer's choosing. The Well poetry community in the weeks leading up to the performance had actually collectively compiled this list of power words.

What is especially interesting to me about this piece is how it redefines the borders of public and private. We tend to think of communications technology as always giving us more presence with each other, but here is a case where things are a bit different: people are able to act as live performers in a group work in solitude, in their own homes, doing the private act of writing and the public, collective act of performing at the same time.

I've been claiming that the American experimental tradition is purely about natural phenomena, that it's not about self-expression, that it's not about the shaping power of the artist's vision, and so on. But now it's time to admit I've overstated my case to make a point. The fact is that this practice is still an artistic one. It is not science, and these pieces are not mere illustrations of scientific principles; they are attempts to create aesthetic experiences. The emphasis is perhaps on finding a way for us to perceive new and alien structures rather than directly expressing personal musical ideas, but the artistry lies in the balance between the two extremes, between wonder at the unknown and self-expression.

The place a composer chooses on this spectrum is a matter of personal temperament. I greatly admire the work of John Cage, for example, but I also know there was a severity in his method, that had to do with a need on his part to expunge the personal from his work, to distance himself from his own taste and his own emotional landscape. He needed to be carried outside himself. In my own work, I don't want to lose Cage's insight of bringing in the foreign and unexpected, but I also need to engage my own faculties in shaping this material.

Much of my recent work has focused on building what are essentially software musical instruments, that are used in live improvisational situations, usually with ensembles of acoustic instruments. These new computer instruments have their own unpredictable complex behaviors, that are partially under my control and partially following their own nature. Playing them, even when playing by oneself, has something of the quality of conversation with another person, or playing music with another person. As in a conversation, each participant doesn't know what his partner will say next, and therefore doesn't even know what he himself will say next in response. One is always responding to what actually happens, which is not always what one expects.

The French philosopher Jean Baudrillard has said, "It is the fate of our technologies to render the world more illusory." Certainly that's the prevalent trend here at century's end, as we live ever more mediated lives, lives in which more and more of our experience is run through conceptual and electronic filters of various kinds. I'm afraid he may be correct—but in looking at the aesthetic position I've been celebrating for the last hour, I see a hopeful alternate vision. This aesthetic repurposes technology away from mediation and towards a means to perceive the dynamics of the world. By engaging in the creation of aesthetic objects beyond our understanding and control, and then applying our perceptual abilities to the task of understanding them, we are closing a circle of connection with the natural world in a new way.