Simplicity and Complexity in Electroacoustic Music

Gerald Bennett

I would like to say a few words about simplicity and complexity in electroacoustic music. To be more exact, I would like to say a few words about complexity, for I must admit that it interests me far more than simplicity. Simplicity seems to me a gift, only to be striven after once the musical fabric attains a certain richness of idea and realization. I will talk about complexity at three levels: at the level of sound synthesis and sound treatment, at what in earlier music would have been called the harmonic level, that is, at the level where sounds go together, and finally at the level of musical form.

Beginnings are often hardest, and that is the case now, for I must first speak about simplicity, what I mean by it here, and why I will speak so little about it later on. I do not mean by simplicity the breathtaking straightforwardness and immediate expressive impact of some music, whose "rightness" depends far more on the balance of several elements than on a reduction of the elements themselves. Mozart and Schubert are names which come to mind immediately in this context. Rather I understand by simplicity monophony, both in ideas and in their carrying out. I understand sameness and repetition and great regularity. I understand formal developments whose trajectory one can guess in advance. More than anything else, I understand singleness of intention of an exclusive kind, one-track-mindedness which forces everything in a phrase or a section to obey it rather than to carry on polyphonic life. I also understand by simplicity the unreflected taking over of structural and expressive models from the past. Here the simplicity comes from the fact that we do after all know quite a bit about C-major and about the sonata-allegro form: it is hard to imagine (and much harder to write) a music which would not get caught in the intricate webs of late romantic harmonies nor would reinvent the chord progressions of the diatonic chords of the scale. A music which discovered new paths within C-major (and there must be many) would hardly be simple.

But what's wrong with simplicity, you ask. I admit that I do not have logical arguments against the FM-sound whose modulation index varies from 1 to 2 in 37 seconds nor against the phrase whose attacks speed up in an inverse Fibonacci series. But everything I see in the world indicates that physical and psychic structures are far more complicated than they seem.

Everywhere I look I see immense disorder barely held together by fragile and frayed threads; chaos is lurking under the surface. The pattern of the branches of the vine on my garage; the path a dragonfly navigates in the three minutes I watch it; the way a glass breaks when I drop it—all these seem to me signs of an infinite polyphony and multifariousness in the world. Nor is this disorder a mistake or a blemish: this is how the world manifests itself, this is how the world *is*. The condition of the world is that it reveals itself incompletely and in seeming senselessness; it is an altogether open question as to whether there are levels of greater order beneath the pandemonium presented us.

Now in view of the general chaos around us, rising higher and higher in compliance with the Second Thermodynamic Law, it may be argued that art should be a bulwark of order, an alternative universe showing how things might have been. I certainly would have argued so as a younger man, and in fact I did so on a number of occasions in print (I am thinking particularly of the article "Musique et langage" in the IRCAM book *Musique en projet* (1975), which some of you may have read and with whose conclusions I could hardly agree less today). I consider it a sign of progress and incipient understanding in my life that I now revel in the chaotic richness and complexity of things in general and of music in particular.

This then is my starting position, riddled with prejudice and absolutely indefensible, should anyone want to prove to me that in fact everything is quite straightforward out there. Put briefly, I like complexity and I don't much care for simplicity.

But to compose—and particularly to compose electroacoustic music—we need to reduce pandemonium to something a bit more manageable. I would like to tell of three personal experiences of meeting chaos while working with electroacoustic music, once at the very low level of synthesis, once at a harmonic level, and once at the level of musical form.

The first experience concerns work I did at IRCAM with Johan Sundberg and Xavier Rodet on analysis and synthesis of the singing voice leading to the CHANT program. It is a story which has been told before—among other places by me here in Stockholm five years ago—and I do not want to dwell on it. We began by trying to imitate vocalises sung without consonants by a male voice. Rodet's technique was to synthesize individual formants and add them together. We measured and

set formant frequencies, amplitudes and bandwidths by hand until we got satisfying results. Johan Sundberg suggested that the acoustics of the vocal tract were pretty well understood and that Gunnar Fant and his workers at the Royal Institute of Technology (KTH) here in Stockholm had developed formulae for the relationships of formant frequency, amplitude and bandwidth to one another. We incorporated these formulae into the synthesis program. We then studied the spectral changes in the singing voice as a function of effort and learned to automate the spectral change independently of actual amplitude. Thus we could synthesize a singing voice with low amplitude that seemed to be singing loudly but at great distance. Finally we learned how to define voices of the same register having clearly different characteristics by describing how various parameters of the synthesis should change as a function of a note's amplitude and its place in the singer's range. The handbook for the CHANT program that Tamas Ungvary prepared at EMS Stockholm in January 1984 lists 107 parameters necessary to synthesize sung tones. Many of these parameters have their values corrected by the algorithm on the basis of other parameter values or of a general development (crescendo, decrescendo, etc.). In fact, as the research advanced, fewer and fewer parameters remained completely independent of the others.

It is hardly surprising that many acoustical parameters are intimately related in natural sounds, for these relationships are but analogs of those between the physical dimensions of the object producing the sound (here the vocal tract). It was far more surprising to me that the same framework would give such satisfying results in the synthesis of non-vocal sounds. When I began working in computer music, I had such difficulty in getting an intuitive grasp of Music V, and I was constantly being shocked at how a small mistake in the value of a Music V parameter could have altogether disproportionate effects on the resultant sound. When I began to use CHANT to synthesize non-vocal sounds therefore I was surprised and delighted to find myself inside one or another "sound-island", where strange parameter values sometimes gave strange but never impossible results. Somehow, the rules we had built into CHANT on the basis of research with human singing voices seemed to help our synthesis of non-human, non-vocal sounds.

Now I certainly do not want to suggest that electroacoustic music must remain close to the human voice. Are there other kinds of models than those resulting from the analysis of the singing voice which will give similarly rich possibilities of extension? There surely are. To begin with, I imagine that any algorithmic expression of a natural sound of some complexity would prove to be equally successful in its departures from natural sound. Examples are Gabriel Weinreich's violin and piano algorithms and the work being done on physical-model synthesis by

Xavier Rodet and his group at IRCAM. None of these algorithms has—to my knowledge—yet been subjected to much disrespectful fiddling by composers.

I see no theoretical reason why satisfying synthesis models need be limited to analogs of the physical world. In principle, it would seem to me that any sufficiently complex body of rules should be able to synthesize sound in a consistent and coherent way, so that even superficially widely varying results will show common traits and will—at least at a subconscious level—be perceived as belonging together, as being "right". I do however think that constructing abstract sound synthesis models without recourse to physical models is a formidable task. I think it is very easy to underestimate the degree and the kind of complexity necessary for satisfying results. I also believe that one of the low-level functions of perception is to give us information about what is making the sounds we hear (is it something that will eat me?). I can imagine that non-physical models might give rise to conflicting impressions of a sound's origin, a kind of perceptual dissonance that might mar the sonorous homogeneity one sought.

I have spoken at length of the importance of formulating synthesis models of complexity and inner coherence. I would next like to speak about harmonic order. I regard the harmonic structuring of electroacoustic music as less decisive for the music's success; nonetheless, the vertical organization of a piece must remain a question of primary concern for every composer.

During most of the history of our western music, the word "harmony" referred to the consonances and dissonances of a single interval or chord. Only in the eighteenth and especially the nineteenth centuries did music theory begin to study the relationships between chords; in the eighteenth and nineteenth centuries the harmonic movement of a piece became a matter of central concern for composers, and harmony was the dimension of music on which the most speculative attention was lavished.

We can surely not aspire to such a rich and subtle relationship between sound and musical form as we find in Schubert, Wagner and Debussy. Harmonic movement in the nineteenth century was based on progression away from and back to a key; the building of tension by going to distant keys and the release brought by returning to the tonic underlined the dramatic structure of all classic and romantic music. But much of our music today is not very interested in this dramatic form. I have in the last years come to view the harmonic intractability of the musical material I use (for instance, what can take the place of the resolution of a dominant chord, or what corresponds to a modulation?) not as recalcitrance on the part of the material, but rather as a great help, showing me, if not which way I should go, at least which directions are

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closed and no longer accessible. I consider listening carefully to what the material says and watching carefully how it reacts as one of the important steps forward in my own compositional technique (at the same time as I am aware of the blatent anthropomorphism of my interpretation).

Nonetheless, it seems to me essential to organize the vertical structures of all music. There seems to be great interest today in organizing timbres in a composition, and in learning more about how the perception orders timbre. While I certainly think it important to continue all psychoacoustic research that will help us understand these matters better, I am sure that this is not a fruitful way for composition to go. Timbre is not complex structure in a compositional sense; it is a simplified product of a complex perceptual act. Timbral organization, timbral interpolation and all the other operations one would like to apply systematically to timbre, must remain anecdotal, in that a solution found for one particular situation says nothing about the solution needed for another situation. What is nowadays so often called the perceptual space is not the proper place to structure music; structure must be given in the more basic dimensions: frequency, duration, dynamics. Timbral "structure" can only help group sounds which sound more or less "alike" into families; timbre alone is far too vague a perceptual category to bear complex differentiation.

Not timbral but harmonic organization, then. As with sound synthesis, so with harmonic structure: I do not believe that there are good and bad kinds of vertical organization. Rather, I think inner consistency is the most important fact for the perception. Now I would like to tell of second experience. It concerns a piece I wrote at IRCAM in 1980, *Winter (1980)*. In this piece, composed with CHANT, I used six synthesized female voices and six very different classes of non-vocal sounds to write a double canon in retrograde movement. The singing voices sang the vowels of the poem by Friedrich Hölderlin upon which the piece was based. The non-vocal "voices" all used the formant structure of the same succession of vowels, but transposed, compressed, extended, inverted. The result was very satisfying harmonic coherence, rich and complex because of the different ranges, inversions, etc., but clearly of one cloth. There was also a timbral coherence in the piece, but it was the result of other complex operations, not a primary goal, as I should say is the case for the perception itself.

Of course, harmonic consistency in this sense is not an invention of mine: *Inharmonique* and *Songes* by Jean-Claude Risset and *Stria* by John Chowning employ this principle very strictly, to name three well-known pieces. Such precise control over frequency and spectrum is best done by computers, but I used some of the same techniques in an analog electroacoustic piece I realized in 1984 at the studios of the

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Groupe de Musique Expérimentale de Bourges. I combined notes from a sung melody to form chords; these chords then were the basic material I treated over long stretches of the work. In this way there was coherence between the horizontal and the vertical dimensions of the music.

I have spoken here about my own need for harmonic organization in electroacoustic music. I said earlier that I find this kind of controlled complexity less decisive for the success of a piece, for I have heard many works I consider successful whose impetus or gestural elegance or formal power has been so great as to carry the expressive burden despite a weak or chaotic harmonic structure. Nonetheless, I think questions of harmonic organization form an important and appropriate topic for compositional investigation.

Finally I would like to speak about musical form. Here too I must be brief, for who would presume to speak other than superficially about form in a talk like this. I think it is important to recall what I said earlier: many composers today are not particularly interested in the traditional means of articulating form in terms of dramatic structure. It is relatively easy to write pieces which get higher and louder and faster all pretty much at the same time, and then get lower and softer and slower again. Experience with art—and sex—suggests that this is a universally understood model, and some people care only for music that works this way.

But life seldom goes to all the trouble of organizing large-scale dramatic forms: most important things come quite unexpectedly and either masquerade as events of no consequence or else break upon one cataclysmically and without a long preamble. Many composers—I suppose particularly those bearing the scars of a long exposure to classical and romantic music—find carefully prepared stepwise progression from calm to storm and back to calm again, the high point ideally being reached at the golden mean of the piece, unbearably naive. There would seem to be—and now I am speaking for myself—at least two difficulties with the classical—or strictly speaking the Beethovenesque—approach to formal design. The first I have already mentioned: so much of life expresses itself in a far more complex, cryptic fashion that it seems ridiculous to long for such artificial formulation. The second problem is subtler: the dramatic conception of form leaves the listener very little freedom to follow his own path in a piece. On the contrary, he is more or less forcefully helped along the road the composer envisions: there are not very many different ways to listen to the *Eroica* symphony. If however the composer prefers to mimic the complexity of everyday life rather than the simplicity of romantic music, and if he wishes to respect the person of the listener by not forcing on him one or another interpretation of his music, preferring to leave the listener room enough to explore the piece

as he will, then traditional conceptions of form will hardly do.

To mimic the complexity of everyday life means to invent structures which often have little apparent relationship with one another. John Cage uses intricate series of "chance operations" to imitate a complexity whose disorder he adores. Bach did much the same thing in the speculative late works, where both numerical symbolism and the very conscious use of the *figurae*—those musical patterns, thought to relate music through rhetoric to speech, which are so dear to the hearts of baroque theorists—are the attempt of a master, to whom the musical material no longer offered sufficient resistance, to impart to his music the same degree of complexity he sensed in the Christian cosmos.

I use numbers to achieve the formal complexity I seek in music. Proportions, sometimes only one or two, sometimes many, determine the borders between sections. The same proportions, but on a smaller scale, define the finer formal structure of each section. Finally, the same proportions at the level of the individual phrase give durations of sound and rest. The proportions act like windows, now opening to let a moment of music through, now closing before one phrase can monopolize the listener's attention. Applied in a polyphonic context, these techniques give satisfyingly complex results.

Is there any way to distinguish between arbitrariness and great complexity in such polyphonic structures? I am sure Cage would consider this a non-question, because he has always claimed to be interested in the greatest arbitrariness. The question did not interest me either, until a remarkable experience I had during the composition of the first piece I wrote with CHANT, *Aber die Namen der seltnen Orte und alles Schöne hatt' er behalten*, for baritone, five instruments and tape. This is the third experience about which I wish to speak.

The tape part of *Aber die Namen der seltnen Orte und alles Schöne hatt' er behalten* was composed as four voices of mostly isolated tones or groups of two or three tones. Of course, in 1979 high-quality synthesis took hundreds and hundreds of hours. I had prepared a low-fidelity version of all the individual notes synthesized at a lower sampling rate than usual. One Friday (this was one of my two ventures into capitalistic composition), I asked my assistant to prepare a sketch tape with all the phrases in their proper place for the next Monday. I gave him a score and wished him well. When I came back on Monday, I was very eager to hear the tape. I had written the score by computer using a complicated process of random selection of pitch, duration, dynamics, etc. I had never before written music this abstractly, and I was not the least sure I would like the results.

I listened to the tape and was shocked: the music sounded horrible, the four voices which had been composed independently made atrocious

harmonies together, the form was all wrong. I had clearly made an immense mistake, and, worse yet, the mistake was not only in the tape part but also in the music for the singer and the instruments, which had been composed using the same processes of random selection. Then I checked the tape with the score and discovered that my assistant had misunderstood my notation and had assembled everything wrong. I put the piece together right, listened again and was very relieved to hear music I could recognize as mine.

Normally, misunderstanding a score would be a disastrous mistake, but because here the score had been composed using "chance operations", I could not understand why my assistant's additional shuffling should make such a difference in the music. I finally decided that it was the consistency of the formal design that was responsible. All my choices had been the result of the same process of refined random choice, from the basic choices concerning the synthesis to those affecting the ordering of the finished sounds; mixing up the finished elements was not part of the plan.

This experience has influenced my thinking about random procedures and arbitrariness ever since. I am now convinced that the most important aspect of formal structure is the stringency with which operations are carried out. The combination of great strictness with superficial and apparent arbitrariness seems to me to give rise to a degree of complexity which I find commensurate with that in the world around me.

When I was young, like all young people, I experienced so much that was new to me; like all young people I sought to discover the order relating all these impressions and experiences. I wrote music with clean sounds and strong, clear formal contours. Now that I am older, I experience less that is really new to me; at the same time it has become much harder for me to hear order in the general noise of life. Now I write music with complicated sounds and broken, labyrinthine formal contours. Where I once experienced musical form as long, straight lines of power, I now hear it as echoes down corridors whose meanderings I will never fully chart.

At the end of his life, Theodor Wiesengrund Adorno called composing *Dinge machen, von denen wir nicht wissen, was sie sind*—making things which we do not know. I spend my life devising complex systems to ensure that I don't recognize what I am doing.