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Generating and Organizing Variety in the Arts

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In the late 1960s and throughout the 1970s, as his successful career in pop music was getting underway, Brian Eno (1948– ; see also chaps. 17 and 22) was immersed in the British "experimental music" scene. He performed in Cornelius Cardew's Scratch Orchestra and Gavin Bryars's Portsmouth Sinfonia—experimental orchestras that welcomed amateur musicians. In 1975, Eno founded Obscure Records, a label dedicated to the dissemination of experimental music by composers such as Bryars, Christopher Hobbs, David Toop, Max Eastley, John Adams, Michael Nyman, Harold Budd, and others. In its first year, Obscure issued Eno's own experimental work, *Discreet Music*, which explored his interest in self-generating and self-regulating systems. In the following essay, written in 1976, Eno draws on cybernetic theory and evolutionary biology to contrast experimental composition and performance with its classical antecedents.

A musical score is a statement about organization; it is a set of devices for organizing behaviour toward producing sounds. That this observation was not so evident in classical composition indicates that organization was not then an important focus of compositional attention. Instead, the organizational unit (be it the orchestra or the string quartet or the relationship of a man to a piano) remained fairly static for two centuries while compositional attention was directed at using these given units to generate specific results by supplying them with specific instructions.

In order to give more point to the examination of experimental music that follows, I should like to detail some of the aspects and implications of the paradigm of classical organization—the orchestra. A traditional orchestra is a ranked pyramidal hierarchy of the same kind as the armies that existed contemporary to it. The hierarchy of rank is in this pattern: conductor, leader of the orchestra; section principals; section subprincipals; and, finally, rank-and-file members. Occasionally a soloist will join the upper echelons of this system; and it is implied, of course, that

the composer with his intentions and aspirations has absolute, albeit temporary, control over the whole structure and its behaviour. This ranking, as does military ranking, reflects varying degrees of responsibility; conversely, it reflects varying degrees of constraint on behavior. Ranking has another effect: like perspective in painting, it creates "focus" and "point of view." A listener is given the impression that there are a foreground and a background to the music and cannot fail to notice that most of the "high-responsibility" events take place in the foreground, to which the background is an ambience or counterpoint.[1] This is to say that the number of perceptual positions available to the listener is likely to be limited. The third observation I should like to make about the ranking system in the orchestra is this: it predicates the use of trained musicians. A trained musician is, at the minimum, one who will produce a predictable sound given a specific instruction. His training teaches him to be capable of operating precisely like all the other members of his rank. It trains him, in fact, to subdue some of his own natural variety and thus to increase his reliability (predictability).

I shall be using the term *variety* frequently in this essay and I should like to attempt some definition of it now. It is a term taken from cybernetics (the science of organization) and it was originated by W. R. Ashby.[2] The *variety* of a system is the total range of its outputs, its total range of behavior. All organic systems are probabilistic: they exhibit variety, and an organism's flexibility (its adaptability) is a function of the amount of variety that it can generate. Evolutionary adaptation is a result of the interaction of this probabilistic process with the demands of the environment. By producing a *range* of outputs evolution copes with a *range* of possible futures. The environment in this case is a *variety-reducer* because it "selects" certain strains by allowing them to survive and reproduce, and filters out others. But, just as it is evident that an organism will (by its material nature) and must (for its survival) generate variety, it is also true that this variety must not be unlimited. That is to say, we require for successful evolution the transmission of *identity* as well as the transmission of *mutation*. Or conversely, in a transmission of evolutionary information, what is important is not only that you get it right but also that you get it slightly wrong, and that the deviations or mutations that are useful can be encouraged and reinforced.

My contention is that a primary focus of experimental music has been toward its own organization, and toward its own capacity to produce and control variety, and to assimilate "natural variety"—the "interference value" of the environment. Experimental music, unlike classical (or avant-garde) music, does not typically offer instructions toward highly specific results, and hence does not normally specify wholly repeatable configurations of sound. It is this lack of interest in the *precise* nature of the piece that has led to the (I think) misleading description of this kind of music as *indeterminate*. I hope to show that an experimental composition aims to set in motion a system or organism that will generate unique (that is, not necessarily repeatable) outputs, but that, at the same time, seeks to limit the range of these outputs. This is a tendency toward a "class of goals" rather than a particular goal, and it is distinct from the "goalless behaviour" (indeterminacy) idea that gained currency in the 1960s.

I should like to deal at length with a particular piece of experimental music that exemplifies this shift in orientation. The piece is Paragraph 7 of *The Great Learning*[3] by Cornelius Cardew, and I have chosen this not only because it is a compen-

dium of organizational techniques but also because it is available on record[4] [. . .] I should point out that implicit in the score is the idea that it may be performed by *any* group of people (whether or not trained to sing). The version available on record is performed by a mixed group of musicians and art students, and my experience of the piece is based on four performances of it in which I have taken part.

Cardew's score is very simple. It is written for any group of performers (it does not require trained singers). There is a piece of text (from Confucius) which is divided into 24 separate short phrases, each of one to three words in length. Beside each phrase is a number, which specifies the number of repetitions for that line, and then another number telling you how many times that line should be sung loudly. The singing is mostly soft.

All singers use exactly the same set of instructions. They are asked to sing each line of the text the given number of times, each time for the length of a breath, and on one note. The singers start together at a signal, and each singer chooses a note for the first line randomly, staying on it until the completion of the repetitions of the line.

The singer then moves on to the next line, choosing a new note. The choice of this note is the important thing. The score says: "Choose a note that you can hear being sung by a colleague. If there is no note, or only the note you have just been singing, or only notes that you are unable to sing, choose your note for the next line freely. Do not sing the same note on two consecutive lines. Each singer progresses through the text at his own speed."

A cursory examination of the score will probably create the impression that the piece would differ radically from one performance to another, because the score appears to supply very few *precise* (that is, quantifiable) constraints on the nature of each performer's behavior, and because the performers themselves (being of variable ability) are not "reliable" in the sense that a group of trained musicians might be. The fact that this does not happen is of considerable interest, because it suggests that *somehow a set of controls that are not stipulated in the score arise in performance* and that these "automatic" controls are the real determinants of the nature of the piece.

In order to indicate that this proposition is not illusory, I now offer a description of how the piece might develop if *only* the scored instructions affected its outcome. I hope that by doing this I shall be able to isolate a difference between this hypothetical performance and a real performance of the piece and that this difference will offer clues as to the nature of the "automatic" controls.

Hypothetical performance. The piece begins with a rich sustained discord ("choose any note for your first note"). As the point at which singers move onto their next line and next note is governed by individual breath lengths ("sing each line for the length of a breath"), it is probable that they will be changing notes at different times. Their choice of note is affected by three instructions: "do not sing the same note on two consecutive lines," "sing a note that you can hear," and, if for some reason neither of these instructions can be observed, "choose your next note freely." Now, let's propose that there are twenty singers, and that by some chance they have all chosen different first notes. Presumably one of them reaches the end of his first line before any other singer. As he cannot repeat his own previous note, he has an absolute maximum of nineteen notes to choose from for his "next note." He chooses one, and reduces the "stock" of notes available to nineteen. The next singer to change has a choice of eighteen notes. By a continuation of this procedure, one would expect a gradual reduction of different notes in the piece until such time as there were too few notes available for the piece to continue without the arbitrary introduction of new notes in accordance with the third of the three pitch instructions. With a larger number of singers this process of reduction might well last throughout the piece. So, in this hypothetical performance, the overall shape of the piece would consist of a large stock of random notes thinning down to a small, even, occasionally replenished stock of equally random notes (as they are either what is left of the initial stock or the random additions to it).

Real performance. The piece begins with the same rich discord and *rapidly* (that is, before the end of the first line is reached) thins itself down to a complex but not notably dissonant chord. Soon after this, it "settles" at a particular level of variety that is much higher than that in the hypothetical performance and that tends to revolve more or less harmonically around a drone note. This level of variety is fairly closely maintained throughout the rest of the piece. It is rare that performers need to resort to the "choose your next note freely" instruction, and, except in the case of small numbers of singers, this instruction appears to be redundant.[5] This is because new notes are always being introduced into the piece regardless of any intention on the part of individual performers to do so. And this observation points up the presence of a set of "accidents" that are at work to replenish the stock of notes in the piece. The first of these has to do with the "unreliability" of a mixed group of singers. At one extreme it is quite feasible that a tone-deaf singer would hear a note and, following the primary pitch instruction to "sing any note that you can hear," would, "match" it with a new note. Another singer might unconsciously transpose a note into an octave in which it is easier for him to sing, or might sing a note that is harmonically a close relative (a third or a fifth) to it. A purely external physical event will also tend to introduce new notes: the phenomenon of beat frequency. A *beat frequency* is a new note formed when two notes close to each other in pitch are sounded. It is mathematically and not harmonically related to them. These are three of the ways by which new material is introduced.

Apart from the "variety-reducing" clauses in the score ("sing a note that you can hear," "do not sing the same note on two consecutive lines"), some others arise in performance. One of these has to do with the acoustic nature of the room in which the performance is taking place. If it is a large room (and most rooms that can accommodate performances on the scale on which this piece normally occurs are large), then it is likely to have a *resonant frequency.* This is defined as the pitch at which an enclosure resonates, and what it means in practice is this: a note sounded at a given amplitude in a room whose resonant frequency corresponds to the frequency of the note will *sound louder* than any other note at the same amplitude. Given a situation, then, where a number of notes are being sounded at fairly even amplitude, whichever one corresponds to the resonant frequency of the room will sound louder than any of the others. In Paragraph 7 this fact creates a statistical probability that the piece will drift toward being centered on an environmentally determined note. This may be the drone note to which I alluded earlier.

Another important variety reducer is preference ("taste"). Because performers are often in a position to choose between a fairly wide selection of notes, their own cultural histories and predilections will be an important factor in which "strains" of the stock they choose to reinforce (and, by implication, which they

choose to filter out). This has another aspect; it is extremely difficult unless you are tone deaf (or a trained singer) to maintain a note that is very discordant with its surroundings. You generally adjust the note almost involuntarily so that it forms some harmonic relationship to its surroundings. This helps explain why the first dissonant chord rapidly thins out.

In summary, then, the generation, distribution, and control of notes within this piece are governed by the following: one specific instruction ("do not sing the same note on two consecutive lines"), one general instruction ("sing any note that you can hear"), two physiological factors (tone-deafness and transposition), two physical factors (beat frequencies and resonant frequency), and the cultural factor of "preference." Of course, there are other parameters of the piece (particularly amplitude) that are similarly controlled and submit to the same techniques of analysis, and the "breathing" aspects of the piece might well give rise to its most important characteristic—its meditative calm and tranquillity. But what I have mentioned above should be sufficient to indicate that something quite different from classical compositional technique is taking place: the composer, instead of ignoring or subduing the variety generated in performance, has constructed the piece so that this variety is really the substance of the music.

Perhaps the most concise description of this kind of composition, which characterizes much experimental music, is offered in a statement made by the cybernetician Stafford Beer. He writes: "Instead of trying to specify it in full detail, you specify it only somewhat. You then ride on the dynamics of the system in the direction you want to go."[6] In the case of the Cardew piece, the "dynamics of the system" is its interaction with the environmental, physiological, and cultural climate surrounding its performance.

The English composer Michael Parsons provides another view on this kind of composition:

> The idea of one and the same activity being done simultaneously by a number of people, so that everyone does it slightly differently, "unity" becoming "multiplicity," gives one a very economical form of notation—it is only necessary to specify one procedure and the variety comes from the way everyone does it differently. This is an example of making use of "hidden resources" in the sense of natural individual differences (rather than talents or abilities) which is completely neglected in classical concert music, though not in folk music.[7]

This movement toward using natural variety as a compositional device is exemplified in a piece by Michael Nyman called *1-100* (Obscure 6). In this piece, four pianists each play the same sequence of one hundred chords descending slowly down the keyboard. A player is instructed to move on to his next chord only when he can no longer hear his last. As this judgment is dependent on a number of variables (how loud the chord was played, how good the hearing of the player is, what the piano is like, the point at which you decide that the chord is no longer audible), the four players rapidly fall out of sync with one another. What happens after this is that unique and delicate clusters of up to four different chords are formed, or rapid sequences of chords are followed by long silences. This is an elegant use of the compositional technique that Parsons has specified, not least because it, like the Cardew piece, is extremely beautiful to listen to—a factor that seems to carry little critical weight at present.

Composition of this kind tends to create a perceptual shift in a listener as major as (and concomitant with) the compositional shift. It is interesting that on recordings, these two pieces both have "fade" endings (the Cardew piece also has a fade beginning), as this implies not that the piece has finished but that it is *continuing out of earshot.* It is only rock music that has really utilized the compositional value of the fade-out: these pieces use it as a convenience in the sense that both were too long for a side of a record. But a fade-out is quite in keeping with the general quality of the pieces and indicates an important characteristic that they share with other experimental music: that the music is a section from a hypothetical continuum and that it is not especially directional: it does not exhibit strong "progress" from one point (position, theme, statement, argument) to a resolution. To test the validity of this assumption, imagine a fade-out ending halfway through Beethoven's Ninth Symphony. Much of the energy of classical music arises from its movement from one musical idea to another—the theme and variation idea—and this movement is directional in the sense that the history and probable futures of the piece have a bearing on the perception of what one is hearing at the present.

Experimental music, however, has become concerned with the simultaneous permutation of a limited number of elements at a moment in time as well as the relations between a number of points in time. I think also that it has tended to reduce the time-spans over which compositional ideas are developed; and this has led to the use of cyclic forms such as that in Gavin Bryars' *Jesus' Blood Never Failed Me Yet.* (It is interesting that this piece, Paragraph 7, and *1-100* are all based on "found material"; and in each case the focus of the composer's attention is toward *reorganizing* given material. There is a special compositional liberty in this situation.)

I do not wish to subscribe to the view that the history of art is a series of dramatic revolutions where one idea overthrows another. I have made some distinctions between classical and experimental compositional techniques, and between the perceptual modes that each encourages in a listener, but I do not wish to propose that the development from one to the other is a simple upward progression. I have ascribed characteristics to these two musics as though they were mutually exclusive, when virtually any example will show that aspects of *each* orientation exist in any piece. What I am arguing for is a view of musical development as a process of generating new hybrids. To give an example: one might propose a "scale of orientations" where, on the right hand, one placed the label "Tending to subdue variety in performance" and, on the left, "Tending to encourage variety in performance." It would be very difficult to find pieces that occupied the extreme polarities of this scale, and yet it is not difficult to locate distinct pieces at points along the scale. A classical sonata, if only by virtue of the shortcomings of musical notation, allows some variety in performance.[8] On the other (left) hand, the most random of *random music* (whatever that term meant) is constrained in its range by all sorts of factors down to the straightforward laws of physics. So we might place the Cardew piece toward the left, but not as far left as, say, a free-jazz improvisation. A scale of this kind does not tell us much about the music that we place on it, but its function is to remind us to think in terms of hybrids rather than discontinuities.

Given the above reservation about polarizing musical ideas into opposing camps, I should now like to describe two organizational structures. My point is not that classical music is one and contemporary music the other, but that each is a group of hybrids tending toward one of the two structures. At one extreme, then, is this type of organization: a rigidly ranked, skill-oriented structure moving sequentially through an environment assumed to be passive (static) toward a resolution already defined and specified. This type of organization regards the environment (and its variety) as a set of emergencies and seeks to neutralize or disregard this variety. An observer is encouraged (both by his knowledge of the ranking system and by the differing degrees of freedom accorded to the various parts of the organization) to direct his attention at the upper echelons of the ranks. He is given an impression of a hierarchy of value. The organization has the feel of a well-functioning machine: it operates accurately and predictably for one class of tasks but it is not adaptive. It is not self-stabilizing and does not easily assimilate change or novel environmental conditions. Furthermore, it requires a particular type of instruction in order to operate. In cybernetics this kind of instruction is known as an *algorithm.* Stafford Beer's definition of the term is "a comprehensive set of instructions for reaching a known goal"; so the prescription "turn left at the lights and walk twenty yards" is an algorithm, as is the prescription "play a C-sharp for a quaver followed by an E for a semiquaver."[9] It must be evident that such specific strategies can be devised only when a precise concept of form (or identity, or goal, or direction) already exists, and when it is taken for granted that this concept is static and singular.

Proposing an organizational structure opposite to the one described above is valueless because we would probably not accord it the name *organization:* whatever the term does connote, it must include some idea of constraint and some idea of identity. So what I shall now describe is the type of organization that typifies certain organic systems and whose most important characteristics hinge on this fact: that changing environments require adaptive organisms. Now, the relationship between an organism and its environment is a sophisticated and complex one, and this is not the place to deal with it. Suffice it to say, however, that an adaptive organism is one that contains built-in mechanisms for monitoring (and adjusting) its own behaviour in relation to the alterations in its surroundings. This type of organism must be capable of operating from a different type of instruction, as the real coordinates of the surroundings are either too complex to specify, or are changing so unpredictably that no particular strategy (or specific plan for a particular future) is useful. The kind of instruction that is necessary here is known as an *heuristic,* and is defined as "a set of instructions for searching out an unknown goal by exploration, which continuously or repeatedly evaluates progress according to some known criterion."[10] To use Beer's example: if you wish to tell someone how to reach the top of a mountain that is shrouded in mist, the heuristic "keep going up" will get him there. An organism operating in this way must have something more than a centralized control structure. It must have a responsive network of subsystems capable of autonomous behaviour, and it must regard the irregularities of the environment as a set of opportunities around which it will shape and adjust its own identity.

What I have tried to suggest in this essay is a technique for discussing contemporary music in terms of its functioning. I have concentrated primarily on one piece of music because I wanted to show this technique at work on one specific problem and because I feel that the technique can thereafter quite easily be generalized to deal with other activities. I do not wish to limit the scope of this approach to music, although because music is a social art that therefore generates some explicit organizational information, it lends itself readily to such analysis. I have in the past discussed not only the fine arts but also, for example, the evolution of contemporary sporting practices and the transition from traditional to modern military tactics by asking the same kinds of questions directed at the organizational level of the activities. It does not surprise me that, at the systems level, these apparently disparate evolutions are very accurate analogues for each other.

In his book *Man's Rage for Chaos* Morse Peckham writes: "Art is the exposure to the tensions and problems of the false world such that man may endure exposing himself to the tensions and problems of the real world."[11] As the variety of the environment magnifies in both time and space and as the structures that were thought to describe the operation of the world become progressively more unworkable, other concepts of organization must become current. These concepts will base themselves on the assumption of change rather than stasis and on the assumption of probability rather than certainty. I believe that contemporary art is giving us the feel for this outlook.

NOTES

1. This ranking is most highly developed in classical Indian music, where the tamboura plays a drone role for the sitar. I think it no coincidence that Indian society reflected the same sharp definition of roles in its caste system.
2. W. Ross Ashby, *An Introduction to Cybernetics* (1956; reprint ed., London: University Paperbacks, 1964).
3. Each paragraph corresponds to one in the Confucian classic of the same title.
4. [Currently available on CD as Cornelius Cardew and the Scratch Orchestra, *The Great Learning,* Organ of Corti 21—Eds.]
5. A number of the score instructions seem redundant; all of those concerning the leader, for example, make almost no difference to the music.
6. Stafford Beer, *Brain of the Firm: The Managerial Cybernetics of Organization* (London: Allen Lane, 1972), 69.
7. Michael Parsons, quoted in Michael Nyman, *Experimental Music: Cage and Beyond* (see chap. 32, above).
8. It is interesting to observe that the sound of a string orchestra results from minute variations of tuning, vibrato, and timbre. This is why electronic simulations of strings have not been notably successful.
9. Beer, *Brain of the Firm,* 305.
10. Beer, *Brain of the Firm,* 306.
11. Morse Peckham, *Man's Rage for Chaos* (New York: Schocken Books, 1967), 314.