in the process. Process and product are two components of one system – the creative process.

13. Artists can explore and record the processes of evolving, moving systems as well as of static ones.

14. Generative Systems does not have to be only the closed system of its historical past. It can be an open/closed system or a mind/body system. [...]

The Generative Systems program at the Institute was not a closed system or a variation on a theme. It was an open system, an ever-changing system, in which the machines would come and go, but the humans would remain the constant factor. Courses would not be named for a specific and therefore static technological process [...] but rather for a dynamic process encompassing change, metamorphosis, inconsistency and chaos. In the process, the mind/body of the human being could create closed systems and open systems, neither one negating the other, but, rather, each complementing the other in a process of continual becoming. [...]

The Generative Systems program was just one way, in one place and at one time, to tackle common problems of creativity in art, science and technology. Perhaps Generative Systems' ten-year existence in an institution was validated by its graduates, who invented new systems for society, set up new learning centres, created new artforms and influenced yet another generation of artists. [...]

Sonia Landy Sheridan, extracts from 'Mind/Senses/Hand: The Generative Systems Program at the Art Institute of Chicago, 1970–1980', *Leonardo*, vol. 23, no. 2–3 (1990) 175–81 [footnotes not included].

Brian Eno
Generating and Organizing Variety in the Arts//1976

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. [...]

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.[1] The *variety* of a system is the total range of its outputs, its total range of behaviour. 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* by Cornelius Cardew,[2] and I have chosen this not only because it is a compendium of organizational techniques but also because it is available on record. [...] 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 behaviour, 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 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.'[3] 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.[4]

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 judgement 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. [...]

Given [my] 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.' 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.'[6] 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. [...]

1 [footnote 2 in source] W. Ross Ashby, *An Introduction to Cybernetics* (1956) reprinted edition (London: University Paperbacks, 1964).

2 [3] Each paragraph corresponds to one in the Confucian classic of the same title.

3 [6] Stafford Beer, *Brain of the Firm: The Managerial Cybernetics of Organization* (London: Allen Lane, 1972) 69.

4 [7] Michael Parsons, quoted in Michael Nyman, *Experimental Music* (New York: Schirmer, 1974).

5 [9] Stafford Beer, *Brain of the Firm*, op. cit., 305.

6 [10] Ibid., 306.

Brian Eno, extracts from 'Generating and Organizing Variety in the Arts', *Studio International*, no. 193 (November/December 1976); reprinted in *Audio Culture: Readings in Modern Music*, ed. Christoph Cox and Daniel Warner (London: Bloomsbury Academic, 2004) 226–33.

Michael Joaquin Grey
Statement//c. 2004

With the development of super computers by the late 1980s it was possible to model a system close to the order of complexity of natural systems, a new territory for the art of observation. I started to record the ontogeny (development) of information: experience, observation, description, explanation and exploitation of form in this new iterative space. Just as Leeuwenhoek looked at cells (biological) for the first time, or Kepler looked at the macrocosmos, I saw the rare opportunity to experience first hand the hubris and problems of the early development of discovery. I worked with Randy Huff to develop proprietary software to visualize some of the first neural networks and genetic algorithms capable of autonomous learning and behaviour. I was interested in recapitulating the dreams of causality that were part of exploring any new frontier.

I found the language to describe and explain the behaviour of information and Artificial Life programs very challenging linguistically. I eventually developed the Citroid System and ZOOB modelling system to have a manipulative [design set] to share and express the unity of complexity and dynamics of information, micro, macro and biological behaviour. I found the linguistic syntax limited to modelling spatial syntax and complexity. Prior to the Citroid System and ZOOB, there were only two variations of manipulative modelling: stereotonic modelling, or stacking, based on the development of the city, the brick, and tectonic, based on engineering from the industrial revolution to Buckminster Fuller. My modelling system is dynamic, based on how the body works, micro, macro and information behaviour. This was the basis for the Citroid System and ZOOB, with body empathy and self-similarity, from molecular behaviour (DNA and protein formation) to the scale of the joints and anatomy of the human body (animation), to celestial formations (network and macro models).

Michael Joaquin Grey, Information statement (c. 2004) (http://www.citroid.com)

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