

newly conceived orders. Though art is not required to predict the future behavior of the universe, artists may exhibit intense interest in considering it, and, in common with scientists, be inspired to make creative products that reveal new orders.

A useful task for art may be to provide exercises in comprehending the undefined.

The Nature of Forms

Form and *cause* are inextricably bound in the Western mind. It may be useful to consider the origins of our notions in this regard and our predilection to conceive form as stable substance.

Aristotle's idea of formal cause, perhaps as brought to us through the Medieval Scholastics or, at least, as interpreted in its most banal form, lies at the root, even today, of misapprehensions regarding form in art. This predominantly held idea is infused with a sense of the static. This stasis feeds resonating detectors for mental categories that support particular cognitive models needing reinforcement. One distinguishes sculpture from lumps of pre-formed raw material with the aid of these models.

However, the order seekers evolving inside individual minds may extract ordered perceptions from the unformed lumps, calling into question their unformedness in a profound way. What we refer to as formed, by contrast, is usually imbued with the intelligence of the forming agent, which we somehow distinguish from the natural order of the unformed lumps.

A view of forms as *dynamic morphologies*, however, calls into question the distinction of these separate intelligences. Form emerges. Form evolves. Forms emanate from points of singular genesis, defining the space surrounding *them*, along with sets of dimensions and axes for describing their dynamic processes of change.

In recent times, some Western minds have begun to assimilate the impermanence of all forms and its ramifications for art making. The evolution of many constructs in Western philosophy has been coerced by the psychological demand for permanence in all structures – the heavens, the molecule, the atom, the fundamental forces and cosmological constants – when all life experience reinforces the presumption of continuous processes, interactions and morphodynamic change. Even the idea of numbers – the most purely permanent construct we have and the foundation of mathematics – is a cognitive pretext born of the continuous interaction of forces in the mind driving the obligation to differentiate, to identify one and then two. Following this, they must bear the burden of erecting a calculus of inductive inference with which to integrate the results.

On global scales, all distinctions result from interaction, not from the hierarchical imposition of ruling agents handing down ordering forces onto lesser agents. Those who act as ordering agents as all life forces do, and who view themselves as rulers operate under an illusion. They are interacting, ordering agents in consort with all regionally effective forces. It may be that all hierarchical (i.e. global) descriptions are synthetic extractions. It may be viable to view only atomic level events and elements as foundational and all else as emergent, summary phenomena.

In the present age, which now includes the global phenomenon of cyberspace, defined as the realm of collective, electronic memory, interactivity through electronic communication networks naturally emerges as a consequence of self-organization. The only requirement forth is a technological society comprised of a critical mass of individuals. It has been hypothesized that in a universe with the proper values for certain of its fundamental physical characteristics, known as cosmological constants, intelligent information processing will naturally evolve. If this is true, then such electronic interactivity is a clearly foreseeable phenomenon of nature.

Compositional Methods: Premises for Making Propositional Music

A composer's license includes the opportunity to construct entire universes. It may be useful to consider some fundamental steps in constructing a compositional method.

- *Choose your universe.* What is the universal set for a world? The universal set will describe a domain of compositional attention and the kinds of distinctions that will be made as a result of compositional thought and choice. Thus, the items that will receive attention in composing are delineated. What are the elements of formal concern? This may include naming the parameters that will carry information that articulates forms. Note that *these* are generative parameters, not necessarily analytical ones. How will composer(s), performer(s) and listener(s) act as ordering agents in the musical experience! Note that musical attention may be directed towards things outside the realm of formal processes, particularly in listening. Compositional attention may also be directed towards things not traditionally considered to be musical.
- *How will the universe be ordered!* (Not, "how is it ordered!") List the potential generative relationships among distinctions in the universal set. For example, in the expression, aRnb, a and b are related to each other by relation, Rn. Can these R's be listed? One useful composing tool is known as the relationship matrix. This is an array that shows whether the elements of a set are considered to be related to each other or not and, if so, how. Note again that these are generative relationships determined in the process of composing and are not necessarily given a priori.

David Rosenboom (U.S.A.)

OAV10@MUSK.CA1ARJHOU

ITTI1/MUSIC.CA1ARTS.EOU10AV10

Propositional Music: On Emergent Properties in Morphogenesis and the Evolution of Music; Imponderable Forms, Self-Organization, and Compositional Methods

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Propositional Music

I am interested in musical thinking that includes the view of composition as the proposition of musical realities – complete cognitive models of music – using propositional musical language accompanied by a propositional language of music theory. This may also be related to what is called speculative music and speculative theory.

The term *propositional music* refers to a particular style of musical thinking in which the act of composing includes proposing complete musical realities, assuming no extant model of music and emphasizing the dynamic emergence of forms through evolution and transformation.

How can we make compositional models in our new environment of knowledge about self-organization and emergent forms? We must begin with an understanding about how perceptual distinctions are made, how forms emerge and how we categorize the distinctions that we can hear among kinds of complexity in adaptive systems when the nature of the musical language we are experiencing is not known a priori.

Comprehending Initially Unrtdined or Imponderable Forms

The universe is a self-organizing system in which transformation, evolution and change enable *entelechy* (actuality). Time is an axis of experience over which features and forms are articulated on other axes. Music is fundamentally involved with sculpting experiences in time. Outside of time, existence is undefined. To participate in the evolving universe, a state of mind must be maintained in which the *intelligent order* contained in observations must be sought without prior knowledge regarding the nature of that intelligence.

Order may be defined as giving attention to similar differences and to different similarities. The beauty of this definition lies in the assumption that order is an active form of manifesting distinctions, not a rigid objectification. In essence, all forms of distinction produce calls, making reference to particular differences around which unique singularities in space-time are created. These are particular distinctions with which we associate properties that result from our observing them interact with other such distinctions. In psychological time, such calls are always temporary. Emanating from each singularity, within the dimensionality of each call, is a zone of influence (a region within which a singularity is able to interact with other singularities), which is characterized, in part, by a notion of strength, associated with interacting forces, that decreases over distance from the singularity until the zone of influence becomes undefined.

We have here a kind of *verbi-cation* of the nouns of our language, which, in the arts, evinces a new kind of dematerialization with which we must become comfortable emotionally. Such dematerialization may ensue from a natural tendency to unbind what was materially and unnaturally fixed in the first place, returning it to a natural state of dynamism and freedom to evolve.

The development of cyberspace, defined as the broad realm of electronic memory, will accelerate this verbi-cation. Such an interactive space encourages focus on the discourse of imaginal dialogues. Objects valued in such networked exchanges will be preserved by circulating in resonant network wells, just as perceptions and synthesized memory idioms persist in any evolving nervous system.

Though science shoulders the burden of hypothesis, experimental verification and fabricating models with predictive value, science and art share a poetic aspect that of creative communication about

- *What are the scales of measure for parametric values to be used!* How will parametric values be compared? For example, different types of measurement scales may be used, i.e. nominal [items are related only by labeling or classification with numbers], ordinal (numerical values indicate rank or order), interval (distances between numbers are equal but with no reference to zero) and ratio (each value measures a distance from zero) scales. Scales for relating pitches, timbres, sounds in spaces, the physical size of instruments, the spectrum of brainwaves and the geographical separation of performers linked in a communications network could all be examples. Multi-dimensional scaling – the construction of a mapping in which the closeness of items located in a contrived space of two or more dimensions is considered analogous to their similarity – may be used. The axes of such a space correspond to the parameters describing formal characteristics of items contained in the space. The language and means for making comparisons must be decided – e.g., how it will be determined that a is more like b than a is like c, and so on.
- *What are the levels of significant difference for each parameter?* Establish the criteria by which things are to be considered the same or different
- *Design the compositional pragmatics needed to make arrangements among the distinctions in the universal set.* Establish the procedures through which unique musical works will be produced

Improvisation

In one sense, *improvisation* is simply composition that is heard immediately rather than subsequently. The act of composing for improvisation may involve constructing a cognitive model of music, creating a good representation of the model to serve as a score and communicating that to musicians. The musicians, then, work from a model instead of a detailed score that is laid out in linear time.

A Self-Organizing Interactive Chamber Opera

On Being Invisible II (Hypatia Speaks to Jefferson in a Dream)

Introduction

Ideas about evolution appear as regular, thematic referents throughout much of my music. *On Being Invisible*, begun in 1976 and recently revived as *On Being Invisible II*, is a self-organizing, dynamical system, rather than a fixed musical composition. The title refers to the role of an individual within an evolving, dynamical environment, who makes decisions concerning when and how to be a conscious *initiator* of action and when simply to allow her or his internal dynamics to co-evolve with the system as a whole. Consequently, *the* work is always ongoing.

One of the objectives of *the* piece is to create an *attention-dependent, sonic environment*, in which a sound language orders *itself* spontaneously, according to the manner in which its components are perceived. To accomplish this, streams of sound events are generated by computers with predetermined compositional methods. Using a partial model of musical perception, the software analyzes them and attempts to predict which ones might be perceived by active listeners as having particular importance in the emerging musical structure. Usually, these correspond to things like *the* ends or beginnings of phrases or changes in textures or patterns. Then, signals from the brains of on-stage performers, known as *event-related potentials (ERPs)*, are tested to determine if these predictions can be confirmed and the events are, in fact, being heard as musical landmarks. If so, these kinds of sound events will gain prominence in the musical fabric. If not, the music-generating algorithms will begin to mutate into new forms. In this way, self-organizing, musical structures can emerge that are related to shifts of attention experienced by the performers. This is composition by listening. The evolving musical fabric exhibits characteristics of what we know today as *complex adaptive systems*, often used to model the evolution of life forms.

To accomplish this, techniques involving signal averaging, peak component analysis, predictive procedures and template matching have been developed for tracking some of the neural concomitants of the dynamics of musical attention and perception, particularly those involving auditory evoked responses (AEPs) – transient waveforms accompanying coordinated activity among groups of neurons involved in hierarchical processing of auditory stimuli – and using them to guide the evolution of spontaneously emerging musical forms.

The various parts of this feedback system remind me of characters in a mythological drama, the spontaneous forces of creativity, *the* drive to converge upon ordered relationships in society, the counterbalancing tension of divergence from order as our consciousness loses its focus on orderings from the past and the fundamental uncertainties regarding nature's only partially knowable forces. Consequently, I began to think about it in narrative terms.

On Being Invisible II (Hypatia Speaks to Jefferson in a Dream) is an aesthetic proposition on these themes, maybe a *self-organizing opera*. The setting is a dream in which Thomas Jefferson hears the voice of the Greek, woman, astronomer, mathematician, and philosopher, Hypatia, traversing the centuries and continents and mingling with his own internal voices as he writes one of his later-to-be-famous, political statements. The opposing, ideological forces emerging from this scenario remind me of the delicacy with which the *On Being Invisible* performer must negotiate the thin dividing line that separates being part of something larger than one's self and trying to willfully direct a naturally

evolving process. The *invisibility* notion is represented by the dream state in which these conflicts energize Jefferson's thoughts, while entreaties to wisdom are transmitted through warps in space-time by the reincarnated mind of Hypatia.

Important References

Some of the work briefly introduced in this paper is explored much more thoroughly in the following publications by the author. The reader is encouraged to explore *them* as well.

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David Rosenboom Web Site—More writings and other information related to these topics is available on-line at the following URL:
<http://musicalarts.edu/~david>