The Computer Music World View: Sketch of an Ethnomusicalological and Aesthetic Approach
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Abstract
This paper explores approaches to characterizing a 'generalized' computer music world view with specific regard to the philosophical basis of the discipline and its relationship both to scientific views of the world and to the history of Western concert music. A brief discussion of the products of the genre follows.

1 Introduction
Recent work in the field of musicology, such as that of Judith and Alton Becker (1981) and Laurence Berman (1993), have come to view music and musical behavior as activities and cultural forms that are involved in creating and maintaining belief systems. This type of inquiry asks questions not only about the nature of specific musical practice, but also about the ways in which that practice is expressive of the culture in which it was created, providing an explication of a world view (with its associated symbols and social order) that supports, and is in turn supported by musical activity. Steve Reich (1974) once observed that "... all music is ethnic music," and the realization that we are, all of us, natives of one kind or another has led to the possibility of an aesthetic self-examination of the culture of computer music through the lens of ethnomusicology. This paper, then, will highlight several key issues as the first step in a continuing exploration of the computer music world view.

2 Philosophical Basis
The fundamental component of computer music, is, of course, the computer; any examination of the culture of computer music will have to take account of the significant impact of computer technology on contemporary life, and the many subtle transformations of consciousness which our continuing involvement with computers has effected. While this potentially limitless topic is too broad to cover in any detail, one of the most basic implications of computer methodology is in its orientation toward data, or the use of binary code to represent complex phenomena: computers are, first and foremost, digital. This is, of course, no revelation, but the realization that our art and an increasingly large portion of human experience) is based on mathematical representation of physical phenomena has far-reaching implications for an understanding of our changing conceptions of musical activity.

2.1 Word Versus Number
The shift from a linguistically-based to a mathematically-based metaphor for understanding musical activity is beautifully illustrated in F. Richard Moore's well-known book Elements of Computer Music (1990), in which he posits a division between two kinds of knowledge and science, the -ology model, which is limited to forms of knowledge that can be expressed in words, and the -onomy model, which is an inclusive sum of the entire field of knowledge in a given area. He suggests a musical equivalent to the astrophysics/astronomy/parallel-uniology model, which is an association of musicology with astrology indirectly belittles musicological disciplines by association with the 'charlatan's art' of astrology, and stands for a de-valuing of strictly verbal representations of music and the world. Computer music, in Moore's view, becomes a branch of Musiconomy, an inclusive, broad science not limited by or to the exclusive use of language—ways of knowing are expanded into mathematical representation.

Moore's insightful characterization puts at a cornerstone of the view of the world which characterizes the endeavor of computer music: posing a unity of music and science through mathematics, and thereby effecting a major break with views of musical activity as primarily analogous to language, as functioning systems of communication, or syntax. In addition, in the Musiconomy model, meaningful activity includes, but is not limited to the creation of art, or communication—it is a discipline primarily of research, a scientific discipline that takes its place alongside the 'hard' sciences of biology, physics, and mathematics. At issue is not so much the communication of meaning, but rather the development of such meaningful communication—processions, and transfer of significant data.

The primary emphasis on mathematics implied by Moore extends to a preference of the use of equations over words for the purposes of exposition or demonstration, implying the belief that mathematical representations are more exact than words. Math as a system of representation between humans also gains in status and postminence since it is the only means of communicating with the machines we use. In addition, the data orientation of the 'hard sciences' listed above correlates to an experiential emphasis on denotizable and measurable phenomena—that is, a positivism focused primarily
on that which can be measured and executed using systematic processes.

2.2 Pythagorean Thought

Pythagorean thought is often cited as the basis for the kind of musical discipline envisioned by Moore, after all, it was Pythagoras who said "All things are numbers" [Russell, 1943]. "Pythagorean theory of pitch ratios are certainly fundamental to our understanding of acoustics today, and Pythagoras himself remains a powerful symbol, often invoked as a "father of modern science" figure in spite of the fact that he was the leader of a religious cult full of superstitious injunctions against such innocuous practices as eating beans and sitting on a quartz measure [Russell, 1945]. That the profound religious overtones of his philosophy have been filtered out so thoroughly speaks to our deep need to support a view of our "scientific method" (with its focus on purely dispassionate rational observation of demonstrable phenomena) as both ancient and venerable, the inevitable outcome of an evolutionary history.

Pythagorean thought, however, differs from contemporary approaches to mathematical representationism in that it is directed primarily toward the achievement of manifestations of static, timeless, relationships that are the objects of mystical reverence and contemplation with essentially religious ends [Russell, 1945]. Our contemporary approach, exemplified, for example, in physical modeling synthesis, is much more process-oriented and detail-oriented; we strive on one hand to capture in greater and greater detail the measurable imperfection of the physical world, and on the other (in the example of interactive computer music environments) to define temporal qualities of action or behavior encoded into a field of possibility. While Pythagorean number abstractions strive to describe mystical, unvarying, and timeless universal proportion, contemporary work with computers is often focused on representing in external the observable physical properties of objects, and on describing how to do something in a set of instructions to account for action over time.

3 Digital Representation

Reliance upon digital representation necessarily runs throughout the entire discipline of computer science, from the lowest level to the highest, from instruction sets through higher-level programming, and all digital audio applications—all of these processes are founded on a belief in the equivalence of objects and actions and their representation in numbers. This is the cornerstone of the entire discipline, and represents a re-conceptualization of human activity in terms of finite and measurable gradation—in terms of a grid.

We demonstrate our faith in digital mapping of our actions every day as we use a mouse to "point."

to "click on" objects, and "open" folders. Anyone who has ever played a video game, or synthesizer keyboard has re-mapped their physical responses onto a system which is virtual, which represents by analogy but does not reproduce the physical world. In time, the behavioral adaptations we make to these virtual spaces become second nature, and the complex chain of technological connections between our actions and their virtual results becomes transparent to us. We begin to assume a direct correlation of physical motion with the resulting technological response.

3.1 Objectification of Process

A similar adaptation influences our concept of sound; we have all probably either witnessed or participated in discussions over what degree sampled (or otherwise digitally represented) instruments were literally equivalent with the physical object which produced them by virtue of capturing their salient features. Regardless of where one's opinions on this question fall, we probably all catch ourselves referring to "the violin" when there are only violin samples to be heard—using language that denotes the physical manifestation of an instrument to refer to digital representations of its sound. This kind of language use blurs the distinctions between sounds as temporal processes and their recorded reproductions: when the appropriate sonic qualities are present without the physical body which produced it, sound is objectified. This important shift in perception is related to, and in part an effect of, what R. Murray Schafer called "schizophrenia," the technological separation of sounds from their physical generating sources [Schafer, 1977]. Further developments in telecommunications and worldwide computer networking will no doubt continue and heighten these perceptual trends.

3.2 Concepts of Time

The ability to conceive of sound as object is the result of radically systematized and objectified digital representation of temporal processes. Our trivially increased ability to capture, represent and manipulate the most ephemeral of phenomena has resulted in significant changes in our conception of time. Daniel Boorstin [1983] has traced the transformation of human "time-technologies" and the changes that they brought about in human thought from early history to the twentieth century—a similar inquiry into more recent shifts in our experience of time would be valuable, and might focus primarily on the area of digital audio, which makes available immediate waveform and Fourier representations of sound, enables us to zoom in and out of different representational levels of time, and to "compress" and "expand" time. Waveform representations also strongly reinforce linear metaphors of time, reading as they do, from left to right. Composing against a grid with over forty-thousand divisions of a second, while it allows extreme accuracy, requires an major
accommodation: the physical sensations of time
must be adjusted to the measured, incremental, and
absolutely spatialized representation of it encoun-
tered in digital editing.

3.4 Body and Machine

The conceptual and organizational levels of com-
mputer music tend to objectify and re-temporalize not
only sound and its qualities, but also our understand-
ing of processes of human perception. Such con-
cepts as "machine listening and composing" [Rowe,1993] see the common currency of our efforts
to make music with computers.

Our practical understanding and use of words
such as "listening" evokes a response to the
structural attributes of our tools; the world and its
processes, including human thought, are viewed in
terms that suit the operating methods of exist-
ing computer technology. This results in a rigor-
ously systematic and hierarchical view in which
human behavior and physiology are seen as iconic
for that of computer systems and vice-versa.

Physical action (such as musical performance) is
seen as "lower order" information, controlled by
"higher order" concepts, such as "musicality" [Rowe,1993]. One effect of the hierarchical represen-
tation of "input" and "control" is to uphold a
Cartesian view of the separation of mind and body,
precluding the possibility of "higher order" processes
taking place at the physical level—this is—precludes the idea that we can know with our bodies
as well as we do, as with our minds, furthering a
mechanistic division between knowing and doing.

Indeed one of the most exciting features of interac-
tive music systems is the potential to overcome the
rigid mind/body dichotomy by re-valorizing physical
knowledge in the form of live performer-generated
inflection.

4 Music-Historical View

The aesthetic development of computer music as
a compositional genre was closely linked with that
of post-WWII era avant-garde concert music in
two significant ways. Heavy emphasis on a hierarchic
mode of expression that placed a premium on
complexity and discontinuity of the musical surface
was associated with the breakdown of musical systems
from the nineteenth century based in large
part on analogy with physical movement (the
"evolved" dance forms of the symphony and sonata
with their emphasis on "harmonic motion"). The
desire to avoid the tainted idioms of a Nationalist
past led as well to the avoidance of the traditional
phase/melody orientation so closely allied to human
vocal production—a new emphasis on speed, discon-
tinuity, and density was made possible by the advent
of electronic music, which also expanded the tradi-
tionally limited timbral resources.

The aesthetic ideals embodied in the creation of
music that pushed beyond the limits of immediate
human perceptual integration described by Boulez [Boulez,1993] seem to fit an intuit-
ive fit with the new capabilities that technology
provided in the form of electronic musical instruments, which extended musical gesture
and the super-human and non-human realm even as
eye facilitated the separation of musical composi-
tion from models based on human performance.

A second substantive parallel between computer
music and that of the post-WWII avant-garde lies in
the intense preoccupation with extremely detailed and
extremely pre-compositional methods that was char-
acteristic of total serialism, and resulted (particularly
in the work of Stockhausen) in a high degree of
surface complexity without revealing in sound the
formal scheme by which it was produced [Boulez,1993]. This creation of a "higher order"
organization method that generates but is not
audible present in the sonic unfolding provides a
direct parallel with the mathematical methods
of algorithmic computer composition in which a
"silent" controlling program generates and/or
organizes the sound data of a piece.

4.1 Heuristic Approach

When operating within the discipline of com-
mputer music, there is often a tendency to concentrate
on the aspects of the endeavor that have to do with
applied science or practical engineering: this focus
reacts back to the beginnings of the discipline with
the advent of the first electronic music studios.
The extremely rapid development of the genre led to
a constant search for technical innovation, as new
techniques of sound production and new working
methods, as well as new equipment required con-
tinual integration. The resulting heuristic approach
to creation is common to computer music today, and
constitutes another parallel with the discipline of
mathematics: composers often find inspiration for
a given work in a psychological problem, and even
innovate structural schemes that were "problems" that are solved in the working process of
composition.

4.2 The Individual Work

A heuristic orientation leads to a strong tendency
to view the creative process as a process rather than
an object, a trend that is reinforced by the unpredictable
elements introduced into many works by widespread
interest in compositional applications of chaos
theory, controlled randomness, improvisation and
live interactive music. Whereas in western concert
music compositions are traditionally viewed as
closed, spatialized, finite objects, the products of
computer music often seem to be more aptly
described as systems. That the creative output of
computer music as a genre should so actively defy
objectification is perhaps ironic in light of the
extreme objectification of physical processes which has been identified with working methods that define the discipline; a probable explanation for this phenomenon is the pervasive emphasis on systematic thought imposed by the work of custom computer programming upon which many compositions are based.

Regardless of individual or collective motivation for the creation of system-oriented works, it is my view that computer music defines a more dynamic and reciprocal relationship between the "art product" and the means/act of creation than has been characteristic of Western art music in the past. The importance and function of the individual work is also revolutionized in the increased importance that is lent to the unique system from which each composition results—each piece comes to function as a validation of the research (in the form of a new process or system) underlying the composition, upon which it is dependent. Further, the relationship between underlying generative process (some form of computer program) and the final product is not fixed; different works explore radically different means of negotiating the relationship between computational hierarchy and its effect on or involvement with the final sound result, making it possible for each new work to attempt a redefinition of the nature of computer-musical composition on its own aesthetic and technological terms.

References