Too Many Notes: Computers, Complexity and Culture in Voyager

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ABSTRACT

The author discusses his computer music composition, *Voyager*, which employs a computer-driven, interactive "virtual improvising orchestra" that analyzes an improvisor's performance in real time, generating both complex responses to the musician's playing and independent behavior arising from the program's own internal processes. The author contends that notions about the nature and function of music are embedded in the structure of software-based music systems and that interactions with these systems tend to reveal characteristics of the community of thought and culture that produced them. Thus, *Voyager* is considered as a kind of computer music-making embodying African-American aesthetics and musical practices.

Voyager [1,2] is a nonhierarchical, interactive musical environment that privileges improvisation. In *Voyager,* improvisors engage in dialogue with a computer-driven, interactive "virtual improvising orchestra." A computer program analyzes aspects of a human improvisor's performance in real time, using that analysis to guide an automatic composition (or, if you will, improvisation) program that generates both complex responses to the musician's playing and independent behavior that arises from its own internal processes.

This work, which is one of my most widely performed compositions, deals with the nature of music and, in particular, the processes by which improvising musicians produce it. These questions can encompass not only technological or music-theoretical interests but philosophical, political, cultural and social concerns as well. This is consistent with the instrumental dimension or tendency in African musical organization, or what Robert Farris Thompson [3] identifies as "songs and dances of social allusion," one of several "ancient African organizing principles of song and dance that crossed the seas from the Old World to the New."

Voyager's unusual amalgamation of improvisation, indeterminacy, empathy and the logical, utterly systematic structure of the computer program is described throughout this article not only as an environment, but as a "program," a "system" and a "composition," in the musical sense of that term. In fact, the work can take on aspects of all of these terms simultaneously—considering the conceptual level, the process of creating the software and the real-time, real-world encounter with the work as performer or listener. Flowing across these seemingly rigid conceptual boundaries encourages both improvisors and listeners to recognize the inherent instability of such taxonomies.

Musical computer programs, like any texts, are not "objective" or "universal," but instead represent the particular ideas of their creators. As notions about the nature and function of music become embedded into the structure of software-based musical systems and compositions, interactions with these systems tend to reveal characteristics of the community of thought and culture that produced them. Thus, it would be useful here to examine the implications of the experience of programming and performing with *Voyager* as a kind of computer music-making embodying African-American cultural practice.

Among the fair number of studies by artists/theorists who have written cogently on issues of race, gender and class in new technological media (such as Loretta Todd [4] and Cameron Bailey [5]), the ethnographic study of Institut Recherche et Coordination Acoustique/Musique (IRCAM) by the anthropologist and improvisor Georgina Born [6] appears to stand practically alone in the trenchancy and thoroughness of its analysis of these issues with respect to computer music. This viewpoint contrasts markedly with Catherine M. Cameron's [7] rather celebratory ethnography-at-a-distance of what she terms "American experimentalism," in which the word "race" never appears, and in which her notion of a "musical class structure" is framed largely in terms of a now-moribund debate about relative privilege between Europe and America.

In contrast, Born's explicit identification of the nearly all-male, all-white musical and cultural canon articulated not only by the French institute, but by its American equivalents, traces the outlines of the development of a post-1950s aesthetic of trans-European experimentalism. Given her so far unrefuted thesis that the overwhelming majority of computer music research and compositional activity locates itself (however unsteadily at times) within the belief systems and cultural practices of European concert music, one can easily imagine a work that, like *Voyager*, exemplifies an area of musical discourse using computers that is not viewed culturally and historically as a branch of trans-European contemporary concert music and, moreover, is not necessarily modeled as a narrative about "composition."

THE AESTHETICS OF MULTIDOMINANCE

In an influential 1990s essay, the artist and critic Robert L. Douglas [8] sought to formalize an African-American aesthetic, synthesizing visual and musical elements of what the painter Jeff Donaldson, founder of the Africobra art movement [9], has called "Trans-African" culture. The aspect of Douglas's theory that I wish to highlight here is the notion of "multidominant elements," which I will henceforth call "multidominance." According to Douglas, the aesthetics of multidominance, involving "the multiple use of colors in intense degrees, or the multiple use of textures, design patterns, or shapes" [10] are found quite routinely in musical

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and visual works of Africa and its diaspora.

By way of introduction to his theory, Douglas recalls from his art-student days that interviews with "most African-American artists with Eurocentric art training will reveal that they received similar instructions, such as 'tone down your colors, too many colors'" [11]. Apparently, these "helpful" pedagogical interventions were presented as somehow universal and transcendent, rather than as emanating from a particular culturally or historically situated worldview, or as based in networks of political or social power. Douglas, in observing that "such culturally narrow aesthetic views would have separated us altogether from our rich African heritage if we had accepted them without question," goes on to compare this aspect of Eurocentric art training to Eurocentric music training, which in his view does not equip its students to hear music with multidominant rhythmic and melodic elements as anything but "noise," "frenzy" or perhaps "chaos" [12].

In fact, virtually every extant form of black music has been characterized as "noise." As historian Jon Cruz notes, the history of this trope in the United States dates back at least as far as the slavery period: "Prior to the mid-19th Century black music appears to have been heard by captors and overseers primarily as noise—that is, as strange, unfathomable, and incomprehensible" [13]. However, as Cruz points out, for slaveowners to hear only noise is "tantamount to being oblivious to the structures of meaning that anchored sounding to the hermeneutic world of the slaves." To hear only noise is to "remain removed from how slave soundings probed their circumstances and cultivated histories and memories" [14].

The notion identified by Cruz that "the production of music and other cultural forms enabled slaves to collectively exercise symbolic control" [15] addresses directly the issue of how a formal aesthetic can articulate political and social meaning. Such modern-day (soon to be old-school) hip-hop groups as Public Enemy, in full recognition of the disapprobation of their music by powerful sectors of the dominant culture of their own day, even appropriated and ironicized this trope, challenging themselves, their listeners and their detractors with their explicit intention and exhortation to "bring the noise" [16].

Douglas's call for a formalist analysis does not exclude the realization that the border between form and content is difficult to police. Moreover, these formal abstractions are not universals; multidominance is not present in all trans-African music and art and certainly must not be applied as a sonic litmus test. In the particular case of *Voyager,* however, the composition's African-American cultural provenance lends particular credence to an identification of multidominance at the levels of both the logical structure of the software and its performative articulation. Moreover, whether or not these multidominant forms have been consciously conceptualized, exploited and extended by artists with full awareness of their implications, they must be viewed as culturally contingent, historically emergent and linked to situated structures of power and dialogue.

The African-American composer Olly Wilson [17] has identified a set of tendencies and principles characteristic of African and Afro-American music-making, while quite similar principles are identified by Robert Farris Thompson in examining African visual forms [18]. In particular, Douglas, Wilson and Thompson all identify rhythm as a critically important structural element in African-derived music. Wilson notices in African-derived music a "principle of rhythmic and implied metrical contrast" [19]. Thompson sees the black Atlantic visual tradition [20] as displaying "a propensity for multiple meter" [21], and his references to Mande cloth work as incorporating a conception of "rhythmized textiles" makes a direct connection with both African and African-American music [22]. Similarly, Douglas connects the visual with the sonic: "the predisposition to use multiple types of rhythm in musical construction speaks equally to a distinct aesthetic as does the multiple use of visual elements" [23].

COMPUTER MUSIC AND TRANS-AFRICAN FORMALISM

I conceived and programmed the first version of *Voyager* between 1986 and 1988. The work was created in Amsterdam at the Studio for Elektro-Instrumentale Muziek (STEIM); I added later ameliorations wherever I happened to be in the ensuing years. Since then, *Voyager* has been performed around the world, with improvisors such as myself (trombone), saxophonists Roscoe Mitchell, J.D. Parran, Douglas Ewart and Evan Parker, pianist Haruna Miyake, and extended cellist Jon Rose. The work has been performed in venues as diverse as the IRCAM Summer Academy, the Groningen Jazz Marathon, International Computer Music Conferences in 1988 and 1994, Xebec Hall (Kobe, Japan) and the Velvet Lounge in Chicago [24].

The various versions of *Voyager* have all been written in dialects of Forth, the curiously hybrid compiled/interpreted environment created by Charles Moore around 1970 [25,26]. Seemingly anti-authoritarian in nature, during the early 1980s Forth appealed to a community of composers who wanted an environment in which a momentary inspiration could quickly lead to its sonic realization—a dialogic creative process, emblematic of an improvisor's way of working. As the Forth culture developed, languages such as Hierarchical Music Specification Language (HMSL) [27] and, later, FORMULA (FORth MUsic LAnguage) [28,29], created by artists working in the field, made Forth and its dialects perhaps the most widely used language group for interactive music before the advent of Max, a language that similarly centers the dialogic as part of the software construction process.

My analysis of *Voyager* as an interactive computer music system uses Robert Rowe's taxonomy of "player" and "instrument" paradigms [30], although these two models of role construction in interactive systems should be viewed as on a continuum along which a particular system's model of computer-human interaction can be located. In Rowe's terms, *Voyager* functions as an extreme example of a "player" program, where the computer system does not function as an instrument to be controlled by a performer.

I conceive a performance of *Voyager* as multiple parallel streams of music generation, emanating from both the computers and the humans—a nonhierarchical, improvisational, subject-subject model of discourse, rather than a stimulus/response setup.

Both the sonic behavior and the program structure of *Voyager* exhibit multidominance in a number of respects. First, the *Voyager* program is conceived as a set of 64 asynchronously operating single-voice MIDI-controlled "players," all generating music in real time. Several different (and to some, clashing) sonic behavior groupings, or ensembles, may be active simultaneously, moving in and out of metric synchronicity, with no necessary arith-

```
:ap setphrasebehavior ( -- )
    ::ap" general phrasing " ( task recurs at intervals of 5000-7000 ms )
    5000 time-advance 11 irnd 200 * 5000 + to cycle

    begin
          ::ev
          bodymusic 0=              \ in this version this red light is always zero
                if calcork          \ set up new group of players, including number and position in space
                else allplayersoff  \ turn off all groups and start over with a new group.
                then
\ set up how system will follow input; set MIDI timbres
          setfollowbehavior         setreplies            setvoxbehavior

\ set melody algorithms, pitchsets, reverb and chorus type
          setwavebehavior           setscalebehavior      setreverbbehavior        setchorusbehavior

          computer-solo?            \ if no one is playing, I have a solo

\ set volume and velocity, microtonal tonic transposition
                if setvelbehavior   setvolbehavior       settonicbehavior

\ set octave, interval range, duration range
                setoctbehavior      setintbehavio        setwidbehavior   setlegatobehavior

\ set length of notes
                bodymusic 0=        \ in this version this red light is always zero
                         if setrestbehavior \ set up average degree of silence
                         then

\ set portamento, whether or not to follow tempo, and tempo ranges
                setportabehavior    settempofollow       setspdbehavior
                then

           ;;ev
    cycle time-advance
    again
    ;;ap
;ap
```

Fig. 1. *Voyager*'s top-level phrase behavior word, written as a FORMULA active process.

metic correlation between the strongly discursive layers of multirhythm. While this is happening, a lower-level routine parses incoming MIDI data into separate streams for up to two human improvisors, who are either performing on MIDI-equipped keyboards or playing acoustic instruments through "pitch followers," devices that try to parse the sounds of acoustic instruments into MIDI data streams.

The aperiodic, asynchronously recurring global "behavior specification" subroutine *setphrasebehavior,* which runs at intervals of between 5 and 7 seconds, continually recombines the MIDI "players" into new ensemble combinations with defined behaviors (Fig. 1). This subroutine (or "word" in Forth parlance) first makes determinations as to how many players will be part of the next ensemble. Additional options include turning off all players in all ensembles and starting afresh with this new group, turning off just the most recently instantiated ensemble, or allowing the new ensemble to enter the fray with the groups that are already playing.

The *setphrasebehavior* word also includes constituent subroutines that specify for the new ensemble choices of timbre, the choice of one of 15 melody algorithms, the choice of approximately 150 microtonally specified pitchsets (see Fig. 2), and choices of volume range, microtonal transposition, tactus (or "beat"), tempo, probability of playing a note, spacing between notes, interval-width range and MIDI-related ornamentation such as chorusing, reverb and portamento, and how such parameters as tessitura and tempo can change over time. Moreover, each new ensemble chooses not only a distinct group sonority, but a unique response to input, deciding which improvisors—one, both or none—will influence its output behavior. Further options include imitating, directly opposing or ignoring the information coming from the improvisors.

The response task word *setresponse* (Fig. 3), which runs asynchronously to the phrase behavior task, processes data from both the low-level MIDI parser that collects and manages the raw data and a mid-level smoothing routine that uses this raw data to construct averages of pitch, velocity, probability of note activity and spacing between notes. This information is used by *setresponse* to decide in greater detail how each ensemble will respond to elements of the input, such as tempo (speed), probability of playing a note, the spacing between notes, melodic interval width, choice of primary pitch material (including a pitchset

```
create partch43 43 i,
0 s,       21 s,      53 s,      84 s,      112 s,     151 s,     165 s,     182 s,
204 s,     231 s,     267 s,     294 s,     316 s,     347 s,     386 s,     417 s,
435 s,     471 s,     498 s,     519 s,     551 s,     582 s,     617 s,     649 s,
680 s,     702 s,     729 s,     765 s,     782 s,     814 s,     853 s,     884 s,
906 s,     933 s,     969 s,     996 s,     1018 s,    1035 s,    1049 s,    1088 s,
1115 s,    1147 s,    1178 s,
```

Fig. 2. *Voyager* pitchset construction, written as a Forth table representing the well-known 43-tone scale of Harry Partch, with approximate values given in cents (a method of specifying musical intervals in which 100 cents equals a musical semitone). The word "s" translates values in cents to MIDI note numbers with 8-bit microtonal pitchbend offsets, and then compiles the 16-bit result into the next available byte pair in the table. The word "I" creates a transposition factor that allows the program's melody generators to perform a rough mapping of the microtonal data in a given pitchset to 12-space data received via MIDI. This permits the program to use these scales with effective interval widths analogous to those in 12-space, if desired.

based on the last several notes received) octave range, microtonal transposition and volume.

Of particular note here is the fact that in the absence of outside input, the complete specification of the system's musical behavior is internally generated by *setphrasebehavior*. In practical terms, this means that *Voyager* does not need to have real-time human input to generate music. In turn, since the program exhibits generative behavior independently of the improvisor, decisions taken by the computer have consequences for the music that must be taken into account by the improvisor. With no built-in hierarchy of human leader/computer follower—no "veto" buttons, footpedals or physical cues—all communication between the system and the improvisor takes place sonically.

The simultaneous multiplicities of available timbres, microtonal pitchsets, rhythms, transposition levels and other elements in *Voyager*—all emblematic of an aesthetic of multidominance—reflect my inheritance from the Association for the Advancement of Creative Musicians' notion of "multi-instrumentalism," where a number of AACM improvisors, including Wadada Leo Smith, Henry Threadgill, Douglas Ewart, Joseph Jarman, Roscoe Mitchell, Anthony Braxton and others moved to develop multiple voices on a wide variety of instruments [31]. In AACM performances, the extreme multiplicity of voices, embedded within an already highly collective ensemble orientation, permitted the timbral diversity of a given situation to exceed the sum of its instrumental parts, affording a wider palette of potential orchestrations to explore.

The attempt to thoroughly map, parse and develop the input data is based on the notion that, through the accumulation and articulation of many small details, an interactive, adaptive input structure that generates a sufficiently detailed representation of its input can then produce a musical output perceptible by an improvisor as analogous to various states that were experienced during improvisation. This notion of bidirectional transfer of intentionality through sound—or "emotional transduction"—constructs performance as an intentional act embodying meaning and announcing emotional and mental intention. In this way, I believe, the emotional state of the improvisor may be mirrored in the computer partner, even if the actual material played by the computer does not necessarily preserve the pitch, duration or morphological structures found in the input.

In improvised music, improvisors often assert both personal narrative and difference as critical aspects of their work. For me, what Jerry Garcia called the "anti-authoritarian" impulse in improvisation led me to pursue the project of de-instrumentalizing the computer. If the computer is not treated as a musical instrument, but as an independent improvisor, difference is partly grounded in the form of program responses that are not necessarily predictable on the basis of outside input. As we have noted earlier, *Voyager's* response to input has several modes, from complete communion to utter indifference. This seeming lack of uniformity is not necessarily correlated with "lack of structure," as is so often expressed in the vernacular discourse of "randomness." Rather, while tendencies over a long period of time exhibit consistency, moment-to-moment choices can shift unpredictably.

It is a fact, however, that the system is designed to avoid the kind of uniformity where the same kind of input routinely leads to the same result. *Voyager's* aesthetic of variation and difference is at variance with the information retrieval and control paradigm that late capitalism has found useful in framing its preferred approach to the encounter with computer technology. As I have observed elsewhere, interactivity has gradually become a metonym for information retrieval rather than dialogue, posing the danger of commodifying and ultimately reifying the encounter with technology:

> Indeed, the rapid development of standardized modes for the relationships between humans and computers is unfortunate for such a young and presumably quickly changing technology. The evolution of the language used to reflect the multimedia revolution is a compelling testament to the power of corporate media. Corporate power assumes an important, even dominating role in conditioning our thinking about computers, art, image, and sound. Much of the descriptive language surrounding multimedia (and related areas, such as "cyberspace") serves to hide the power exercised by corporations [32].

Finally, Wilson notices in African-derived music a tendency toward a high density of events in a relatively short time frame [33]. It is to be noted that the work of many important African-American improvisors—in particular Cecil Taylor, John Coltrane and Albert Ayler—exhibit a notion of extended form that involves the sustained use, often for very long periods, of extremely rapid, many-noted intensity structures. Donaldson's 1988 visual work *Jam Packed and Jelly Tight* [34] exemplifies the approach of the Africobra artists, who, according to Douglas,

> used the jampack and jelly-tight concept as a means of filling up the void, to add as much as possible to the act of creation. Africobra members accept these concepts as an African axiom: that to add to life is to ensure that there is more to share [35].

The *Voyager* program often combines dense, rapid accretions of sonic information with sudden changes of mood, tempo and orchestration, eschewing the slowly moving timbral narratives characteristic of much institutionally based com-

```
setresponse ( -- )
 setinputbasedur            \ set tempo ranges based on input note durations
 bodymusic 0=               \ in this version this red light is always zero
    if setinputplayprob     \ probability of note or rest, based on input
    then

\ set duration range and length of notes, interval range
 setinputlegato   setinputwid       setinputint

\ use pitchset based on last few input notes; set octave and microtonal tonic transposition
 setinputscale    setinputoct       setinputtonic

\ set MIDI volume and velocity
 setinputvol      setinputvel
;
```

Fig. 3. *Voyager*'s input response word, written in Forth, sets parameters based on analysis of MIDI input.

puter music. Thus, *Voyager* is in clear violation of the dictum that Douglas identifies here as Eurocentric: "Don't overcrowd your composition with too many elements" [36]. These real distinctions from much institutionally produced trans-European computer music led one puzzled Italian listener to ask me "why so many things are happening at the same time." Or, to quote the king from the movie *Amadeus,* speaking of Mozart's work, "There are too many notes" [37].

EMOTIONAL TRANSDUCTION: SOUND, PERSONALITY, DIFFERENCE

In the context of improvised musics that exhibit strong influences from African-American ways of music-making, musical sound—or rather, "one's own sound"—becomes a carrier for history and cultural identity. As Yusef Lateef maintains, "The sound of the improvisation seems to tell us what kind of person is improvising. We feel that we can hear character or personality in the way the musician improvises" [38]. Essentially the same notion was advanced in the 1940s by Charlie Parker, who declared that "Music is your own experience, your thoughts, your wisdom. If you don't live it, it won't come out of your horn" [39].

The incorporation and welcoming of agency, social necessity, personality and difference as aspects of "sound" distinguish such music from work that "incorporates" or "uses" improvisation, or that features "indeterminacy" or aleatoric practices. "Sound" becomes identifiable, not with timbre alone, but with the expression of personality, the assertion of agency, the assumption of responsibility and an encounter with history, memory and identity.

Part of the task of constructing *Voyager* consisted of providing the program with its "own sound." In *Voyager,* this notion of sound appears in tandem with a kind of technology-mediated animism, expressed as an interactive aesthetic of negotiation and independent computer agency. This recalls the frequent references by Malachi Favors Maghostut, contrabassist and co-founder of the Art Ensemble of Chicago, to someone he met on his travels as "this African brother who had instruments that played themselves." Further, the trope of musical performance on an instrument as communication between two subject intelligences is exemplified by Francis Bebey's description of an incident wherein an accomplished African musician, after trying an instrument briefly, handed it back to its owner with the remark that he had no way of communicating with "someone who did not speak the same language" as he did. Bebey, in general discussion of African music, further maintains that in a number of African musical traditions a musical instrument "is often regarded as a human being." As evidence he offers the story of another African musician, who described his refusal to sell his drum (despite his near-destitution) by saying that he did not want to "deliver a slave into bondage" [40].

The other important notion that animates *Voyager* is that of the improvising orchestra. While *Voyager* can be seen as appropriating or even playing the dozens with the notion of the nineteenth-century European orchestra, my model in this regard is the Javanese gamelan ensemble, where a large number of players playing a relatively fixed composition nonetheless have considerable latitude in interpretation, even at primary levels such as pitch, duration and rhythm. Control of musical process is shared among players; inter-player communication takes place without necessarily involving a central authority. Local decisions taken by individual players percolate up to the global level, at which the overall form is maintained.

The Javanese musician Hardja Susilo characterizes "improvisation" in court tradition according to its interactive, social or intentional role, acknowledging how intentionality of process affects the musical result. For example, the Javanese term *kembangan* (literally, "flowering") refers to an improvisation that adds beauty. *Isen-isen* ("filling") is an improvisation that "pleasantly fills a vacuum." On the other hand, *ngambang* ("floating") refers to musicians who are improvising without clear knowledge of where the music is going, and *ngawur* ("blunder") denotes an out-of-style or irrelevant improvisation [41]. Thus, the success of this heterarchically oriented approach to large-group musical interaction can be seen to depend not only on the performative skills of the players, but upon their real-time analytic capabilities.

Finally, it is striking to note how an African-American perspective on improvisation reflects a similarity with recent thinking in the game of basketball, an area in which African-American players have continually presented revolutionary possibilities. The situation with improvisation, conventional classical music wisdom notwithstanding, is remarkably similar to basketball coach Phil Jackson's description of the triangle offense, in which "there are no set plays, and the defense can't predict what's going to happen next." As with improvisation, the ideal of the triangle system is for each player to be "acutely aware, at any given moment, of what's happening on the

floor" [42]. While in both areas, triangle offense author Tex Winter's dictum that "the offense must utilize the players' individual skills" has major relevance, it is absolutely crucial that both basketballers and experienced improvisors "develop an intuitive feel for how their movements and those of everyone else on the floor are interconnected" [43].

Thus, continuous awareness is the means through which these possibilities are articulated in performance. Part of the analytic task facing any improvisor (whether or not that improvisor is a computer) involves discovering or even positing ways in which seemingly unrelated material can become part of either an existing or a new structure within the emergent music. Depending on context, the responses of the computer to the improvisor's input can potentially be seen as either related or unrelated, either during the improvisation itself or upon further reflection. Moreover, the explicit possibility of encountering completely unrelated material encourages the possibility of changes in the music initiated by the computer as well as by the humans.

Thus, with both computers and humans, the data gathered must be viewed in a variety of contexts and from diverse perspectives in order to decide how the material to be presented next might function in terms of what has already been presented. The relatedness of particular materials need not be, and quite often cannot be, "objectively" demonstrable. Rather, the framing, by all parties to the music-making, of the relationship that the new material has to the overall piece at that moment is a crucial factor in structure formation. This process may be subsumed under the general heading of "creativity."

AFTERWORD: STRUCTURE AND FREEDOM

"Structure," as we understand it in music pedagogy, is highly desirable. On the other hand, at the same time that most students learn fairly early on that "jazz" (whatever that might be) is improvised, the dominant culture informs them, in myriad ways that are continually reinscribed across the breadth of daily experience, that "improvised" is a synonym for "unstructured." In apparently welcome contrast, we are provided with the role of the "composer," which can be usefully summarized as "bringer of structure." The structure inevitably arrives in the form of a written text, a coded set of symbols, intended for realization in performance by a "performer."

This metonymic dialectic between "composed" and "improvised" ways of producing musical texts serves to obscure a more fundamental constructed binary comprising the two most influential musical cultures of the twentieth century, the trans-European and trans-African. Proponents of each form-complex tend to construct an Other from proponents of the complementary form—particularly in creating competing notions of "art music"—but the asymmetrical distribution of cultural power clearly rests, for the moment, with the "bringers of structure." In Euro-American art-music culture this binary is routinely and simplistically framed as involving the "effortless spontaneity" of improvisation, versus the careful deliberation of composition—the composer as ant, the improvisor as grasshopper.

To move beyond this tendentiously posed opposition, a meaningful distinction between these different ways of knowing—the improvisational and the compositional—must inevitably turn upon the axis of interaction. Improvisation must be open—that is, open to input, open to contingency—a real-time and (often enough) a real-world mode of production. In machine terms, what we may have in *Voyager* is a composing machine that allows outside intervention. If we do not need to define improvised ways of producing knowledge as a subset of composition, then we can simply speak of an improvising machine as one that incorporates a dialogic imagination.

Thus, if there is to be serious talk about "our" identity as humans, those identities are continually conditioned and reinscribed through processes of interactivity, where negotiation, difference, partial perspective—and in the case of music, sonic signaling—enter the picture. *Voyager* asks questions concerning ways in which historically contingent meanings are exchanged through sound. Even given my emphasis on the personal conception of "sound," *Voyager* is not asking whether machines exhibit personality or identity, but how personalities and identities become articulated through sonic behavior. Instead of asking about the value placed (by whom?) on artworks made by computers, *Voyager* continually refers to human expression. Rather than asking if computers can be creative and intelligent—those qualities, again, that we seek in our mates, or at least in a good blind date—*Voyager* asks us where our own creativity and intelligence might lie—not "How do we create intelligence?" but "How do we find it?" Ultimately, the subject of *Voyager* is not technology or computers at all, but musicality itself.

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18. See Thompson [3] p. xiii.

19. See Wilson [17] p. 84.

20. Paul Gilroy describes the "black Atlantic" as an "intercultural and transnational formation" that encompasses Africa and its diasporas, on both sides of the Atlantic Ocean, including Europe (especially Britain), the United States, the Caribbean and South America. In particular, he argues that "the literary and philosophical modernisms of the black Atlantic have their origins in a well-developed sense of the complicity of racialized reason and white supremacist terror." See Paul Gilroy, *The Black Atlan-*

tic: Modernity and Double Consciousness (Cambridge, MA: Harvard Univ. Press, 1993) pp. ix–x.

21. See Thompson [3] p. xiii.

22. See Thompson [3] p. 207.

23. See Douglas [8] p. 19.

24. Recent citations and reviews of this work include the following: Joel Chadabe, *Electric Sound: The Past and Promise of Electronic Music* (Upper Saddle River, NJ: Prentice Hall, 1997) pp. 299–301; Ben Ratliff, "Improvisers Meet the Machines," *New York Times* (14 October 1997); Zane East, "George E. Lewis: *Voyager*," *Computer Music Journal* **19**, No. 1 (Spring 1995).

25. Leo Brodie, *Starting FORTH* (Englewood Cliffs, NJ: Prentice Hall, 1981).

26. FORTH was spelled in upper case until the late 1970s because of the prevalence of upper-case-only I/O devices. The usage "Forth" was generally adopted when lower case became widely available, because the word was not an acronym. E.D. Ratner, D. Colburn and C.H. Moore, "The Evolution of Forth," *ACM SIGPLAN Notices* **28**, No. 3 (March 1993); <http://www.forth.com/Content/History/History1.htm>.

27. Phil Burk, Larry Polansky and David Rosenboom, "HMSL: A Theoretical Overview," *Perspectives of New Music* **28**, No. 2, 136–178 (Summer 1990).

28. D.P. Anderson and R. Kuivila, "Continuous Abstractions for Discrete Event Languages," *Computer Music Journal* **3**, No. 13, 11–23 (1989).

29. D.P. Anderson and R. Kuivila, "Formula: A Programming Language for Expressive Computer Music," *Computer IEEE* **24**, No. 7, 12–21 (July 1991).

30. Robert Rowe, *Interactive Music Systems* (Cambridge, MA: MIT Press, 1992) p. 8.

31. References to the AACM, one of the most creatively diverse organizations of the last 30 years, are present in international abundance, so I present here just three citations that detail the organization's structural and cultural strategies: George E. Lewis, "Singing Omar's Song: A (Re)construction of Great Black Music," *Lenox Avenue* **4** (1998) pp. 69–92; Ronald M. Radano, "Jazzin' the Classics: The AACM's Challenge to Mainstream Aesthetics," *Black Music Research Journal* **12**, No. 1, 79–95 (1992); Ekkehard Jost, "The Chicagoans," in Jost, *Free Jazz* (New York: Da Capo Press, 1994; originally published 1974).

32. George E. Lewis, "Singing the Alternative Interactivity Blues," *Front* **7**, No. 2, 18–22 (November/December 1995).

33. See Wilson [17] p. 84.

34. Jeff Donaldson, *Jam Packed and Jelly Tight,* artwork, mixed media on canvas, 36 × 50 in (1988). The work is reproduced in Driskell [9] plate 10.

35. See Douglas [8] p. 21.

36. See Douglas [8] p. 18.

37. *Amadeus,* Milos Forman, director (1984).

38. Yusef A. Lateef, "The Pleasures of Voice in Improvised Music," in Roberta Thelwell, ed., *Views on Black American Music: Selected Proceedings from the Fourteenth, Fifteenth, Sixteenth and Seventeenth Annual Black Musicians' Conferences, University of Massachusetts at Amherst,* No. 3 (1985–1988) pp. 43–46.

39. Michael Levin and John S. Wilson, "No Bop Roots in Jazz: Parker," *Down Beat* **61**, No. 2, 24–25 (February 1994; originally published 9 September 1949).

40. Francis Bebey, *African Music: A People's Art* (Westport, CT: Lawrence Hill, 1975) pp. 119–120.

41. H. Susilo, "Toward an Appreciation of Javanese Gamelan," (unpublished, 1992).

42. Phil Jackson, who during the 1990s won six National Basketball Association championships as head coach of the Chicago Bulls, as well as the 2000 NBA championship with the Los Angeles Lakers, adopted as part of his winning scheme coach Fred "Tex" Winter's unusual system of basketball offense, variously known as the "triple-post" (Winter's term) or the "triangle" offense. Jackson often describes the offense in terms of its spiritual and cultural implications, as well as its efficacy in basketball. See Phil Jackson and Hugh Delehanty, *Sacred Hoops: Spiritual Lessons of a Hardwood Warrior* (New York: Hyperion, 1995) p. 87. Also see Fred Winter, *The Triple-Post Offense* (Englewood Cliffs, NJ: Prentice-Hall, 1962) for the original documentation of Winter's conception.

43. Jackson and Delehanty [42] p. 91. See also Winter [42].

Selected Discography

George Lewis, *Endless Shout,* Tadik TZ CD 7054 (2000).

George Lewis, *Homage to Charles Parker,* Black Saint BSR 0029 (1980).

George Lewis, *Voyager,* Disk Union-Avan CD 014 (1992).

George Lewis and Douglas Ewart, *George Lewis/Douglas Ewart,* Black Saint SR 0026 (1979).

Richard Teitelbaum, *Concerto Grosso,* hat ART CD 6004 (1988).

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The work of George Lewis has explored improvised music, electronic and computer music, computer-based multimedia installations, text-sound works and notated forms, and is documented on more than 90 recordings. A member of the Association for the Advancement of Creative Musicians (AACM) since 1971, Lewis has worked closely with other genre-busting contemporary musicians, such as Anthony Braxton, Anthony Davis, Bertram Turetzky, David Behrman, Derek Bailey, Douglas Ewart, Evan Parker, Frederic Rzewski, Gil Evans, Irene Schweizer, James Newton, Joelle Leandre, John Zorn, Leroy Jenkins, Misha Mengelberg, Muhal Richard Abrams, Roscoe Mitchell, Steve Lacy and Wadada Leo Smith. Lewis has received numerous fellowships from the National Endowment for the Arts, and is the 1999 recipient of the Cal Arts/Alpert Award in the Arts. Lewis now teaches in the Critical Studies/Experimental Practices area at the University of California, San Diego.