

# Real-time Composition or Computer Improvisation? A composer's search for intelligent tools in interactive computer music

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## 1. INTRODUCTION

At several recent conferences and festivals of electroacoustic music, I have been somewhat surprised at the live EA that I have heard. A vast majority of these performances have involved composers sitting behind their computer, clicking on buttons in Max/MSP or SuperCollider, and triggering specific signal processing algorithms, while a musician, playing into a microphone, performs notated music from a score. Not that there is anything wrong with live signal processing, but it points out to me that live electroacoustic music has become conservative.

At one such recent conference, a young composer, almost at the point of graduation with a doctorate, mentioned to me that she had not yet composed a live electronic work. Although she felt a bit apprehensive about the certainty of technology onstage, her reticence resulted more from her lack of programming experience. Her advisor suggested that she simply use someone else's Max/MSP patch, and concentrate upon writing a good piece of music.

This struck me as odd for two reasons. Firstly, live EA seems to have reached the level of "orchestral work", "choir piece", "solo instrumental work", "tape work" on the list of required compositions of young composers; but, more importantly, this composer (whom I think is representative of this generation) didn't seem to have any particular calling to create live EA, but seemed about to do so because it filled out her CV.

Has experimentalism gone out of live electroacoustic performance? Firstly, I readily accept that live EA does not require a computer; however, in this paper, I will limit my discussion to the use of the computer in performance.

Secondly, many performers treat the computer as an improvising instrument, an example of *computer improvisation*. If one accepts that improvisation, on its own, is experimental, then it follows that experimentalism in live EA is alive and well.

However, compared to how the computer was *first* used in performance in relation to *composition* – what Joel Chadabe termed *realtime composition*, an aspect that has all but disappeared – then the contemporary use of the computer within live performance can be argued to be conservative.

## 2. THE BEGINNINGS: CAGE

If one looks at the history of live electroacoustic music, one finds a series of new *instruments* as well as a larger

notion of *electroacoustic performance*. In the former case, the new instruments (such as the *Theremin*, *Ondes Martenot*, the voltage controlled synthesizer) were often treated as extensions of current practice; witness Clara Rockmore's interpretations of the music of Tchaikovsky and other romantic composers.

Played in that light, these new instruments did not catch on for the simple reason that they could not compete with the expressive potential and timbral richness of acoustic instruments. Therefore, composers could either accept their timbral and expressive limitations, and instead explore the instruments experimentally (i.e. Varese's use of the *Theremin* in *Ecuatorial*); or they could use them as traditional instruments of limited timbral variety (i.e. Messiaen's use of the *Ondes Martenot* in *Oraison*).

Other composers saw a need to incorporate *performance* within the presentation of the new electroacoustic music.

Two streams are evident here:

- an extension of the traditional model of performance of a fixed score, beginning with Bruno Maderna's work 1952 work *Musica su Due Dimensioni* for flute and tape;
- an exploration of new models of composition, beginning with John Cage's *Imaginary Landscape No. 1* of 1939.

Cage's experimental aesthetic suggested that a composition's resulting sound may not matter as much as the process involved in creating it. Unlike his development of the prepared piano a year earlier, the use of turntables to play single frequency test recordings in his 1939 work could not have been motivated by practicality – it would have been just as easy to use sinewave generators – nor timbral exploration: traditional instruments capable of glissandi would have been richer in terms of spectrum.

Cage's experimental aesthetic was at odds with the emerging *musique concrete* tradition, which was fundamentally based around the research into new sound sources and their manipulation in controlled environments. This separation continued to exist for many years within electroacoustic music between tape composers and performers of live EA. The former continued to strive to create music in which *timbral development* was the guiding factor, while the latter used whatever means were available to explore the nature and/or role of *performance* within electroacoustic music.

Cage, of course, went on to automate musical decision making in his exploration of random procedures within the compositional process. This led to

the entire school of process music, which filtered into electroacoustic music, including some studio composed works:

- Cage's *William's Mix* (1952/53) and *Fontana Mix* (1958);
- Reich's *Come Out* (1966);
- Eno's *Discrete Music* (1975);
- Lucier's *I Am Sitting in a Room* (1970) and *Music on a Long Thin Wire*, (1977).

Cage, together with David Tudor, also continued to explore process composition through aleatoric and indeterminate methods in live performance:

- Rainforest (1958);
- Cartridge Music (1960);
- Variations V (1965).

The interest in these works lay in their conception, and the ability of the audience to hear sounds generated live, in response to performer actions. The complexity of the material, however, both in terms of timbre and composition (i.e. development of material, interaction of layers, etc.) was limited in comparison to the studio-based EA that was emerging at the same time.

### 3. ALGORITHMIC COMPOSITION

Cage's exploration of random processes to automate musical decisions was one extension to the long history of algorithmic composition, which I will define simply as "procedure-based composition".

The use of the computer in algorithmic composition began with Hiller's *Illiac Suite* of 1958, and was continued by composers such as Brun (Illinois), Koenig (Utrecht), Xenakis (Paris) and others. Contemporary models of algorithmic composition include the exploration of chaotic equations and fractals, cellular automata, genetic algorithms, many of which are now being explored in live performance.

### 4. CHADABE AND INTERACTIVE COMPOSING

Joel Chadabe was the first to actually interact with musical automata. In 1971, he designed a complex analog system, built by Robert Moog, called the *CEMS*, which allowed him to compose and perform *Ideas of Movement at Bolton Landing*. This was the first instance of what he called *interactive composing*, "a mutually influential relationship between performer and instrument."

The instrument, in this case the *CEMS* analog computer, offered more complexity in its response than a traditional one, in that its musical output was not in a direct one-to-one relationship to its control input. Such a

relationship is the basis of *interactive composing*, which he defines as a process in which:

the instrument is programmed to generate unpredictable information to which the performer reacts during performance. At the same time, the performer at least partially controls the instrument. Since the instrument influences the performer while, at the same time, the performer 'influences' the instrument, their relationship is mutually influential and, consequently, interactive. [5]

In the jacket notes to the original LP record, Chadabe reveals the conceptual origins of the work, when he states that since

each signal is changing independently, and controlling a different aspect of the sounds, the succession of sounds is difficult to predict, and the piece does not move along lines of ordinary musical logic... It's a certain idea of how people can interact with technology, and one that I find appealing because it's using technology for its cleverness rather than for its brute force or efficiency. [5]

**EXAMPLE: Chadabe, *Ideas Of Movement at Bolton Landing* (1971)<sup>1</sup>**

### 5. SAL MARTIRANO'S SALMAR CONSTRUCTION

At about the same time that Chadabe was developing the *CEMS*, Sal Martirano built his *SalMar Construction*, a similar analog synthesizer controlled by discrete-component digital circuitry and performed by touching a large number of touch-sensitive switches. Martirano described his role in performance as follows: "I enabled paths. Or better, I steered. It was like driving a bus."

The musical result was, not surprisingly, quite gestural; however, it is interesting that the music almost approaches the timbral and textural complexity of Subotnick's studio-composed electronic music of the period.

**EXAMPLE: Martirano, *Look at the Back of My Head* (1974)**

### 6. DAVID BEHRMAN

Another composer exploring the use of the technology within performance in the 1970s was David Behrman. In his 1978 work *On the Other Ocean*, pitch-sensing circuits were connected to a Kim-1 microcomputer that controlled oscillator frequencies on a hand-made analog synthesizer.

<sup>1</sup> In the presentation of this paper, excerpts of these examples were played. Because they are under copyright, they cannot be included here.

The relationship between the two musicians and the computer is an interactive one, with the computer changing the electronically-produced harmonies in response to what the musicians play, and the musicians are influenced in their improvising by what the computer does. [1]

Behrman's choice to interact with live musicians, playing equal tempered, tonal harmonies, resulted in a less "radical" sound than that of Chadabe or Martirano. However, decisions are made in software that retain an experimental approach when an unchanging chord that lasts for almost a minute is heard.

**EXAMPLE: Behrman, *On the Other Ocean* (1978)**

## 7. SUMMARY TO 1978

In all three cases, these composers had to make concerted efforts to explore their compositional aesthetics: each had to build a dedicated instrument with which they could interact. Although these new instruments lacked the control of traditional acoustic instruments, as well as the timbral richness and expressivity, they offered the ability to create complex, multi-voiced gestures during performance.

In this sense, they continued the tradition of electroacoustic instruments begun with the Theremin, but also the aesthetic of Cage: the process of composition and its execution into sound were more important than the resulting sound itself.

And finally, as Chadabe himself proposed, these instruments provided a new paradigm for composition, one beyond mere improvisation: interactive composition. Composers could create complex, multi-voiced gestures in performance.

## 8. THE NEXT GENERATION OF TECHNOLOGY: DIGITAL

In 1977, Chadabe had begun to compose for, and perform with, a digital synthesizer/small computer system, specifically one of the first *Synclaviers* made by New England Digital. In *Solo*, the first work he finished using this system, the computer "improvised" a melody in eight voices that he was able to "conduct" using two *Theremins* to control timbral groupings and overall tempi. By "guiding the system by responsively controlling certain variables", [3] the complexity of interaction increased, with more responsibility given to the software instrument.

His decision to control timbre (the grouping of predefined instrumental sounds) and tempi allowed him seemingly high-level control, but one that ultimately remained at the surface. The music was pitch-based (Chadabe suggested that *Solo* implied an intimate jazz group): however, musically significant parameters -

such as harmonic change - are left entirely to the computer.

**EXAMPLE: Chadabe, *Solo* (1979)**

## 9. SUMMARY - DIGITAL PRE-MIDI

By the early 1980s, live electronic music had passed through two generations of technology (analog and digital). The new digital technology allowed for an expansion of ideas (more voices, greater control over materials), yet the predominant aesthetic that favoured the unknown of performance over the exactitude of studio creation remained intact.

## 10. MIDI & 1980S

With the development of MIDI and the availability of commercial synthesizers and personal computers in the mid-1980s, composers no longer had to build their own equipment, and could concentrate upon the only missing element: software. This third generation of technological change still had little effect on live electronics, other than, perhaps, to entrench the existing paradigm of pitch/rhythm organization.

As demonstrated in his 1987 work, *Four, Not Two*, Martirano, using his yahaSALmaMac system, completely accepts a note-based framework.

**EXAMPLE: Martirano, *Four, Not Two* (1987)**

## 11. INTERACTIVE COMPOSITION VS. IMPROVISATION

Interactive computer music (as it was now known) was often linked to improvisation, and not only for its oft-incorporated use of live improvising musicians. Many of its practitioners, however, took pains to point out differences between what they were doing and instrumental improvisation.

In 1977, Chadabe stated the following:

[Interactive composition] is different from typical instrumental improvisation in that an improviser specifies and performs data in reaction to another improviser, but here the composer specifies and performs control strategies rather than data...The difference between instrumental improvisation and control strategy interaction is, then, primarily that of one's position in a control hierarchy, but it is true that in both cases the performer must act and react in realtime. [2]

George Lewis describes his *Voyager* system as an "automatic composing program that generates complex responses to the [improvising] musician's playing" [8]. He distinguishes "improvised music", the framework within which he and his system perform, from music

that merely *incorporates* improvisation; furthermore, the notion of improvisation as “real-time composition” is implicitly disavowed.” [8]

Each piece ... functions in some sense as an improvised concerto, where a single performer is engaged in dialog with a computer-driven, interactive chamber orchestra acting as a “virtual improviser. [8]

Unlike other systems discussed, *Voyager* is completely autonomous, and not under the control of any human.

In *Voyager*, the computer system is not an instrument, and therefore cannot be controlled by a performer. Rather, the system is a multi-instrumental player with its own instrument. [8]

*Voyager* does, however, clearly resemble traditional acoustic instruments, defined by an ability to play notes of specified durations and essentially unvarying timbre. This is made obvious in the limited information the system extracts from the human performer: pitch and velocity. Although this data is used to extract a great deal of information about what the performer is doing, the model clearly remains one of instrumental music.

**EXAMPLE: Lewis, *Voyager* (1993)**

## 12. RANDOMNESS AS A CONTROL STRUCTURE

If instrumental improvisation was one model for interactive electronics, randomness was its method of control. Chadabe suggests that unpredictability of response is the goal, and randomness is the means to achieve this goal:

The important quality of random-number generators is what I have come to call *complexity*. In general, by complexity, I mean that the rules which determine a certain succession of events are underlying and elusive and not evident in the succession of events they generate. [4]

Similarly, Lewis uses randomness to control “melody, harmony, orchestration, ornamentation, pacing, transposition, rhythm, and internal behavior decisions”. [8]

The use of white noise allows me to filter the resulting stream of numbers in a conceptually simple and orthogonal fashion, where “tuning” the program for a desired musical result, or setting up input response parameters for interaction with improvisers, ultimately becomes a process of setting percentages. This manipulation of the many program variables whose values are determined by

various filterings of white noise results in the emergence of complex global personality. [8]

As Todd Winkler pointed out, such use of constrained random procedures allowed interactive composers to shape and influence their musical output; at the same time, it permitted the music to be unpredictable, yet remain within a defined range that determines a coherent musical style. [9]

## 13. TECHNOLOGY CATCHES UP: LIVE DSP

Toward the end of the nineties, affordable hardware became fast enough to allow for live signal generation and processing. Instead of relying upon the sounds of a MIDI synthesizer, composers of interactive music can now record and process material live, using many of the same signal processing routines that were formerly restricted to the studio. The result has been a dramatic change in live electroacoustic music: it is no longer note-based, but instead is based upon the development of timbral gestures. I do acknowledge that there are still many experimental practitioners of live electronics - for example, those involved in live coding, as well as those exploring new methods of algorithmic composition in live settings; however, these are in the minority, or have been shuffled off into the “late night concerts”.

The role of improvisation has also changed; in those few works that do employ improvisation, the tendency is either to combine existing recordings on the fly, and process them (witness the popularity of Ableton’s *Live* in laptop circles), or to record these files live from a live musician, and do the same. In fact, a recent work by Chadabe, *Many Times...* utilizes just such a strategy: recording a performer, transforming these recordings, and playing them back in a multichannel sound system.

Chadabe claims that the “transformations, generated by the software that animates the instrument, are essentially unpredictable. Because of their unpredictability, they provide the performer with something to react to.” [5] While this certainly fulfills the requirements of interactivity, the process is little more than a signal processing delay unit: the sounds may be timbrally complex, but there is little conceptual interest or development from what occurred thirty years ago. Somewhat ironically, this contradicts Cage’s experimental philosophy, the former principle behind live electronics: it seems that *sounds* are what matter now, as opposed to *concept*.

I don’t see this new model changing anytime soon, since there are a wealth of potential combinations of sound sources and new signal processing routines which will continue to produce works of timbral richness, but without conceptual development. Ironically, the movement away from MIDI has also resulted in the loss of MIDI’s representational quality: the only information available to Lewis, for example, was the pitch, velocity, and time information, this *representation* of the incoming audio gave him clear understanding as to *what* was being played. While this information is still

available, it is so much easier (and sonically satisfying, it seems) to simply manipulate the actual recordings without understanding what is occurring within them.

#### 14. PARADIGM SHIFT - A NEW MODEL?

Clearly, the model has shifted: earlier interactive music could look to complex models of improvisation and existing strategies of pitch/time organization, whereas live DSP-based music now looks to studio-based composition, yet without the benefit of contemplative decision making. Although we are now able to play back and manipulate several independent layers of soundfiles, the resulting musical development relies more upon the timbral evolution of the original material rather than anything we can control, for the simple reason that we are limited in what we *can* control.

Chadabe could, for example, allow himself to only control timbre and speed in *Solo*, confident that his software could create unpredictable, *yet musically appropriate* pitch combinations. Unfortunately, rules for timbral combination and development are less clearly formed than rules for pitch/time. The result is that some effort is required to manually manipulate gestures (even if it is just using a fader box to control volume): the shaping of gestures has now fallen back into the lap of the composer. The end result tends towards a performance in which gestures progress slowly, usually initiated one at a time, with a good deal of repetition in the background layers.

One solution to this problem is to exploit this repetition through the use of clear loops. Gregory Taylor's work is an example of this rather "postmodern" aesthetic (emphasized by his use of non-western source material). Several layers are created via looping, each with independent processing that has constrained random variation of its parameters; the foreground layer has the greatest variation - and usually the least repetition - and is most often under the direct control of the composer. Gestures are slow moving, with sectional changes, in which all layers change together, rarely occurring; furthermore, there is little, if any, interaction *between* the layers.

**EXAMPLE: Gregory Taylor, *Lima* (2007)**

#### 15. CASE STUDY - STREAM: LIVE SOUNDSCAPE COMPOSITION

My own exploration into what I called "live soundscape composition" was an attempt to bring methods of interactive music - specifically constrained randomness, improvisation, and live performance - to what has been traditionally a studio-based genre: soundscape composition. What I quickly came to realize in practice is what I had only assumed in theory: there were too many musical decisions to make in performance,

decisions that could not be off-loaded to constrained random procedures.

Interestingly, Chadabe recognized these limitations very early on:

(interactive composition) demands performance skill and performance-oriented thinking, and it raises questions as to how well a composer can deal with realtime problems ... Composers cannot think fast enough to specify controls in realtime for quickly changing variables. [3]

His proposed solution was to combine what he called memory automation with process automation; in other words, use some pre-sequenced material. This is what, in fact, I had to resort to in my 2005 work *Stream*: in the studio, I "performed" the processing on independent layers; in performance, I combined these layers and mixed them using a data-glove.

#### 16. MORE INTELLIGENT CONTROLLERS?

Guy Garnett, in his 2001 paper, talks about performance, and various new ways of including a performer to make a work interactive, including extending a traditional instrument through processing, hyperinstruments, or creating new instruments such as the BoSSA. [7]

A more novel approach would be for the software to be more intelligent, and adapt to the performer, who could concentrate upon what he or she does best.

For example, a violinist has a huge number of performance variables to contend with, which require years of practice to master. Compared to this, a software program such as Ableton *Live* has only a few variables, and can be mastered in a much shorter period of time. Furthermore, the performance *variation* afforded within *Live* is much more restricted than that of the violin. Ideally, it is the *software* that should be smarter, and provide something other than a dumb interface.

#### 17. ONE POSSIBLE DIRECTION

Few composers, myself included, have the pedigree that improvisers such as George Lewis have, and we seem more interested in creating works that *incorporate* improvisation, rather than are pure improvisation. Personally, I view myself as a composer, rather than an improvising performer. As such, my interest lies within composition, rather than improvisation.

Furthermore, we are now engaged in controlling many more independent layers than did Lewis's *Voyager*, layers that require timbral control over their evolution. This control can no longer rely upon constrained randomness, as could the pitch-based improvisation model. Therefore, I firmly believe that the evolution of interactive composition is, in fact, realtime composition, rather than computer improvisation.

And if we wish to truly explore the nature of composition during performance, the software will have to have a much greater musical understanding of the music being created. As such, intelligent tools that assist in the creation of the composition itself are necessary to assume responsibility over many high-level decisions. The discussion of such tools is beyond the scope of this paper; however, I point the reader to some of my own research in this area. [6]

## 18. REFERENCES

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