Aesthetic Considerations in the Use of "Virtual" Music Instruments

Christopher Dobrian
Music Department
303 Music and Media Building
University of California
Irvine, CA 92697-2775 USA
+1 949 824 7288
dobrian@uci.edu

ABSTRACT
Computer-mediated music control devices compell us to re-examine the relationship between performer and sound, the nature and complexity of which is theoretically unlimited. This essay attempts to formulate some of the key aesthetic issues raised by the use of new control interfaces in the development of new musical works and new performance paradigms: mapping the gesture-sound relationship, identifying successful uses of "virtual" instruments, questioning the role of "interactivity" in performance, and positing future areas of exploration.

Keywords
Music, instruments, control interfaces, interactivity

INTRODUCTION
Much of the work being done with computers and music involves experimentation with the design and use of new "controllers"—new interfaces to computer-controlled instruments. This experimentation can be divided roughly into two types of activity: design of new instruments, and adaptation of non-music technology for musical use.

In the case of most earnest inventors/builders of new instruments, the design grows from the urge to "build a better mousetrap", to overcome the limitations of traditional instruments. Most artists who have worked extensively performing with, and composing for, new instruments, however, have come to realize that this quest for the ultimate instrument is a modern-day search for the mythical holy grail. Any instrument requires considerable dedicated practice to achieve mastery of it, any instrument has its own immanent limitations, and any instrument is only useful to the extent that it serves in producing "good" music, which still has to emanate from the creative human spirit.

Those who work with adapting non-music technology to usage for the control of music are usually attracted to the novelty of the interface for musical applications, and the potential for new relationships between human activity and resultant sound. Nearly anything that can produce a voltage is fair game for experimentation as a control interface to a computer-mediated instrument. In some cases the very unconventionality of the instrument becomes a theatrical element in a performance.

In both cases the fundamental technical issue is the conversion of analog or digital electrical signals into control data useful for a computerized sound generator. This requires thoughtful mapping of gesture to sonic/musical meaning, and ultimately requires consideration of the creative utility and aesthetic value of any such mapping.

This article will deal with some of the aesthetic considerations I have encountered while working with alternative methods of music control, specifically referencing the use of video-tracking (using such software as BigEye and VNS) and motion capture (with a Vicon 8 system) to produce dancer-controlled music. An unfettered dancer who is directly producing and controlling the musical events can be considered an extreme case of an alternative gestural interface: a human moving unrestricted to perform a "virtual" instrument, one with no tangible physical interface.

THE GESTURE-SOUND RELATIONSHIP

The Performer-Instrument Relationship
Much of our appreciation of music is in its performance: the contributions the interpreter makes in terms of dynamics, rubato, timbre, ornamentation, in some cases even improvisational decisionmaking, and notably in this context, the performer s virtuosity and mastery of the instrument. Indeed it can be said that a major part of the drama of, for example, the Bach Chaconne is witnessing the violinist s mastery of the technical challenges that the written music presents. We are aware of the skills and maneuvering required, and when the music flows elegantly from the instrument we are impressed and enthralled by the technical success of the performer. Our knowledge of the instrument also contributes to our appreciation of the timbres, intonation, and effects the player produces.

When we witness a music performance with a new, unknown instrument, especially one for which the player-instrument relationship is obscured by the effects of software and electronics, the drama of the player s control of the instrument is different. In this case—as in the case of witnessing for the first time a performance on an instrument from a foreign culture—our sense of the performer-instrument relationship is primarily based on how we perceive the releationship between the performer s gestures and the sounds (which we presume to be as a direct result of the gestures).

In traditional instruments—especially percussion and keyboard instruments—the relationship between gesture and sound is usually one-to-one: a single action triggers a single sound, embodied notationally as a single dot on a page. This traditional relationship leads computer musicians to be too frequently restricted by this notion when experimenting with new controllers. In computer-mediated instruments, however, in which a computer controls the relationship between gesture and sound generator, a single trigger can have *any* result. (The extreme case is the compact disc player, which permits an entire Beethoven symphony to be triggered by the flick of a finger.)

This situation is placed in an interesting reversal when we witness dancer-controlled music. Traditionally dancers move in response to a rhythmic stimulus, and the music is viewed as the independent generator of rhythm which activates—and to a degree controls—the movement of the dancer. In some styles, such as flamenco, the musician reacts to the dancer such that the music is created by a complex realtime interaction between dancer and musician; nevertheless, even in this context it is clear that the musician generates the rhythmic impulses to which the dancer s movement is synchronized. When the music is produced by video tracking, motion capture, or other form of motion sensor, however, these roles are completely reversed. This raises several new aesthetic questions, which will be discussed later in this section.

Control Data

Most data received from controllers is one of two types: 1) inidividual discrete triggers at specific moments, in response to a specific action or passage of a threshold (e.g., a button is pressed, a contact is made, etc.), or 2) streams of discrete data representing a sampling of a continuous phenomenon (e.g., a measurement of the movement of a potentiometer).

Trigger data is most commonly used to act as a toggle switch from one state to another, or to enact "note" events in music. The data may contain descriptors of the number and type of trigger, as in a MIDI note message which contains channel, key number, and velocity information. As noted above, this trigger need not actuate only a single note or sonic event; it can have *any* result. It is fairly easy to obtain trigger data from a control device. The only real challenges are a) the technical question of how to discern different types of triggers from a single interface, and b) the aesthetic question of what the triggers should *do* sonically.

If one thinks of a note not as a single static event, but as a complex evolving sound with its own internal shape—as in fact almost all notes are, contrary to their simplifed notation—then one realizes that the majority of expressive potential comes from the continuous control of the note s timbre and dynamics after its initial trigger. This is one of the principal values of the use of continuous control data. Continuous control of electronics can give access to sound parameters not traditionally available, such as filtering and modulation, panning and reverberation for localization effects, and simultaneous realtime control of other related media in performance such as lighting, animation, or video processing. Continuous control can also be used over longer periods of time—over the course of many notes—for shaping larger formal parameters such as crescendi, accelerandi, note density, etc.

New Issues in Dancer-Controlled Music

As noted earlier, dancer-controlled music reverses some traditional roles: dance generates music instead of music generating dance, and the dancer controls musical performance (and potentially musical structure and content) instead of musician. This raises interesting new aesthetic questions for designing the dance-music relationship, for designing the mediating software, and for composing the music.

—Choreographic conventions and styles have always developed without one ever needing to be concerned about their effect on the music. But when the choreography is concerned with performing the music as well as the dance, how does (must) traditional choreography change? Could/should the prospect of dancer-controlled music lead to a new vocabulary of movement?

—Given that, in the case of video motion-tracking, the dancer s movement in the two-dimensional video image is what controls the musical sound, what is the meaningful language (i.e., the most useful data to be derived) in the 2D space? Location? Velocity? Acceleration? Proximity? Size?

—At what structural level of the sound does one want the dancer s control to be oriented? At the "microcosmic" timbral level, giving subtle expression to sounds by continuously controlling sonic parameters? At the "middleground" level, providing pitch rhythm, and dynamic information? At the "macrocosmic" level, providing input parameters for automated algorithmic music or shaping the formal structure of the piece (note density, tempo, etc.)?

—In the case of multi-dimensional data input, such as the Vicon 8 s multiple points in 3D space, how does one manage and map so many simultaneous control parameters? As a single progression through a multi-dimensional musical parameter space? As multiple agents in a 3D parameter space? Can one use this wealth of data to derive higher-level information about the characters of the dancer(s) motion, which might give a more direct interpretation of the intended expressivity of the movement?

These are some of the questions with which one grapples when designing software and composing music for dancer-controlled instruments. The next section provides a few basic observations and suggestions.

TENETS AND GUIDELINES FOR VIRTUAL INSTRUMENTS

Simplicity

Because there is no established standard for the relationship between movement in a virtual space and the musical results of that movement, mappings of gesture to sound—programmed into the computer that mediates between the controller and the sound generator—must be simple and direct in order for the audience to perceive the cause-effect relationship.

Other Relationships

The relationship between gesture and sound need not always be directly proportional. Inverse proportionality, exponential relationships, slightly distorted or not-strictly-linear relationships can also be perceived easily, and such divergence from the expected direct proportionality can be satisfying.

Variety

As with anything in art, things that are overly predictable quickly become tedious. If one is working with simple gesture-sound relationships, one must recognize that those relationships can become boring for the audience very quickly, and must therefore be frequently varied or changed. The form of the music/dance piece will thus be influenced to some degree by the nature of the relationships established by the virtual instrument.

Multiple Simplicities

A single simple gesture-sound relationship may soon seem simplistic to an audience, but two or more simple simultaneous relationships established by the mediating computer can be considerably more engaging. The audience follows not only the direct correlations, but also the *counterpoint* of mappings—the interaction between the correlations.

Multiple Performers

The complexity for both performers and audience in perceiving and understanding the workings of the virtual instrument seems to grow quickly as soon as a second performer is introduced. Part of the audience s appreciation of the work is discovering the nature of the virtual interface, and this is complicated by the uncertainty of *which* dancer is causing which sonic result. The issue is again one of managing counterpoint. For example, separating the dancers in space (avoiding "voice-crossing" in counterpoint terminology), and giving the dancer s contrasting movements (independence of contrapuntal elements) can enhance clarity of understanding. And of course, when obfuscation is the desired goal one can do the opposite.

"Intelligent" Mappings

Directly mapping motion to sound—for example, mapping a dancer s position onto pitches of the chromatic scale—can be unsatisfying musically because of the lack of musical "sophistication", the lack of stylistic reference. One can lend some measure of "musical culture" to the instrument by mapping the gesture in a non-linear realtionship to the intended musical material. A linear movement can be mapped onto a familiar non-linear musical structure—such as a diatonic scale—and/or onto a non-linear contour. (This is most easily achieved with table-lookup, or random perturbations of input data.) Similarly, events triggered by the dancer can be realtime-quantized to a metric grid or a desired rhythmic pattern (i.e., a "groove", to which all events must conform or be usefully syncopated). With these techniques one can read through a table of possibilities which are an inherently strong sequence, and which can be presented in any rhythm.

Music is not just Pitches

Too frequently computer musicians are contented with the simplest and most banale first-choice mapping—location-to-pitch—and do not explore more complex and interesting relationships sufficiently. Continuous control (of portamento, timbre, dynamics, etc.) is often more expressive and more satisfying dramatically than simply mapping motion to pitch.

Time is Malleable

Introducing delay between gesture and result retains the simplicity of the correspondence but offsets it in time, to potentially interesting effect. This can be achieved with computer scheduling, delay buffers, or even storing input data and accessing it algorithmically or probabilistically in the future. Extreme delay, reverse delay, and capture and storage of data, are potent tools for dealing with relationships over longer periods of time, to create form in a composition or improvisation. Combining these techniques helps one create works with an "open" (indeterminate) form.

THE QUESTION OF INTERACTIVITY

What is Interactivity?

Interactivity is a term too often employed to describe any use of a computer in live performance or installation. A computer might act independently, or might *re*act to human actions (responding slavishly to triggers, or tracking continuous input), but this is not *inter*activity. The prefix *inter-* implies that both human and computer can act independently and react responsively to the actions of the other. Thus, true interactivity must involve mutual influence, and cannot be all deterministically programmed.

In a truly interactive instrument, the computer will have the capability to act independently and to react indeterminately to input. These characteristics are inherently contrary to an attempt to produce a fully controlled, determinate, predictable work of music. One can program an instrument that responds in a known manner to all likely input data, but that is just reactive, not interactive.

A truly interactive instrument must have the capability to respond to input that is not previously known to it (i.e., is not pre-programmed in a knowledge base, nor handled with a fully deterministic algorithm), and must be capable of producing results that are not fully predictable. In other words, the computer must be able to respond appropriately to improvisation, and must itself be able to improvise.

This implies that the instrument must not only receive data, but must have at least rudimentary cognitive ability, in order to make "musical sense" of the data it receives. The logical conclusion that interactive instruments encourage—and indeed are most appropriate for—improvisatory music, means that it is almost anachronistic to think of using an interactive system in a fixed piece.

If, as asserted earlier, the drama of musical performance depends at least in part on the interaction of performer and instrument, and if an interactive instrument must contain elements of unpredictability, the performer must have worked sufficiently with the instrument to be able to improvise with it in an interesting way. Obviously, then, working with an interactive instrument requires no lesser virtuosity and no less rehearsal than any other sort of improvisation.

Audience Participation

Some have argued that it is less interesting to watch a performance on an interactive instrument, because the gesture-sound relationship can be so complex as to be incomprehensible, and in such a case it becomes an improvisation that is interesting only to the performer. Part of the answer to this charge is for the composer, programmer, and performer to find the appropriate balance of complexity and comprehensibility (as in any musical work). But also, the ability of an interactive instrument to respond to unforeseen input makes such an instrument ideal for works which incorporate audience participation rather than passive audience observation. This is already being actively explored by installation artists. The potential for participatory musical performance has been insufficiently explored in the computer music community.

In conceiving works that incorporate audience participation, the problem for the composer/programmer is how to create an open form in which the the music or dance can be varied freely within certain parameters, providing a compelling experience of interactivity for the audience, but in a manner that can somehow still be "guaranteed" to work artistically.

If the audience controls the piece, one might wonder, how can you "guarantee" that it will still be artistically compelling? Composers may be afraid to relenquish full control of a piece by allowing improvisation to play a large role in it, and it s difficult to conceive of composing a piece that successfully incorporates interactive control by an unknown audience. But first of all, how certain are we that compositional determinism of form and content is the main reason for the success of a music performance? We have certainly all witnessed bad, lifeless performances of well-written music, and we have also witnessed plenty of compelling improvisations. The conditions that frame a performance, and the expressive and creative input of the performers, can be enough to create good music in a variety of forms and with a wide variety of content. And why should we apply traditional criteria of what constitutes a rewarding artistic experience for an audience, in this new case of audience interaction? The old model is based on the audience as passive observers of music-making. This new model proposes audience members as active participants in the music-making, interacting with intelligent control systems.

To summarize, true interactivity demands that both human and computer engage in both original action and responsive reaction, to create mutual influence. The computer s ability to do these things in real time demands that the human performer also do them in real time, that is, improvise. An improvisation with an interactive instrument may be more interesting to do than to watch; this implies that audience participation may be in order.

AREAS FOR FUTURE EXPLORATION

In addition to the possibilities for virtual instruments and the new exigencies of interactivity outlined above, working with virtual instruments, video motion-tracking, and dancer-controlled music provides many other new avenues of exploration.

—Often discussion of alternative controllers and interactive instruments focuses too narrowly on control of pitch material and traditional music constructs. But digital sound generators open up the music to a whole world of sound. Digital sampling of recorded sound (pre-recorded or captured in real time) allows one to explore other relationships, such as gesture-to-text.

—Given that a virtual instrument (or any computer-mediated instrument) is just a controller of numerical data, the controller can be used to shape other digital media. One can thus explore other relationships, such as gesture-to-object movement (video-controlled animation), and even gesture-to-image/video (which, in the case of motion tracking, is video-controlled video).

—New inexpensive wireless cameras present many promising possibilities, such as dancers carrying cameras or wearing cameras attached to their body. In this way the interface to a sensing program such as VNS can move about the space, personally directed by the performers.

—As noted earlier, controllers can influence not just notes, but internal aspects of notes (timbre, dynamics, etc.) and new musical parameters unique to electronic music (modulation, filtering, spatial location, granular note density, etc.). Employing scheduling and storage techniques (extreme delay, capture and storage of data, reordering of events, etc.) one can shape a larger formal structure in real time.

CONCLUSION

The discourse regarding the design of new interfaces for music mostly focuses on technical issues and engineering challenges. A fascination with novelty drives not only the design of the instruments, but also the way they are used. But this is no longer such a new field that novelty alone can suffice. It is necessary to analyze the instruments effectiveness in terms of their artistic usage, and time for the musicians who work with them to discuss what they have learned up to this point. This article reflects my attempt to categorize and represent some of my recent confrontations with compositional and programming problems while working with interactive virtual computer-mediated instruments.