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Devices I have known and loved

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Do performing devices match performance requirements?

Whenever we work with an electronic music system, whether composing in a studio or performing in public, we use a performance device of some sort — mouse, keyboard, slider panel, or any other device — to control that system. Too often, we use conventional devices without being aware of how they affect our musical thoughts.

Keyboards, for example, are common performance devices. Like every performance device, a keyboard's structure and, consequently, the physical gestures required to play it, cause us to think in a certain way about the music that we play. A keyboard is structurally a discontinuous controller which leads us to think of music as separate notes; and we play it with our fingers, which suggests a note-after-note data entry approach. Deriving from a long history of western music and western tuning systems, keyboards satisfy musical needs when those needs are consistent with conventional musical values.

When a musical concept is unconventional, however, the use of a particular performance device should be carefully considered. The rule is that the performance device must suit the musical situation. In broad terms, every physical gesture suggests a musical process. To wave one's arms in the air, for example, implies conducting. To touch different positions of a physical object with one's fingertips suggests playing an instrument.

In more specific terms, the particular sounds and processes in a composition will determine which particular performance device best fits the musical needs of that specific composition. If a composer wants to wave his or her hands in the air, for example, which specific performance device is the most suitable?

Beyond the suitability of a performance device to a particular musical situation, it is common sense to observe that in a performance the public should be able to perceive a meaningful relationship between a performer's gestures and the musical result; whereas at home a performer can concentrate on a more delicate control of sound without worrying about how obvious the process may be to observers.

Performing interaction

At two different times in my artistic career, first in designing a system for public performance, second in producing a device for interactive performance at home, I used performance devices in situations (my own and those of projected users) that were not conventional.

How physical gestures relate to an audience: Solo

In creating *Solo* in 1977, my performance idea was to stand on stage and interact with an automatically-generated computer orchestra by waving my hands in the air. The first question, then, was: What device shall I use? My answer was to ask Robert Moog to build two separate single-antenna theremins, one for each hand, which output slowly-varying voltages that I could input to a computer to derive information about the position of my hands relative to the antennae. That information was used to control variables in an algorithm that generated a melody modeled on a free-jazz clarinet improvisation and, simultaneously, played that melody in eight voices. The timbres of the voices were vaguely reminiscent of two clarinet sounds, two flute sounds, and four vibraphone sounds. As I moved my left hand relative to the left antenna, I controlled instrumentation by controlling which voices were playing. As I moved my right hand relative to the right antenna, I controlled tempo. Because I was conducting instrumentation and tempo, my performance was similar to what a conductor does while conducting an orchestra. My physical gestures were appropriate to the musical task.

Performance options

Could I have used other performance devices? Yes, I could have used 'gloves' with mercury-switches and other built-in controllers, for example, something like Laetitia Sonami's *The Lady's Glove*. But the model for *The Lady's Glove*, perfectly conceived for Sonami's control of accompanying sounds as she recites, is more related to the hand movements used in South Indian singing than it is to conducting.

Accelerometers attached to my hands might have provided a solution, but they would have sensed motion rather than position, and position is more easily understandable by an audience.

Video motion-sensing systems, as in Simon Veitch's 3DIS System or as in David Rockeby's Very Nervous System, were not available at the time, but even if they had been available they would have been less suitable for this specific musical situation than the theremins. With video systems, there is no perceived range within which a performer moves, except perhaps for an entire performance area such as a stage; whereas in *Solo*, it was the visual feedback of seeing my gestures relative to the antennae that made it clear what I was doing. Moving my hands in the air without reference to any fixed point would have been extremely confusing for the audience (I think), and made it more difficult to connect my gestures to their musical results.

If the specific musical situation had been different, the performance device could have been different. Had the music not so clearly suggested conducting, for example, I might have used a video system to trigger complex sounds, or used an accelerometer to control the speed of change in complex clouds of sound, or used a glove to perform detailed changes in a composition. But given the musical nature of *Solo*, moving my hands in relative proximity to the antennae was, at least from my point of view, an excellent solution.



Fig. 1. Joel Chadabe performing *Solo* with the Moog's single-antenna theremins.

The TouchSurface 3-dimensional touch-sensitive controller

The process of performing *Solo*, in fact, was so enjoyable that I formed (with others) a company to simulate the performance process of *Solo* in an instrument that could be played by a consumer at home. The company was Intelligent Music, and by 1990, engineer David Asher had developed the first version of a circuit for what we referred to at the time as a 3-dimensional touch-sensitive controller. We called it the TouchSurface.

Based on resistive ink technology, the TouchSurface was a small touchpad. It consisted of three layers of electrical ink — conductive ink, pressure-sensitive ink, and a dielectric — printed in various circuit patterns on pieces of plastic roughly the size of a laptop computer touchpad. It responded to continual changes in the force with which it was touched and at the same time to continual changes in the up-down and left-right positions at which it was touched. The output contained four separate voltages: a gate that shifted from zero to six volts when the pad was touched, and three continually-changing voltages that responded respectively to position up-down, position left-right, and pressure.

At first, we saw the TouchSurface as the ideal controller for a software-configured musical instrument that would be on everyone's coffee table. There were many advantages. It was very inexpensive. It did not resemble any conventional musical instrument interface. Different graphic patterns or templates could be printed on its touchable surface. And it did not seem to require any physical musical skill. It met our needs. We wanted to design a multi-purpose performance device that would be usable in a great variety of musical situations and we wanted it to appeal to amateurs, many of whom had no prior musical skills.

Asher had also written software for the TouchSurface that allowed us to use it to control MIDI synthesizers. At first we used the gate to trigger a note-on, with the three continuously changing signals controlling other parameters, such as pitch, program change, and velocity. But we also found that the idea of applying independent controls to independent variables — that up-down position, for example, would control pitch, while left-right position would control program change — was crude and basically unmusical. Through software experimentation in relating multiple controls to different MIDI variables, we did find delicate and interesting solutions to fingertip control of sound, but we also found that very few MIDI sounds could respond well to these complex controls.

Financial pressures led us eventually to develop the TouchSurface as a computer pointing device rather than a musical instrument controller. But as I evaluate the TouchSurface in retrospect, my reflection is that it would have made a superb single key in a super-sensitive keyboard, similar to Robert Moog's Multiply-Sensitive Keyboard. Because the nature of the physical gesture was so subtle and so oriented towards fingertip control, I doubt that it would have made a successful 'conducting' controller.

A brief conclusion

Unfortunately, our ideas for performance devices, as well as for every other part of a musical instrument, must be tempered by engineering realities which in turn are tempered by financial realities. Yet even if we had the resources to design new controllers, then experiment with them and evaluate them, our ideas as to what types of controllers to design will be consequent to our concepts of the functioning of an electronic musical instrument as a whole.

Those concepts will emerge and evolve gradually through the 21st century, as we better understand the new musical possibilities in such instruments.

After all, what we are inventing is not a new performance device. It is a new musical instrument.