Separating Physical Actions From Cognition Via Technology-Based Instruments

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An interactive music system is a hardware or software configuration that allows an individual to accomplish a musical task, typically in real-time, through some interaction. The design of such systems could allow them to be used in novel ways to allow individuals to compose and perform with greater ease than traditional instruments.

Advances in technology have led to where what once took months of mastery on a traditional acoustic instrument, such as playing each triad in all keys, can now be accomplished with immediacy through the use of some accessible electronic musical instrument. Tod Machover, of the Hyperinstruments Group (Machover, et al., 1986), shared an interesting thought: "Traditional instruments are hard to play. It takes a long time to [acquire] physical skills which aren't necessarily the essential qualities of making music. It takes years just to get good tone quality on a violin or to play in tune. If we could find a way to allow people to spend the same amount of concentration and effort on listening and thinking and evaluating the difference between things and thinking about how to communicate musical ideas to somebody else, how to make music with somebody else, it would be a great advantage. Not only would the general level of musical creativity go up, but you'd have a much more aware, educated, sensitive, listening, and participatory public." (Oteri, 1999).

If asked, for example, to play a I V vi IV chord progression on a polyphonic instrument for the learning exercise of hearing what a I V vi IV progression sounds like, a musician who is unfamiliar with performing on a polyphonic instrument like guitar or piano, might focus most of their attention on ensuring that they are playing the chords correctly and miss the purpose of the activity altogether: hearing what a I V vi IV progression sounds like. Using an accessible software instrument that could allow an individual to, for example, press the number keys on their computer keyboard to perform the corresponding diatonic chord function could remove some of the need for attention to performance and technique issues that one might encounter while performing on a traditional acoustic polyphonic instrument. For educators, asking a student to play a I V vi IV progression might then only require the student to press the four number keys on their computer keyboard labeled *1,5,6,* and *4* in order to hear the harmonic result. In essence, there could be less instructional emphasis placed on teaching physical technique, tone production, and other timbral factors since these variables are controlled by the computer software. The task of playing the chord progression by using a software instrument like this could allow users to focus attention on hearing the chord progression while they are playing it.

Separating the physical act of performing from the cognitive function of hearing harmony is important to educators because it allows *musicing* (Elliott, 1995) to occur by students without making them wait until they have learned the performance skills of a traditional instrument in order to play chords. In this way, playing chords and, conceivably, being able to compose and perform with them can occur much sooner with an electronic instrument than with traditional acoustic instruments. This allows a platform by which educators can help students make sense of the harmony of which they now have adept control.

It is important then to separate instruction in performance (i.e., instruction in the techniques of performing a musical instrument such as posture, chord shapes, and finger patterns) and instruction in musicality (i.e., instruction in theoretical constructs like harmony, melody, and timing). If the instructional objective of an educator is to teach a rhythmic pattern to a student for the purpose of performing it back, such a task can likely be accomplished with any instrument including just the voice. The instrument best suited for the task is the one that provides the most transparency for the student in terms of enabling them to conceptualize the rhythmic pattern and physically demonstrate the rhythmic pattern with the fewest external factors not directly related to the conceptualization of the rhythm, but to the demonstration of the rhythm (e.g. proper fingerings, not holding the strings against the fret hard enough to produce the proper pitch, etc.). In this way, an electronic instrument that, for example, would allow students to tap two distinct percussive sounds by simply tapping their fingers on a table would seem a much more transparent instrument to perform than a drum pad where stick grip and other factors become additional layers between the student and the task of demonstrating the rhythm. By minimizing the number of layers between the student and the task, the concept of the rhythm can be isolated to some extent and understood apart from the context of it being performed on a particular instrument. Though the performance skills associated with the electronic instrument might not be transferrable to other instruments, they did not require much time in order to learn them, and they served the purpose of facilitating the acquisition of the rhythmic concept. Conversely, it is entirely possible to spend a great deal of time learning a traditional instrument, also gaining non-transferrable skills, simply to facilitate the same acquisition.

Similarly, separating the cognitive functions of creating and performing music

from the physical actions involved, at least to some degree, can allow individuals to develop an understanding about music using a musical instrument that is accessible to them. This is particularly important for disabled and special needs populations.

Adaptive Instruments

Some individuals cannot play traditional acoustic musical instruments, but, instead, play "adapted" or "adaptive" instruments designed for accessibility. Adaptive instruments can provide ease of use and accessibility for disabled and special needs populations. The instruments themselves are commonly created for a specific purpose, such as to play chords or percussive sounds, with a specific individual or group in mind with which the instrument will help overcome some limitation, perhaps physical or mental, on the part of the performer. Adaptive instruments can be acoustic or electronic in design and Crowe (2004) has reviewed the literature of electronic adaptive instruments used to assist in music making. Recent advances in technology have helped many new adaptive instrument projects to form including "Skoog" (Schogler, 2010), AUMI (Pask, 2007), "My Breath My Music Foundation" (Wel, 2011), and my own project, "EAMIR" (Manzo, 2007).

An electronic instrument can be much easier to play than a traditional instrument like the violin simply because the capacity for advancements in electronic instruments is far greater than that of traditional instruments. The open-architecture of technology-based instruments, particularly those that are primarily software-based with interchangeable hardware controls, can allow an individual to customize an instrument for any performer, performance environment, or performance application. Even hybrid electro-acoustic instruments like the electric guitar have a greater capacity for advancements than traditional acoustic instruments simply because of their inclusion of technology. Changes to nearly every musical variable such as pitch, timbre, and dynamics can be expanded and enhanced to a greater degree than traditional acoustic instruments that possess no electronic technology.

Musical concepts are often introduced to beginning music students using instru-

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ments of simple design such as in the Orff approach. These Orff instruments are easy to play, in principle; much easier than a violin, but limited in terms of the number of musical variables one can control compared to other acoustic instruments such as the violin. However, as a result of electronic technology, accessibility in terms of ease of instrument playability does not need to be a determining factor in musical sophistication any longer.

If the design of a musical instrument, electronic or acoustic, can allow musical variables to be produced, manipulated, and controlled to some acceptable degree of sophistication, and the instruments potential to operate in this way is understood to some degree, then the control interface itself by which the instrument is operated is the primary remaining factor in evaluating the accessibility of the instrument and its potential for performance. Comparing the limits of traditional instruments to electronic ones, then, only reflects the shortcomings of traditional instrument design, not electronic instrument design which is seemingly without boundaries. Arguably, the more important comparison that can be made is with regard to the control mechanism of an instrument and those properties of the instrument that make performing certain musical operations more or less idiomatic than others.

As technology continues to develop, the musical instrument as a physical "layer" between a cognitive process and the production of a related musical event may become more transparent. This layer will likely dissipate as the design of instruments become more user-centered in terms of accessibility related to specific musical tasks as opposed to the traditional design of instruments being acoustically-centered; that is, instrument design now being able to favor physical gesture efficiency and accessibility over what will produce the best timbre and the loudest volume as opposed to.

If software systems can be implemented in pedagogical situations where there is little difference in terms of their role in serving an instructional, compositional, or performance objective compared to traditional instruments, considerations like the performer's body-type, physical capabilities, and so on, can, instead, become determinant factors regarding instrument use and design. Instrument creation can be designed to fit specific activities. These were possibilities that simply did not exist only a few short years ago, yet are now available through advances in technology.

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