

LiveScore: Real-Time Notation in the Music of Harris Wulfson

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LiveScore is the title given to an interactive music piece and a software tool created by composer, multi-instrumentalist, improviser, and software programmer Harris Wulfson (1974–2008). The software allows network streaming of real-time notation delivered to one of several client computers. The interactive music piece consists of this real-time notation system set up for audience control. The authors describe both the musical work and the software and touch briefly upon the unique musical background of this visionary composer.

Keywords: Harris Wulfson; Real-time Notation; LiveScore; Algorithmic Music; Automatic Notation Generators

Introduction

Five musicians are seated on stage: a violinist, a harmonium player, two guitarists, and a keyboard player. It would appear as any other musical performance except for the presence of laptop computers in the place where one would normally expect to find music stands. Each performer—holding his instrument, or seated in front of it as with the keyboardist and harmonium player—is huddled around the warm glow of a computer screen. Other than the computers, what is somewhat unusual is the presence of a knob-box device the size of a personal mixer placed on a stand just in front of the ensemble. The performance begins. Initially, the reason the computers and electronics are present is unclear. Indeed, nothing of the all-acoustic sounds produced by the ensemble would seem to warrant the array of laptops, the tangled mess of cords and wires, or the knob-box in any obvious way. The music is delicate and captivating. A texture emerges consisting of quietly articulated tones, each lasting a few seconds, occasionally overlapping with another performer's tone in various combinations; sometimes two or three instruments sound at once, occasionally all five players are heard. The resultant harmonies shift inconspicuously between consonance and dissonance; a major 2nd created by the violin and harmonium turns

into a minor 6th between the violin and keyboard. Overall, one wouldn't be entirely off the mark in suggesting that the music had something of the character found in John Cage's late number pieces, such as *Five*² (1991). The pacing of each performer is seemingly free; like the Cage, there is no pulse, though in this piece, each performer's respective entrances and exits, though ever-changing, appear somehow precisely coordinated.

After a few minutes of this relatively stable soundworld, one of the audience members gets up from her seat and approaches the knob-box. The audience member (at this point as much a performer in her own right) begins to slowly change the settings on the knob-box. She turns one knob and then pauses to listen for a change in the ensemble's playing—within seconds the whole ensemble changes from the previously heard slowly moving texture to a sharply accentuated, almost pointillistic texture. The audience member waits a little while before tweaking a few more knobs. At this point, the texture is more similar to the one heard initially, though entrances and cut-offs now tend to be more concerted; it's now almost chorale-like, with a vague sense of pulse. After a brief pause, the audience member adds a few finishing touches to the knob-box's settings. Satisfied, she returns to her seat as the music continues.

Is this the latest invention intended to streamline a venue's catering to patron response, a re-negotiation of the relationship between audience and performer? Perhaps a tool designed to make those audience survey cards given out in the lobby at Carnegie Hall function in real-time? The description comes from none other than a performance of *LiveScore* (2006),¹ an interactive work for variably sized ensemble and laptop computers by the late composer, multi-instrumentalist, improviser, and software programmer Harris Wulfson (1974–2008). In this work, laptop computers are connected in a network designed to produce algorithmically generated music, shaped directly by individual audience members' use of a MIDI control device and delivered to each musician's computer screen as music notation, all occurring in real-time as the performance unfolds. Before the performance begins, the audience is invited to sculpt the music according to any member's individual preference using a set of straightforward controls found on the knob-box. Knobs are labelled according to various intuitive musical features, such as 'togetherness', 'sparseness', 'dynamics', and 'pitch-i-ness'. An audience member is free to tweak each parameter to her own whim and fancy.

Background

LiveScore represents not only a truly unique technological innovation, but also the intersection of a few of Wulfson's specific musical interests. A voracious musician, Wulfson played violin, guitar and mandolin, each with astounding skill and across a breathtakingly wide variety of genres. From Baroque to bluegrass, eastern European folk music to East Coast blues, from country to Klezmer, Wulfson played it all. It would be the specific meeting of algorithmic music composition and electronic music improvisation, however, that would prove most relevant for the genesis of Wulfson's



Figure 1 Performance of *LiveScore*, The Stone in New York City, 19 November 2009.

LiveScore. While pursuing an MFA in Composition and Integrated Media at CalArts, Wulfson became fascinated with the algorithmic instrumental music of James Tenney and the electronic music and interactive computer music of Morton Subotnick, and studied intensively with both composers. Wulfson's *Az Meshiach Vet Kumen* (2005) is an early instrumental work composed using statistically driven (or stochastic) algorithmic processes not unlike many of James Tenney's compositions. Rather than shaping the note-to-note details of a composition, in this work Wulfson defined overall forms and allowed computer algorithms to fill in the details based on predetermined probability distributions. Of particular importance was Wulfson's move to create computer software that would allow notation to be produced and rendered in real-time. This allowed the rapid prototyping of new algorithms and compositional ideas. The composer noted, 'A few of us who were all at CalArts started writing software to actually notate scores, to automate that process. What I realized was that it's so instantaneous, that you could conceive of a composition that is being notated as it's played' (Stern, 2007). Wulfson would subsequently co-found the Society of Automatic Notation Generators (SAMN), a group geared toward the exchange of ideas related to automatic notation and real-time algorithmic composition.²

These threads of Wulfson's musical life relate to his background as a computer programmer (he helped develop social-networking cell-phone technologies long before the ubiquity of today's social-networking sites), which doubtless also informed his interest in interfaces and interactivity and his general wish to make the use of computers and technological devices a more visceral experience. He often spoke of the desire to bring interactivity and the process of composing closer to the workings of a musical instrument—something one could actually *play*. A seemingly unlikely counterpart to the figures of Tenney and Subotnick came from the music of Japanese improviser and 'no-input mixer' performer, Toshimaru Nakamura. Drawn to Nakamura's 'hands-on' control of a semi-chaotic system, Wulfson created his own

instruments for controlling computer-generated sounds. His *SensorBall* (2006) consisted of a small orb-like object containing sensors used to shape sounds that were transmitted back to the ball's own set of embedded speakers. The uniqueness of *LiveScore* comes from bringing together these otherwise seemingly disparate musical universes: the real-time, intuition-driven experience of improvisation using interactive systems and the creation of instrumental music using computer algorithms.

The *LiveScore* System

Wulfson's *LiveScore* employs a sophisticated and technologically robust system consisting of a client-server network, a specialized notation system, an algorithmic composition engine and a MIDI controller (see Figure 2). A server computer first processes messages sent from the audience-controlled MIDI knob-box. These messages are used to control parameters of the algorithms that generate musical information (pitch, duration and dynamic markings for each musical voice). These data are then sent to one of several client computers (as notation directives) and displayed as music notation.

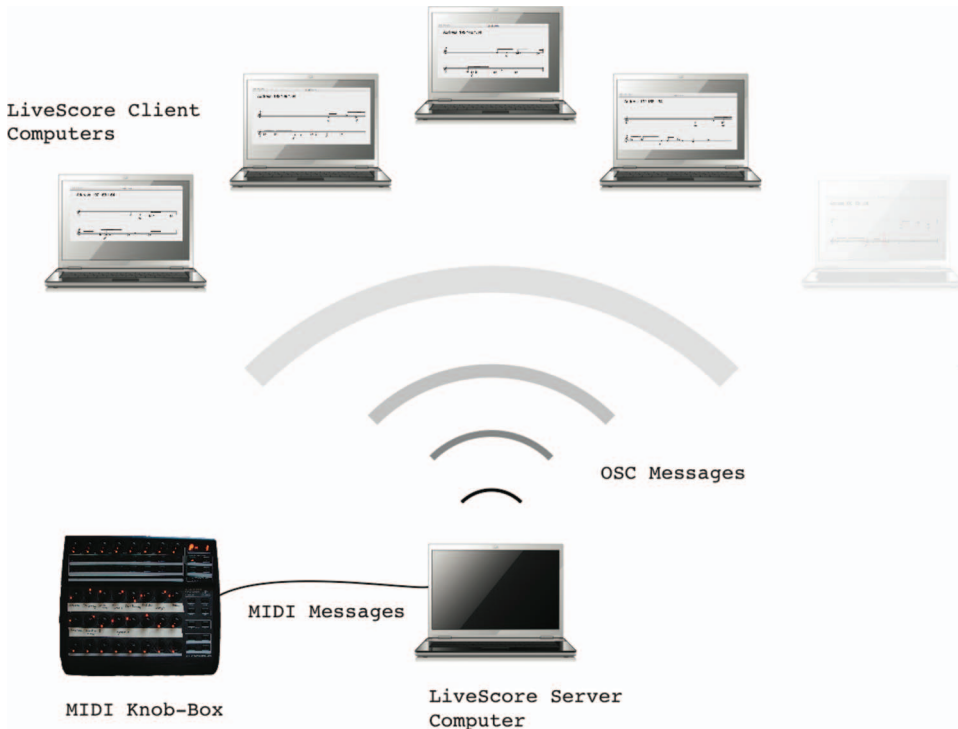


Figure 2 Diagram of *LiveScore* Setup.

The process by which *LiveScore* generates musical material is nearly transparent to an audience member who engages with the controls found on the knob-box. When an audience member changes the settings on the knob-box, the musical texture changes accordingly. The straightforward labels given to the knob controls encourage the audience to intuitively sculpt the musical texture and listen for direct feedback.

Rather than beginning with pre-existing formal structures, musical phrases, melodies, motives, or even sequences of tones or rhythms, *LiveScore* begins as a blank slate, a virtual 'tabula rasa' influenced by parameters open to the audience's control, which determine quantitative features directly or define ranges within which parameters fluctuate with equal probability. Dynamics, for example, are set independently for each part and remain static until changed further. Other parameters affect all instrumental parts in the same way. For example, the 'range knob' determines a width in semitones centred around a specific pitch set by the 'register' knob. Pitches are uniformly distributed within that range and are assigned to instruments able to play the pitch. Similarly, the 'durations' and 'duration range' knobs control tone lengths. On the other hand, the 'sparseness', 'irregularity', 'pitch-iness' and 'non-stasis' knobs control how the instrumental parts combine to affect the overall density in both horizontal and vertical dimensions, or time and pitch. There is also a parameter that determines how the various voices of the ensemble interact: the 'togetherness' knob determines how close together in time note onsets are, with results ranging from polyphony to total homophony. Taken together, these parameters³ govern the entirety of the musical textures produced during a performance of *LiveScore* (see Figure 3). The 'black box' function of the algorithm in algorithmic composition—in which the inner workings of the program remain hidden—is, in a sense, undermined by the audience's access to the explicitly labelled control of each parameter accessible during a performance of *LiveScore*.

Notation

On the screen of each client computer, a single, initially blank page of musical staves is continually updated with notes, dynamic markings and other notation. When a new client computer is added to the *LiveScore* network, a performer simply selects her instrument from a drop-down menu, and corresponding clef and pitch range information is set automatically.⁴ For the second performance of *LiveScore*, held at the CalArts Integrated Media show on 11 May 2006, the work was presented as a performance-installation in which musicians entered and left the piece as they pleased over the course of several hours.

Rather than using measures and metred rhythms, notes are placed on the page of each client computer's screen in direct proportion to their start time; beam extensions indicate the length of each tone. Musicians sight-read the music displayed on laptop screens by following a vertical scrollbar as it moves across a page filled with notation that is updated in real-time as the client receives messages from the server



Figure 3 Knob-box MIDI Controller used in LiveScore.

(see Figure 4). This space-equals-time notation is significant for the creation of highly variable, though synchronized rhythms performed by the ensemble. As a result, the musical textures are able to move seamlessly from disjointed passages or floating independent textures to closely coordinated, even rhythmically-concerted musical material. In practice, this feature of the LiveScore system has provided an effective way of producing complex musical structures in real-time without overburdening the performers with difficult notation.

Audience Interaction

Interestingly, the premiere performance of *LiveScore* was part of *You too can play difficult music*, a concert series held in 2006 at Los Angeles art space Machine Project.⁵ The series intended to address the underlying ideas behind the performance and reception of ‘difficult music’. In *LiveScore*, presumptions regarding ‘aesthetic difficulty’ are undermined by the audience’s (quasi-democratic) control of the resultant musical textures. The performers’ own challenge in dealing with what might otherwise be music that is difficult to play is at least somewhat alleviated by the notation system. *LiveScore* incorporates what ostensibly appears as an open and democratically regulated system for controlling the general musical texture. The result is a series of momentarily stable musical scenarios along with the various in-between textures that result from each audience member’s tweaking of the parameters.

A remarkable variety of aesthetic results occurs not only as a result of the shaping of *LiveScore*’s comprehensive set of controls, but also as a result of the process by which the musical texture is continually re-negotiated by audience members in what emerges as an intricate and delicate social dynamic. The audience is often hesitant to participate at first. However, as the piece progresses, an overall shyness gives way to

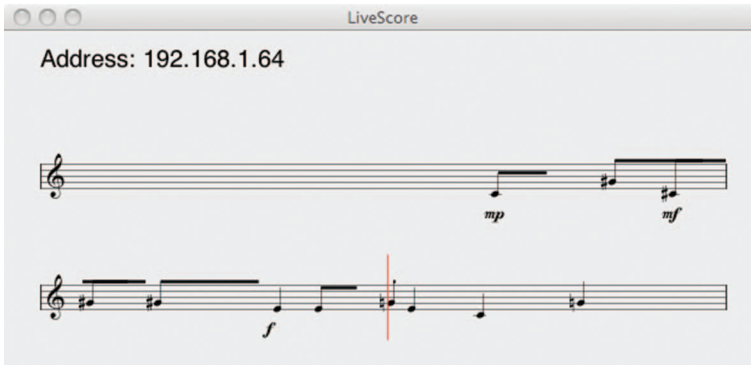


Figure 4 Screenshot of the LiveScore Client written in Java.

a rather interesting interplay. An audience member becomes a part of the performance, at least momentarily, though never exactly crosses over into the ‘proper’ domain inhabited by the ensemble performers. The ‘fourth wall’ is never itself exactly breached, even though the audience becomes aware of its collective role as a kind of puppeteer with respect to the ensemble performers, the former exerting its control over the latter, as it were, from a safe distance.

A different kind of performance, however, does take place *between* audience members, for example, as one daring audience member’s carefully and deliberately crafted knob-box settings are erased and replaced by another audience member’s preferences. The audience then becomes a spectator not only to the ensemble’s activity, which it controls, but also to the activities of its own members. Following the initial hesitation to approach the knob-box and then a relatively slow turnover time between knob-box manipulations, audience members become less inhibited, and even begin to approach the knob-box in groups. An interesting phenomenon that occurred during the aforementioned performance-installation version was when at times the audience congregated around the instrumentalists as well as the knob-box. Instead of remaining seated to ‘wait one’s turn’, people milled about freely, generally disregarding the idea of the concert hall as a place where an audience remains static, passively observing a pre-planned experience.

Further Use of the LiveScore Software

Although Wulfson envisioned *LiveScore* as a self-contained work, the composer would later use its technology in his subsequent piece *Enumerated Types* (2008). This work premiered as part of a George Antheil tribute concert held in New York on 7 June 2008 and used notation generated in real-time, though it did not incorporate audience interaction. Wulfson developed the LiveScore software as an open-source and freely configurable and extendable package. The composer noted that ‘the scope of screen-based notation is potentially very large, and some of the concepts from

LiveScore—the networked environment, the conductor function, the controller input—could be adapted to many kinds of notation and many styles of music’ (Wulfson in Barrett et al., 2007). The most recent and stable version of the LiveScore client is written in the multi-platform Java language and accepts notation directives using the OSC networking protocol from any server application. The server for the original *LiveScore* piece is written in SuperCollider. While no additional works were created using the LiveScore software, Wulfson expressed in conversation his wish for other composers and musicians to use and extend the software as they saw fit. Concurrent with the publication of this article, the authors release the latest version of Wulfson’s LiveScore software.⁶ It is our hope that the public release of the LiveScore software will encourage the continued use of Wulfson’s software and, taken together with this article, will invite further interest in the music of this wonderfully imaginative composer whose creative world ended far too soon.

Notes

- [1] We use italics to refer to the piece *LiveScore*, while the software system appears as LiveScore.
- [2] The inaugural meeting of SAMN, held on 18 September 2006 at CiNE Studio Space, New York, was host to the third performance of *LiveScore* (see Barrett, Winter, & Wulfson, 2007). A portion of this performance is described at the beginning of this article.
- [3] One knob not mentioned above, ‘pulse’, is not handled by the software code. Though Wulfson may have intended to address this issue in future versions of the LiveScore system, in practice the presumed function of the knob can currently be accomplished by using the ‘duration range’ and ‘togetherness’ knobs in tandem: if tones are set to be the same duration and to consistently begin together, the resulting pulse may then be altered by the ‘durations’ knob.
- [4] The ability to add new instrumental parts throughout the course of the performance was a feature Wulfson had incorporated in the original Objective-C version of the LiveScore client following the piece’s premiere, but the feature has yet to be implemented in the latest version of the software written in Java.
- [5] Wulfson provides a statement on *LiveScore* in *Everybody Loves Difficult Music* (Orsher, So & Roberts, 2007, 24), the publication that accompanied the Machine Project event.
- [6] The posthumous performances of Wulfson’s *LiveScore* that have occurred in Los Angeles and New York were facilitated by adapting the original server written in SuperCollider to work with the newest client written in Java (specifically for *Enumerated Types*). These packages are now available at <http://wulfson.com/livescore/>.

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