Real-Time Generation of Open-Form Scores

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ABSTRACT
The author describes a recent work for cello and computer in which an open-form score is generated in real-time with a MaxMSP/Jitter patch. The generative technique is described in detail and compared to an earlier method of score generation employed by the author as well as considered in the context of traditional open-form scores.

Keywords
Open-form, score generation, Jitter.

1. INTRODUCTION
tunings is a recent work for cello and computer in which an open-form score is generated in real-time with a software patch designed in Cycling '74s Jitter. During a performance the cellist reads the score from a laptop computer. Rather than remaining fixed the score is radically transformed in real-time.

The materials that are described in the score are drawn from five different sonic materials. These include the Courante of J.S. Bach's Second Cello Suite, various sustained harmonic gestures, resonant tones produced by bowing on the tailpiece with bowing pressure and speed varied to explore different timbral and dynamic characteristics of the sound, continuous noise tones produced by bowing on the bridge with similar variations in bowing technique applied, and silence.

The musical phrases and sounds performed by the cellist are processed and transformed in real-time by a separate computer with MaxMSP. This computer also controls the score generation computer via a wireless network. During the performance the computer operator/performer builds complementary musical textures by triggering various samples taken from historical political speeches, Bach's Second Cello Suite and numerous other musical excerpts. These are also subjected to various transformations during performance. Of particular interest during the composition of *tunings* was a musical model based on the idea of an old-fashioned radio tuning into different stations, sometimes pausing, often moving on. This model is realized in the ways in which transitions between sonic groups are delineated.

2. VISUAL TRANSFORMATIONS AND MUSICAL INTERPRETATION
Both the Bach Courante and the sustained harmonic gestures of *tunings* are displayed with traditional staff notations although they are often transformed by several real-time blurring and other distortion techniques. These transformations intentionally obscure some sections of the manuscript such that they approach illegibility, see Figure 1. The cellist is free to interpret these sections with a corresponding ambiguity in pitch, gestural rhythm and timbre. Where gestures are visually blurred, the cellist is also asked to dissolve the corresponding gestural dynamic accordingly. The musical realization of notations which become progressively more ambiguous is of especial interest.

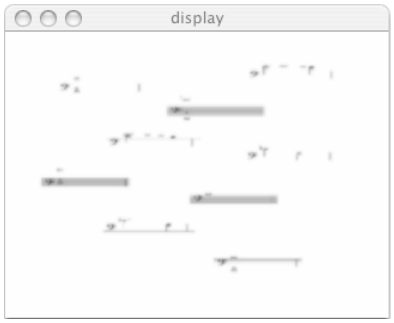

Figure 1. Blurred harmonic gestures.

The resonant tailpiece tones and noise tones that the cellist performs are identified by abstract green shapes which transform over time, see Figure 2. The resonant tones and noise tones are distinguished by the labels "Resonant tones" and "Noise tones" which appear on the top left corner of the computer display. During performance, the discrete graphical shapes displayed on screen correspond, where possible to discrete gestures and phrases. As these shapes evolve and move around the screen, the cellist is asked to make corresponding transformations in timbre and dynamic. The spaces between the shapes are treated as silent pauses between contiguous phrases even though from an aesthetic perspective these empty spaces help to define the gesture.

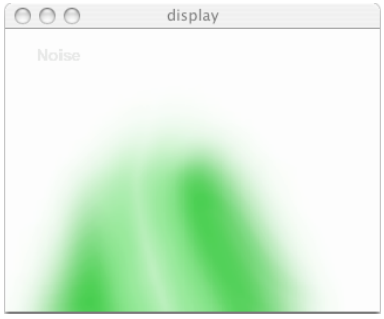

Figure 2. Noise tones.

At certain times in the work sections of manuscript are visually masked and/or distorted by either noise or resonant tones. During these moments, the cellist interprets only those sections of the manuscript displayed with the appropriate articulations - i.e. either on the bridge or on the tailpiece. The

performer is free to draw correspondences between the abstract shapes and variations in bowing position and pressure. Examples of such passages are illustrated in Figure 3.

Figure 3. Abstract graphical shapes masking manuscript.

When the computer monitor displays white the cellist does not perform.

3. SCORE GENERATION CONTROL

The order in which sonic materials or groups are displayed is determined with five first-order Markov chains. These chains determine the likelihood that one sonic group will follow another. The process is similar to that employed in an earlier work by the author for piano and computer in which the score displayed for the pianist to interpret was selected from eight possibilities using weighted probability curves [1]. In *tunings* the probabilities that determine the order of events is predetermined although these do change once the Bach Courante has been performed to ensure that the Courante only appears once. Another simple rule includes the non-succession of tailpiece and noise tones. The interface that controls these Markov chains is built around the Max *prob* object which allows the computer operator to change the probabilities during performance.

The laptop that is used to display the scores is controlled via a wireless computer-to-computer network. Using akustiche-kunst's *netsend* and *netreceive* Max objects [2], this wireless connection enables the computer operator to affect the score generation process by changing the duration that score indications are displayed, by varying the Markov probabilities and by varying the properties of the abstract shapes and transformation parameters. This ability to change the score in response to musical events is a key component of *tunings* and radically changes the possibilities that performer's typically face in the interpretation of open-form works.

4. OPEN FORM CONTEXT

The ability to vary the order of musical events is a fundamental aspect of classic open-form works. In a number of such works by composers such as Brown, Haubenstock-Ramati and Stockhausen [3, 4] the global and sometimes local order of musical gestures and phrases is determined by the performer during the performance. In Brown's *Available Forms I* (1961) for small orchestra [5], for example, each page of the score is divided into subsections each of which is individually numbered. During performance, the conductor indicates which subsection will follow another through various hand gestures. In a similar manner, in Haubenstock-Ramati's *Liaisons* (1958) for solo vibraphone or vibraphone and marimba [6], and Stockhausen's *Klavierstücke XI* (1956), for piano [7], the performers select the order of musical sections based on simple rules. Henri Pousseur's *Scambi* (1957) for analog tape is a rare acousmatic work in the open-form tradition in which sound materials and instructions are given from which alternate mixes can be produced [8]. *tunings* follows very much in the tradition of these works although in *tunings*, as outlined above, the order of subsections is determined with Markov chains not by the performer per se.

In all the aforementioned works while the distribution of materials can vary from performance to performance the musical material itself remains fixed. In *tunings*, as described, these materials are often described graphically, expanding the role of the role of the performer considerably and introducing a degree of variability from interpretation to interpretation. While having performers interpret graphical shapes is by no means new, see for example much of the work of Cardew, Brün or Braxton, having them interpret shapes that gradually transform over time is unique. As mentioned, this seems to be an area of musical notation rich in possibilities especially with the use of techniques that intentionally obscure legibility.

5. FUTURE WORK

The author is particularly interested in investigating the applications of wearable computing in this project [9] although it is imagined this will have a radical impact on the scope of the work - particularly in regard to how the performer responds to the score and indeed how the very concept of the work itself is defined. A more complex method of determining the order of sonic groups, using genetic algorithms or higher order Markov chains, is also being investigated.

6. ACKNOWLEDGEMENTS

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